

## Poor school performance: an updated review

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### ABSTRACT

This study is an updated review on poor school performance aiming at healthcare and educational professionals. It addresses current aspects of education, learning, and the main conditions involved in poor school performance. It also provides updated data on neurobiology, epidemiology, etiology, clinical features, comorbidities, diagnosis, early intervention, and treatment key aspects of the major pathologies most frequently concerned. This is a comprehensive and non-systematic literature review on learning, school performance, learning disabilities (dyslexia, dyscalculia and dysgraphia), attention deficit/hyperactivity disorder (ADHD), developmental coordination disorder (DCD). Poor school performance is a frequent finding in our children, leading to serious psychological, social and economic outcomes. An updated view on the subject makes clinical judgement, accurate diagnosis and appropriate treatment easier.

**Keywords:** Learning; dyslexia attention; reading; attention deficit and disruptive behavior disorders; underachievement.

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## INTRODUCTION

Formal education is socially and culturally valuable in our world. A good school performance is an indication of future social success.

Since the early 20<sup>th</sup> century, there has been concern in understanding why some children had difficulty learning. In recent years, access to school became universal and, consequently, complaints of poor school performance and difficulty learning have increased in doctors' offices.

In Brazil, free elementary school is lawfully granted to children aged 6 to 14 years through public institutions. Since last decade, the vast majority of children are enrolled in elementary schools. The access to school is no longer restricted, but "education quality" and school dropout are still problems to be solved.

Several studies show that about 15% to 20% of children in their early school years have difficulty learning and, thus, a poor school performance. These estimates can reach 30-50% if the first six school years are analyzed<sup>1</sup>.

The pediatrician is the healthcare professional who is firstly informed about the poor school performance complaints. These complaints should be valued and appropriately assessed for early diagnosis and interventions. This article aims to review the topic and provide aids to allow the pediatrician to make an initial approach to children having poor school performance.

## LEARNING FROM A NEUROBIOLOGICAL POINT OF VIEW

Although there are several definitions in literature, they all consider learning as a process occurring through the integration of many nervous system functions, promoting better adaptation of the individual to the environment. An interaction between the individual and the environment through experience is brought on by learning, thereby promoting changes<sup>2</sup>.

The environment provides information that will be processed by the individual. Didactically speaking, the information acquisition and processing can be divided into some parts: input, processing, and output. The input occurs through afferent visual, hearing, and somatosensory (touch, taste, smell) pathways, making up the information sensory perception by the brain. Processing occurs in perception (gnosis) and motor (praxis) cortical areas. This processing requires integration between cortical and sub-cortical areas in which information is organized, complemented, and stored. The output or effector response occurs through motor efferent pathways<sup>2</sup>. Motivation and positive reinforcement are central to learning. The more interesting and important the information, the easiest will be to retain it and retrieve it as required.

Therefore, during learning, information processing depends on the integration of several abilities, namely the attentional cognitive, linguistic and mnemonic, in addition to emotional and behavioral development<sup>1-3</sup>.

Cognition is a construct of many skills which are integrated into a common goal of "solving new problems" coming from the environment. It is considered by many as the main predictor of the learning ability<sup>2,4</sup>. Higher cognitive processes involved in organizing and monitoring thought and the behavior are known as "executive functions"<sup>5</sup>. There is great dynamism and plasticity in cognition, being refined through training and appropriate mediation (learned/taught). Intelligence is an innate ability genetically inherited and poorly modulated by the environment<sup>2</sup>.

Attention and memory have an essential role in acquiring new skills (learning). It is through attention that relevant information is filtered from the environment (*selective attention*) and maintained under focus if desired (*sustained and focused attention*). The working memory has the ability of selecting, analyzing, connecting, synthesizing and retrieving information that has already been consolidated and captured (*long-term memory*). Working memory makes the connection between new and already learned information<sup>6</sup>.

Psychomotricity is a human characteristic that allows for planned, sequenced, and self-regulated execution of complex motor acts, mediated by the prefrontal lobe. Praxes are considered by many authors as the end product of cognition<sup>2</sup>.

It is worth mentioning that learning has peculiarities in childhood, specially regarding neuroplasticity and neurologic maturation (synaptogenesis and myelination). The neuroplasticity, which is very deep in children, consists of the brain ability to adapt to changes, whether they are new learned functions or reactions to brain injury. As the child matures, perception and motor areas and functions become more functional and capable of executing increasingly complex tasks. Therefore, maturation and integration of several brain areas are required in the learning process<sup>1-3</sup>.

Every professional involved in child education and healthcare should master the child development stages and their particularities. The development occurs step by step through mediation between the child and a competent individual, whether he/she is another child or an adult. It is a continuum of acquisitions from simpler acts to improving increasingly complex functions. A good example is writing: it starts naturally as scribbles (drawing lines in all directions), followed by drawings of geometric shapes (circles, cross) until writing in capital letters and cursive handwriting. A five- to six-year-old child is expected to have mirror writing, as this is the maturation stage of visuospatial areas. However, mirror writing may have pathological implication after seven.

## POOR SCHOOL PERFORMANCE (PSP)

Poor school performance (PSP) can be defined as a school achievement below the expected for a given age, cognitive skills, and schooling<sup>2,3</sup>.

PSP should be seen as a symptom related to many etiologies. It is noteworthy that regardless the etiology, PSP results in emotional distress (low self-esteem, demotivation) and family concern, in addition to repercussion in individual, family, educational, and social realms.

Regarding a child with PSP, it is primordial to investigate the cause and consequently outline the best treatment for each individual. The causes are varied, with two groups standing out: extrinsic (environmental) or intrinsic (individual) factors.

In this setting, it is important to distinguish between school difficulty (SD) and learning disability (LD). SD is related to pedagogical and/or sociocultural problems. There is no organic impairment. It is extrinsic to the individual. LD is related to problems of acquisition and development of brain functions involved in learning, such as dyslexia, dyscalculia, and writing disorders. In addition to specific learning disabilities, attention deficit/hyperactivity disorder (ADHD) and developmental coordination disorder (DCD) should be mentioned as entities related to poor school performance. All these conditions have a neurobiological basis, i.e., they are intrinsic to the individual<sup>7-9</sup>. Table 1 summarizes the main causes of poor school performance discussed in this review.

It is noteworthy that PSP can have more than one cause, being a confluence of factors (e.g., alcoholic mothers' children exposed to alcohol during pregnancy in a sociocultural environment with adverse conditions). Table 1 summarizes the main causes of PSP.

### SCHOOL DIFFICULTY

Among the school difficulty causes, factors predominantly extrinsic to the individual without organic impairment can be mentioned, such as pedagogical inadequacy and unfavorable or poorly stimulatory sociocultural status. The emotional causes, usually secondary to environmental factors, such as demotivation, low self-esteem and indifference, should be considered.

Therefore, for a successful learning, several cognitive skills associated with appropriate opportunities are required. Environments rich in sensorial experiences are

**Table 1** – Main causes of poor school performance addressed in this review:

- **Pedagogical difficulties:**
  - Pedagogical (teaching problems)
  - Social (unfavorable and poorly stimulating sociocultural conditions)
- **Diseases and associated disabilities:**
  - 1) Specific learning disabilities (reading/writing/math);
  - 2) Attention deficit/hyperactivity disorder (ADHD);
  - 3) Developmental coordination disorder (DCD);
  - 4) Other neuropsychiatric disorders, neurologic diseases and medical conditions

essential, with sensory deprivation leading to some damages<sup>10</sup>. Family environments poor in stimulation and sociolinguistic interaction can lead to a situation in which the child will not develop his/her abilities and skills. The literature has solid evidence that socioeconomic and cultural unfavorable conditions negatively influence the cognitive and academic performance, bringing on higher poor school performance and failure rates. This socially vulnerable child group is considered at risk for school difficulty (SD) and, according to some authors, learning disability (LD)<sup>11,12</sup>.

Family education encouragement plays a cardinal role. In some cultures, such as the Eastern one, formal education is greatly appreciated. In Brazil, Orientals have the highest educational levels compared to other ethnic groups in all income ranges, particularly in lower income. Data also reveals that mothers with higher education have children with higher educational level<sup>13</sup>.

There is strong correlation between good schools, resource availability and school progress. Poor quality of education directly affects more vulnerable children coming from poorer socioeconomic and cultural conditions. The school (formal education) should have the role to compensate for differences, reducing social inequalities and empowering individuals.

Several questionings are raised regarding the current teaching methods. The best method certainly is the one providing skill improvement and potential development in most individuals. It is important to stress that some children require actively mediated individual teaching strategies.

Currently, an important issue, in some social groups, is pedagogical expectations pushing children beyond their capabilities, skills, and interest. Exposing a child to exceedingly difficult or very easy learning situations (beyond or below his/her capacity) leads to lack of interest, demotivation, and distraction. Such a circumstance has serious consequences, resulting in frustration, failure, low self-esteem, in addition to family and school stress<sup>2,11</sup>.

### SPECIFIC LEARNING DISABILITIES (LD)

According to the DSM-IV, a learning disability (LD) is defined as a situation in which the “results in standard reading, math, or written expression tests individually administered are substantially *below the expected for the individual's age, schooling and intelligence level*. The learning problems significantly interfere with the school performance and the daily life activities requiring reading, math, or writing skills”<sup>9</sup>.

Therefore, LD is considered an intrinsic cognitive difficulty leading to a lower than expected academic performance for the intellectual, schooling, and motivational potential<sup>11,14</sup>. For LD diagnosis, the child should present normal cognitive level, absence of sensory impairments (hearing deficits and/or visual), emotional adjustment, and

access to appropriate education. Some authors emphasize that it is not possible to classify a child as having LD until there is at least one attempt of appropriate education<sup>12,14</sup>.

LDs affect 5% to 17% of the population and can endure for a lifetime, leading to academic, social, and emotional damage<sup>12,15</sup>. LDs can be classified according to the educational field as mathematics, written expression, and reading disorders<sup>9,11</sup>.

In mathematics disorder (or developmental dyscalculia), the individually tested mathematical ability is lower than expected for chronological age, intelligence, and education,<sup>9</sup> corresponding to 6% of LDs. It occurs equally in both genders, in contrast with the other LDs. A number of specific conditions may be associated with mathematics disorder, such as epilepsy, Turner syndrome, ADHD, fetal alcohol syndrome, treated phenylketonuria, among others<sup>11,16,17</sup>.

In written expression disorder, the individually tested writing ability is markedly lower than expected for chronological age, intelligence, and education<sup>9</sup>, corresponding to 8% to 15% of LDs and affecting all academic areas. It can result from motor, spatial perception, and language changes, as well as from memory and attention changes. It can impair the script (dysgraphia) and/or spelling and text production (dysorthographia)<sup>8,11,15</sup>.

In reading disorder (specific reading disorder or developmental dyslexia), the individually tested reading achievement is markedly lower than expected for chronological age, intelligence, and education<sup>9</sup>, corresponding to 80% of all LDs and being the most prevalent of them<sup>1,2,4,8,11,12,15</sup>.

*Reading and understanding* disability is one of the major obstacles to learning, with serious educational, social, and emotional consequences. Through reading, the individual draws understanding and meaning from written symbolic characters.<sup>15</sup> Reading develops in stages: first, decoding (letter-sound association); second, fluency (ability to read words and texts automatically); and third, understanding (proficient reader)<sup>12</sup>. Initially, the individual learns how to read and later he/she reads to learn. Typically, dyslexia makes decoding and spelling (phonological deficit) difficult, influencing further reading stages<sup>8,11,12,15</sup>.

Developmental dyslexia is a chronic condition heterogeneously present in a dimensional model (continuum). It has a neurobiological origin with strong genetic inheritance, but it is modulated by environmental factors. There are several genetic studies in progress, as family history is considered the most important factor in dyslexia. Nine genomic regions and six candidate genes have already been identified, but there is no single gene responsible<sup>12,15</sup>.

Developmental dyslexia is more frequently found in boys in a 1.5:1 ratio according to updated data, quite lower than historical estimates<sup>12</sup>. It is also more commonly associated with ADHD, rates ranging from 25% to 40%<sup>11</sup>. The

need to assess ADHD as a comorbidity in children having LD becomes unquestionable

Table 2 summarizes LD main signs and symptoms. It is important to realize that diagnosis is made by a set of symptoms, not by isolated data.

### ATTENTION DEFICIT / HYPERACTIVITY DISORDER (ADHD)

ADHD is a common cause of poor school performance. ADHD always should be investigated, as it is subject to specific treatment with good outcome<sup>18,19,20</sup>.

In DSM-IV<sup>9</sup>, ADHD has an essential characteristic of persistent inattention and/or hyperactivity pattern, which is more frequent and serious, compared to peers. The symptom onset occurs around three to seven years of age and persists throughout adolescence and adulthood in over a half of cases.

Regarding etiology, ADHD shows neurobiological basis and strong inheritance. Evidence indicates genetic and neurobiological factors as the main likely causes, greatly reducing the role of purely social factors. However, social factors may contribute to associated morbidities development, not to ADHD development<sup>5</sup>.

Recently, ADHD neurological risk factors have been described. They are: pregnancy or delivery complications; acquired brain injury; toxins, smoking, and alcohol during pregnancy; prematurity; low birth weight; and possibly high phenylalanine levels in mothers with phenylketonuria<sup>5</sup>.

As diagnostic criteria, DSM-IV considers that six or more inattention and/or hyperactivity symptoms lasting at least six-month, beginning before the age of seven in two different settings should be present, stressing the significant academic, social, and occupational damage. Table 3 outlines the signs and symptoms according to DSM-IV<sup>9</sup>.

ADHD can be classified into three types: predominantly inattentive, hyperactive, and combined, according to the DSM-IV criteria<sup>9</sup>. There is marked clinical heterogeneity. Inattention is present in all subtypes and in all age groups. Most children and teenagers have the combined type, but younger children show a further hyperactive behavior<sup>21,22</sup>. The literature reports hyperactivity symptoms are reduced over adolescence, but inattention and impulsivity symptoms persist, which is seen in clinical practice.

Polanczki *et al.*<sup>23</sup>, in a systematic Review, found a worldwide prevalence of about 5.29%, associating with significant variability according to the diagnosis criteria used in different countries. The prevalence is variable, depending on the study group (clinical/population samples, age) and mainly on the diagnosis criteria used (International Disease Classification – ICD 10, DSM-IV, neuropsychological assessment, and others). The prevalence in boys is higher, ratios ranging from 9:1 to 3:1. In girls, the most frequent manifestation is the inattentive subtype, with the disorder often not being recognized at all. In adults, the prevalence is 2.9% to 4.4%, with no gender difference<sup>5</sup>.

**Table 2 – Main LD signs**

	<b>Main LD signs</b>
Reading disability or developmental dyslexia (Rotta, Ohlweiler, Riesgo) <sup>1</sup>	<ul style="list-style-type: none"> <li>• Reading and writing are often incomprehensible. The subject does not understand reading.</li> <li>• Difficulty in identifying the letters. Confusion in letters having opposed orientations or small writing differences (p/l – b/d – c/e – u/v – i/j – n/u) or similar sounds (b/p – d/t)</li> <li>• Difficulty in learning letter-sound. This leads to a syllable or word inversion (sun/ snu), substitutions in similar structure words; letter or syllable suppression or addition (marine/mariner); syllable or word repetition.</li> <li>• Difficulty in phonological awareness and phonological immaturity tests. Difficulty in making and identifying rhimes at 4 years old or older. Wrong fragmentation in writing (I jum pedin thepool/ I jumped in the pool).</li> <li>• Confusion in time-space relationships, body scheme, and laterality (not recognizing right and left on him/herself by 6 years old.) Mirror writing after six/seven years old.</li> <li>• Family history of attention deficit /hyperactivity disorder (ADHD) and/or LD.</li> </ul>
Written Expression Disability (Ciasca) <sup>7</sup>	<ul style="list-style-type: none"> <li>• Dysgraphia: illegible handwriting, difficulty in writing, letter mixture (capital/lower case, print/cursive), letter tracing incompleteness, visuomotor (copying) and visuospatial difficulty. It is commonly associated with developmental coordination disorder (DCD).</li> <li>• Dysorthography: usually accompanying dyslexia. It is a linguistic (phonological an orthographic) difficulty and a difficulty in producing a text.</li> </ul>
Mathematics disorder or developmental dyscalculia (Bastos) <sup>16</sup>	<ul style="list-style-type: none"> <li>• Number writing error (mirror writing), difficulty in signs of mathematical operations, difficulty in setting a mathematical operation up and in ordering and dividing the numbers into spaces.</li> <li>• Difficulty in reading multi-digit numbers.</li> <li>• Difficulty in simple additions, limited memory for basic numerical facts.</li> </ul>

Regarding school disadvantage, unattentive and combined subtypes cause greater impairment<sup>5,20-24</sup>. In literature, ADHD is associated with poorer school performance (reduced study time, study incompleteness, tutoring requirement, failures, and expulsions). Literature data is alarming: up to 56% require an academic monitor, 30% to 40% attend special education programs, approximately 30% have failure history, up to 46% have a school suspension history, and 10% to 35% drop out or do not complete the studies<sup>5,18</sup>.

Several reports also point to a poorer academic performance, mainly in mathematics, in cases of inattentive ADHD subtype. In addition to mathematics, these children can also be found with a reading difficulty because of attention, working memory, and executive function deficiencies<sup>18</sup>.

A broad knowledge to make differential diagnosis and to identify comorbidities is required, as many clinical conditions mimic and accentuate ADHD symptoms. Early and accurate recognition of comorbidities is the basis for a successful treatment. Investigations show high comorbidity prevalence, with the most common being oppositional defiant disorder and conduct disorder (30% to 50%). In contrast, ADHD is present as a comorbidity in 25-40% of LDs<sup>11</sup>. Another frequent association is with the developmental co-

ordination disorder (DCD), being around 47% in children with ADHD. Most investigations claim the existence of motor control deficits, mainly in executing motor sequences, having great impact on daily life activities<sup>5,25</sup>.

#### **DEVELOPMENTAL COORDINATION DISORDER (DCD)**

Since 1994, it is classified by DSM-IV as a motor ability disorder<sup>9</sup>. In literature, it can also be found as dyspraxia<sup>1,2,25-27</sup>.

It is defined by marked motor coordination impairment, with no neurological or sensory cause being identified, leading to academic and daily life activity losses. The motor performance of these children is significantly lower than expected for their age and intelligence. It should not be diagnosed in children with an IQ lower than 70 or presenting with medical pathologies (e.g., cerebral palsy)<sup>9</sup>. It occurs in about 6% of 5-children aged 5 to 11 years and can persist into adult life<sup>9,24</sup>.

Several motor aspects can be affected, such as fine motor ability, gross motor function, general coordination and control during movement execution. The impact is noted mainly in daily activities, such as dressing, tying shoes, using tableware and scissors, riding a bicycle, drawing, copying and writing. Some children are found with academic impairment, mainly in writing and spatial organization.

**Table 3 – Diagnostic ADHD criteria according to DSM-IV9****A. Either (1) or (2)**

(1) six (or more) of the following inattention symptoms persisting for at least six months in a maladaptive grade which is inconsistent with the development level:

**Inattention:**

- a) often fails to pay attention to details or makes careless mistakes in school, work or other activities;
- b) often has trouble paying attention to tasks or playful activities;
- c) often seems not to listen when is spoken to;
- d) often has trouble following instructions and finishing school or homework, home chores or professional duties (not because of a oppositional behavior or an inability to understand instructions);
- e) often has trouble organizing tasks and activities;
- f) often tries to avoid, dislikes and is reluctant to engage in tasks requiring continuous concentration (as in school or homework);
- g) often loses things required for tasks or activities (toys, school work, pencils, books or other materials);
- h) is easily distracted by stimuli unrelated to the tasks;
- i) often forgets daily activities.

(2) six (or more) of the following hyperactivity symptoms persisted over at least six months in a maladaptive grade which is inconsistent with the development level:

**Hyperactivity:**

- a) often fidgets with hands or feet or in his chair;
- b) often leaves his seat in a classroom or other settings when he/she is expected to be seated;
- c) often too much running and climbing in settings where this is inappropriate (in teen-agers and adults, this can be limited to subjective feelings of restlessness);
- d) often has trouble playing or engaging in leisure quiet activities;
- e) often is a person “on the go”;
- f) often talks too much.

**Impulsivity:**

- g) often answers in a hurry before the questions are completed;
- h) often has trouble taking turns;
- i) often interrupts or meddle in other people’s subjects (e.g., meddles in conversations or children’s plays or games)

**B.** A number of hyperactive/impulsivity or inattention symptoms that caused damage had been present before the age of seven.

**C.** Some damage caused by the symptoms has been present in two or more settings (at school/work and at home).

**D.** There must be clear evidence of clinically significant underachievement in social, academic or occupational functioning.

**E.** The symptoms do not occur exclusively during the course of a pervasive developmental disorder, schizophrenia or other psychotic disorder and are not well-explained by other mental disorder (mood disorder, anxiety disorder, dissociative disorder or a personality disorder).

Recent investigations show DCD and ADHD are separate entities, but they usually coexist and have overlapping symptoms which reinforce each other. Frequently, it is found as a comorbidity with ADHD and LD (mainly affecting writing), in addition to oppositional defiant, conduct, mood, and anxiety disorders<sup>25,28</sup>.

Motor execution difficulties (praxes) are associated with low self-esteem, higher anxiety (internalizing symptoms) and impaired social relationships. Recent studies reveal these children have a higher risk for developing obesity and cardiovascular conditions due to their adopted life style (sedentariness) and consequently to their motor difficulties<sup>25</sup>.

### OTHER MEDICAL AND NEUROPSYCHIATRIC CONDITIONS

The international literature brings evidence that some medical conditions, such as malnutrition (mainly over the first years of life), iron-deficiency anemia, zinc deficiency, hypothyroidism, worm infestations, sensory deficiencies (visual and hearing deficits), chronic diseases leading to school absences and/or emotional conditions – asthma, diabetes mellitus type 1, sickle-cell anemia, neurofibromatose type 1, and acquired immunodeficiency syndrome directly influence the learning capacity<sup>11,27</sup>.

Prematurity and low birth weight, even with no established neurological impairment, are considered risk factors for SD and/or LD. Over 33% of premature babies born between 32 and 35 weeks of pregnancy and over 25% of newborn babies weighing less than 2,000 grams are believed to have school problems in the future<sup>27</sup>. Riech, in 2008, conducted a survey in Brazil on the impact of preterm low birth weight deliveries on students' neuropsychological functions and found the following results: higher impairment in touch-kinesthetic, visuoconstructive, visuomotor and visual memory impairment; poorer school performance in arithmetic and reading areas; higher frequency of learning disabilities (six times the control population), and attention deficit/hyperactivity disorder (three-fold increase). Such results were worse than the international literature data. The author concludes that poor socioeconomic, cultural, and educational conditions enhance these children's disadvantages<sup>29</sup>. These data highlight that longitudinal follow-up and early intervention are required for these children in order to minimize their handicap and allow their real social integration.

Neurological insults, depending on their extension, affected area, etiology, and timing (prenatal, perinatal or postnatal) can lead to brain function impairment (sensory, linguistic, cognitive and motor types) and consequently to an increased learning difficulty. A few examples are cerebral palsy, stroke, central nervous system infections, cranial irradiation history, and others.

Some neurological conditions, such as epilepsy, show certain particularities regarding learning. Various factors are linked to the epilepsy type, seizure control, and the use of antiepileptic drugs, as well as their cognitive effects, among others.

An intellectual deficiency (or mental retardation/deficiency) is a common condition. Retardation or deficiencies in several mental functions (e.g., cognitive, linguistic, motor, and social areas) are shown in major or minor grade. Mental deficiency (MD) occurs more often in boys and reaches 2% to 3% of worldwide population<sup>30</sup>. The causes are diverse and a considerable proportion of patients receive no etiological and/or clinical diagnosis, mainly in mild cases. From individual and standard tests, MDs can be classified according to the IQ score into: mild (50-70), moderate (35-50), severe (20-35), and profound (below 20). Mild cases are

the most commonly seen and correspond to 65% to 75% of MD cases<sup>30</sup>. Usually, these milder deficits are observed only in a school setting when they are exposed to literacy. These individuals are able to learn, since the process occurs through competent active mediation. These children are benefited by early intervention from a multidisciplinary team and by quality education. Characteristically, they find it more difficult to transfer, generalize, and deal with associative information strategies<sup>31</sup>.

Many neuropsychiatric conditions also have a major risk for PSP due to impairment of functions and abilities required for learning<sup>20</sup>. A few of these conditions ADHD, pediatric bipolar mood disorder, oppositional and defiant disorder, conduct disorder, anxiety disorders, obsessive-compulsive disorder, Gilles-la Tourette syndrome, Asperger syndrome, and others.

### DIAGNOSIS AND EARLY INTERVENTION

In most cases, the first professional seen by parents or guardians for help and guidance in PSP is the physician, most often the pediatrician.

The literature stresses the optimal strategy would be early detection and intervention, regardless the PSP etiology.

The physician has a key role in PSP management, acting on: 1) parent and guardian guidance about the importance of education in their children's life, mainly for those coming from unfavorable sociocultural conditions; 2) being alert to neuropsychomotor development (NPMD) and child's individual biorhythm; 3) early sign and symptom identification of the disorders associated with PSP; 4) ruling out extrinsic causes (sociocultural and pedagogical causes) and intrinsic causes – emotional causes, visual disorders (convergence insufficiency and failure of accommodation, refractive errors), hearing problems (repeated otitis media, hearing processing change and others), sensory deficits (visual and hearing deficits), iron-deficiency anemia, sleep apnea, hypothyroidism, and others; 5) referring to specialists when required (otorhinolaryngologist, ophthalmologist, neurologist, psychiatrist, psychopedagogue, speech therapist, psychologist, and occupational therapist); 6) informing the disorders (LD, ADHD, DCD) are mostly chronic conditions that last a lifetime, but possibly improving once appropriately treated; 7) discouraging alternative treatments with no scientific evidence; 8) making safe and reliable information source available for the guardians and the children. Children from informed families which are engaged in the treatment are known to have a better prognosis<sup>5,32,33</sup>.

The main early signs and symptoms of learning disability (LD) in literature are: oral language delay, difficulty in naming and telling stories again, limited vocabulary, phonologic immaturity, difficulty in recognizing symbols (letters and numbers), difficulty in body schema and time-space relationships, ADHD and/or LD family history<sup>1,8,11,34</sup>.

The literature guidance is towards an early intervention that should be started as soon as possible, as even children LD-free benefit from worked strategies. Therefore, in the presence of LD suggestive signs, the family should be guided and referred to a specialized assessment and to early intervention if required. Educational intervention should be individual according to each child's requirements. Overall, the weaknesses are improved and the abilities are strengthened. Some children will require multidisciplinary strategies for successful academic experiences; for others, guidance and family interventions will be enough.

The developmental dyslexia diagnosis is made by a multidisciplinary team through a series of tests involving reading, writing, memory, attention, in addition to cognitive, linguistic, and academic abilities. The evidence converges into phonologic deficit with no interference in other cognitive or language domains<sup>11,12,14,15</sup>. These children's literacy is successful by the phonic method – based on the alphabetic principle, with an explicit letter-sound relationship<sup>8,12,14,35,36</sup>.

Developmental dyslexia treatment is made in two scopes: remediation and accommodation. Remediation aims to seek decoding training, reading fluency, vocabulary and comprehension acquisition. Many children will not reach reading proficiency and, in these cases, accommodation will be required. Accommodation includes extra time for reading (essential), use of computers and recorders, and avoidance of multiple choice questions, oral tests, and/or separate classrooms<sup>8,12,14</sup>.

Alternative treatments should further be observed with caution, as they can be costly, but lack scientific background. In 2009, the American Academy of Pediatrics emphasized that the primary cause for LD (including dyslexia) is not visual, although visual conditions interfere in learning processes. "There is no scientific evidence warranting ocular exercises treatment, behavioral visual therapy or the use of colored filters or lenses. These treatments are not endorsed and should not be recommended"<sup>15</sup>.

As for ADHD, the diagnosis is ultimately clinical. There is no ancillary test to confirm diagnosis. The optimal treatment is drug therapy associated with family education and educators guidance. It is a consensus that psychostimulants are the first line treatment for ADHD due to their efficacy, tolerance, and safety, being approved by the FDA for children over 6 years old. In Brazil, methylphenidate is the only psychostimulant available as immediate- and extended-release formulations (sodas and oros technology).

Extended-release methylphenidate (sodas technology) has a bimodal effect, designed to release two peaks a day, with the action lasting 6 to 8 hours. The Oros technology is designed to have an ascending methylphenidate

plasma concentration curve over the day, with the action lasting 10-12 hours. The extended-release formulations should be administered in the morning because of their extended action. The immediate release formulations can be used from two to three times a day.

Dosage of psychostimulant should be individualized according to need, treatment response, and side effect emergence. The most frequent short-term side effects are headache, appetite loss, weight reduction, abdominal pain, insomnia, irritability, gastrointestinal symptoms. Most of these side effects are self-limited, dose-dependent, medium intensity, and clear with reduced dose and/or extended use. The long-term side effects most frequently found are slight changes of heart rate and blood pressure and slightly reduced final height. Psychostimulant dependence and abuse are very rare. In clinical practice, the "therapy holidays" are common – the medication is withdrawn on weekends and school vacations in children with school handicap and excess weight loss, but such a practice is controversial in literature<sup>5,20,21,37</sup>.

When treating ADHD, the medication withdrawal is indicated after one-year symptom improvement and frequent follow-up by a physician who assures the child will be back to medication as required<sup>5,21,22</sup>.

Tricyclic antidepressants have lower therapeutic efficacy than psychostimulants. Among the tricyclic antidepressants, the most frequently used is imipramine, mainly when ADHD is associated with enuresis and anxiety symptoms. Because of its cardiotoxic effects, the literature recommends to have an electrocardiogram done before starting the medication and when high doses are used. The side effects are: dry mouth, drowsiness, cardiac arrhythmias, (orthostatic) hypotension, urinary retention, and gastrointestinal symptoms.

In literature, the use of clonidine and bupropion is also reported in ADHD treatment. Clonidine is indicated as add-on treatment when there is a rebound in the trough levels of the psychostimulant, in disordered sleep, and tics. Caution should be exercised in using clonidine due to its cardiotoxic effects, hypotensive action, the risk for hypertension, and sympathetic hyperactivity as a rebound effect after sudden withdrawal. Bupropion can be used as an alternative when psychostimulant use fails and in the presence of depressive symptoms; its use is limited due to the risk of triggering seizures<sup>38</sup>.

The differential diagnosis and comorbidity identification of oppositional-defiant disorder, conduct disorder, anxiety disorder, depression, bipolar mood disorder, tics, and others are the key for a successful treatment<sup>39</sup>. Depending on the comorbidity found, add-on medication, such as mood stabilizers (lithium, divalproex, sodium valproate), selective serotonin reuptake inhibitors (fluoxetine, sertraline), or antipsychotic drugs (thioridazine, pimozide, risperidone) may be required.



## CONCLUSION

Childhood is a critical period for ability and knowledge development. Children education has a basic role in integrating the individual to society. Healthcare and educational professionals must be qualified to identify children at risk for learning disabilities, guide the family and refer the children to a multidisciplinary rehabilitation program, and seek an etiologic diagnosis. A key factor is the possibility of improving the learning disadvantageous situations, provided that timely and appropriate strategies are early implemented. Such difficulties can potentially be compensated for and even overcome.

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