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Review Article

Specific Learning and Language Disorders: Definitions, Differences, Clinical Contexts and Therapeutic Approaches

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Abstract:

In educational psychology, the specific disorders of learning and language probably represent the two most general categories among the subjects in the evolutionary phase under eighteen. Failure to diagnose leads to a high level of school exclusion and therefore, social marginalization, with an exponential danger of developing important latent psychopathologies. The present discussion first analyzes the definitions, differences and clinical contexts of reference, and then moves towards the best therapeutic approaches and techniques to help young patients to manage these disorders better.

1. Definitions, differences and clinical context

1.1. Introduction [2]

In clinical psychology, with the term "specific learning disorders" we intend to present disorders to the learning of some specific skills that do not provide a complete self-sufficiency in learning, since the difficulties develop on the activities that serve for the transmission of culture such as, for example, reading, writing and/or accounting. They are therefore part of the family of "specific evolutionary disorders" and cannot be considered "diseases" in the strict sense, as much as "disturbances".

For the diagnosis of "specific learning disorders," the following data are required: intellectual functioning in the norm; at least two diagnostic tests with values below -2 standard deviations; insufficient school functioning.

The specific learning disorders most commonly encountered are the following, even if in a subject there can also be more disorders together, as it is believed that they have the same neuropsychological origin and usually have a hereditary character: "dyslexia"; "Dysgraphia"; "Dysorthography"; "Specific spelling disorder"; "Dyscalculia"; "Specific language disorder"; "Dyspraxia"; "Hearing processing disturbance"; "Non-verbal learning disability".

1.2. Dyslexia

"Dyslexia" is the cognitive (and non-intellectual) disorder of reading par excellence: it is a condition characterized by problems with the reading and incomprehension of the lip, despite those who suffer from it having a standard or superior intelligence. Problems can include difficulty in pronouncing words, in fast reading, in handwriting, in the pronunciation of words while reading aloud and in understanding what is read. Often these difficulties are initially noticed at school. In the case of total impairment of reading skills, one speaks of alexia. [1]

Compared to the definition, there are some variables: the US National Institutes of Health defines it expressly as a learning disability; other sources, instead, define it only as the inability to read in the context of an average intelligence and distinguish between evolutionary dyslexia (a learning disorder) and acquired dyslexia (loss of the ability to read caused by brain damage). [3]

Dyslexia, as we wish to define it, presents itself in very different ways from subject to subject. The most common features relating to the decoding of the single word or the written text are presented below. These may not all be present simultaneously: a) "poor discrimination of graphemes differently oriented in space". The subject shows clear difficulties in discriminating equal or similar, but differently oriented graphemes. He, for example, confuses the "p", the "b", the "d" and the "q"; the "u" and the "n"; the "a" and the "e" ... In the small print (with which this page is written and all the texts of the school books) many pairs of graphemes differ concerning their orientation in space, so the uncertainties and discrimination difficulties can impede reading. b) "poor discrimination of graphemes that differ in small details". The subject shows difficulty in discriminating graphemes that have similarities. For example, he can

confuse "m" with "n"; the "c" with the "e"; the "f" with the "t"; the "e" with the "a" ... this happens especially if it is a script in italics or script. c) "poor discrimination of graphemes that correspond to deaf phonemes and sound phonemes". The subject shows difficulty in discriminating graphemes related to phonemes with perceptive-auditory similarities. The alphabet is composed of two groups of phonemes: deaf phonemes and sound phonemes, which are similar to each other so that even in this case, the perceptive uncertainty can represent an obstacle to reading. d) "sequential decoding difficulty". Reading the Romance languages requires the reader to proceed with his eyes in a left-to-right and top-down direction; this process appears complex for all individuals in the initial stages of learning to read but, with the refinement of the technique, the difficulty gradually decreases until it disappears. In the dyslexic subject, on the other hand, we sometimes find ourselves facing an obstacle in sequential decoding, which can be given by two factors, often present simultaneously: the ocular "skips" or the lack of the concept of orientation (of the self, of the graphene and of the word) in space. So the following errors occur with high frequency: omission of graphemes and syllables; jump of words and jump from line to line; syllable inversions; additions and repetitions: prevalence of the intuitive component. [4]

From the phonological point of view, the reading can go through different ways: a) the "phonological way", which from visual perception passes through the grapheme-phoneme conversion and therefore for the phonemic buffer. It is a slower path because each phoneme is read individually. b) the "non-semantic lexical pathway", which from visual perception passes through the input spelling lexicon and reaches the phonological output lexicon and therefore the phonemic buffer. It is based on reading the whole word based on parallel processing. c) "the semantic lexical pathway", which goes from the visual perception to the semantic system to the phonemic buffer. It is used in the presence of known words. [1]

In learning to read, the child goes through various stages, corresponding to the acquisition of different ways: a) Logographic stage: the child elaborates the salient properties of the word; b) Alphabetical stage: the grapheme-phoneme association is realized, new words are read; c) Orthographic stage: one begins to perform elaborations in parallel and to read the whole word, applying phonological rules; d) Semantic stage: the semantic lexical path is activated, the reading becomes much more fluent. [1]

These different paths are associated with different reading disabilities. It is possible to classify dyslexia in a) Superficial: lexical pathways are compromised but reading, although difficult, is possible; b) Phonology: the phonological path is compromised because a correct grapheme/phoneme association is missing, but the orthographic path is not compromised; c) Deep: the semantic path is compromised, and semantic paraphasias are performed. A clinical interpretation of dyslexia comes from E. Border, who distinguishes between: a) dyshidrotic dyslexia: the representation of the word in its variations is severe, the new words are not understandable; b) Dysphonological dyslexia: the deficit is at the level of the grapheme-phoneme maps. A further neuropsychophysiological classification, devised by Bakker, proposes to consider dyslexias according to the damaged hemisphere: a) Type L (right hemisphere): visuo-perceptive deficits are present, the reading is full of errors because there is not enough mediation of the designated areas. b) Type P (left hemisphere): perceptive strategies are used, although reading is challenging. [5]

In early childhood, the symptoms involving the formulation of a diagnosis of dyslexia include delayed onset of speech, difficulty in distinguishing the left from the right, difficulty with the direction and lack of phonological awareness, in addition to the ease of being distracted by background noise. The reversal of letters or words and mirror writing are behaviours that are sometimes found in people with dyslexia but are not considered as characteristics of the disorder. School-age children with dyslexia may show signs of difficulty in locating or generating rhyming words or counting the number of syllables; both abilities depend on phonological awareness. They can also show difficulties in segmenting words into individual sounds or merging sounds into word production, indicating reduced phonemic awareness. The difficulty in naming objects or searching for the right word is also a feature related to dyslexia. People with dyslexia frequently have poor spelling abilities; a feature sometimes called dysorthography and dysgraphia. Problems persist in adolescence and adulthood and can be accompanied by difficulties in summarizing stories, memorization, reading aloud or learning foreign languages. Adults with dyslexia are often able to read with a good understanding of the text, although they tend to do it more slowly than others, without however having a learning difficulty and have worse performance in spelling tests or reading. [3]

Dyslexia is often accompanied by several learning difficulties, such as dysgraphia but also attention deficit hyperactivity disorder, although it is not clear whether they share the underlying neurological causes. [1]

1.3. Dysgraphia

"Dysgraphia", known as writing disorder, is a specific disorder of writing in the reproduction of alphabetic and numerical signs; may be linked to a picture of dyspraxia, may be secondary to incomplete lateralization, and is characterized by difficulty in reproducing alphabetic and numerical signs. It concerns the graphism exclusively and emerges in the child when the writing begins its phase of customization, indicatively (and only generically) to the third-grade class. In general, the problem of disorganized writing is raised by elementary teachers who complain about the difficulty of following the child in his disorder. In the two previous classes, effort and disorder are generally determined by learning fatigue, in the third grade, the gesture is entirely automated, leaving room for spontaneity and, consequently, for highlighting the difficulty. In summary, dysgraphia is an anomaly of the cursive movement and of the behaviour of the stroke which results in coordination difficulties, irregularities of spacing, malformations and disagreements of any kind associated with a weak quality trait. [1]

The hand of the dysgraphic children runs with difficulty on the writing surface, and the handle of the pen is often incorrect. The ability to use the space available for writing is usually minimal: the child does not respect the margins of the sheet, leaves uneven spaces between the graphemes and between words, does not follow the writing line and proceeds in "ascent" or "descent" concerning the line. Hand pressure on the sheet is not adjusted correctly; sometimes it is excessively loud (due to excess tension), and the mark leaves a marked imprint also in the following pages of the notebook, sometimes it is weak, and the handwriting is fluttering (poor psychophysical resilience). Muscle tone is often stiff or, on the contrary,

excessively released. Inversions in the direction of the gesture are also frequent, which are evident both in the execution of the individual graphemes and in the freewriting, which sometimes proceeds from right to left. The dysgraphic child presents considerable difficulties also in the copy and the autonomous production of geometric figures (he tends to round off the corners and not to close the forms). Also, the level of development of the design is often inadequate to age; the reproduction of objects or the copy of images is very general, and the details are not very present. Often the child subject to this dysfunction reverses the digits of the numbers or the letters of the words he reads. Copying of words and sentences is incorrect; there are inversions in the graphomotor activity and errors due to poor ocular-manual coordination. Copying from the blackboard is even more difficult, as the child must carry out more tasks at the same time: distinction of the word from the background, shifting of the gaze from blackboard to paper, reproduction of graphemes. The dimensions of the letters are not respected; the shape is irregular, the setting inverted, the gesture is poorly fluid; the links between the letters are incorrect. All this often makes the writing incomprehensible to the child himself, who therefore cannot even identify and correct any spelling errors. The writing rhythm is also altered; the child writes with excessive speed or extreme slowness, but his hand performs "jerky" movements, without harmony of the gesture and with frequent interruptions: the predatory / supinator flexor movement of the hand is disharmonious and negatively influences the inversions of the gesture (for example in the lapels and connections) that lose their natural curvature. The speed is altered in both directions: the writing can be prolonged (a symptom of enormous psychophysical effort) but also excessively fast (a symptom of psycho-nervous overexcitation), the graphic forms are fragmented, the praxes disconnected from each other, the balance of the dimension, often they are like "dented". [2]

1.4. Dysorthography

The "dysorthography" is a specific disorder of writing that does not respect rules of transformation of spoken language into a written language not attributable to lack of experience or the motor or sensory deficits. Dysgraphography is often associated with dysorthography, which is a disorder of the neuromotor rhythm of writing (nothing to do with calligraphy) not always dependent on other specific learning disorders. The symptoms of dysorthography can be omissions of graphemes or parts of speech, substitutions of graphemes, inversions of graphemes. Therefore, dysorthography is the difficulty in correctly translating the sounds that makeup words into graphic symbols. [1]

The dysorthography can derive from a language difficulty, from poor visual and auditory perception, from a space-time organization not yet sufficiently acquired, from a slow process in graphic symbolization. It is a disorder that occurs when the form is passed to the content, when there is the problem of writing as a means of communication, with the need to respect the spelling of words. [2]

1.5. Specific spelling disorder

With "specific spelling disorder", in the medical field, one of the specific learning disorders consists in the difficulty of subdividing words into syllables, usually associated with dysgraphia problems but not phonetic ones. The main character is a specific and significant disorder in the development of spelling skills in the absence of a history of specific reading disorders, it is not due solely to a young mental age, problems with vision or inadequate scholastic level. Both the ability to pronounce and write words correctly are affected. [1]

1.6. Specific language disorders [1-2]

The "specific language disorder" is an evolutionary disorder of the language, called "specific" because it is not connected or caused by other developmental disorders of the child, such as mental retardation or hearing loss.

It is part of the family of specific developmental disorders and is defined as a condition in which the acquisition of standard language skills is disturbed from the early stages of development. The linguistic disturbance is not directly attributable to neurological alterations or anomalies of physiological speech mechanisms, sensory impairment, mental retardation or environmental factors. It is often followed by associated problems such as difficulties in reading and writing, abnormalities in interpersonal relationships and emotional and behavioural disorders.

Specific language disorders are often associated with difficulties in motor coordination, cognitive functioning, and attention disorders; for this reason, the dysphasia linked to this disorder can be classified as a deficit in understanding, production and articulation:

a) *phonological decoding disorders*: it is a group of pathologies that penalize the ability to discriminate linguistic sounds and reproduce them. The "dyspraxia", one of the alterations belonging to this category, is the difficulty (or impossibility) of transforming mental images into words. The phonological programming deficit, on the other hand, is a disorder that prevents the child (able to produce and articulate sounds) from forming words.
b) *morphological and syntactic coding and decoding disorders*: they affect the ability to combine words based on relatively stable rules, with meaning (those of grammar, mostly). In this case, understanding can be more or less conserved, and the degree of conservation determines the prognosis.
c) *disturbances of the highest levels of processing*: the child produces a formally correct language, but with difficulties in understanding and using the contents. One of the paradigmatic manifestations of this group is the lexical syndrome, which involves difficulties in the recognition and retrieval of words.

1.7. Other disorders in comorbidity [1-2]

Related to the category of neurodevelopmental disorders, in the sub-category of communication disorders, we find several related and comorbid pathological conditions with specific learning disorders. Between these:

a) "*phonetic-phonological disorder*". Also referred to as a phonetic-phonological disorder, it is a difficulty related to the acquisition of language, which leads the child to produce language sounds (phonemes) incorrectly and not appropriate to his age. The oral phrase, although correctly structured, is incomprehensible due to the numerous phonological deviations. Each sound (phoneme) is learned at a different age, based on its articulatory complexity and the child's attitudes in learning. From 4 years onwards, the child should stabilize the pronunciation of all the phonemes, even those that are more difficult (e.g. the / r /). It is a defect in the articulation of the word in

which there is no alteration of the brain centres responsible for the regulation of language. The difficulty of pronouncing words up to 3-4 years of age can still be considered physiological, and therefore can disappear spontaneously with growth. Only later can we begin to talk about this diagnostic hypothesis.

b) "*verbal fluency disorder*". With the term "fluency" (or fluidity) we want to indicate the ease, regularity and relatively abundant quantity of movements or expression. When referring to the spoken word, it refers to the regularity, ease and abundance of emission of sound and vocalized word sequences and sentences. Fluency can have quantitative aspects (in particular related to time) and qualitative aspects (i.e. characteristics of regularity and irregularity, such as interruptions or insertions of extraneous elements). The verbal flow disorders mainly include:

1) *Cluttering*, often confused with stuttering and not typified in DSM-5 but ICD-10. In the Italian translation, it indicates the cluttering with the term of "disorderly speech"; according to the manual: "it is a condition characterized by rapidity and interruption of the flow of speech, but without repetitions or hesitations, of such intensity, as to compromise the comprehensibility of speech. The speech is irregular and dysritic, with sudden jerks that usually lead to defects in the construction of sentences ". Cluttering, although present in a "pure" form as a simple language disorder, is often combined with stuttering (hence the confusion) and is associated with other neurodevelopmental disorders such as dysgraphia, and attention disorder. Cluttering is also present in several other disorders such as Tourette's syndrome, Asperger's disorder, apraxia, and executive function disorders (for example, planning difficulties, and behavioural regulation).

2) *Stuttering* is defined as a complex multifactorial and multidimensional disorder determined by physiological, genetic, environmental, cognitive, emotional and linguistic factors. In this perspective, the child who stutters is not only a child who presents disfluencies (overt characteristics) but is also a child who manifests avoidance and delegation behaviours in the face of communicative exchanges because of his communicative attitude (characteristics covert). Stuttering is considered a disfluency of the word, characterized by extensions of a sound, blocks, repetitions of the single sound or of the syllable, which interrupt the normal flow of speech. These represent what is called "primary symptoms" of Stuttering. The primary symptoms prevent the speaker from producing "what he means to say as he would like to say". Also, the "secondary symptoms" of stuttering, behaviours that accompany the speech of the person who stutters (lowering of the gaze, facial grimaces, movements of the head or body) may be present. The primary symptoms and the secondary symptoms together constitute the Overt characteristics of Stuttering, that is, that part which all listeners can "see and hear". They are often associated with Covert characteristics, the hidden part, that is "a state of tension or excitement, negative emotions such as fear, embarrassment, anger or the like". The criteria identified by DSM-5 for the diagnosis of this pathology are:

A) alterations of the normal fluency and of the cadence of speech, which are inappropriate for the age of the individual and the linguistic abilities, persist in time and are characterized by the frequent and marked occurrence of one (or more) of the following elements:

• Repetitions of sounds and syllables;
• Extensions of the sounds of the consonants as well as of the vowels;
• Interruption of words (e.g., pauses within a word);
• Audible or silent blocks (speech pauses filled or not filled);
• Circumlocutions (replacement of words to avoid problematic words);
• Words spoke with excessive physical tension;
• Repetition of entire monosyllabic words (e.g., "Lo-lo-lo-lo see").

B) The alteration causes anxiety in speaking or limitations of the effectiveness of communication, social participation, or academic or work performance, individually or in any combination.

C) The onset of the symptom occurs in the early developmental period (cases with late-onset are diagnosed as fluency disorder with onset in adulthood).

D) The alteration is not attributable to a motor deficit of speech or sensory deficits, dysfluencies associated with neurological damage (e.g. stroke, tumour, trauma) or other medical condition, and is not better explained by another disorder mentally.

c) "*Social communication disorder*". This disorder has been codified as an independent nosological entity in the fifth edition of the Diagnostic and Statistical Manual of Mental Disorders, concerning generalized developmental disorders and the autism spectrum. In the previous edition, the old wording "Generalized Developmental Disorders" was in force, which included autistic disorder, Asperger's disorder, a disintegrative disorder of childhood, pervasive developmental disorder not otherwise specified, and Rett syndrome. In DSM 5, however, Rett Syndrome is classified among neurological disorders, while other disorders are coded within the Autism Spectrum Disorders category. Distinct from the latter is the disorder of social communication, characterized by pragmatic and social anomalies and dysfunctions of verbal language. This disorder shares some deficits in language development with autistic disorders, but stereotypes and motor rigidity are absent. In the development of language, we distinguish in fact two levels: a) the semantic one, relative to the child's ability to learn the conceptual meanings to which the words refer; b) the pragmatic one, related to the use of verbal and non-verbal communicative language with aims and practical consequences on social interaction. Children with social communication disorders, although they can learn the conceptual meanings behind the words, at least in their more concrete references, fail to develop a social use of these expressions, that is, they are unable to adapt the way they speak to the context, to respect the conversational shifts, nor to understand the rhythm and the communicative intentions of one's interlocutor. In more specific terms, the difficulties that characterize the disorder of social communication are the following:

1) Present difficulties in the social use of verbal and non-verbal communication as manifested by all the following elements:
- deficits in the use of communication for social purposes, such as greeting and exchanging information, with methods appropriate to the social context;
- impairment of the ability to modify communication in order to make it appropriate to the context or needs of the listener (such as speaking differently depending on whether you are in a classroom or on a playground, talk to a child differently from

how you speak with an adult, and avoid the use of too formal a language);
- difficulty in following the rules of conversation and narration, how to respect shifts in a conversation, rephrase a sentence when misinterpreted and know how to use verbal and non-verbal signals to regulate interaction;
- Difficulty in understanding what is not explicitly declared (e.g., making inferences) and the non-literal or ambiguous meanings of the language (e.g., idioms, humorous phrases, metaphors, multiple meanings whose interpretation depends on the context).

2) Deficits cause functional limitations on the effectiveness of communication, social participation, social relations, academic performance or professional services, individually or in combination.
3) The onset of symptoms occurs in the early period of development (but deficits may not fully manifest until the time when the demands of social communication exceed the limited capacities).
4) The symptoms are not attributable to another medical condition or low abilities in the areas of the structure of speech and grammar.

2. The neural correlates

2.1. Dyslexia

Researchers have sought to discover the neurobiological basis of dyslexia since the identification of the condition in 1881. Modern neuroimaging techniques such as functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) have allowed us to provide both functional and structural correlation in the brain of children with reading difficulties. [54] Some people with dyslexia show inferior electrical activity in some parts of the left hemisphere of the brain, involved with reading, such as the inferior frontal convolution, the inferior parietal lobule and the middle and ventral temporal cortex. In the last ten years, studies on brain activation using PET have made it possible to make significant progress in understanding the neural basis of language. Neural bases for visual and auditory lexicon have been proposed for short-term verbal memory components. The fMRI in people with dyslexia has provided essential data indicating the interactive role of the cerebellum and cerebral cortex, as well as other brain structures. The cerebellar theory of dyslexia proposes that the impairment of muscular movement, controlled by the cerebellum, influences the formation of words that need the muscles of the tongue and facial to be formulated, causing the looseness problems that are characteristic of some people with dyslexia. The cerebellum is also involved in the automation of some activities, such as reading. The fact that some dyslexic children have deficits in motor activity and balance impairments has been mentioned as evidence for the role of the cerebellum in their reading difficulties. However, the cerebellar theory is not supported by controlled studies. [7] [12]

The anatomical differences observed in the linguistic centres of these brains include microscopic cortical malformations known as ectopies or, more rarely, microvascular malformations and microcircuit malformations. Studies suggest that abnormal cortical development occurs before or during the sixth month of fetal brain development. Furthermore, abnormal cell formation in the non-linguistic brain and subcortical structures has been reported in dyslexic patients. Several genes have been associated with dyslexia, including DCDC2 and KIAA0319 on chromosome 6, and DYX1C1 on chromosome 15. [8-11]

2.2. Dysgraphia

In describing the cerebral elaboration behind the writing two main ways have been highlighted: a) the "non-lexical way": from the auditory input we pass to an acoustic-phonological analysis, then to the phonological/orthographic conversion and the passage of this in the visuospatial notebook with its written output. b) the "lexical way": from the auditory input we pass to the acoustic-phonological analysis, then to the phonological input lexicon. It has not yet been established whether there is a passage for the spelling vocabulary or to go directly to the semantic lexicon, then to the visuospatial notebook and written output. However, a typology of dysgraphia may depend on a deficit in a non-lexical way, which can be highlighted with a test for writing non-words. [2] [5]

The necessary skills involved are movement coordination, Spatio-temporal orientation and organization, eye-hand coordination, body schema awareness, sequential memory, language, sense of rhythm (generally immature), the process of symbolization (slowed down), the ability to discriminate sound-signs. It may be secondary to the presence of other learning disabilities, but it is not necessarily related to them: one may be dysgraphic and not dyslexic or dysorthographic. The causes can be different: lesions, minor neurological disorders, sensory deficits, irregularity of the lateralization, incorrect posture, incorrect perception and spatial organization, neglected motor problems, emotionality. [2]

2.3. Specific language disorder

The causes of specific language disorders are five: a) inability to discriminate sounds and syllables; b) impairment of the implicit memory of constructed language in the basal ganglia. There is, therefore, a conscious learning of the language and the use of conscious memory but due to a deficit of chromosome 7q31 this distortion is produced; c) paroxysmal anomalies of paradoxical sleep (non-REM) that affects the semantic memory of language; d) cerebral micro-malformations, i.e. the cerebral cortex is disorganized in some points; e) procedural memory disorders. [1-2]

However, although the origin of specific language disorders is not yet apparent, over the years, some indices have been highlighted that correlate with a subsequent language disorder. In particular: a) 5-10 months: absence of the lallation (first vocalic, then consonantal); b) 12-14 months: absence of use of gestures (deictic and referential); c) 12 months: failure to acquire action patterns with objects; d) 18-24 months: vocabulary less than 20-50 words; e) 24-30 months: absence or reduced presence of symbolic play and delay in understanding non-contextual orders; f) 30-40 months: reduced presence of symbolic play; g) more than 30 months: persistence of idiosyncrasies (i.e. linguistic creations limited to a restricted area and built without applying the rules valid in the broader areas: in practice, this means above all the inventions of the individual speakers, the which form words and syntactic structures according to imagination and its structure). [5]

2.4. The genetic profile in language and reading

Recently, researchers have identified, within the human genome, ten regions of different chromosomes known as DYX loci, related to the genetic framework for dyslexia and two known as SLI loci related to specific language disorders. Further genetic studies have identified four genes for dyslexia within the DYX loci: DYX1C1 (chromosome 15), ROBO1 (chromosome 3); KIAA0319 and DCDC2 (chromosome 6); while FOXP2 is linked to language deficits. Functional studies have shown that all four genes play an important role in brain development, and ongoing molecular studies are trying to understand how these genes exert their effects at the subcellular level. Taken together, these loci and genes probably represent, only a fraction of the human "leptinoma"; a term referring to the collection of all genetic elements and proteins involved in the development of human language, in its expression and reading. Like DYX1C1 and ROBO1, FOXP2 was also found by karyotype analysis, when a genetic translocation was noted in an individual with DSL related to the FOXP2 gene. From this starting point, the family members in whom the DSL was originally described were screened for mutations. This analysis found a FOXP2 SNP inherited in the same pattern for language defects that were not present in any of the 364 control individuals highlighting that FOXP2 is responsible for the development of DSL (Lai et al., 2001). A more recent study has found an association between a different FOXP2 polymorphism and the development of isolated cases of verbal dyspraxia in 46 children (MacDermot et al., 2005), which indicates a broad role for FOXP2 in word and language formation. Specific investigations have shown that the DCDC2 gene in mRNA (messenger RNA), is synthesized in the brain, especially in the temporal cortex and in the cingulate gyrus, areas notoriously involved in the reading process. Functional studies of the gene involved may be necessary to understand the correct migration of neurons, from the region around the cerebral ventricles, where they originate during the initial embryogenesis, and then move to the outer layer of the cerebral cortex, where they live during maturity. From experiments done on rats, the DCDC2 gene is prevented from translating into protein, in early neural progenitor cells. This neuronal arrest in mid-migration in the intermediate layers of the brain prevents the DCDC2 gene from locating in the outer cortex. At the molecular level, the DCDC2 effect on neuronal migration can occur through interactions between the DCDC2 protein product and the cellular scaffold, called cytoskeleton. It has been shown that one of the functional domains of the DCDC2 protein product has the function of stabilizing the assembly of some components important for the cytoskeleton called microtubules. If the level of the protein produced by the DCDC2 gene decreases, the structure of the microtubules is destabilized, compromising the ability of the neurons to migrate through the developing brain. It is not difficult to imagine how the discontinuous development of the neurons involved influences the normal development of the neuronal circuits that connect the reading centres to the brain, compromising the functions of a complex process such as reading. Like the DCDC2 gene, DYX1C1 is also highly present in the brain; in general, the messenger RNA of this gene also appears to be implicated in neuronal migration, which implies that it performs important functions in early brain development. Unlike the other genes, ROBO1 does not influence neuronal migration, but this gene has been shown to encode a receptor for axonal guidance, in fact it produces a protein involved in the reception of cellular signals capable of directing the projections of the axons, which transmit the signals electrics outside the cellular body of the neuron. As for the FOXP2 gene, to date, we do not know exactly its role and why it is implicated in the language. We know that this gene is important in transcription coding, in particular, its protein product binds and regulates the transcription of DNA into RNA. The mutations of this transcription factor would lead to deleterious development of language. Studies on songbirds have shown that low FOXP2 production in RNA in associated regions of the brain would compromise their ability to mimic the singing of other birds perfectly. From here, we can understand that the FOXP2 gene has an important evolutionary role in the development of language and communication. It is not yet clear how cellular dysfunction can be the basis of disorders that lead to the destruction of higher neurological functions such as reading and language. As well as, for example, changes in the migration of some neurons interrupt the development of reading skills, preserving the overall intelligence. What we currently know is that from functional magnetic resonance imaging done to dyslexic people, it is clear that some polymorphisms of the DCDC2 and KIAA0319 genes are associated with unique brain circuits, compared to fluent readers. However, apart from some DSLs that appear to have purely genetic causes, in language disorders and reading disorders, both genetic and environmental components seem to coexist. [7] [12-16] Recent research has shown that the 16p11.2 genetic mutation is strongly associated with various neurodevelopmental disorders, such as autism and attention deficit hyperactivity disorder, functionally related to learning disabilities and language. [17]

2.5. The role of memory in learning and language disorders [7]

A mental faculty seems to play a crucial role in both reading and language deficits: memory. It is not merely the elaboration of ideas, images, feelings and past emotions, even if common sense understands it. What we call memory is the result of a complex intervention, which involves the interaction of different memory systems.

It is divided into short-term memory and long-term memory. The first is immediate; it passively stores information that will or will not be transferred to long-term memory. It is strictly domain-specific (verbal or visual-spatial), maintains and processes information during the execution of cognitive tasks, has a minimal and short-lived capacity. The second is a sort of warehouse of information and events that occurred in the past that has consolidated. It is divided into explicit or declarative, and implicit or non-declarative.

The explicit memory is located in the temporal-medial lobe and the hippocampus and regards autobiographical information and events, knowledge related to past facts. This includes the episodic memory, which contains the events that have been witnessed directly and the semantic one, which concerns the whole of knowledge. While the implicit memory concerns all the procedures we acquire automatically, only thanks to repetition, intentionality is not involved in these processes (walking, driving, cycling ...), in these procedural processes seem to be involved cerebellum, motor areas and ganglia basal. Part of the implicit memory is also the procedural one, which is used in the performance of complex tasks, it is this area that contains the knowledge that each individual has about perceptive, cognitive and motor processes.

The memory that plays a central role in the learning processes is the "working memory", it can retain the information acquired for a longer or shorter time, to have it available in the performance of a task. For a long time, it was associated with short-term memory, as if they were the same

thing, but for decades it has been considered as a faculty in itself. The working memory can keep present and active information coming from the outside of the long-term memory, for the time necessary to perform certain complex operations. It can, therefore, be defined as a cognitive system, which allows individuals to understand and mentally represent the surrounding environment, to keep information on their experiences, to acquire new knowledge to solve new problems, to establish and formulate relationships to achieve goals specific (Baddeley, 1999). So also the language learning, the learning of reading, the comprehension and production of the text, as well as the solution of problems and the calculation in mind, are all activities in which working memory is indispensable. It is a limited capacity memory system. Therefore it allows working on information for short periods and with a limited number of elements.

The most widely used working memory model in Europe is that of Baddeley, which envisages three central areas: phonological memory, the visual-spatial notebook and the central executive. The first area concerns verbal information; the other visual-spatial information and the third performs the task of coordinating the activities of the two systems, interacting with the long-term memory. Only the central executive communicates with both memories in a bidirectional way; the two systems can work in parallel by exchanging information through the central executive: being independent, the two memories can be efficient or inefficient, without affecting the work of the other system, whereas if the central executive is to be inefficient this will be reflected on both warehouses. The verbal-phonological memory, as we have already said, has a limited capacity, and also phonologically encodes visual stimuli, it also stores phonologically similar "neighbours" stimuli, for which the effect of phonological similarity occurs (there is an evocation) better if the stimuli are phonologically different, such as home and book, rather than dog and bread). The phonological component also includes the articulatory phonological loop, which has the function of not decaying the mnestic information for about 30 seconds. It uses a reiteration cycle which takes about 2 seconds to carry out a review, so the material that can be repeated must not exceed the time length of 2 seconds. This component is affected by the "length effect", so short words are recalled earlier than long ones (dog, sun sea, lake vs banana, telephone, piano). Furthermore, it appears to be negatively affected by articulated suppression. Furthermore, it appears to be negatively influenced by articulatory suppression, whereby repetition of nonsense material would block repetition. The development of phonological memory is mediated by several factors: increase in the speed of vocal articulation; increase in the number of familiar words and known sub-lexical units; improvement of meta-phonological skills around 4-5 years. Inevitably a working memory deficit involves difficulties in following the instructions, combining storage and processing, monitoring the activity in progress, self-correcting and continuing the performance of a task independently. The other component of the Baddeley model is the visual-spatial notebook, of which I will only mention. It is responsible for the storage of visual and spatial information, so all the activities we carry out daily and that involve the use of visual MBT, such as drawing, imagining, keeping in mind spatial relationships, orienting ourselves, remembering scenes of the film, understand descriptions, work with numbers. It also seems to be concerned with the production and manipulation of mental images (Baddeley, 2006; De Beni 2007). A phonological processing deficit is closely associated with dyslexia, but not with DSL if it occurs in the absence of dyslexia (Catts, HW, Adlof, SM, Hogan, TP, & Ellis-Weismer, S. 2005), although it is true that both dyslexics and subjects with DSL present numerous phonological, spelling and semantic errors (MacArthy JH, Hogan TP, Catts H, W. 2013).

3. *Clinical strategies for the management of the disorder* [1] [7]

The best strategy is undoubtedly to thoroughly diagnose the psychopathological situation of the subject, intervention with compensatory and functional tools concerning specific disorders of learning and language, while it will be necessary to intervene with psychotherapeutic support session and psychotropic drugs in the hypothesis of comorbidity conditions with psychopathologies that require specialist clinical support.

For pupils with appropriately certified specific learning difficulties, the assessment and verification of learning, including those carried out during the final examination of the cycles, must take into account the specific subjective situations of these students; for these purposes, in the performance of the teaching activities and the exam tests, the compensatory and dispensatory methodological and didactic tools deemed most suitable are adopted, within the financial resources available under current legislation.

Compared to psychotherapeutic support, the best approaches appear to be the cognitive-behavioural and strategic ones; with respect to drug therapy, instead, we refer to the opinion of the child neuropsychiatrist with respect to the need for an approach of this type, identified one or more comorbid psychopathologies with the learning and language disorder (e.g. attention deficit and hyperactivity disorder, mood disorders, conduct disorders, ...).

Among the "best methodological and didactic strategies" we find:

a) to enhance in the didactic communication languages other than the written code (iconographic, spoken language), using didactic mediators such as images, drawings and summaries;
b) use conceptual schemes and maps;
c) teach the use of extra-textual study devices (title, paragraphs, images);
d) promote inferences, integrations and links between knowledge and disciplines;
e) divide the objectives of a task into "sub-objectives";
f) offer graphic diagrams of the topic of study in advance, to guide the student in the discrimination of essential information;
g) give priority to learning from experience and laboratory teaching;
h) promote metacognitive processes to stimulate self-control and self-evaluation of one's learning processes in the student;
i) to encourage small group teaching and peer tutoring;
j) promoting collaborative learning.

Among the "best dispensing strategies", namely to avoid certain activities for the student/patient, we find:

a) reading aloud;
b) writing under dictation;
c) take notes;
d) copy from the board;
e) the excessive amount of homework;
f) the mnemonic study of formulas, tables, definitions.

It is more functional to guarantee compliance with a softer schedule for the delivery of written assignments (planning according to the needs), the

carrying out of more evaluation tests in short times and the replacement of the writing with verbal and/or iconographic language.

Among the "best compensatory strategies", i.e. to guarantee the student/patient certain activities, we find:
a) forms, summaries, diagrams, conceptual maps of the learning units, with underlining, keywords, tables and diagrams;
b) table of measurements and geometric formulas;
c) computer with a word processor, spell checker; printer and scanner;
d) calculator or computer with spreadsheet and printer;
e) recorder and audio resources (voice synthesis, audiobooks, digital books);
f) specific educational software;
g) computer with voice synthesis;
h) multimedia vocabulary;
i) applications that can be downloaded from the reference stores.

There are also a series of functional techniques suitable for each type of specific learning disorder. In particular, attention has always been focused on disorders related to reading and writing, recognizing in these techniques the best possible school: [18]

a) ***Delacato*:** The Delacato Method is a neuro-rehabilitative program and aims to correct the behavioural disorders present in subjects suffering from the autistic syndrome or other pathologies affecting the Central Nervous System. The Delacato Methodology is based principally on 3 assumptions:

- the first is that human behaviour is only partially genetically determined and that, instead, the environment plays a significant role, or rather that sensory stimuli deriving from the environment are fundamental for the formation of neuronal maps, in which the information that dictates the behaviour of each individual is archived;
- the second assumption is that these neuronal maps can undergo at different times (in the prenatal, perinatal and postnatal periods) minimal and widespread lesions so that the entry of sensory inputs is drastically modified. The alterations of sensory stimuli such as hearing, sight, touch, smell and taste can be distinguished in: hyper- (indiscriminate entry of information), in hypo- (loss of information entry) given by white noise (distortion of incoming information);
- the third assumption is that thanks to the neuronal plasticity of the Central Nervous System, and to the persistence of this characteristic even many years after birth, it is possible, with appropriate stimulations, to modify the activity of the neuronal maps, reorganizing the entry of the environmental stimuli, and in this way allow to adopt behaviors functional to survival and social coexistence.

b) ***Davis:*** Ronald Davis theorizes that dyslexic individuals are visual thinkers who experience disorientation in the perception of time, sight, hearing, and / or balance and nation co-ordination. The correction of Dyslexia Davis provides a solution based on two key elements: a method to control perceptual disorientation and one to eliminate the causes of perceptual disorientation. All one has to do is teach the student how to recognize when he is disoriented, and then how to use his mind and his awareness to overcome disorientation - or, in other words, teach one to "orientate." This is actually how to teach a child to hold his breath when underwater; it is merely a matter of learning to consciously control something that usually happens unconsciously in mind. It is necessary to resolve the confusion before the student can get worse because otherwise, he will continue to misunderstand letters and words. If a word sometimes seems "finger", and sometimes it seems "dowries" or "mice" or "type", there is no hope that the student will ever be able to recognize the word. A parent or teacher might think that the student has memory problems and could encourage repetition and memorization. Instead, the student is confused and frustrated because it seems to him that the teacher is showing him different words every time. However, learning to control disorientation does not solve dyslexia. With this, one learns to overcome the key symptom of this, not the cause. Until the cause is overcome, the symptoms will inevitably recur. They are overcoming the factors that trigger disorientation and specific learning disorders. To improve reading, writing and spelling, the Davis method involves three necessary steps: a) mastery of the alphabet and basic linguistic symbols; b) mastery of words for which the person with dyslexia does not figure an image or a meaning; c) ability to arrange letters and words and understanding when reading. There are more than 200 trigger words in the Italian language that must be mastered, but once this has happened, the student will have developed a working arsenal of visual words - words that are recognized and understood at the time they are read. All you have to do is count the number of small and abstract words in this sentence to see what kind of difference there will be with the other words.

c) ***Panlexia)*:** The original program for the English language was "The Andover Program for Specific Language Disabilities" was created in 1970 by Dr Pamela Kvilekval for public schools in the city of Andover, Massachusetts. In the following years also other cities such as Methuen, Massachusetts, Manchester New Hampshire, and Nova Scotia, Canada made an express request for training for all their specialists by adopting the method for their schools. In 1995, Dr Pamela Kvilekval structured a similar re-education program for Italian dyslexia by developing the same criteria and principles adapted to the Italian linguistic structure. The Panlexia Method was published in Italy in 1998 together with the book of stories that follow the structure of the Method "The Stories of Aunt Lara", written by Nelly Meloni, mother of a student of Pamela. Now the method is used in Italy by various specialists: speech therapists, psychologists in the re-education of dyslexia both in the rehabilitation setting and in the school-educational setting by teachers and speech therapists. In Curitiba (Brazil) public schools for children with special needs/dyslexia have adopted the method since 2004, and currently, the institute "Pamela Kvilekval" based in Curitiba (Brazil) carries out training and certification of the method for professionals and educators in many other cities in Brazil. In Italy, Dr Silvia Costa carries out an essential training and supervision project in two schools in Rome aimed

at teachers to guarantee the correct application of teaching methods and the principles of the re-educational method.

d) ***Tomatis:*** The Tomatis Method, or audio-psycho-phonological method, was devised by prof. Alfred Tomatis, otolaryngologist and surgeon, born in Nízza in 1920 from Italian parents. Since 1945 i1 prof. Tomatis has dedicated his life, first in France, then abroad (Canada, United States, Europe, where his theories and their applications are widely distributed), to research on audition, language and communication, thus highlighting the relationship between ear, language and psyche. The professor.

e) Tomatis first conducted his research in the Audiology laboratory of the French Air Force and later in his centre of medical audiology. Analyzing a sample of subjects who carried out their work activities in particularly noisy environments (test bench for jet engines, test bench for internal combustion engines, sheet metal re-working in shipyards, pneumatic hammer, etc.), he observed that the frequencies of the sounds that the ear could not perceive, were the same ones that the voice could not emit. Continuing his research on a more extensive and more varied sample of subjects (including singers), Tomatis deduced that this was a general characteristic valid for any subject: the person is not able to reproduce with his voice those frequencies that he is not able to hear. Furthermore, in the laboratory, it was proved that every modification of the auditory scheme involved a modification of the vocal scheme: this was called "Tomatis Effect". Starting from this intuition Prof. Tomatis carried out his research on a multidisciplinary plan, making use of studies of audiology, phonology and psychology. The audio-psycho-phonological method or the Tomatis method was born, then presented at the Academy of Sciences and the Academy of Medicine in Paris (1957-1960). The Tomatis Method is a technique of sound stimulation and a pedagogical intervention to improve the functioning of the ear, verbal communication, the desire to communicate and learn, awareness of body image, audiovocal and motor control. The initial budget is carried out by a trained listening therapist under the supervision of prof. Alfred Tomatis. The budget includes tests of listening, of lateral dominance and drawings of figures integrated by a personal anamnesis. The human ear has the ability to perform the following functions: 1 regularly) Perceiving sounds; 2) Processing sounds without distortion; 3) Distinguishing high and low sounds; 4) Perceiving the spatial origin of sounds; 5) Pay attention to the sounds you want to hear and avoid those you don't want to listen to (concentration); 6) Transmit energy to the brain through the nervous signal of sound (cortical recharge); 7) Integrate and coordinate information from muscle movements; 8) Maintaining balance and relationship with gravity; 9) Stimulating and maintaining neurovegetative balance 10) Controlling speech; 11) Check the musical ability.

f) ***Stimulation of the weak hemisphere*** (Balance-Model): According to this model, reading is the result of a balance between the contribution of the left and right hemisphere of the brain. Concerning the classification of dyslexia, Bakker distinguishes three types of dyslexia: linguistic, perceptual and mixed. Linguistic dyslexia is characterized by a fast reading that presents, however, numerous specific errors (little involvement of the right hemisphere in reading tasks). Perceptual dyslexia is characterized by prolonged reading and time-consuming errors (reduced involvement of the left hemisphere in reading). Mixed dyslexia occurs when in the reading, specific errors and dispersant time errors occur in the same measure. According to the neurological hypothesis of the authors of Flashword, some children, at some point in their development, would not follow the usual modifications of the strategies used for reading: a progressive change was demonstrated from the involvement of the right to the left hemisphere. This change (hemispherical shift) occurs around the second year of reading learning. The application tool is FlashWord, which through a tachistoscopic technique activates a quick presentation of visual stimuli (words, short sentences), which stimulate the two cerebral hemispheres. The operator can carry out a specific recovery path, choosing from time to time the stimuli to be presented, depending on the objectives and the treatment protocol provided.

Concerning writing (and rehabilitating this ability), instead, according to Pratelli (1996) the intervention program can be divided into two itineraries that must be carried out in parallel: a) itinerary related to the development of necessary skills; b) specific itinerary for writing.

The first is aimed at reducing the gaps found in the necessary skills; the second has the purpose of promoting the achievement of more adequate writing skills instead. It is essential that the two paths are proposed in parallel and gradually. The necessary skills on which it is essential to work are the following:

a) ***Perception.*** Some activities related to this area are: to combine equal images differently oriented in space; match equal colors; match equal geometric figures; to search, in a series, for geometric figures of the same shape but of different colors; perform geometric compositions with logic blocks on imitation of a model; observe the construction phases of a geometric composition, undo and execute it again trying to remember the sequence of actions; identify similarities and differences in pairs of images; identify the missing elements; connect the dots by reproducing a figure shown as a model.

b) ***Space-time organization***. The activities that can be proposed are for example: defining the position of objects present in the environment; place objects on a plane following a model provided by the adult; complete an arrangement of objects by inserting others based on the spatial indications provided by the adult; copy groups of graphemes without meaning respecting spatial relations; mimically represent a situation suggested by the adult respecting the sequence of actions; rearrange in a temporal sequence a series of scenes related to everyday life situations; reorder sequences of images identifying and verbalizing the cause-effect relationship.

c) ***Space-time integration***. You can propose to: listen and reproduce a rhythm performed by the adult; to match a beat of hands to each of the objects arranged on a plane; listen to a sequence of lines and represent it graphically; mark a graphic rhythm respecting pauses and intensity.

d) ***Knowledge and representation of the body schema*.** Exercises of this type can be proposed: the child touches on his body the parts named by the adult; the child assumes positions previously observed on images shown by the adult; in the supine position, take the ball by squeezing the feet and lift it following the verbal command of the adult; in the supine position, start to ball up the body so as to occupy as little space as possible and slowly return to the initial position, then widening the arms and legs so as to occupy as much space as possible; in a prone position, roll your body over a ball; describe the adult's positions; to name the parts of the body involved in a movement; graphically represent the human figure enriching it with details.

e) ***Balance and coordination*.** Activities relating to the static and dynamic balance can be proposed: stand with your eyes closed, count to ten, trying to remain still; on one foot, counting quickly up to ten trying to remain motionless within a circle; standing on the heels maintaining a position of immobility for as long as possible; run on the spot, jump with feet together and apart; marching on the spot associating the swing of the arms with the movement of the legs; walk quickly between two rows of pins; play ball games like throwing it up and take it again after clapping your hands; perform motor sequences following the indications of the adult or in reverse order.

f) ***Relaxation***. This area includes: preparatory activities for relaxation; the noise-silence contrast (guide the child towards the ability to discriminate pleasant noises from annoying noises, invite the child to perform movements trying to make as little noise as possible); slow-fast contrast (alternate movements slowly followed by movements performed quickly according to the indications of the adult or in reverse); the heavy-light contrast (walking pretending to be extremely heavy or light, or dragging something very heavy); movement-mobility contrast (perform the most significant number of movements and stop at a signal, make movements only with one part of the body, leaving the rest as still as possible); relaxation (invite the child to take a position of comfortable rest, to verbalize the perception of well-being that can derive from rest).

g) ***Laterality*.** It is common for dysgraphic children to present lateralization that is not yet fully acquired, which hinders visual-motor coordination and the learning processes of reading and writing. Some exercises aimed at achieving greater body awareness in relation to the privileged use of the eye, hand, ear and foot may be: naming images by covering one's hand with an eye; observe and name objects in a room adjacent approaching the eye to the keyhole; raise the hand you need to write; touch the eyes that you don't need to look at the keyhole; raise the right arm and at the same time raise the left leg.

h) ***Visuomotor and oculo-manual coordination*.** It is possible to propose, for example, to travel by car on a track designed on the floor; hit a target drawn on the wall with a ball; throw the ball with one hand and pick it up with the other; scan a rhythm and invite the child to match each line with a line drawn on a sheet.

4. *Conclusions* [19]

The specific disorders of learning and language probably represent the two most popular categories among the subjects in the evolutionary phase under eighteen. Failure to diagnose leads to a high level of school exclusion and therefore, social marginalization, with an exponential danger of developing important latent psychopathologies.

The comorbidity between dyslexia and other scholastic learning is now well established, as is contemporaneity and coexistence, in the absence of a causal relationship, between learning deficits and other disorders of the neuropsychological organization; in particular, language disorders, disability in motor coordination, difficulty with attention or hyperactivity.

The most reliable, among the etiological hypotheses, is undoubtedly the one that considers establishing, at the base of the two disorders, the phonological working memory deficit and the weakness of procedural memory; that is to say that memory system that allows a good fluency, both at a discursive level and in reading, thanks to the automation of the processes activated in the two expressive productions.

Undeveloped or inadequate language is a high predictor of the onset of developmental dyslexia, which allows us to identify risk factors related to reading disturbance from school. The fact that some language disorders tend to regress; however, naturally does not have to authorize us to ignore or underestimate the problem.

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