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# LITERACY FROM THE PERSPECTIVE OF NEUROSCIENCE

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## ABSTRACT

This article has the purpose to introduce a bibliographic study on the contributions of neuroscience, especially the cognitive science, approaching the dynamics of human brain in reading learning, the neuroplasticity phenomenon seen under the methods of scientific studies, the cognitive foundations of reading learning, the initial stages of this learning, the evidence of the effectiveness of some literacy methods, the method of reading teaching, the neurobiology and some literacy policies that are based on this scientific perspective. In an attempt to answer the question about how the human brain learn to read and how the educators can re-evaluate the teaching methods to get accurate and efficient results on reading learning, we used bibliographic research. The choices we made were based on the importance of the authors and groups of Brazillian and Foreigner researchers who built some materials about this subject, especially: ABREU (2020-2021), CAPOVILLA (2005), DEHAENE (2012), GARDNER (1996 ), GT: CHILDREN'S LITERACY: new paths final report (2007), GE: CHILDREN'S LEARNING, an approach from Neuroscience, from the Brazilian Academy of Sciences (2011), PERRENOUD (2002), PNA (2019) and others.

**Keywords:** Neuroscience and education. Reading learning. Reading teaching methods. Literacy policies.

## INTRODUCTION

This article proposes an analysis regarding the application of neuroscience contributions in education. Educational neuroscience, a basic science for pedagogy, can base it empirically and not only the social sciences, but the biological and behavioral ones, given the current framework of Brazilian education, especially with regard to learning to read – as part of schooling and even being a solid scientific branch of studies in the last 30 years, it is on the sidelines in the debates of Brazilian educational policies, as the Cognitive Science of Reading presents a discourse that goes against the conception of learning to read presented in the country, and such scientific knowledge is rejected often for political and ideological issues ( *GT: CHILD LITERACY: the new paths final report* , 2007,21).

Our brain is evidently capable of learning, but learning to read, unlike acquisition of speech, is limited. Everywhere in the world, in all cultures with their different written languages, the same brain region, with minimal differences of millimeters, intervenes to decode written words, whether in any language, because learning to read always runs through a circuit brain identical, in Brazil or Japan. Our brain is not a blank slate where cultural constructions accumulate: it is a structured organ that makes the new with the old. In "The New Science of Mind", GARDNER (1996) states that:

" Cognitive scientists […] seek to understand what is known and the person who knows – their perceptual apparatus, learning mechanisms, memory and rationality. They investigate the sources of knowledge: where it comes from, how it is stored and retrieved, how it can be lost. [...] adopt the most recent scientific and technological advances from various disciplines". (p.18-19).

According to **LDB**[3] (Law No. 9394/96, art. 32, item I): "*The basic education of citizens is the objective of elementary education, through the development of the ability to learn, having as basic means the full mastery of reading, of writing and calculation* ", as well as what was stated in Goals 5 and 9 of the **PNE**[4] (2014) respectively *: Literate all children by the end of the 3rd year of PE and reduce the rate of functional illiteracy (condition of those with limited reading and text comprehension skills) by 50%. Eradicating absolute illiteracy (a condition of those who cannot read or write) by 2024* serves as a basis for analyzing whether the objectives on the processes and results of literacy in Brazil were satisfactory or not. The **BNCC**[5] (2017), which proposes minimum content for each stage of schooling, it is expected *that the child is literate in the 1st and 2nd year of elementary school, a process that will be*

*complemented by another in the 3rd year, called "spelling"*.

However, statistically analyzing the current Brazilian reality in literacy, **ANA**[6] of 2016, which covered more than 2 million students completing the 3rd year of PE, found that: 54.73% of students had insufficient performance in the reading proficiency exam and 400,000 of these were at level 1 of this scale; 33.95 were at insufficient writing levels (1, 2 and 3) and 680 thousand cannot write "words alphabetically" or write them with spelling deviations; (INEP, 2016). It is proven that the school trajectory of these students is compromised, reflecting in failure, age-grade distortion, dropout and dropout, and loss of text comprehension capacity due to the impoverishment of the linguistic repertoire.

## 3 THEORETICAL FOUNDATION

### 3.1 NEUROSCIENCE AND LEARNING

Neuroscientific research in reading, in the last 30 years, has acquired an undisputed scientific status through the use of experimental methodologies (laboratory and field) strengthening the quality of data and analysis, based on hypothesis tests, isolating the variable in experimental and control groups , with well-established procedures recognized by the international scientific community, breaking with the world of speculation and amateurism to place itself within scientific rigor, as well as in research in Physics or Biology.

The study methods of Cognitive Reading (Neuro)Sciences were based on computational cognitivism, in which the human brain is metaphorically understood as a device that processes information and emits responses. The advanced use of computational technologies and their functional studies such as positron emission tomography (PET or TEP), functional magnetic resonance imaging (fMRI or fMRI) and magnetoencephalography (MEG) verified the cerebral neuroplasticity in learning, the development of structures concluding that the ability to read is related to specific regions of the brain that need to be deeply stimulated and activated, taking into account the neurotransmitters involved. It made it possible to localize learning disorders, measure brain activity based on changes, respectively, in regional cerebral blood flow or in blood oxygenation.

The presentation of a stimulus or a mental state involves neural activation in specific brain regions, activation by oxygenation or blood flow. Functional neuroimaging is "*a useful technique to identify neural systems that support cognitive processes such as reading*" (SNOWLING & HULME, 2013, 492). It is up to the neuroscientist to interpret the volume of information captured by these instruments in order to better understand the phenomenon within a multimodal or multidisciplinary assessment and thus arrive at a scientific answer.

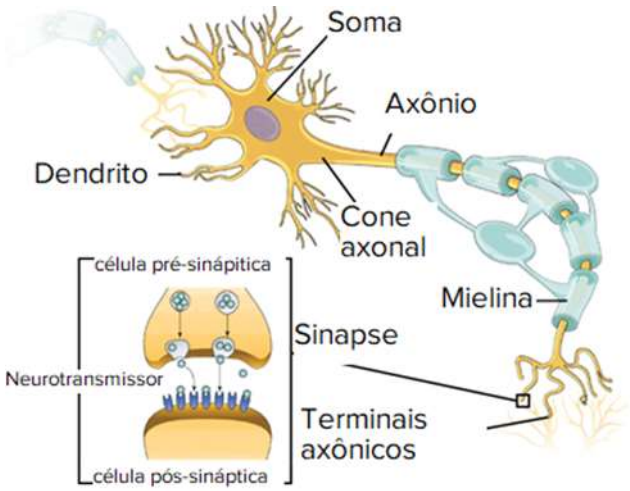
The human brain is capable of Neuroplasticity, which is " *the functional and structural adaptation that minimizes or reverses the effects of structural (injury) or functional changes in the nervous system and that also allows for the acquisition of knowledge*". (BRAZILIAN ACADEMY OF SCIENCES, 2011, p. 48). In DEHAENE's Neuronal Recycling (2012), opposed to cultural relativism, cultural inventions, such as learning to read, fall on the margin of neuroplasticity, in which the ability to read makes use of the brain's predispositions already present in the individual.

In Cognitive Neuroscience, human learning can be understood as the processing and elaboration of information coming from the brain's perceptual aspect and its ability to associate such information with meanings, interpreting them. Acquiring new information and retaining it in memory is learning, requiring only that certain neurons be stimulated. In the process of learning to read, neuroplasticity in organic terms occurs through the increase of neuronal bodies, making dendrites more robust, increasing synaptic power.

Sensory stimuli captured by the neuron that works as a switch that allows or does not pass electrical current, in a reconfigurable way. The neuron's body is the source of power and oxygen absorption. Dendrites receive information from other neurons and if these meet certain conditions, the neuron fires an electrical pulse through the axon (body) that when such pulses reach the end, it is distributed by more branches that connect to other neurons. Information from synaptic connections is transmitted chemically by Neurotransmitters.

However, the neuron only triggers the electrical pulse if the excitations from the various presynaptic neurons that reach the postsynaptic neurons reach or exceed a certain threshold intensity, otherwise it remains quiet. Through training, a neural network can, without changing the physical connections between neurons, modify its behavior by learning to perform other tasks (this is neuroplasticity), changing the "strength" of the synapse by modifying the amount of neurotransmitters that cross the synapse when it is excited. It is precisely in the synapses of tens of millions of neurons that the mechanism of thought takes place and learning to read is the result of neuroplasticity.

Figure 1 – Structure of a neuron




At one end of the cell body are the dendrites. Protruding from the other end of the cell body is the axon. The axon is surrounded by myelin, which forms a sheath around some sections. At its farthest end of the cell body, the axon branches into many axon terminals. Each forms a synapse with a dendrite or cell body of another neuron. There is a space between the two neurons. Communication takes place through the release of neurotransmitters in this space.
Source: Image modified from "Neurons and glial cells: Figure 2" and "Synapse," by OpenStax College, Biology (CC BY 3.0).

The ability to learn is wide, unlimited and the brain can renew itself, and plasticity is important, as the brain areas of a given function can assume other functions when necessary, presenting cerebral interdisciplinarity (p.35), which is when knowledge from one area is used in another area: *"Learning takes place through the creation of new memories and the expansion of neural networks that store what has already been worked on, through the learning of concepts and methodologies that will form or expand these memoirs"*. (RELVAS, 2007, p. 35)

All brain areas are involved in learning, including emotion, and neurobiologically, neural cells change or grow when potentially strong stimuli are passed from one cell to another. RELVAS (2009) describes this process:

"[...] *there is a biochemical organization involved, called neurotransmitter of the GLUTAMATE type. The receptors for these stimuli are called NMDA (act on blocked channels) and AMPA (mediate what comes from presynaptic membranes). When the stimulus is too strong, the stimuli go to the NMDA. There, there is passage of Ca (calcium) ions. This entire process can take hours or days and interferes with memory and learning processes*". (p.36)

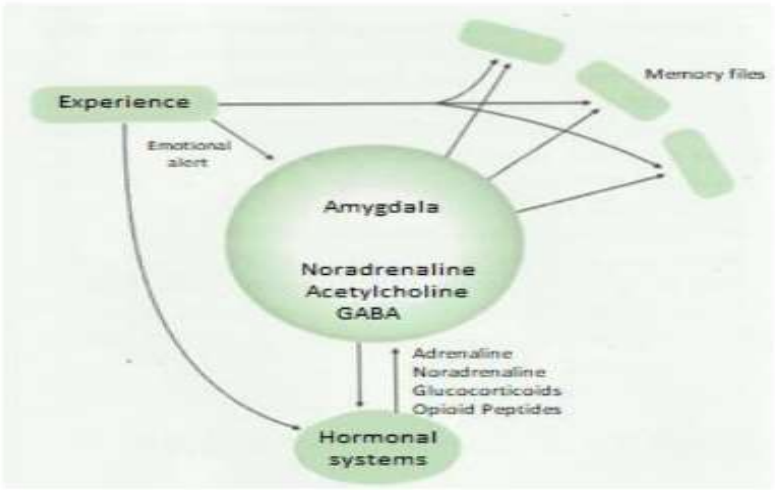
For the child to learn, permanent changes must occur in the synapses of the neural networks of each memory and, for memory activation, the reactivation of synaptic networks of each stored memory is necessary and as their nervous system is more plastic than that of an adult , early and correct stimulation can increase the potential of learning in the school context, especially in the development of multiple intelligences mentioned by Howard Gardner (1995). Thus, memory is the basis of learning, because the more neural connections, the more memory and the more capacity for planning, abstraction, judgment and attention.

RELVAS (2007) describes the path taken by stimuli in the central nervous system (CNS) as follows: the cerebral cortex, in the temporal lobe, receives, integrates and organizes auditory stimuli; in the occipital lobe, the cortex receives, integrates and organizes visual stimuli; in the temporal and occipital areas, they connect to the areas of the frontal lobe responsible for the articulation of words; the parietotemporoccipital area is responsible for the integration of knowledge and the prefrontal areas for the integration of practice, all through the bias of affect and the cognitive conditions of each individual (p.92). Nerve cells grow and change in response to experiences and "*the external stimuli that cause emotional reactions and the meaning given to these reactions are the way in which the human expresses the learning result* ". (p. 192).

The brain either behaves using the neural networks already configured, or the processing remains turned off, reconfiguring synapses during sleep. This "configure and reconfigure" that corresponds to learning also obeys the circadian rhythm. (PIAZZI, 2014, p. 95) This entire process, within synaptogenesis, in which learning resulting from neuronal plasticity takes place, chemically, anatomically and physiologically alters the brain, by requiring changes in neural networks, from situations that inhibit or stimulate the appearance of new synapses, through the release of neurotransmitters (MORA, 2004).

Neurotransmitters play a preponderant role in the learning process, insofar as they contribute to the creation of reading habits, memory formation, in shaping the culture of curiosity in children. They are responsible for transmitting information between pre-synapses and post-synapses. In this learning process, GABA, for example, is indicated as an activator of brain metabolism in situations of memory deficits, difficulty in attention and memorization of contents. Serotonin contributes to motivation in learning, improving mood, regulating sleep, proving that sleep interferes with learning, and its alterations cause inattention. Noradrenaline as the main neurotransmitter of the peripheral sympathetic nervous system is the object of study regarding sleep, learning and attention, executive functions and the desire to learn (ABREU, 2020, p. 4-5). The dopamine known as reward neuro, synthesized through tyrosine and accumulated in synaptic vesicles in axon terminals, is linked to Motivation, Movement and Intellectuality. It is what promotes the repetition of pleasurable actions, being necessary for the formation of the reading habit despite being addictive[7] . Dopaminergic changes affect the formation of personality with regard to the lack of attention that is so necessary for learning and sometimes presents itself in the form of TDH.

Figure 2 – Work of neurotransmitters




Source: https://www.neurometria.com.br

Learning to read consists in accessing, through vision, the brain areas of the spoken language in the interactions and culture of curiosity. And presenting difficulties in this learning, means the amount of neuronal recycling necessary. Thus, exams capable of evaluating hemodynamic and metabolic changes with fMRI and PET allow a very precise location of the brain regions involved in the act of reading. Neuroscience brings, from the scientific basis, the didactic, curricular and structural change of school and learning.

### 3.2 LEARNING FROM READING

The child's brain is extremely structured, our brain networks are enabled for complex processing thanks to neuronal recycling (or neuroplasticity), by which neurons are able to learn, through the reorientation of brain systems to new symbols, belonging to each culture. The baby, even without the developed oral language, has a natural curiosity, because everything he observes is new, even without speaking he demonstrates such curiosity. As you expand orality it enters the "why" phase. Hence, the role of parents and caregivers comes in when answering such curiosities, inciting her more and more, filling them with answers, thus creating the culture of curiosity that is so necessary to neuroplasticity. By formatting such culture, this child builds the will to learn, the search for more knowledge, changing and forming an instigating, investigative, self-taught and curious personality. The desire to read and learn is related to this personality shaped by the culture of curiosity.

RELVAS (2009) explains that to understand the mechanism of learning, it is necessary to know the functioning of the central nervous system, the organizer of our behaviors, because each type of skill or behavior is related to certain areas of the brain in particular, there are areas that are able to interpret stimuli that lead

to visual and auditory perception such as the hypothalamus and amygdala (present in the limbic system responsible for memory and emotion) , to understanding and linguistic capacity, cognition, planning of future actions, including movements.

The formatting of neuroplasticity started in childhood leads to the understanding that memory can be worked on from a very early age. A child inserted in a family environment where their curiosities are instigated, remedied and not devalued, will have more possibilities to memorize the object of knowledge, since they have contact with "'new' and this factor can determine this 'new' as learning and , consequently, in memory for being a more adapted brain". Memory has three stages: • Encoding which is the contact with the information, the Storage of this information and the Retrieval of the information. In order to store it in memory, attention is necessary, otherwise it will have deficits. (ABREU, 2020, p. 2). The formation of long-term memory, necessary in the process of learning to read, for example, requires structural and functional changes in neurons, especially in synapses, and in learning, new synapses are formed and old ones are strengthened.

OLIVIER (2010) states that Learning, in the view of cognitive sciences, occurs in three stages: *underlearning,* which is when the person comes into contact with the subject, but did not pay attention and, therefore, did not assimilate; *simple learning* , when the person came into contact with the subject, paid attention, but did not memorize it; and *superlearning or ideal learning* , which occurs when the person came into contact with the subject, paid attention, assimilated and memorized it. In the first two cases, interventional monitoring is necessary to detect where there is and what is the existing failure, whether they are psychological, organic, or failures in the teaching-learning system – role of the mediator in Vygotsky (1998).

Teaching a person a new skill implies maximizing the brain's functioning potential, as learning requires planning new ways to solve challenges, activities that stimulate different brain areas to work with maximum capacity and efficiency. Learning is only formative: " *insofar as it operates transformations in the constitution of the* learner " (RELVAS, 2009, p.26) and thus it is possible to say that there was activation of a cortical area, determined by a stimulus, causing changes in others areas in intra-hemispheric connections or not.

Reading acquisition is a complex process and requires all brain areas to be developed. We learn through three verbal systems: the auditory (spoken word), the visual (read word) and the written, and the auditory is acquired naturally, while the other systems are developed. Language can be understood in three aspects: semantic language – spoken and written words and their meanings; phonological language – sound of words; and in syntax

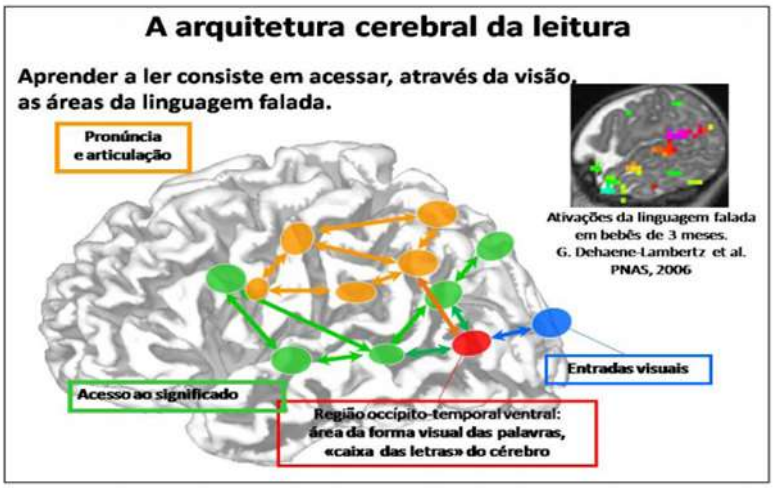
– grammatical rules. Spoken language or speech is translated into sounds that depart from the brain area called Broca and are arranged in reading or writing.

For reading, it is necessary to participate in the existing connection between the visual cortex (occipital lobe) where the graphemes are identified and Wernick's area (temporal lobe), where the graphic symbols of writing are recognized and understood. Sounds are picked up and taken to the cerebral cortex of Wernick's area, where they are decoded and recognized by comparing them to previously memorized sounds. The ability to decode phonemes is linked in parallel to Broca's area (phonation) and verbal perception to Wernick's area, which confirms that learning to read and write, cultural inventions, need explicit learning and must start from sound and visuals to be effected. (Annex 1)

The ability to decode is learned. " *If the decoder is weak, reading comprehension will be poor. Learning to read essentially consists of acquiring the skills to decode*". (CAPOVILLA, 2005, p.22). " *Reading-writing is a cultural object that was created and developed from the readaptation of neurobiological networks destined for other adaptive functions of our species*" (BENEDETTI, 2020, p. 111) .

Parallel to the speech system, the visual system is structured and at around six years of age the ventral visual system (responsible for letter recognition) is in intense plasticity, which makes this a favorable moment for teaching reading, and that it requires extensive neuronal reorganization (neural recycling) to install itself in visual and linguistic circuits. The occipitotemporal cortex was not developed to learn to read, it was the writing systems that adapted to be recognized by it.

Figure 3 – The brain architecture of writing processing




Source: Dehaene (2012)

According to DEHAENE (2012) we do not inherit a reading organ, nor are we like clay malleable to all types of learning, which shows that learning is based on the innate and brain plasticity has certain limits, although it is this that, in its flexibility, it partially reconverts our visual cortex to recognize letters and words. The recognition of words in primates is not global, " *the visual object explodes into myriads of small fragments that our brain strives to recompose line by line and, in the case of reading, letter by letter*" (BENEDETTI, 2020, p. 119) .

Learning to read in DEHAENE (2012) goes through three phases in the child or brain pathway and universally (it happens in the human brain anywhere on the planet and for any language): the *logographic* phase in which the child registers or identifies the image global of some words usually seen more often as if photographing them within a visual treatment that is based on the principle of invariance of the letters through the occipital visual regions; the *phonographic* phase in which the child, through school teaching-learning, learns the alphabetic principle, accessing sounds, learns to decode graphemes into sound classes and to pronounce through the left ventral occipitotemporal region; and the *spelling* phase in which the child, within a training and automation of the phonological reading strategy, begins to recognize the spelling of morphemes as well as the meaning of words (semantic cortical areas), in a process in which the various brain circuits, especially the left occipitotemporal cortex was profoundly modified, because "*Learning to read consists, therefore, in connecting the visual areas with the areas of oral language* ". (DEHAENE, 2012, P.78).

*"to the activation and development of neural circuits in specific regions of the brain, which since preschool age are already present, mainly located in areas of the left cerebral hemisphere* " (ACADEMIA BRASILEIRA DE SCIÊNCIAS – Infant Learning, 2011, p. 40).

Learning the letters, the sounds of the letters, the invariances, phonemes, syllables, letters, words and sentences does not mean that the teaching of understanding should be left aside or for a later act, quite the contrary, the two processes must be linked and walk together. Reading helps the reader to broaden comprehension, as reading always implies both the ability to recognize and understand the meaning of what is read. To understand a written text, a person learns to read, becomes able to read and uses this ability to broaden understanding by learning more and more. " *Learning to read essentially consists of acquiring the skills to decode.*" (GT: CHILD LITERACY: the new paths final report, 2007, p.27) and the document continues:

*"The essence of learning to read is translating letters (printed, written) into sounds that make sense. [...] learn to do phonological decoding (that is, convert sounds into letters for writing and letters into sounds for reading). [...] the purpose of reading is to allow the reader to*

*understand, interpret and modify the text by dialoguing with it."* (p.27) *"It is a well-established scientific fact that learning to read requires: understanding the alphabetic principle, learning the correspondences between graphemes and phonemes, segmenting spelling sequences of written words into graphemes, segmenting phonological sequences of spoken words into phonemes, and using grapheme-phoneme correspondence rules for decoding information."* (p.28)

Reading is like a learner's achievement: the literacy process serves to help the child discover the fundamental principle, the alphabetic principle underlying the alphabetic code as well as all the skills that are necessary for the development of the fluent reader: phonological processing, morphosyntactic manipulation language, working memory and logical thinking, phonological memory, vocabulary, phonological awareness (especially phonemic) and sequencing. Children's brain extracts speech segments, exploring their regularities and phonological rules and this learning is implicit and spontaneous, while learning to read and write requires systematic and explicit teaching.

### 3.3 TEACHING METHODS OF READING

Considering the constant and rapid scientific evolution, and especially in the field of Education, especially in the literacy bases within neuroscience, scientific evidence obliges researchers to review and reformulate their theories and hypotheses, and this in any area of knowledge. The biggest question is: *Why Brazil and its educational system still insist on remaining short of scientific discoveries about how the human brain learns to read, wrapped in literacy policies and practices, whose methods come from developed countries, but which have already surpassed and Have they reformulated their literacy methods* ? It is no longer possible that areas such as education, psychology, pedagogy, speech therapy and others remain behind from the neurobiological point of view of how the human brain learns to read. The results have been disastrous.

The teaching of reading has been developed along two paths or approaches: the global and the analytical called phonic. The latter occurs through the teaching of the alphabetic principle, as it considers that learning to read is not natural and spontaneous, it sees the need for formal learning of the alphabet through systematic and explicit teaching of phonological awareness. The global method is based on recognizing whole words as a unit of the child's reading and context. The teaching of the sound of letters does not take place in an explicit way. The *GT* report *: CHILD LITERACY: the new paths final report* (2007) brings the following consideration based on the experiences of other first world countries:

*" the teaching practices recommended by the PCNS do not represent the best techniques and practices, recognized worldwide for children's literacy; the*

*concept of literacy espoused and adopted by the majority of Education Secretariats in Brazil is not shared by the governments of industrialized countries where alphabet-based languages predominate.*" (p.146)

Without the arrogance of underestimating the importance of the documents that guided Brazilian education and especially literacy, it is possible to see that in the National Curriculum Parameters (PCNS, 1998) and in the BNCC (2017) learning to read cannot start with letters, syllables and words or sentences out of context, confusing the objective (to teach the student to produce and interpret texts) with the process (learning to read) of literacy , i completely ignoring the findings of neuroscience that it claims, throughout the study and brain mapping, that our visual sense captures the image and it explodes into small fragments that our brain strives to recompose line by line, letter by letter, in addition to what confuses reading with understanding. The global word teaching approach demands a lot from the child's memory, as he was not taught the mastery of the alphabetic code for decipherment. The brain is forced to use neuronal pathways that are not suitable for processing reading (brain activation takes place in the right hemisphere in the global approach). And, even if it is a slow progress, reading from the grapheme-phoneme decoding allows you more security, less probability of making mistakes when you are an adult, as well as mastering the alphabetic code, makes the child read new words or not .

We read to understand, as this is the purpose of reading and should not be ignored by any method. A person can understand without reading and read without understanding. "*Reading is different from learning to read. The process of learning to read cannot be confused with the purpose of reading*". (CAPOVILLA, 2005, p.20). The purpose of learning to read in order to understand does not need to learn the act of reading and writing, and one process does not impede the other.

*"Functional and neurophysiological imaging studies have shown that during learning to read according to the phonological model, the teaching of phoneme-grapheme correspondence implies a greater activation of the superior angular and supra marginal temporal gyrus of the left hemisphere, which is called the pathway indirect .*" ( BRAZILIAN ACADEMY OF SCIENCES – childhood learning, 2011, p.67)

Several countries showing great concern with their literacy methods and educational issues. All neuroscientific studies in relation to reading reinforce the importance of stimulating the phonological decoding capacity at the beginning of literacy (05 to 07 years old), regardless of the approach and method used, as such a delay may imply in the loss of the best moment for the

development of this capacity, after this moment (called the critical period ), the techniques would be around intervention and rehabilitation for the realization of learning to read. The phonic process, therefore, is beneficial as it corresponds to the neurobiological process.

### 3.4 LITERACY POLICIES

When analyzing historically, we realize that literacy policies and practices in Brazil have remained firm and rooted in social conceptions of education and, therefore, under a single perspective of understanding and applicability. Therefore, it is necessary that literacy policies accompany neuroscientific advances for public benefit as recommended in the objectives of the OECD ( *Organization for Economic Cooperation and Development* ):

"*founding and defining the requirements for collaboration between educational science and brain research* " and " *promoting education policymakers and brain researchers together, as well as presenting research facts that we can (and should and should) we must) transpose into practices, if we want to make the educational system more efficient* ". (BRAZILIAN ACADEMY OF SCIENCES – childhood learning, 2011, p.69)

In 2003, from the *Programa Brasil Alfabetizado, the "GT: CHILDREN'S LITERACY: the new paths* " created a final report that was presented by the Committee on Education and Culture in the Chamber of Deputies in the government of President Luís Inácio Lula da Silva, brought a extensive and grounded discussion on the neuroscientific discoveries of learning to read, at the Seminar *Legislative Power and Children's Literacy: New Paths* , held on September 15, 2003, which became a documentary report in 2007. In 2004, the *Committee Cearense for the Elimination of School Illiteracy* of the Legislative Assembly of the State of Ceará, produced a *final* report *Quality Education Starting at the Beginning* that pointed to literacy the same essential components identified by the *National Reading Panel* giving rise to the *Program Literacy in the Right Age* (PAIC) of the state of Ceará. (PNA, 2019, p.17).

The document, in comparison with general guidelines, national documents and literacy programs in other countries such as Brazil, found that: the guidelines for programs and curricula are based on scientific and non-philosophical criteria as in Brazil, as the philosophical criterion is a competence of the school as an institution and is included in its political pedagogical project, the PPP; however, the guidelines are concrete covering competencies and skills to be taught in the literacy cycle; the instructions for the structured and sequential teaching of literacy is detailed and directive; the contents to be taught in the literacy cycle must be related to the skills needed to learn to read, focused on decoding, mastery of the alphabetical code,

phonological awareness, fluency and understanding, unlike literacy programs and policies in Brazil.

In 2017, the BNCC was enacted and in 2018 the Mais Literacy program was created. Thus, considering literacy, the BNCC maintains the main assumptions contained in the PCNS, but presents changes that can already be visible from the perspective that the appropriation of the alphabetic writing system has specificities and should be placed as the main focus of pedagogical action in the early years , being able to glimpse a connection between the end of early childhood education and the beginning of elementary school: the literacy cycle. Despite not losing focus on the social use of language and writing hypotheses as seen in the PCNS, the Base demonstrates a certain openness to work explicitly with the alphabetic system and phonological awareness and proposes skills and competences in the acquisition of alphabetical notation , sometimes in the immersion of the text in its social context. Such aspects must not be dissociated.

In 2019, the PNA - *National Literacy Policy* tried to rescue the scientific basis on how the human brain learns to read, via Decree 9765 of April 11, 2019. Several groups from the literate society participated in the construction of this document by inserting in Brazil the foundations of cognitive sciences to obtain more effective literacy practices, based on scientific evidence and successful experiences in Brazil and in the world . It is divided into literacy, numeracy and literacy: literacy consists of teaching and learning reading and writing skills regardless of the writing system used, advancing to applicability (autonomous understanding and knowledge production) and is divided into basic and intermediate literacy and disciplinary, (UNESCO, 2006) and literacy is the teaching of reading and writing skills in an alphabetic system. (PNA p.18).

Another program created by the PNA is the *Time to Learn* , whose purpose is to tackle the main causes of literacy deficiencies in the country and aimed at the last years of pre-school and the 1st and 2nd year of elementary education in state, municipal and public schools. district, offering pedagogical support for literacy, Continuing training of literacy professionals with emphasis on BNCC skills and abilities and explicit, direct and systematic teaching based on phonological awareness and apprehension of the alphabetic code whose modules are: Learning to listen, Alphabetical knowledge , Fluency, Vocabulary, Comprehension, Writing production, Assessment as well as Improvement of literacy assessments and Valuing literacy professionals. In 2020, the ABC Course – Evidence-Based Literacy was launched, bringing theoretical perspectives on the subject from RENABE[8] .

## 4 METHODOLOGY

This article used bibliographic research as a research strategy, whose

research sources were technical reports and articles, as well as research in books by renowned authors, added to data collection through research carried out in the MEC databases and others websites linked to Education.

This research has an exploratory and descriptive character in that it tries to answer some questions, understand some collected data, deepen studies, describe the theme and explain the concepts to be presented about literacy - learning to read based on the Cognitive Sciences of Reading, interconnected , therefore, with educational neuroscience, cognitive psychology and pedagogy. Its exploratory character comes from the question whether there is or has been in the country research and literacy policies based on neuroscience, arising from the search for literacy reports or programs that match the theoretical framework and what the results have been in terms of literacy in the country in recent years.

The purpose of this work is to encourage the further study of the theoretical framework to develop scientific works and applicability in the classroom context, considering the almost scarcity of research materials on this subject and of didactic and pedagogical materials that are properly elaborated. for the basic work in literacy and teaching of the mother tongue having as a presupposition the Cognitive/Educational Neuroscience.

**5 RESULTS**

Understanding that the human brain has multiple efficiencies, such as individual, social, motor, affective-emotional, creative, inventive and genius brain, as well as knowing how it behaves to promote learning, the teacher will have another perspective of educational practice, not only by the need for pure and simple change, but by the knowledge of how to make the student learn or how to act in the face of learning disorders. The change will occur consequently, in the conception that the focus will be on learning and not only on the teaching process.

If this professional is confident about his repertoire of learning to read based on scientific evidence, he will inevitably change or adapt his teaching practices. You will notice that the purely expository class, without the conscious concern with the child's prior knowledge and motivating stimuli, without the concern of doing together ( didactic mediation and cognitive mediation by direct instruction ), without the innovation to deal with the same content so that it reaches to all kinds of intelligence, it will possibly fail in its goals and in the teaching process. It is necessary to create " *individualized education cycles based on all the technological potential* ", since Education must be singular and not plural, because "the student, the being that is in front of us must be seen in its particularities, it must be motivated to develop their capabilities, the areas of their interest and where it is particularly

outstanding. Teaching must be done at its own pace, exploring the best of each one" (ABREU, 2020). Direct instruction assumes that all students can learn as long as they receive instruction that is motivating, stimulating (planned stimulation) and well suited/appropriate to the types of intelligence presented in the classroom.

In terms of specific public policies for literacy, it is necessary to be based on scientific criteria and methods, clearly define what literacy is and how it is, provide materials and training for teachers, systematically evaluate the results, expand debates and forums for scientific production, and within the classroom, expand the use of systematic, explicit and direct teaching, adjust the time of direct instruction, systematically use the phonic approach to teaching reading, use diagnostic tools for the process, promote family literacy, intermediate and advanced, as well as improving and perfecting issues related to teachers and school management throughout the country.

## 6 FINAL CONSIDERATIONS

Therefore, through this proposal, we seek to encourage further studies with regard to evaluating the effectiveness of literacy methods developed in the classroom across the country, as well as evaluating the results, whether in experimental laboratory contexts or in field studies involving teachers and their classrooms, taking as an example the many literature reviews that address this issue through neuroscience in other countries, and that used complex statistical models to discuss literacy outcomes.

There is an urgent need to produce teaching material - pedagogical and scientific research based on neuroscience on the elements that the Cognitive Science of Reading exposes in the literacy process: phonological awareness, phonemic awareness, system decoding and alphabetical code, fluency, vocabulary expansion, comprehension and writing production. The Cognitive Science of Reading opts for the phonic instruction or phonic approach, proven to be the most effective for alphabetizing, despite being the most criticized.

Advances can be seen in current public education policies such as the BNCC and the PNA, because from them we can glimpse the achievement of goals 5 and 9 proposed in the National Education Plan, considering that Literacy is an instrument to overcome vulnerability Social. Hence the need, as an educational system, to expand studies in the area to answer these and other questions in order to create effective, preventive and corrective literacy programs, as this is the least we can guarantee to children in Brazilian society.

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