DAMARIS FLOR LITERACY NEURODIDACTIC METHOD: AN ASSOCIATION BETWEEN THETA (4-8 Hz) AND BETA (15-23 Hz) BRAIN WAVES

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ABSTRACT

Introduction: The Damaris Flor literacy method was based on an adaptive neurodidactic protocol based on the three order symbologies of human communication, which are image, sound, and spelling. This construction makes it possible to base the acquisition of reading through the phylogeny of writing transformed into a literacy teaching method in Brazil, made possible by the association between image, which depends on Theta waves (4-8 Hz), and words, syllables, and letters, which depend on the Beta waves (15-23 Hz). The authors Damaris José Flor da Silva and Fernanda Crístian Gonçalo da Silva developed this method, after a meeting of several scientific studies on the electrical brain activities responsible for the learning process of human beings, especially of individuals who have a higher percentage of Theta waves (4-8 Hz) when compared to total Beta waves (15-23 Hz). ***Objective:*** The objective of this study was to report the origin of the method and the sequence of the strategic organization of the adaptive neurodidactic protocol for image-based literacy teaching. ***Method:*** Searches were carried out in the electronic databases MEDLINE/PubMed, Web of Science, SCIELO, Lilacs, Scopus, CAPES journal portal, BIREME and Google Scholar, and the findings were organized and described in a narrative review pattern. ***Result:*** The applicability of the Damaris Flor Neurodidactic Method covers, in its protocol, the following categories: 1st) Foundation, 2nd) Structure, 3rd) Complement and 4th) Sustenance or maintenance of the reading acquisition process. ***Conclusion:*** This study found several findings demonstrating that Theta waves (4-8 Hz) are associated with the production of images, creativity and mental representation and Beta waves (15-23 Hz) with the production of words. These findings also made it possible to understand that literacy, using images, colors and words, allows greater activation and integration between several neural circuits, facilitating learning. Finally, it was concluded that the organization of the Damaris Flor Neurodidactic Method in the 4 (Four) categories (Fundament, Structure, Complement and Support), possibly allows the creation of synapses, increases concentration and the ability to maintain the focus of attention, enables the understanding of nominal realism, stimulates executive functions and the associative cortex, and allows complete reading associated with social functions.

INTRODUCTION

The Damaris Flor Neurodidactic literacy method: different paths to literacy, was based on an adaptive Neurodidactic protocol based on the three order symbologies of human communication (image, sound, and spelling) (BERGMAN*et al*., 2018). This method allows the acquisition of reading through the phylogeny of writing transformed into a didactic protocol of literacy through the association between image and word, syllable, and letter in the neurological and linguistic process of literacy developed by the authors Damaris José Flor da Silva and Fernanda Crístian Gonçalo da Silva in 1992 in the city of Recife/PE, Brazil. At first, the authors developed the method through empirical observation.

This experience subsequently led them to an incessant search for understanding this specific type of brain functioning through several studies (CHABOT *et al*., 2001; CHABOT *et al*., 1996; CHABOT & SERFONTEIN, 1996; MONASTRA *et al*., 2001; MONASTRA *et al*., 1999; MONASTRA *et al*., 2002; VALDIZAN & ANDREU, 1993) organized and described in a narrative review pattern. The whole context of this review was directed to the electrical brain activities responsible for the learning process of typical or atypical human beings, especially those individuals who managed to communicate better with the outside world through images, made possible by Theta waves (4-8 Hz), instead of words, made possible by Beta waves (15-23 Hz) (RIBAS *et al*., 2016). The greatest examples of findings in quantitative electroencephalography (QEEG) in the

literature of electrophysiology, demonstrating high amplitudes of Theta waves (4-8 Hz) are with individuals affected by Autism Spectrum Disorder (ASD) (MEKKAWY, 2021), Dyslexia (MAHMOODIN *et al*., 2019) with excess of Delta waves (2-4 Hz) and Theta (4-8 Hz) in Wernicke's area and/or Attention Deficit Disorder with or without Hyperactivity (ADHD) (NEUROFEEDBACK COLLABORATIVE, 2022) with excess Delta (2-4 Hz) and Theta (4-8 Hz)) in most of the brain, especially in the prefrontal region (CALAFANGE *et al*., 2023). There are two patterns of ADHD studied and already presented by the scientific community in the quantitative electroencephalography approach described by the Trainers' QEEG method in version 7 (TQ-7) (RIBAS *et al*., 2016). These two patterns were studied and made possible from a perspective of descriptive percentage statistics, based on the Theta/Beta ratio (ROLEY-ROBERTS *et al*., 2022), and published in the Scientific Journal Dementia & Neuropsychologia in 2016 and were called Processing (with excess of the Theta wave percentage) and Filtering (with excess Beta wave percentage) (RIBAS *et al*., 2016). The percentages of each brain wave of the Theta/Beta ratio are calculated and compared using the reasoning that the brain presents an alternating current signal – A/C (GUARNIERI *et al*., 2020). The voltage, in this case, is not equivalent to the peak value, but to the effective value, which corresponds to a sine function, because the amplitudes vary, and because it is a sine function, the Fourier Transform is used to define the power spectral density (CUSIDÓCUSIDO *et al*., 2008). Signal power is a squared value and percentages must be calculated relative to the total brain power.

Brain waves are generated in different regions of the brain and have different functions (KAMIYA-MATSUOKA & TUMMALA, 2017). In the eligibility criteria of brain waves for the study and elaboration of the adaptive and neurodidactic method of literacy, the authors highlighted exactly the frequencies of brain electrical activities related to ASD processes (CHAN *et al*., 2007), Dyslexia (WALKER; NORMAN, 2006) and ADHD (OGRIM *et al*., 2012) for facilitating the understanding of learning difficulties, especially because, in these dysfunctions, the individual tends not to focus on external stimuli, staying inside the mind, processing images (RIBAS*et al*., 2016) due to the specific feature of functionality of the Theta wave (4-8 Hz) (NETO *et al*., 2018). In this sense, the inclusion criterion highlighted the understanding of the functionality of the Theta (4-8 Hz) and Beta (15-23 Hz) waves (CHIARENZA *et al*., 2016; DELGADO-MEJIA *et al*., 2014; PARK *et al*., 2017). Theta wave describes the frequency of 4 to 8 Hz and is predominant in subconscious states, enabling creativity, intuition, visionary, jump in conclusions and, mainly, image processing and its origin happens in two different regions of the Central Nervous System (CNS). Theta frequency (4-6 Hz) is generated in the thalamus (NETO *et al*., 2018) and theta frequency (6-8 Hz) is generated in the hippocampus (DO NASCIMENTO FILHO *et al*., 2018; RIBAS *et al*., 2016).

METHODS

This is a study with a qualitative approach; with an exploratory and descriptive objective; source and literature review collection procedure. A narrative review was carried out through a search in the electronic indexing databases MEDLINE/PubMed, Web of Science, SCIELO, Lilacs, Scopus, CAPES journal portal, BIREME and Google Scholar.

RESULTS

Neurodidactic method of literacy Damaris Flor: The elaboration of the method was constituted, from the use of images due to the excess of the amplitude in percentage of theta wave (4-8 Hz) (MARKOVSKA-SIMOSKA & POP-JORDANOVA, 2017), when compared to the amplitude in percentage of beta wave (15-23 Hz) and covers, in its protocol, according to the authors, the following categories or cycles: 1st Foundation, 2nd Structure, 3rd Complement, and 4th sustenance or maintenance (FLOR DA SILVA & CRÍSTIAN,

2017). This method has already mediated the literacy of approximately 12,000 (twelve thousand) typical students and 800 (eight hundred) atypical students, since its implementation in 1992.

1st Cycle (Foundation of literacy): 1st Cycle or foundation phase of literacy is mediated by a referential block of previously systematized activities for self-programming the learner's brain with guide images for reading the whole of words and their parts in syllables, sounds and letters, sharpening the learner's perception for the quantity and repetition of phonemes and graphemes, as well as word formation by juxtaposing syllable guide images in the apparent syllabism of the alphabetic language (FLOR DA SILVA & CRÍSTIAN, 2017). Foundation is a category that was called foundation cycle of literacy organized by the authors in 106 referential activities for this 1st Foundation Cycle. This imagetic initial cycle represents the establishment of the didactic contract between the professor and the student in a subtle and welcoming way and, at the same time, the insertion of the first synaptic clues (PÉREZ-OTAÑO & EHLERS, 2004). These new synapses will enable the creation of large learning neural networks (HAGAN *et al*., 1996; SCHMIDHUBER, 2015; SUTSKEVER *et al*., 2014), which will enable what Jean Piaget called mental schemes (GRIDER, 1993). In this first cycle, the authors suggest an opening with a message, which helps to promote a presentation between the Damaris Flor method and the learner, allowing the establishment of a relationship of trust, acceptance and security (BROOKFIELD, 2015). In this initial welcome, the student is informed that he/she will learn by playing, without crying, with drawing and being able to make a mistake to get it right, considering the applicability of the association between cognition and affectivity (GALASTRI, 2009) in the learning process, according to Henri Wallon (WALLON & CARVALHO, 2007).

The initial message mentioned above at the end of the previous paragraph brings, in its intention, the communication that there will be no repression or judgment (ERIKSEN & KUETHE, 1956). This message also communicates that there are rules, because even in children's games there are rules. However, there is the possibility of making mistakes between these rules, metaphorically expressing that you do not need to feel fear or discomfort, validating the feeling of empathy (BACHARA, 1976; COOPER, 2010) between the Damaris Flor method mediator and the learner. After establishing the relationship, the mediator will present the magic house, stimulating the imaginary mental representation that everything will fly away, such as: rooster, bicycle, orange, ball, avocado, dice, knife, plane, monkey, boot, pencil, among others. Then, the mediator should inform that the name of the game will be Hunting for Magic, because everything will fly out of the magic house and, without the student realizing it, the mediator will already be conducting the learning process following the protocol, stimulating them, first of all, to think about the objects in the magic house, saying: do you know the name of all these things? The objects are represented in images, as if they were flying out of the magic house. Then, to encourage the student to participate, the mediator says: choose three beautiful objects from this house. At that moment, the students interact with the mediator and among themselves, debating the three best drawings they chose (FLOR DA SILVA & CRÍSTIAN, 2017).
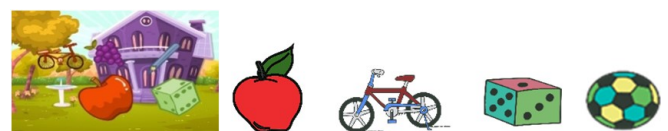
Still following the 1st cycle, the mediator will present each drawing accompanied by the written form of each one. From that moment on, the learner begins to create the first synapse of logical understanding that each image has a written form. What enable the perception of images in the brain are the Theta waves (4-8 Hz) (DO NASCIMENTO FILHO *et al*., 2018) and what enable the perception of words in the brain are the Beta waves (15-23 Hz) (RIBAS *et al*., 2018). However, during the applicability of the Damaris Flor Method there is no increase in the amplitude of the Beta wave (15-23 Hz), but rather, the combination of the Theta wave (4-8 Hz) with the Beta

wave (15-23 Hz), which is the association of the image and the written form of the image, thus enabling the understanding and perception of writing, now neglected by the brain due to the low amplitude of the Beta wave (15-23 Hz) in these children (RIBAS *et al*., 2016).

HOUSE　MONKEY　PADLOCK　AIRCRAFT　ICE CREAM
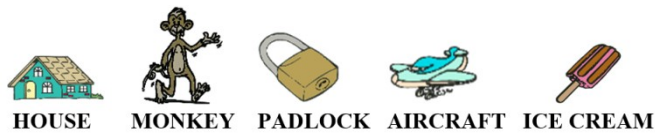
Then, the mediator asks the learner to mark a dash on each letter. Afterwards, the mediator asks the learner to mark the same letters in the words of the different images, because, in Damaris's practical experience, the author observed that one student, one day, argued with another, saying that the letter on the toy, which his colleague had in his hands, belonged to his father, believing that each word has its own letter (FLOR DA SILVA &; CRÍSTIAN, 2017).

HOUSE　COCK　ALLIGATOR　PARROT
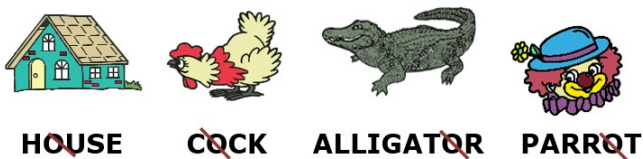
Still in the 1st cycle, the Damaris Flor method stimulates the perception of small differences between some letters such as G and C. This, from a scientific point of view, increases the student's ability to maintain focus, which is highly evaluated by neuropsychologists in a test psychological test called Test d2 (ARÁN FILIPPETTI *et al*., 2022; GUERRA RIBAS *et al*., 2010). Afterwards, the author asks the learner to highlight the vowels in the words associated with the images. Based on the idea that the drawing or image contains the word in the first instance, the authors suggest that the mediator ask the student to link the drawing to the word. However, the connection is horizontal only; then, ask to circle the first letter of each word; then the task will be to paint the first letter; they are asked to connect the drawings to the words horizontally and name them again; then, they are asked to link the drawings to the first letters of the words. But still horizontally; you are asked to write the first letter of the drawing on a dashed line; reconnects the drawings to the letters. However, now they will not be connected horizontally anymore, but with diagonal crossings (FLOR DA SILVA & CRÍSTIAN, 2017). When the child thinks that everything big has a big name and everything small has a small name, the teacher must work on nominal realism (DELOACHE, 1991), that is, nominal realism is worked on at the age of (4-5 years) in the period classified as preoperative by Piaget (2-7 years) (MARWAHA *et al*., 2017) or whiles the period known as illiteracy outside the age range lasts). Some students in this context tend to associate the size of the object with the size of the words, involving the number of letters. Thus, to work on breaking nominal realism, it is now proposed to cross out the biggest thing in each pair. It's not the biggest design. But the biggest objects; then, they are asked to cross out the smaller objects, not the smaller drawings; then, they are asked to write the first letter in drawings displayed on a board, but they are drawings that start only with vowels, such as: church, glasses, grape, elephant, and plane, among others. While the authors introduced nominal realism in this phase of the Damaris Flor Method, they also began to include Jean Piaget's classes, linked, however, to linguistic neopositivism, highlighting the knowledge of vowels (FLOR DA SILVA & CRÍSTIAN, 2017).

Then go back to writing the first letter of each drawing in dashed lines; then, they are asked to cross out the drawing that has the word, which names it, bigger, which are: bicycle, church, cow, pineapple, parrot, house, padlock, etc.; then, they are asked to cross out right or wrong and return to working on nominal realism, asking themselves the following question: can a large object have a small name? And then there is a drawing of a cow with the word cow; the question is also asked: can a small thing have a big name? And there is a drawing

of a padlock and the word padlock; it is asked: can big thing and little thing have small names? And the drawing of a house and the word house is exposed next to the drawing of a ball with the word ball (FLOR DA SILVA & CRÍSTIAN, 2017). Further on, several drawings of objects are shown: church, glasses, monkey, padlock and plane, and they are asked to write the first letter of the name of each drawing on the box (It is a kind of demonstration/return, which the child gives to the teacher, if you learned the vowels or not); then, the letter A of each word is crossed out: avocado, ball, cat, jackfruit, crazy, salad, among others. This task will encourage the child to realize that almost all words have the letter A; ask to cross out the letter "E" of each word: finger, ladder, elephant, tree, table, Pelé; Cross out the letter "O" in each word: mouse, among others. Then, the mediator presents various objects, such as: padlock, church, airplane, and monkey, and asks the learner to write the first letter of each object. Now, in a way, the learner will return it, demonstrating whether he has learned to identify the letters or not. It is a way of identifying Piaget's Assimilation process (BORMANAKI & KHOSHHAL, 2017). In the next exercises, continuing the precept of learning feedback, the mediator should ask to cross out the letter "a" of each word and this will draw the learner's attention to the fact that all the words shown by the mediator (the) have the letter "a", such as: avocado, ball, house, dice, knife, cat, jackfruit, monkey, shoe, crazy, and salad. In this exercise, the learner will believe that every word has the letter "a". But the mediator should not say yes or no, but involve him in the next exercise, which will teach that not every word has the letter "a". In the next one, the mediator already says: cross out the letter "e" of each word and expose the following: finger, ladder, elephant, avocado, padlock, Rebeca, school, alligator, table, and Pelé. Finally, this cycle represents letters, the relationship between sounds and syllables and the formation of the word by juxtaposing drawings, joining the first syllable of each drawing to induce mastery of the word two-syllable, three-syllable and simple polysyllable.

VIDA　SA　U　DE　BANANA DA
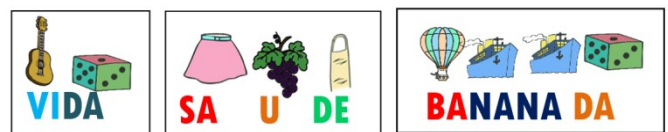
Legend of the meanings of words in Portuguese:

Vida - Life;
Saúde - Health;
Bananada - Brazilian cuisine meaning dessert made from banana pulp.

2nd Cycle (Structure of literacy):

The Literacy Structure Cycle is a category that was organized by the authors to mediate the self-programming of the student's brain to deal with the official structure of the language without the aid of images or face-to-face drawings. In this phase, the images are removed from the activities, knowing that the image of the word will remain in the student's brain, anchored by the inseparable neurolinguistics principle of meaning (image) and signifier (sound) of the word (AKHUTINA, 2003). This literacy structure strategy ensures the initiation of the reader effectively and quickly. This cycle repeats the teaching of letters, relationships between sounds and syllables and the reading of words and phrases without necessarily resorting to drawing. It is noticed, during the application of the Damaris Flor Method, that this way of teaching involves the applicability of the intertwining of learning neuroscience made possible by electroencephalography, the use of the use of cognitive development in several phases described by Piaget (sensory-motor, pre- operative, concrete and formal operative) (SAMAIYA, 2022), in the context of the images, the Gestalt method (Supersoma, transposability, segregation, similarity, unity, proximity, pregnancy, simplicity and closure, which enable the brain to see the whole, and not the parts, in the sense of the child looking at an image and associating that every image also has a written form) (O'CONNOR, 2015), because, the brain responds, images and symbols due to the primitive inheritance of engravings, (RUSHTON & LARKIN, 2001), as well as, due to their parallel with

the phylogeny of writing in humanity that developed ideo-phonically-graphically with the Egyptians, the Phoenicians, the Greeks and the Romans and, above all, by Behaviorism with the triple contingency (MEDINA ARBOLEDA & SANDOVAL ESCOBAR, 2011), where and the consequence stimulates a change in behavior, highlighting the analytical units of [Sd: R + Sr]. In this case, the condition of perceiving through images or figures seems to be the consequence that stimulated and stimulates the will to learn or motivation, and with repetition, which is the main mark of conditioning in behaviorism, it is possible to reach a high performance of reading learning (RIBAS *et al.*, 2016).

3rd Cycle (Complementary Literacy): Complement is a category that was for the self-programming of the literacy student's brain to deal with the neurolinguistics specificities organized by the authors to enter the advanced phase of the structural cycle of the acquisition of reading and writing. This cycle represents the mediation of changes in syllables categorized by the authors as linguistic additions and intercalations (FLOR DA SILVA & CRÍSTIAN, 2017). Linguistic additions occur with the insertion of letters (r, s, l, m, and n) at the end of syllables to change them in their phonic-graphic representations of reading-writing, such as occur in Portuguese words: *parta – pasta – campo – canta* and so on. While the linguistic intercalations occur with the insertion of letters (r, l, h) inside the syllables to modify them, such as in the words (*Prata – placa – chave – minha - pilha*) and others (FLOR DA SILVA & CRÍSTIAN, 2017).

Linguistic additions and intercalations to represent phonic-graphic changes in syllables (OEHRLE, 2002).
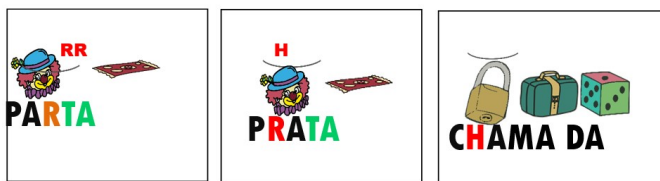
Legend of the meanings of words in Portuguese:

Parta - *Part comes from the verb to leave. Same as: shatter, divide, break, flee, shake, set sail, fragment, subdivide, fractionate;*
Prata – *Silver (Chemical element, metallic and precious, with atomic number 47);*
Chamada - *Call (Act of calling people to verify their attendance);*
Pasta - *Portion of solid matter agglutinated, bonded or kneaded with a liquid or viscous substance. Example: toothpaste;*
Campo - *Field;*
Canta - *Verb to sing in the third person singular of the present tense;*
Placa - *Metal or plastic plate affixed, for example, to a car with the purpose of its official identification;*
Chave - *Key;*
Minha - *My, possessive pronoun.*

4th Cycle (sustenance ormaintenance): Sustenance is a category organized by the authors that represents mediation of self-programming of the student's brain to perceive and master basic grammar in full reading with understanding and social function. In this phase, traffic signs are compared with written signs (CRUNDALL & UNDERWOOD, 2001), since both are symbols that issue express orders. (Period-Stop), (Question Mark-Ask) and so on. On the other hand, the stress of words signals to open or close the sound of the syllable and indicate the strongest syllable of the word in the basic stress of the language. This phase also shows the variation of the uppercase alphabet into lowercase and cursive. Finally, the Damaris Flor method, in this phase, completes the student's literacy with several exercises (FLOR DA SILVA & CRÍSTIAN, 2017).

CONCLUSIONS

This narrative review presented several studies demonstrating that Theta waves (4-8 Hz) are associated with the production of images, creativity and mental representation and Beta waves (15-23 Hz) with

the production of words. Several studies presented also made it possible to understand that literacy, using images, colors, and words, allows for greater activation and integration between various neural circuits, facilitating the learning process. The organization of the Damaris Flor Neurodidactic Method in the 4 (Four) categories (Fundament, Structure, Complement and sustenance or maintenance) enables the creation of synapses, increases concentration and the ability to maintain the focus of attention, enables the understanding of nominal realism, stimulates the executive functions and the associative cortex, and still enables full reading associated with social functions.

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