Overview of Neuroeducation Basic Principles

Panorama general de los principios básicos de la neuroeducación

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Abstract

The following working paper emerges from the first research stage of the junior research group Insights which is part of the Bachelor's Degree in Modern Languages with emphasis in English at Universidad La Gran Colombia. This first work is the recollection of the literature review and the background of the areas that neuroeducation involves in relation to the teaching and learning process of the language acquisition, specifically the foreign languages. The analysis and interpretation of the data collected is distributed in different categories such as introduction to neuroscience, brain anatomy, brain functions, cognitive functions, interdisciplinarity of neuroeducation, brain-based learning, neurodidactics and neurolinguistics. All the information summarized and analyzed allows findings to start some problem statements to contribute to research and innovative methodologies to enhance the educational acquisition and teaching of foreign languages.

Keywords: brain, cognitive functions, neuroeducation, neuroscience, neurolinguistics.

Resumen

El siguiente documento de trabajo surge de la primera etapa de investigación del semillero de investigación Insights que hace parte de la Licenciatura en Lenguas Modernas con énfasis en Inglés de la Universidad La Gran Colombia. Este primer trabajo es la recolección de la revisión de

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literatura y los antecedentes de las áreas que involucran la neuroeducación en relación con el proceso de enseñanza aprendizaje de la adquisición de lenguas, específicamente las lenguas extranjeras. El análisis e interpretación de los datos recolectados se distribuye en diferentes categorías como introducción a la neurociencia, anatomía cerebral, funciones cerebrales, funciones cognitivas, interdisciplinariedad de la neuroeducación, aprendizaje basado en el cerebro, neurodidáctica y neurolingüística. Toda la información resumida y analizada permite hallazgos que dan inicio a algunos planteamientos de problemas para aportar a la investigación y a metodologías innovadoras con el fin de mejorar la adquisición educativa y la enseñanza de lenguas extranjeras.
Palabras clave: cerebro, funciones cognitivas, neurociencia, neuroeducación, neurolingüística.

Introduction to Neuroscience

Jesús Daniel Barón Peña[2]

Neuroscience is the scientific study of the nervous system, which includes the brain, spinal cord, and peripheral nervous system. It is a multidisciplinary field that combines various disciplines such as physiology, anatomy, molecular biology, psychology, physics, and more. Neuroscientists aim to understand the fundamental properties of neurons, glia and neural circuits. They explore topics like learning, memory, behavior, perception, and consciousness.

There are numerous authors who have made contributions to the field of neuroscience. Some of these authors have made significant contributions including Cristopher Timmerman with his research of the altered states of consciousness, psychedelics, and brain function, which was deeply explained in the magazine Trends in Cognitive Sciences. Timmerman investigates the neural correlates of consciousness during psychedelic experiences in 2023. Other author is Leor Roseman which is known for his work on the effects of psychedelics, particularly psilocybin, on brain activity and subjective experiences in the article pharmacological and extra pharmacological perspectives. His research sheds light on the neural mechanisms underlying altered states of consciousness. Another neuroscientific is Robin L. Carhart-Harris, who is a prominent figure in psychedelic research, he explores the therapeutic potential of psychedelics for mental health conditions in the same magazine as Timmerman. His studies focus on the brain imaging, neural networks and consciousness in 2023, and many other authors. These authors have written extensively on various topics in neuroscience, contributing to the advancement of the field.

Neuroscience is a rapidly evolving field as well, with new discoveries and advancements being made regularly. Some of the advanced topics in neuroscience include brain connectivity, brains converging, and the use of polygenic risk scores. Other topics include the study of neural systems, machine learning for neural data analysis, Decision-Making processes, live 3D brain mapping, sleep and artificial brains and brain-computer interfaces. These topics represent the cutting edge of neuroscience research and are the focus of ongoing studies.

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In recent years, neuroscience has seen remarkable progress and discoveries, illuminating the intricate workings of the human brain like never before. One notable advancement is the refinement of non-invasive brain imaging techniques such as functional magnetic resonance imaging (fMRI) (Smith, J. D., & Johnson, A. B. (2020). Effects of sleep deprivation on cognitive function.) and electroencephalography (EEG) (Becker, S. I., & Harris, A. M. (2021) the role of attention in visual statistical learning, allowing scientists to observe brain activity in real-time with unprecedented clarity. These imaging technologies have unveiled insights into various aspects of cognition, emotion, and behavior. For instance, researchers have gained a deeper understanding of how different regions of the brain communicate and coordinate during tasks such as decision-making, memory retrieval, and language processing. Such discoveries have implications not only for basic scientific understanding but also for potential applications in fields like education, healthcare, and artificial intelligence.

Moreover, there have been significant breakthroughs in our understanding of neuroplasticity—the brain's ability to reorganize and adapt in response to experiences. Studies have revealed the mechanisms underlying neural plasticity, shedding light on how learning, rehabilitation, and environmental factors shape brain structure and function across the lifespan. These findings hold promise for developing novel interventions for neurological disorders and optimizing cognitive performance.

Neuroscience research employs a variety of methods. Some of these include Electroencephalography (EEG) which is used to record the electrical activity of the brain by waves controlling the amount of electrodes that are being emitted and picked up by signals generated by brain cells, Quantitative electroencephalography (QEEG) that is a modern type of electroencephalography (EEG) analysis that involves recording digital EEG signals which are processed, transformed, and analyzed using complex mathematical algorithms, Stereoelectroencephalography (SEEG), Functional magnetic resonance imaging (fMRI), Magnetoencephalography (MEG), These methods are used to study the activity within the brain during certain activities or behaviors.

In conclusion, neuroscience is a dynamic and interdisciplinary field that seeks to unravel the complexities of the nervous system, encompassing the brain, spinal cord, and peripheral nervous system. With contributions from diverse disciplines such as physiology, molecular

biology, and psychology, neuroscientists are making strides in understanding the fundamental properties of neurons, neural circuits, and their roles in behavior, perception, and consciousness.

The field has been significantly enriched by the work of researchers like Cristopher Timmerman, Leor Roseman, and Robin L. Carhart-Harris, who have explored the effects of psychedelics on brain function and consciousness. Recent advancements in brain imaging techniques, such as fMRI and EEG, have provided unprecedented insights into brain activity, cognition, and neuroplasticity, opening new avenues for understanding and treating neurological disorders. Additionally, cutting-edge research topics like brain connectivity, machine learning for neural data analysis, and brain-computer interfaces are pushing the boundaries of what we know about the brain and its potential. Overall, the ongoing discoveries and innovations in neuroscience hold great promise for enhancing our understanding of the human brain and improving mental health care.

Brain anatomy

Daniela Campuzano Rojas[3]

It is the most important and complex organ in the body located in the head for most living beings. It is protected by the meninges and a thick segment of the skull to prevent injury. It refers to the physics structure and brain functioning. Through the five senses of sight, smell, hearing, touch and taste, the brain receives messages, often many at the same time (Mayfield Brain & Spine, 2018). In addition, there are two types of cells in the brain which are neurons and glialglia cells.

Its process of growth from birth goes according to Physopedia (n.d., parr, 2):

> At birth, the average brain weighs about 350 - 400 grams, approximately 25% of the final adult brain weight of 1.4 - 1.45 kg and accounting for only 2% of overall body mass, which is reached between 10 and 15 years of age. The fastest growth occurs during the first 3 years of life, with almost 90% of the adult value reached by the age of 5 years. Its average width is about 140 mm, the average length is about 167 mm, and average height about 93 mm.

Furthermore, the brain controls a huge part of the body which gives it functioning and coordination, given that the thoughts, the memory and speech, also arm and leg movements and the function of many organs within the body are governed by the brain. Moreover, it is the part which people use when they face stressful situations in their daily life, i.e. writing of an exam, illness, loss of a job, making a discussion, and so on. And how they may regulate heart and breathing rates now (AANS, 2023).

It is formed by three parts which are cerebrum, cerebellum, and brainstems.

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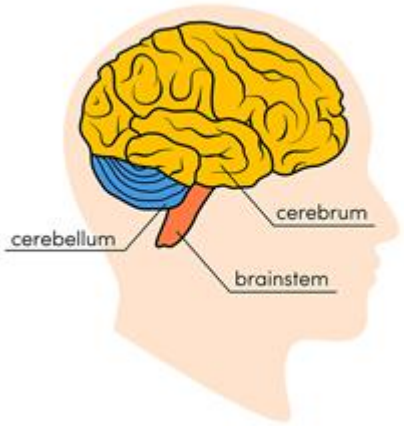

Figure 1. The three parts that make up the brain.

Note. Johns Hopkins Medicine (n.d.).

Cerebrum: The largest part of the brain, it is composed by the right and left hemispheres or halves which coordinate movements and other important functions. These two halves are linked by a bundle of fibers called the corpus callosum and send messages to the opposite side of the body.

Cerebellum: Located at the back of the brain, it is responsible for maintaining posture, coordinating movement and maintaining balance and motor learning (Jimsheleishvili and Dididze, 2023).

Brainstem: The brain is the link between the brain, the spinal cord and the cerebellum which sends and receives messages from the body. It also modulates heart rate, breathing and balance, as well as other basic functions. It contains three sections which are the midbrain, pons, and medulla oblongata.

Cranial nerves: There are 12 pairs of nerves which help the brain and body with the communication sense and/or movement throughout the head, face and neck regions.

CN I: Olfactory: It is responsible for the sense of smell.

CN II: Optic: Responsible for the visual fields and ability to see.

CN III: Oculomotor: Controls most eye movements; eyelid opening.

CN IV: Trochlear: Controls downward and inward eye movements.

CN V: Trigeminal: Responsible for facial sensation and chewing muscles.

CN VI: Abducens: Controls outward eye movements.

CN VII: Facial: Eyelid closing; Controls facial expression; taste sensation.

CN VIII: Auditory/vestibular: Responsible for hearing; sense of balance.

CN IX: Glossopharyngeal: Controls taste sensation; swallowing from the back of the tongue.

CN X: Vagus: Regulates various involuntary functions such as swallowing; taste sensation.

CN XI: Accessory: Control of neck and shoulder muscles.

CN XII: Hypoglossal: Control tongue movement during speech and swallowing.

Lobes

The cerebrum has four lobes whose functions are distinct:

Frontal lobes - the largest lobe of the brain. It is involved in personality characteristics, decision-making and movement.

Occipital lobes - the middle part of the brain. It involves interpreting pain and touch in the body.

Parietal lobes – the back of the brain. It is involved with vision.

Temporal lobes - the sides of the brain. Short-term memory (Johns Hopkins Medicine, n.d.).

In closing, the brain remains the most complex and mysterious organ despite thousands of studies that have been done on it. Even today we cannot fully decipher how the brain works, as it is composed of billions of neurons and other micro systems. In addition, its functions are clearly impressive. Its entire system helps the human being with a wide range of physical, emotional and cognitive productions. However, one thing that is well known is that to know in depth its incredible work, one must first know the autonomy of the brain.

Exploring brain functions and their impact

Carmen Yohana Barrera Sepulveda[4]

Throughout time, we have been interested in understanding mental abilities and their connection with brain structure and the processes that allow human beings to speak, walk, feel, cry, think and perform all the activities that characterize us.

To better understand the functions of the brain, (Ardila, 2020, in which he cited Luria, 1947) one of the most important contributions consists of his model of brain organization, since according to his theory, each function must be understood as a brain product that is defined as holistic and dynamic, which implies that the function is not limited to a specific brain region, but it is centered on multiple structures and connections that work together.

In this sense, it is important to mention the Russian psychologist and physician Alexander Luria who was a precursor of brain research and special education. Ardila (2020, in which he cited Luria, 1947) proposes that the human brain comprises three functional units that work together: one for tone and wakefulness; the second for receiving, processing and storing information; and the last for programming, regulating and verifying mental activity.

In this research it is important to know that there are several types of brain functions such as:

1. Lower brain functions

They focus on the capacities of the species that allow them to ensure survival in different habitats.

According to Rodríguez et al. (2006), the following can be distinguished among the main lower brain functions: a) motor, b) sensory-motor, c) auditory and d) visual. Regarding their neuro-anatomical location, they are in specific and concrete places of the cerebral cortex, which allows inferring that their functioning is of a basic nature. An example of this function is that of a child who cries when is hungry, since crying, in this specific context, implies a reaction to the internal tension experienced by the child in relation to the lack of food (hunger).

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2. Higher brain functions

These brain functions are based on the capacities that allow human beings to modify the environment by differentiating one species from another.

In the case of the child who cries, but not because of hunger or pain in his body, but with the purpose of attracting the attention of other people, there will be a higher brain function, since it implies a direct relationship with others, a form of communication or a way of relating.

3. Executive functions

Executive functions are a set of cognitive skills that play an important role in the way we face new situations or experiences to have the ability to adapt to change.

Thus, executive functions are understood as control of cognition and regulation of behavior through the different (cognitive) processes involved, described above, and related to each other (Gonzalez & Ostrosky, 2012).

On the other hand, according to Campos (2011), brain development is a complex and fascinating process that begins in utero, although some mothers do not know they are pregnant. In this context, the prenatal period ceases to be exclusively a stage of transformations for the mother, since the changes are mainly focused on the development of the child's brain, with the purpose of preparing it completely and adequately for life after birth.

A fundamental aspect is that from the 1970s onwards, powerful techniques for the study of brain function began to be developed. There are three types of techniques that contributed to produce a quality change in the study of mind-brain relationships:

1) Brain imaging techniques, which make it possible to observe the structures and functioning of the human brain in vivo.

2) Electrophysiological techniques, which enable it to measure and analyze the potentials generated during tasks such as recognizing a written word or analyzing the syntactic coherence of a sentence.

3) Magnetic stimulation techniques allow interfering or stimulating the activity of circumscribed regions of the cortex to observe their effect on psychological abilities such as speaking, counting, reasoning, etc.

Today it is understood that brain functions are complex and dynamic, not confined to specific areas, but the result of the interaction between multiple brain regions and systems. The brain's capacity for adaptation and reorganization is recognized, which has led to a more detailed view of neurological and psychiatric diseases. Advances in neuroimaging technologies and brain stimulation techniques are expected to further our understanding of these brain functions.

Development of cognitive function

Anamaria Cantor Herrera[5]

The brain is divided into 5 parts known as frontal, parietal, temporal, insula and limbic. In this case, it is going to be introduced the right frontal lobe data, which area is composed of neurons that are the brain cells and nerves, they can send or transmit signals to other neurons. Signals travel as electricity or "impulses" within neurons. The neurons convert the electrical signals into chemicals that are released outside the neuron. The next neuron detects the chemicals and triggers another impulse. In this way, a message travels quickly into and through the neurons and glial cells that are the support cells of the nervous system. They do not handle signals. Instead, they maintain the neurons by removing waste, providing nutrients and offering structural support and it is supplied by the anterior and middle cerebral arteries, which are branches of the internal carotid artery. The anterior cerebral artery mainly supplies the superior and medial surfaces of the frontal lobe, while the middle cerebral artery supplies the inferior and lateral surfaces.

The right frontal lobe is responsible for managing different skills such as reasoning which is a simple and complex process, along with decision making and creativity, other skills are social understanding that determines what to do or say, voluntary muscle movements, and learning and remembering information. It is also responsible for motor speech expression, which includes verbal fluency, phonological, and verbal and grammatical processing during speech. The frontal lobe is responsible for decision making and self-control. It also helps regulate emotions. This is the part of the brain that manages interactions with other people. The frontal lobe regulates behavior and helps know what is socially acceptable and what is not. According to Vega (2023), the dominant side of the frontal lobe is involved in several functions including: Language and speech, rational and logical thinking, or the ability to make sense of things, quantitative thinking, or thinking that has to do with numbers and statistics 'analytical reasoning or the ability to make decisions after considering facts. Thus, the non-dominant frontal lobe is involved in more creative functions, which include creativity, imagination, intuition, curiosity, musical and artistic ability.

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According to Sendić (2023), frontal lobe functions are numerous. It is associated with higher cognitive functions such as decision making, motivation, problem solving, planning and attention. These functions are carried out primarily by the prefrontal cortex (management of higher cognitive functions such as planning, organization, motivation, discipline, problem solving, self-control and emotional regulation) of the frontal lobe. It also contains the motor cortex (control of voluntary movement, spatial orientation), which is responsible for planning and coordinating voluntary movements. Finally, the frontal lobe contains Broca's area (oral production), which is essential for producing the motor component of speech.

However, studies have shown that the frontal area is the most common region of injury following mild to moderate traumatic brain injury (Levin et al., 1987). where there are complications or disorders such as Alzheimer's disorder, attention deficit, hyperactivity disorder, autism spectrum disorder, seizures, mood disorders, anxiety disorders and personality disorders where there is damage to the lobe may present difficulties in such things as:

- Loss of simple movement of various parts of the body (Paralysis).
- Inability to plan a sequence of complex movements needed to complete multi-step tasks, such as making coffee (sequencing).
- Loss of spontaneity when interacting with others.
- Inability to express language (Broca's aphasia)
- Loss of flexibility in thinking and persistence of a single idea or behavior (Perseveration)
- Inability to concentrate on a task and filter out distractions (Attention)
- Mood fluctuations (Emotional lability)
- Difficulty solving problems
- Difficulty inhibiting or controlling a response or impulse (Disinhibition)
- Reduced motivation, initiation and persistence in activities (Adynamia)
- Reduced awareness/awareness of difficulties.
- Changes in social behavior.
- Personality changes.

In conclusion, the right frontal lobe of the brain plays a critical role in a variety of cognitive skills and executive functions, such as reasoning, decision making, creativity, social understanding

and behavioral control. It is crucial for social interaction, emotional regulation and language processing. Lesions in this area can cause a range of difficulties, from motor problems to alterations in cognitive and emotional function. Disorders and diseases affecting the frontal lobe can manifest in a wide range of symptoms, including difficulties in movement, planning, concentration, emotional regulation and social behavior, which is important to maintain its integrity through proper brain function and a healthy quality of life.

Interdisciplinary of Neuroeducation

Cristian Stiven Gonzalez Giraldo[6]

To begin, it is going to be shared some neuroeducation research and implementations of methodologies about its implementation in the field of education and learning, and its importance around the world, also the knowledge lack in addition with the neuromyths, learning styles and multiple intelligences that there are still among us as teachers and students.

How neuroeducation has helped through time

Neuroeducation is the mix between neurology and education, it helps us both teachers and students, in instance that teachers will be able to know what the best approaches, methods, didactics and pedagogics are for their students, and students will be able to identify how and what the best way is by which they can learn better. This document will focus on the teacher's improvement that is one of the most important pillars on development of neuroeducation as mention Peregrina et al. (2023) there are training plans, programs to learn and didactics to guide at teachers in this world of neuroeducation with the aim of improving environment in the classroom.

Neuroeducation does not just focus on how teachers and learners do play their roles better like in a general way or point of view, this discipline deepens beyond these ones and it shows us how the physical activity plays a crucial role on how we learn, for example, the VAK (visual, auditory, kinesthetic) methodology helps us identify what kind of students we have and how they learn based on their skills. According to Dekker et al. (2012), people and children could learn better in a way through their preferred learning based in their sense-motors skills although, this subject has not been proved yet as truth by the science community.

On the other hand, returning to what the teachers must know? According to Jolles et al. (2012), there are four tips which teacher shall know being, firstly, the nervous system handles the actions, body functions, emotions and behavior, the second one, is based on structuring system is pre-established by our life experiences throughout life and factors established by parents into

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genetic, the third one is one, is the mind. It is controlled by the brain, and the fourth one, researching helps us know what essential for improving knowledge is about the nervousness in teaching and learning.

Neuromyths

Neuromyths are knowledge lacks that teachers still have, even with all researches and investigations there are populations that have misunderstanding about how the neuroscience can help into the education, this is a serious problem because this misunderstanding affect negatively to us in instance to close new paradigms, useful information, methods and techniques for our classroom even knowing the good results obtained from implementation of neuroeducation as Ávila-Toscano et al. (2022), in Colombia shows through the Dekker scale that 99.36% of teacher show presented neuromyths and about how the neuroscience can assist into education in addition with lack of information about how the brain hemispheres work; methodologies and techniques of learning.

LIRRA model

This methodology is one among others methodologies that exist about how neuroscience can help us teach and learn, in the LIRRA model, in general, it is a procedure which facilitates the acquisition of a language through automaticity of lexical skills by repetition, time, and improvising among others subjects, an evidence of this according to Segalowitz and Segalowitz (1993) presented a study carried out on intermediate English students to improve their lexical-grammatical skills, according with Segalowitz and Segalowitz, a reduction of time showed a better time reaction in the pre-tests and post-tests, this is an increment of automaticity, nevertheless, this does not mean that it is a good result, given that the study shows this lack of quality in the results, consequently, automaticity is not correlated with quality and it also involves mechanisms beyond just neuroeducation.

To conclude, neuroeducation has information and a great field of research, and implementation in both students and teachers, before it must make teachers learn about these methodologies already existing to improve their classrooms and leave the misunderstandings above this topic and neuromyths. There are scientific evidence and results based in pedagogical activities carried out, as a teacher, it must look for how our students learn to get a correct approach, this is

not only “teacher as the main character” all students are different, and the neuroeducation as a tool could help us reach better results.

Brain Based Learning

Paula Alejandra Castro Aroca[7]

It is significant to show a comprehensive understanding of brain-based learning. It is an educational methodology grounded in the principles of neuroscience, that aims to see the complexities of students' learning outcomes through understanding brain functions. This approach not only acknowledges the role of the brain in learning but also seeks to optimize educational practices by aligning them with cognitive processes.

Brain-based learning delves into the workings of the brain, exploring how neural mechanisms underpin various learning processes. By leveraging insights from neuroscience, educators can gain deeper insights into how students acquire, process, and retain information. This knowledge empowers educators to design instructional strategies that are better suited to the natural functioning of the brain, thereby enhancing learning outcomes. Furthermore, brain-based learning is inherently intertwined with the cognitive functions of the brain. It recognizes that cognition, encompassing processes such as attention, memory, and problem-solving, is fundamental to the learning process. This article delves into the myriad principles and implications of brain-based learning within the realm of education. By exploring its theoretical underpinnings and practical applications, we aim to shed light on how educators can harness the power of neuroscience to inform and improve their teaching practices.

Specifically, brain-based learning focuses on understanding a cognitive process that involves learning. Recent research has revealed the brain's ability to adapt and change throughout life. Neuroscientists like Eric Jensen and John Medina have identified connections between brain function and effective teaching strategies, emphasizing the importance of attention, emotion, and relevance for learning (Jensen, 2008; Medina, 2008).

On the other hand, when delving into the principles of brain-based learning, it becomes evident that establishing learning environments that are both secure and stimulating is paramount. This fosters a conducive atmosphere conducive to active exploration by students and encourages

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collaborative teamwork, thereby promoting metacognition and self-regulation in the learning process. By embracing these principles, educators have the potential to significantly enhance the student learning experience and optimize educational outcomes (Caine & Caine, 2020).

In practice, Brain-Based Learning (BBL) has been employed across various educational settings, from traditional classrooms to online platforms. Educators have implemented methods such as project-based learning, differentiated instruction, educational technology, and hands-on activities to enhance the learning experience. Recent research has demonstrated the benefits of BBL, including improvements in academic performance, increased student engagement and the development of critical thinking skills.

Brain-based learning faces challenges which may include the need to develop educators' capacity to integrate neuroscience into teaching practice, addressing resource, time constraints, and adapting strategies considering the individual needs and characteristics of students. Furthermore, it is important to consider the ethical and social implications of using neuroscience in education and ensure that practices are inclusive and equitable for all students.

In short, BBL offers a powerful framework for enhancing teaching and learning by integrating principles of neuroscience into educational practice. By understanding how the brain functions and how students learn, educators can create more effective and meaningful learning environments that prepare students for success in a constantly changing world (Johnson, 2019).

Neurodidactics as an educational tool

Laura Nicol Cárdenas Madrigal[8]

Neurodidactics is a fundamental branch in which we talk about the process and capacity of the brain to learn and retain information. In the development of knowledge, we find different stimuli which allow a person to learn more easily, be it auditory, visual, graphic material, etc., which are relevant when learning or acquiring new knowledge.

Every human being has a limbic system, which is responsible for managing participation stimuli in the brain, to retain or deny information, since it has access to emotions and memory. This system is in place from birth, for example: a baby can distinguish the mother tongue and a foreign language, another example would be when a infant differentiates the voice of each member of the family. Over time, as the individual grows, the baby creates different tastes which generate external stimuli that allows her to create neural networks faster.

Now, it is important to keep the following in mind: additional, different skills are strengthened, especially when they are starting at a very early age to develop different knowledge and are seeking affinity with different themes, being these games, music, books, novels, etc. An example that could become quite relevant when a child is in the process of acquiring knowledge, for instance: The complexity of learning a new language is less for a person who is older than a child who has a better ability to know how to do it, named in the document Holbekova, M. A. (s.f.). Neurodidactics in Teaching Foreign Languages in Fergana State University. “By the age of 4 or 5, children have mastered the basic structures of the language or, in the case of bilingualism, the basic structures of languages. Two or more languages in the brain. All recent studies show that children who grew up in multilingual families (bilingual, trilingual) receive important cognitive advantages over those who grew up in a monolingual environment. However, neurodidactics is also an interdisciplinary field that combines cognitive neuroscience and education, where there is a very specific objective such as understanding how the brain learns and how this understanding can

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inform and improve teaching and learning methods. Therefore, we will talk about some characteristics to consider in neurodidactics:

1. Knowledge and approaches from neuroscience, psychology and education enable a deeper understanding of how learning occurs in the human brain.

2. Understand the way students learn and how their brain processes information, since in this way teaching strategies can be implemented to improve their context.

3. Look for different teaching and learning strategies in the classroom.

4. The capacity for interaction and retention that the brain can have through experiences and emotions that allow it to learn throughout life.

5. Understanding the different cognitive processes is important to create learning strategies to maximize retention and understanding of information.

6. Investigates how the human brain processes information, pays attention, stores and retrieves memories.

In conclusion, neurodidactics is a fundamental part of education, where a very effective path is found for the learning of the human being. By researching and bringing together different skills, the brain is one of the organs that receives the greatest impact in neurodidactics, on the other hand, there is a fundamental part such as the art of teaching.

This discipline helps develop different capacities, helps and allows students rethink and revitalize pedagogical strategies that allow them to create educational practices with the aim of learning. Finally, it embraces neuroscience and pedagogy, since it cultivates a learning environment that not only nourishes minds, but also hearts, preparing future generations.

Neurolinguistics introduction

María Paula Arias Castañeda[9]

Neurolinguistics is a captivating interdisciplinary field that explores the intricate relationship between language and the brain. This extended investigation aims to provide a comprehensive overview of neurolinguistics, focusing on recent research and developments in the field.

Overview of neurolinguistics

The study of how language is processed in the brain, neurolinguistics examines the organizational bases of language within the human nervous system. It maps the interaction between language and the brain based on various theoretical models, shedding light on the complex interplay between linguistic information and neural networks.

Understanding neurolinguistics

Neurolinguistics delves into how language is processed in the brain, investigating the neural mechanisms underlying language acquisition, comprehension, production, and representation. It seeks to unravel the complex interplay between language and the brain, shedding light on how linguistic information is encoded, stored, and retrieved within the neural networks.

Recent advancements in neurolinguistics

Recent studies in neurolinguistics have significantly advanced our understanding of how language functions in the brain. Cutting-edge neuroimaging techniques such as functional magnetic resonance imaging (fMRI), electroencephalography (EEG), and magnetoencephalography (MEG) have revolutionized the field by providing insights into the neural correlates of language processing at unprecedented levels of detail.

Key areas of focus in neurolinguistics

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Language Processing: Investigating how linguistic information is processed at different levels - phonological, syntactic, semantic - within the brain offers valuable insights into the neural mechanisms underlying language comprehension and production.

Bilingualism and Multilingualism: Studying bilingual and multilingual individuals provides a unique perspective on how the brain adapts to and processes multiple languages, offering valuable insights into cognitive flexibility and language control mechanisms.

Neuro-Linguistic Programming (NLP): NLP is a therapeutic approach that uses language and other communication techniques to influence and change thought patterns, behaviors, and emotional responses. It has been applied in various fields, including education, psychology, and business.

Recent studies and techniques

Advancements in neuroimaging techniques in recent years. One of the most notable developments is the increased use of advanced neuroimaging techniques, such as electroencephalography (EEG) and magnetoencephalography (MEG), to study language processing in the brain. These techniques allow researchers to detect event-related potentials (ERPs) and functional magnetic resonance imaging (fMRI) to localize brain areas associated with specific linguistic events.

Another area of progress is the application of natural language processing (NLP) techniques in clinical neuroscience and psychiatry. NLP tools, such as word embeddings, attention mechanisms, and transformers, have shown promise in improving the diagnosis and treatment of neurological and psychiatric disorders. Additionally, the integration of NLP with other fields, such as cognitive neuroscience and psychiatry, has led to a better understanding of the relationship between language and mental health.

The study of bilingualism and multilingualism has also seen significant advancements in recent years. Research has shown that bilingual individuals exhibit cognitive flexibility and language control mechanisms that are not present in monolingual individuals. Furthermore, studies on the neuroimaging of bilingual individuals have revealed greater activation of the right occipitotemporal region for logographic system processing than alphabetic processing.

In the field of speech and language disorders, neurolinguistic studies have been conducted to investigate the contribution of neurolinguistics in understanding and treating various conditions.

For instance, neurolinguistics has been used to study the process and experience of language learning in children with mental retardation conditions.

In conclusion, the recent advancements in neurolinguistics have led to a better understanding of the relationship between language and the brain, as well as the development of new techniques and applications in various fields. As research continues to advance, we can expect further breakthroughs in our understanding of the complex interplay between language and the brain.

Neurolinguistic approaches

Vanessa Embus Alzate[10]

Throughout the evolution of human being, it has shown its development in different aspects, one of which has been the way of communicating their ideas and their verbal intention through language, as it is linked to the field of neurolinguistics, which allows and explores important elements such as knowledge acquisition, thought processes, understanding, interaction, writing skills, speaking skills, among others. Those elements are represented in the brain by studying its process to acknowledge how and why this cognitive mechanism in activities occurs by using it in everyday life.

Therefore, the purpose of general review will be in focusing on neurolinguistic strategies in language learning since, as it has been mentioned before, communication takes relevance within in an educational process that involves the student's needs and besides the teacher's role as a mediator to respond to them by means of different methods of teaching where they will enrich not only the learning process but also the teaching one, thus, ‘‘language students must be able to choose strategies for communicating that are not only successful but also suitable for their level of proficiency’’ (Silalahi et al.,2022 as cited in Purnama et al., 2023, p. 50).

Following this line of thought, it is important to address the role of the teacher and its importance and influence in a classroom through this neurolinguistic process that has been worked on. For this reason, Egamberdiyeva (2022) asserts that basically the educator can know students’ needs to inspire them and encourage their cognitive abilities by means of techniques where will enrich their learning process and active participation, in the case of English learning, they are the mediator and the organizer to enhance the communication among the scholar community through these strategies.

As it is said, it will start by looking at these strategies, better known as Neurolinguistic Programming (NLP). According to Begum et al. (2022), NLP is an academic strategy to help people communicate better. Being immersed in education, in this way, helps teachers and learners

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develop outstanding competencies such as emotional intelligence, self-efficacy, critical thinking, actions and emotional control, empathy and so on. Where they are willing to reach an achievement in English education to get excellent results, facilitating their learning progress through motivation and respecting the multiple intelligences that belong to each student related to their learning style. Moreover, NPL plays an important role in learning due to critical thinking and a metacognition process because metacognition makes one aware of the students' abilities and have a control and understand their potential knowing how, why it is happening, and in a certain way, it affects their schooling (Zhang et al., 2023).

According to Purnama et al. (2023) and Hedayat et al. (2020) provide important elements used as techniques regarded as tools to assist learners to become excellent performers and they serve as the main pillars of the system applied in Foreign Language Classrooms.

1. **Rapport**: It is the ability to create a harmonious environment to facilitate the teaching process and get a closer relationship between teacher and student. Hence, their relationship will push forward cooperative work, and the educator will play the role of a leader who establishes trust among the students, reducing the differences and being possible to achieve a fruitful learning environment, higher productivity and results.
2. **Outcome thinking**: It is to be able to predict goals or objectives as a priority, within the field of NLP it is important to be clear about what the student wants to get and how. Being precise and setting objectives will help to establish the way of doing things and visualizing their ideas with the aim of making them as clear and realistic as possible.
3. **Anchor:** ‘‘An anchor is defined as any representation in the human neurological system that activates any other representation’’ (Rogan, 2022:87 as cited in Purnama et al., 2023, p. 53). Therefore, according to NLP, it can bring a wide variety of connotations from different items making it be able to develop in function with the senses.
4. **Modeling:** As the process of learning through observation and tendencies of language and behavior, it is essential to facilitate the learning process by observing and learning through means of the teacher, encouraging them to achieve the determinate task. Besides, it is essentially a nonconscious assimilation of the ideal behavior (Drigas et al., 202, p. 32).
5. **Sensory Awareness:** It is linked to the use of the senses as they allow them to experience the world as it is, so this will enrich the NLP process for the students, as they become aware of the

environment that happen around them, increasing their knowledge and in this way facilitating their decision making (what works and what doesn't) in a successful way.

6. **Behavioral flexibility:** Is the capability to be more variable in the situations and it is related to adaptability in the entire situation, the more several actions variables the more chances of success increases, therefore NLP pushes towards being more adaptable in different situations and accepting the changes in life.

7. **Role-playing:** It's a meaningful strategy for students to appropriate the environment and practice through new behavior, adapting to new situations, focusing on real life, allowing them to be touched by new experiences.

To sum up, it is evident how theses neurolinguistics strategies are aimed to enhance all these cognitive skills as were mentioned before to highlight their importance; Therefore, this brings implication either teachers and learners, on the one hand educators have the responsibility to be updated about the needs of students, their environment and context where they are surrounded of techniques and methods where they develop and improve their communication with students, and at the same time, recognizing their strengths and weaknesses. On the other hand, students by means of NLP being an influential tool that affects their personal and educational life in a positive way, as beyond being a scholar process but also improving their quality of life getting ready for the reality.

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