THE 14TH EDITION OF THE INTERNATIONAL CONFERENCE
EUROPEAN INTEGRATION
REALITIES AND PERSPECTIVES

The Spoken Language and Our Brain

Lăcramioara Mocanu[1], Camelia Nicoleta Neguț[2]

Abstract: One of the main characteristics discriminating the man from animals is the spoken language. Once the man acquired this ability to express himself by words he is then able to do this in different pattern languages, such people are called polyglots. Our brain is such a powerful machine, to a certain degree we follow the same development course as animals in terms of breathing, eating, walking but higher on the evolution scale the man achieved this higher level of communication by words. Language, i.e. spoken language, is a complex communication system consisting in speech-sounds combinations expressed by words. Assembled correctly, to specific and coherent patterns words create then sentences which result in ideas and thoughts. Human nervous system plays a huge role in facilitating this communication function. How do we do this? Is that a mystery or a predictable pattern that our brain creates to code and decode spoken language?

Keywords: Language; brain; neuron patterns; phonemes; sound; communication; nervous system; cortical structures

Language- the Miracle of Speech

Our brain is genetically predispose for language, while writing is an optional skill, spoken language is the main form for communication. Toddlers have a genetically predisposition for spoken language, whereas for other skills like eating, dancing they need special assistance.

What scientists mean by genetic predisposition? It means that long before walking or sitting babies start uttering different sounds or babbling incoherent sentences, around the age of 2-3 months. The miracle takes place about age of 8 months when babies succeed to articulate the magic word “mama” or “dada”. The “big bang” of the language universe when the language centers of the brain became active occurs soon after the birth. It is very interesting that this window for acquiring the spoken languages tapers off for the first time around the age about 5 years, then again around the age of 10 to 12 years. Scientist revealed that beyond that age learning any language becomes more difficult.

Human beings are born with this language instinct which is very strong so that in the absence of the spoken communication some toddlers invent words, whereas others become very affected by this lack of human spoken interaction and die. Human being is a social being who needs interaction with other beings, and one the most wanted interaction is the verbal one. People need to express themselves and language is one of the most fascinating ways of expression as words carry emotions that lead to thoughts which create out reality.

[1]. Associate Professor, PhD, Danubius University of Galati, Romania, Address: 3 Galati Blvd., Galati 800654, Romania, Tel.: +40372361102, Romania, E-mail: lacramioaramocanu@univ-danubius.ro.
[2] Student, Faculty of Communication and International Relations, Psychology, Danubius University of Galati, Romania, Address: 3 Galati Blvd., Galati 800654, Romania, Tel.: +40372361102, Romania, Coresponding author: cami_nicoleta@yahoo.co.uk.

So spoken language is a huge accomplishment in many ways, actually language is a complex system not only at a semantic level but also at a neuro-cognitive level. If we think of words as a trigger to our memory we can understand how powerful the words are, they can lock and unlock many drawers in our brain.

Cognitive neuroscience has revealed a deal of how the brain acquires and process spoken language. The neurons in a baby's brain can respond to sound of all the languages on this planet. This could explain our predisposition for the all the languages not only to a specific one like our mother tongue. Studies revealed that adopted babies acquired the language of the adoptive parents not the biological parents in cases where both languages were substantially different like Chinese and English. Why is that?

At birth, newborns respond first to the rhythm, cadence, pitch-off of their mother's voice, not the words. Language is a system including among others minimal units of sound, that we call phonemes which combine to form syllable. The number of phonemes in the entire world's languages is more than 200, representing the maximum number of sounds that human voice apparatus can create, not counting changes in pitch and volume (Sweeney, 2009).

Although the infant's brain can perceive the entire range of phonemes, only those that are repeated get attention, as the particular neurons reacting to the unique sound patterns are continually stimulated and reinforced. The mother helps in this process by speaking in slow, lilting tones with exaggerated emphasis. This precise enunciation is found in all cultures and is called *parentese*. By the age of 10 to 12 months, the toddler's brain has begun to distinguish and remember phonemes of the native language and to ignore foreign sounds. For example, one study showed that at the age of 6 months, American and Japanese babies are equally good at discriminating between the /l/ and /r/ sounds, even though Japanese has no /l/ sound. However, by age 10 months, Japanese babies have a tougher time making the distinction, while American babies have become much better at it. During this and subsequent periods of growth, the ability to distinguish native sounds improves, while one's ability to distinguish nonnative speech sounds diminishes (Cheour et al., 1998; Yee, 2007).

The Language and Thinking

There is a strong relation between language and the act of thinking. Of course language is an interface that fosters the thinking process. Our brain is a magic machine that processes lot's of data almost instantaneously. There is a huge difference between written language and spoken language in term of patterns recognition. In case of the written language the brain recognizes the letters, words meaning but the process is more profound for the spoken language as our brain has to work harder. If for the written language the brain could recognize the spaces between words giving the sentence the proper meaning in the spoken language people don't pause between words when speaking and yet the brain has to recognize the difference between, for example, "greenhouse and green house" or the difference between "sea horse" and "see horse", such operation being related very much to thinking.

Every nanosecond we receive a huge bunch of information through our senses and the language is one of the tools coordinating this chaos and storing information in separates compartments. It's the brain who organizes categories and concepts. The great linguistic Noam Chomsky is sure that language was not created for communication but for thinking, and communication is a secondary outcome of the information received.

How the Language is computed in the Brain?

Sapir Whorf hypothesis is that language systematically influences how one perceives and conceptualizes the world. Language as previously mentioned is a complex system consisting in words, rules, syntax, morphology, phonology, etc. All these microsystems connect to each other helping us to understand the language coming from others and also to produce the same language that others understand us. In other words, when we spell a word, table, for instance, we don't focus on spelling the word, sound by sound, rather than remembering the image of the meaning of the specific word. This is the field where semantic memory plays o huge role. Several decades ago, Tulving (1972) coined the term "semantic memory" to refer to "memory necessary for the use of language. It is a mental thesaurus, organized knowledge a person possesses about words and other verbal symbols, their meaning and referents, about relations among them, and about rules, formulas, and algorithms for the manipulation of these symbols, concepts, and relations." (p. 386).

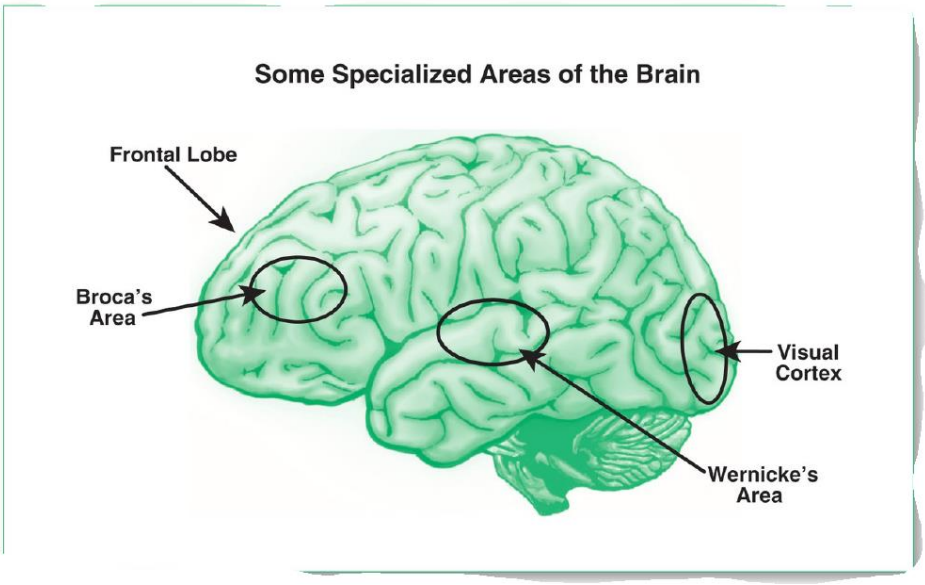
So, when we learn a language we don't take our memory like drawer full of bunches of words that come out to express our meanings, we actually assimilate the grammar or the algorithm to combine the elements into brand new assemblies. This is why Chomsky sustained that linguistics is a branch of psychology; it is a window into the human mind. Language is the stream through which we express our thoughts to one another, it' a gate to new cultures, experiences, it's an artefact constructed on identity.

Where Exactly Language Lies in our Brain?

At neurophysiologic level sub cortical structures such as cerebellum, thalamus, and basal ganglia have a great contribution to the language computation. However the most complex computation is carried out in the cerebral cortex which contains approximately 30 billion neurons connecting with other at least 1000 neurons resulting in a massively interactive data processing system fostering the high level mental functions.

The ability to understand language and produce speech is associated with several areas of the cerebral cortex.Researchers discovered that left side of the brain hosts the so called "language centers" such as Broca's area responsible with process that leads to speech utterance and Wernicke's area whose main role is to decode the speech. Once these areas are damaged the ability to speak or to understand the speech is also affected.

Basically spoken language is first perceived in the auditory cortex, while written text or sign language is processed in the visual cortex. The information is then sent to the Werniche's area, in the temporal lobe where is matched against the person's vocabulary stored in the memory. This is where meaning is assigned to words and the language comprehension is achieved. The signals are then transmitted to a bundle of nerve fibres knows as Arcuate fasciculus to Broca's area in the frontal lobe.



Source: David A. Sousa (2017), How the brain learns, SAGE Publications Ltd

Broca's area is responsible for production of speech. The output from Broca's area goes to the motor cortex which controls muscles movement necessary for speech. A language disorder caused by brain damage (stroke, epileptic seizures) is called Aphasia. Lesion caused in the Werniche's area cause sensory or receptive aphasia. Werniche's aphasia causes troubles understanding language whether is spoken or written, but have no motor problems. They can speak but their speech is often incoherent. It can be described as a strange mixture of words that may sound like completed sentences but they make no sense and have nothing to do with the subject of conversation Patients with lesion in Broca's area on the other hand can understand language but have difficulty to speaking. They talk slowly searching for words forming incomplete sentences with poor syntax, but usually manage to say important words to get their message across. In the early days research on language pathways was based on mainly on steady patients who had specific language deficit that can be associated to brain specific damage. Nowadays advanced brain imaging techniques (PET Scan- positron emission tomography) allows mapping in real time the areas of the brain that are activated when a person carries on a specific task. Thanks to these techniques a third area is found to be essential for the language comprehension – the inferior parietal lobule. This lobule is not only connected to both Werniche's and Broca's but also to the auditory, visual and somatosensitory cortical areas. The inferior parietal lobule is therefore perfectly wired to perform multi modo complex synthesis if information. It can process different word element such as sound of the word with the look and feel of the object. The language centers are usually located in only one hemisphere. The dominant hemisphere of the brain which is the left side in the right handed people. The corresponding areas in the right hemisphere are responsible for the emotional aspect of the language. Lesions in the right hemisphere do not affect speech comprehension or formation but result in emotion less speech and the inability to understand the emotions behind speech such as sarcasm or a joke. The right hemisphere may also to develop take over the mean language function if the left side is damaged in the early childhood. This phenomenon is known as neuroplasticity.

Does Language Change our Perception?

Journalist Flora Lewis once wrote, in an opinion piece for *The New York Times* titled "The Language Gap" that:

"Language is the way people think as well as the way they talk, the summation of a point of view. Its use reveals unwitting attitudes. People who use more than one language frequently find themselves having somewhat different patterns of thought and reaction as they shift."

A study that appeared in the journal *Psychological Science*, for instance, has describe how bilingual speakers of English and German tend to perceive and describe a context differently based on the language in which they are immersed at that moment.

Another example is the Russian people who have many words for shades of blue are good to better discriminate between colours. The same with people working in fashion which are better in describing a colour, so they actually see more colour than other people who don't have words for that. So the people knowing more words for many different colours (pink, magenta, fuchsia) they will actually see those colours in reality. So language is changing our perception on the world.

What Exactly Happens in our Brain when we Hear a Word?

The sound arrives to our hearing analyzer, the ear, in sequential orders. Then brain starts to process the rest of the words it's hearing, the analogy would be the Google search motor or the telephone text assistance that when you start typing a word you're getting things as the motor is trying to figure out what you're typing. The same thing happens with our brain, when we try to say the word canister, the brain hears "can, and is just starting putting words together, in a sort of" "can, Canada, canary..." it's a way our brain is trying to figure it out.

In case of bilingual individuals the process includes also words from the second language, and if trilingual...from the third language and so on, the brain is trying out all these different combinations. It's a lot of processing. Language is kind of software by which we express our thoughts. So, language doesn't determine what you think but it can determine how you think about things.

The Effects of the Bilingualism on the Brain

The journal Neuropsychologia published the findings of a study where authors explained that speaking two languages helps developing the medial temporal lobes responsible with memories.

In fact, when a bilingual person hears words in one language, the other language also becomes activated. Scientists think that the brains of bilinguals adapt to this constant coactivation of two languages and are therefore different to the brains of monolinguals.

Does Language makes our Brain Bigger?

The answer is Yes!

When we learn a new language our brain has to essentially grow in size, it has to make more connections; it has to learn how to do a whole new thing. MRI scans showed that specific parts of the brain were getting increased in size; they were getting bigger, just because they were learning a new language. Another group was scanned for doing something else, different from learning a new language. Their brain structures didn't change in size at all. Learning a new language helps a lot, significantly improves the cognitive function. A study revealed that younger adults proficient in foreign languages proved to

have high scores on attention tests, better concentration, than other who spoke only one language. (study published in journal Frontier in Psychology).

Conclusions

Knowledge of a language involves the ability to assign deep and surface structures to an infinite range of sentences, to relate these structures appropriately, and to assign a semantic interpretation and a phonetic interpretation to the paired deep and surface structures. (Chomsky, 2006, Language and mind). All these operations could not be possible without the complex cognitive matrix that brain is capable to release by its specializes cortical and sub-cortical structures creating one of the most precious tool that human kind acquired throughout the phylogenetic evolution.

Bibliography

Anjan, Chaterjee & Branch, H. Coslet (2014). *The roots of cognitive neuroscience.* Behavioural Neurology and Neuropsychology. Oxford University Press.

Pinker, Steven (1995). *The language instinct- how the mind creates language*. First Harper Collins publisher.

Sousa, David A. (2017). *How the brain learns.* SAGE Publications Ltd.

Pinker, Steven (1998). *How the mind works.* Penguin Books.

Aitchison, Jean (1987). *The words in mind*. Padstow: T.J Press Ltd.

Cohut, Maria, Scientific article- *Language in the brain.* Medical news today.

Chomsky, N. (2006). Language and mind. UK: Cambridge University Press.