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# The Impact of Neuroscience on Foreign Languages in School

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**The Impact of Neuroscience on Foreign Languages in School****Abstract:**

Second Language Acquisition (SLA) is standing at a crossroads today notably because of the impact of neuroscience in school. Can cognitive neuroscience and exploring brain activity really facilitate the acquisition of English with young learners? In this presentation the focus will be on developing attention, the different types of memory, the fundamental role of emotions, brain plasticity and multi-modal learning strategies connecting theory and practice in the field. In order to do so, some activities in singing and role playing with traditional tales will be displayed.

**Introduction**

Personal presentation. I have worked with teacher students supposed to teach English at primary school level for more than fifteen years now. My sphere of research gravitates toward phonological accommodation, in other words how to facilitate the transfer from a syllable-timed language like French to a stress-timed language like English, notably at primary school level.

**Slide 1****How to facilitate the acquisition of English with young learners?**

As Aristotle put it: 'If you want to know how a system works, you have got to find out what the origin of such a system is'.

In other words, as regards SLA (Second Language Acquisition), how do the brains work since language originates in the brains as evidenced biologically by Broca's area as early as 1860 and more speculatively by the hypothesis of Generative phonology developed by Noam Chomsky in the late 1950s.

**Slide 2****Exploring the brains – two hemispheres**

To solve this issue, I think we need more interdisciplinary work between neuroscience, brain mapping, Artificial Intelligence, linguistics, etc.

Brain mapping or neuroimaging falls into two broad categories:

- Structural imaging, which deals with the structure of the nervous system and the diagnosis of large scale intracranial disease, such as tumor, and injury.

- Functional imaging, which is used to diagnose metabolic diseases and lesions on a finer scale and also for neurological and cognitive psychology research and building brain-computer interfaces.

### **Slide 3**

#### **About Interdisciplinarity**

As you can see cognitive neuroscience stands at the crossroads between linguistics psychology neuroimagery and memory – semantic, episodic, procedural memory, etc.

In that sense, it all boils down to the question of change comes about in today's linguistics and notably, through interdisciplinary work, I mean cognitive neuroscience must be interdisciplinary by nature and definition.

### **Slide 4**

#### **A small reminder as regards definitions**

Neuroscience – the scientific study of the nervous system which has been growing steadily for thirty years now. For some researchers, it's a new paradigm - rightly or not - like the digital age we talked about this morning.

Cognitive science - the field of science concerned with cognition. It includes parts of cognitive psychology and of course, what we are interested in here, I mean linguistics and SLA (Doughty and Long 2003).

### **Slide 5**

#### **Neuroscience and SLA**

There is no such a thing as theory on the one hand and practice on the other. Within the brains theory and practice, the body and the mind are deeply connected (Johnson 1987).

As Benjamin Franklin put it in 1820: *Tell me and I forget, Teach me and I remember, Involve me and I learn.*

In other words involve my hand, involve my body and I can learn.

*L'expérience sculpte la conscience* (Edelman 2008).

Experience will shape conscience.

### **Slide 6**

#### **Overview**

When we deal with cognitive neuroscience, we deal with some specific fields of research: Attention, Memory, Emotions, Brain plasticity, Multi-modal learning strategies, Multiple intelligences, among other things.

Logically, ATTENTION will be our first focus.

### **Slide 7**

#### **Attention**

Attention is the complex process that encodes language input, keeps it active in working and short-term memory, and retrieves it from long-term memory.

Attention is the absolute prerequisite. To memorize learning, you have got to be conscious of what you are doing. No conscience, no memorization.

In the brain attention manifests itself by a relaxed receptivity (Chevallier & Lachaux 2016).

### **Slide 8**

#### **Brain waves**

When people are in a state of relaxation waves are more active. Actually,

two brain waves are at stake.

Alpha: frequencies between 8.5 and 12 Hz. They characterize a peaceful state of consciousness. Alpha brain waves correspond to a state of relaxed alertness and calmness. It helps keeping the attention high.

Theta: frequencies between 4.5 and 8 Hz. They are characteristic of certain states of mind when information is stored.

## Slide 9

### Learning through relaxation

For instance, the smell of chocolate increases theta brain waves which in turn triggers relaxation and attention.

In the classroom, if you don't have any chocolate at hand ;) use music and songs instead to create a state of relaxed receptivity in the brains. It is a well-known ritual in the classroom. For instance, "My Bonnie".

## Slide 10

### Music and the brains

The French neurologist Pierre Lemerquis (2009) worked a lot in that field.

For the record, *My Bonnie* was the first (Scottish) song ever recorded by the fab four in 1961. It goes like that.

My **Bonnie** lies **Over** the **Ocean**

My **Bonnie** lies **Over** the **Sea**

My **Bonnie** lies **Over** the **Ocean**

**Bring back** my **Bonnie** to **Me**

## Slide 11

### Visualization

As you can see, the syllables printed in bold are stressed syllables because English is a stress-timed language. So the beat is almost isochronic.

It's important to couple sound and sight because as we mentioned before French is a syllable-timed language. If the input is both visual and auditory, the new information is twice likely to be memorized. Moreover, perception is heteromodal as evidenced by Barone *et al* in 2008.

## Slide 12

### From perception to memorization

Memory: the human mind works by association.

Facilitating perception/memorization through oral, visual, kinesthetic modalities. In other words, developing multi-modal learning strategies. In fact, this is the way the brains work.

So, the teacher invites the students to combine singing, gesturing and focusing on the stressed syllables at the same time (Freiss 2014).

## Slide 13

### Curiosity and playfulness

Step by step, some syllables are erased. Students' curiosity is aroused. Neuroimaging indicates that curiosity leads to an increased activation of neurons in the reward circuit, especially within the hippocampus, a region that plays a central role in memory. Curiosity would act as a playful reward for motivation, attention, and memorization.

## **Slide 14**

### **Avoid cortisol secretion**

In so doing, students memorize playfully without being under pressure. When people are anxious their brains produce a hormone called *cortisol*, also called the *stress hormone*, which could be counterproductive in the learning process, memorizing process.

You cannot memorize when there is too much cortisol in your brain tissues (Siaud-Facchin 2016).

## **Slide 15**

### **The different types of memory**

According to neuroimager, generally memorization originates from short-term memory (45 seconds) to long-term memory or life-long memory through the hippocampus. What is it? It belongs to the limbic system and plays important roles in the consolidation of information from short-term memory to long-term memory and spatial navigation, walking, dancing, running, etc.

## **Slide 16**

### **The hippocampus**

Our hippocampus sorts out information, builds up our memories and our autobiography. The hippocampus is not bigger than a walnut. This tiny highly-connected *walnut* is supposed to sort out information, build up our memories and our autobiography at the same time. Humans and other mammals have two hippocampi, one in each side of the brain. The hippocampus is located under the cerebral cortex (Andersen *et al.* 2006)

## **Slide 17**

### **Language function**

The association areas are the parts of the cerebral cortex which produce a meaningful perceptual experience of the world, enable us to interact effectively, and support abstract thinking and language. The association areas are organized as distributed networks. Each network connects areas distributed across widely spaced regions of the cortex. In humans, association networks are particularly important to language function.

## **Slide 18**

### **Brain plasticity**

Language abilities are localized in the left hemisphere in areas 44/45, the Broca's area, for language expression and area 22, the Wernicke's area, for language reception. However, some recent research suggests that the processes of language expression and reception occur in areas other than just those structures, around the lateral sulcus, including the frontal lobe, basal ganglia, cerebellum, and pons (Price 2000).

## **Slide 19**

### **Chomsky's turnaround**

Chomsky took a different stand for almost forty years, but he anticipated those recent discoveries when he finally put that 'in the brains phonological mechanisms are shared with other cognitive patterns notably music and dance' (Chomsky 2005). Now we can assert that there is no such a thing as an autonomous faculty of language in the brains.

## Slide 20

### **Music and dance: Five Little Elephants**

This song meant for primary school children learning English as a second language is another example showing how the different modules work and interact within the brains to support language memorization.

*Five little elephants*

*Standing in a row*

*Five little trunks*

*Waving Hello!*

*'Oh' said an elephant*

*'It's time to go!' Cheerio* (Freiss 2010)

## Slide 21

### **Singing, gesturing, visualizing, memorizing**

As we mentioned before, this song is accompanied by many gestures describing each line or scene, enabling students to visualize the whole story. For example, *Five*: the right hand is open to show the five fingers. *Little*: the thumb and the forefinger are in the shape of a pair of pincers with a narrowing space, and so on and so forth for every word in the song.

## Slide 22

### **Why make gestures while speaking?**

The 'scissors theory' (Ramachandran 2011). When you use a pair of scissors you press and release the two blades at the same time. Vilayanur Ramachandran noticed that everybody tends to open and close their jaws when pressing and releasing the two blades. What for?

In fact, the explanation lies in Broca's area.

## Slide 23

### **Broca's area**

Broca's area, or the Broca area, is a region in the frontal lobe of the left hemisphere, which originally was dedicated to moving the right hand to make tools. Progressively this area became involved in more complicated gestures of the mouth, the lips, the jaws, or even the tongue. In other words, the more you move your right hand, the more you are able to move your articulators (Dortier 2003).

## Slide 24

### **Gestures processing**

Gestures processing takes place in Broca's area which is also used by speech. Language is thought to have evolved from manual gestures to articulatory gestures over time. This is a theory which has general acceptance today - even if it is not the only one - as regards the emergence of the faculty of language (Corballis 2002).

## Slide 25

### **Modern humans**

In modern humans, the two Broca's areas, uttering speech sounds and moving the right-hand fingers, are contiguous. Consequently, the more you stimulate the first one, the more you facilitate the utterance of speech sounds and the articulatory process, notably concerning SLA (Dehaene *et al.* 2001). Speculatively this fact had been amply demonstrated by the motor speech

theory as early as in the 1960s (Lieberman *et al.*).

## **Slide 26**

### **The motor theory of speech perception**

The MTSP is the hypothesis that people perceive spoken words by identifying the vocal tract gestures with which they are pronounced rather than by identifying the sound patterns that speech generates. The idea remains that the role of the speech motor system is not only to produce speech articulations but also to detect them. The hypothesis has gained more interest outside the field of speech perception than inside. This has increased particularly since the discovery of mirror neurons (Rizzolatti 1998) that link the production and perception of motor movements, including those made by the vocal tract.

## **Slide 27**

### **Affect and emotions**

We have just seen that Rizzolatti discovered the mirror neurons in 1995, but this decade was also instrumental in getting rid of cartesianism and redeem the role of emotions in language learning thanks to Antonio Damasio.

*Rather than being a luxury, emotions are a very intelligent way of deriving an organism toward certain outcomes (Damasio 2003).*

## **Slide 28**

### **What about emotions?**

First of all, they create a positive learning atmosphere in the classroom. Then, let's not forget that for a child, the first few months in his mother's arms are crucial to babbling, - *motherese* - and the relationship between an infant and his/her mother are filled with emotions, based on emotions, everything is emotional in the first months!

## **Slide 29**

### **Another quotation by Antonio Damasio**

*We are not thinking machines that feel; rather, we are feeling machines that think.*

That's food for thought for teachers!

## **Slide 30**

### **What is the role of emotions when learning new vocabulary?**

New vocabulary has to address itself to the whole person – to the imagination, the will, and the emotions, as well as to the intellect - the supposed cartesian subject -

This is a holistic view of learning a new language. By 'holistic', I mean at the crossroads between the intellectual, the physical, and the emotional, and even the spiritual dimensions. Why spiritual? Because love is a catalytic force!

## **Slide 31**

### **Role playing games**

So the subsequent question is how to create an emotional context that in turn will enable learners to memorize new vocabulary, functional language

as well as implicit grammar and phonological practice?  
Of course, we immediately think of the traditional tales pregnant with emotions, suspense, fantasy situations, happy endings, etc.

### **Slide 32**

#### **Advantages**

Playing traditional tales can be engaging, enjoyable, stimulating, and memorable.

Furthermore, it may lower learners' affective filter and build confidence: You can be yourself or someone else. It's a 'cortisol-free' activity. However, tales are pregnant with emotions (Freiss 2014).

### **Slide 33**

#### **For example**

A classic among classics *The Three Little Pigs and the Sound Makers*.

The Three Little Pigs revisited.

The procedure goes as follows: The teacher narrates the story while some learners are the Sound Makers. To make the soundtrack they repeat some key words.

### **Slide 34**

#### **Developing selective attention**

*Kids, listen to this tale. Some of the words are repeated. Say them with us!*

The first little pig builds a house of straw. Scrunch, scrunch, scrunch.  
Now it's finished, and here comes Mister Wolf. Stomp, stomp, stomp.  
He knocks on the door. Knock, knock, knock.  
Who is it? Who? Who? Who? (now you visualize the scene).

### **Slide 35**

#### **Developing attention, visualization and phonological patterns**

It's Mister Wolf, Stomp, stomp, stomp.  
Open the door little pig! Yum, yum, yum.  
No, I won't No, no, no.  
So, I'll blow your house downwwnnn!  
Mister Wolf blows, and blows and **blows**, blows, blows, blows.  
And he blows the house down, Down, down, down.  
How sad! Sniff, sniff, sniff. (now you visualize the scene again).

### **Slide 36**

#### **How role playing affects brain plasticity**

We are not going to review the whole story, but the same procedure is kept until 'all's well that ends well'. Now, we can return to what is going on in the brains during this activity. First, neuroimaging noticed a strong cortex activity: the motor cortex, the sensory cortex, and frontal cortex are activated, which in turn generates a new brain configuration due to brain plasticity (Stordeur 2014).

### **Slide 37**

#### **Neuronal coupling/dopamine production**

Second, the listeners/actors turn the story into their own mental representations/images creating new neuronal connections.



Third, dopamine makes it easier to remember and with greater accuracy!  
In the brain, dopamine functions as a powerful neurotransmitter - a chemical released by neurons to send signals to other neurons.

### **Slide 38**

#### **Mirroring**

It has also to be noticed a similar brain activity/brain wave between the speaker/teacher and the listeners/actors. Finally, it's a community of brains built around SLA through this activity.

#### **Attention: be focused**

Attention is underpinned by a set of executive functions such as the inhibition of sources of distraction, the planning of the steps to be taken to perform a task and the storage of the necessary information.

### **Slide 39**

#### **Conclusion**

Through some short examples, we have just seen how neuroscience underpins some SLA activities, in other words the relationship between brain activity and language activities for the brains. As this short presentation is anything but exhaustive, the story is 'to be continued'.

### **Slide 40**

I thank you for your attention and your cooperation in the singing and role playing.

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