A Proposal for a Hyperspace based on neurolinguistics to represent the Natural Languages. Cognitive Linguistics in Wroclaw Conference. **2015** Available online on> https://sites.google.com/site/coglingwroc/panels/cognitive-and-construction-grammars/a-proposal-for-a-hyperspace-based-on-neurolinguistics-to-represent-the-natural-languages

A Proposal for a Hyperspace to represent the Natural Languages

Nizar El Imrani, Maciej J. Mendecki

University of Silesia in Katowice, Bankowa 12, 40-007 Katowice

nizarimrani@hotmail.fr;

maciej.mendecki@us.edu.pl

Introduction

The aim of this paper is to define and to present a mathematical space that can be used for the mathematical representation of natural languages. The "brain space", which have been proposed in this paper, is based on Minkowski's space and was chosen as the space to model this proposal, rising from the evidence that the neurocongnitive processes of perception and categorization occur in a hyperspace of 3 dimensions + time. It can be shown that the proposed hyperspace is in accordance with the intrinsic characteristics of the brain's functioning, i,e. those established under the latest advances in neurolinguistics. (Levy, 1968; Llináz & Pellionisz, 1985; Mayer, et al., 2001; Warren, et al., 2001; Lewis and Miall, 2003).

Flow chart of information

Our other studies present that the flow chart of information that deals with the brain can be represented as follows in figure 1. (El Imrani, 2010), (El Imrani & Mendecki, 2011):

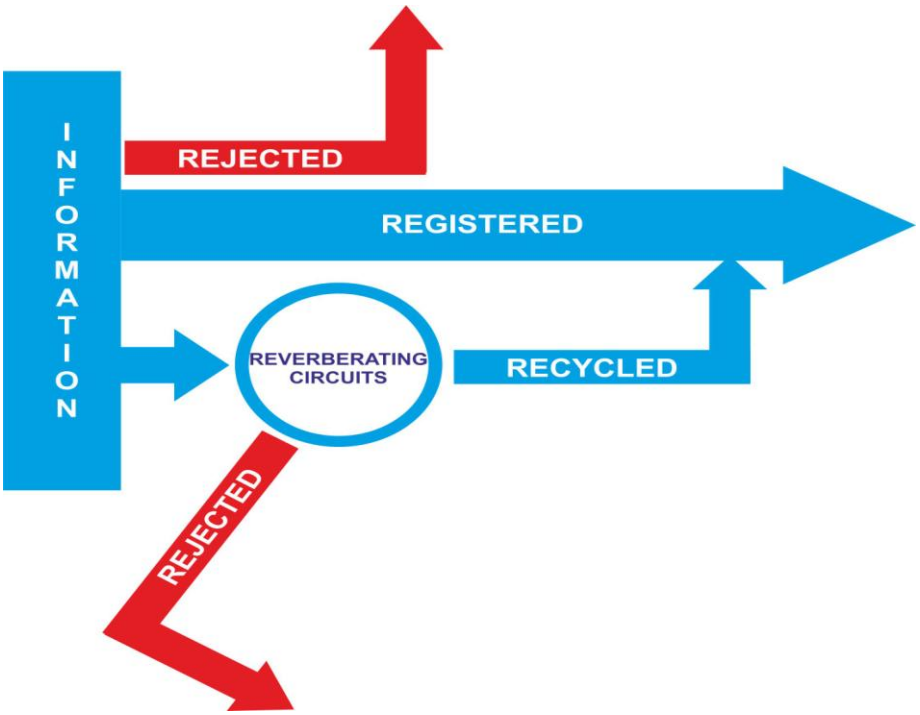

Fig. 1 After El Imrani and Mendecki 2011.

The brain gets information from the five senses. The first thing, that it does, is either to discard a large amount of unnecessary information, or rather to inform which the brain deemed as unnecessary at a given moment. However, a portion of the recorded information remains for a few moments in the prefrontal cortex (Pimienta & Arango-Dávila, 2004), represented in Fig.1 as a circle. In the process of information sifting, the brain often discards important or even essential information. This results in an inadequate response with further effects. This information is then manipulated by the

brain. The brain performs three basic tasks: completion, correction and ordering. It does so according to previously learned patterns and to information obtained from other previously mentioned sources.

Brain operations and manipulations

The proposed schematic is based on the contributions of (C.A. H.J Pimienta & Arango-Dávila, 2004) in relation to the collection of information from the senses and the permanence of some of the information in what was called as reverberating circuits. To establish the sources of such information which is relied on the studies of (Paniagua, 2000):

> "*Consciousness is knowledge's special psychological quality that supposes a higher level of awareness about mental organization. It is a subjective experience of receiving external and interoceptive that prepares the individual for the intelligent responses to stimuli."*(Paniagua, 2000).

When the brain collects the information, the manipulations take place subsequently to the data collection phase, and there are three kinds of them: Completion (Katz, 1967), (Gilberto Leonardo Oviedo, 2004), ordering (Chambers, 1979); (O'Connor and Forster, 1981); (Perea, Rosa, & Gómez, 2005), (M. Perea & Stephen J. Lupker, 2007), and correction (El Imrani, 2011).

Furthermore, more complex processes take place and support the previously mentioned manipulations. These processes are the location of information within time and space (Fig. 2).

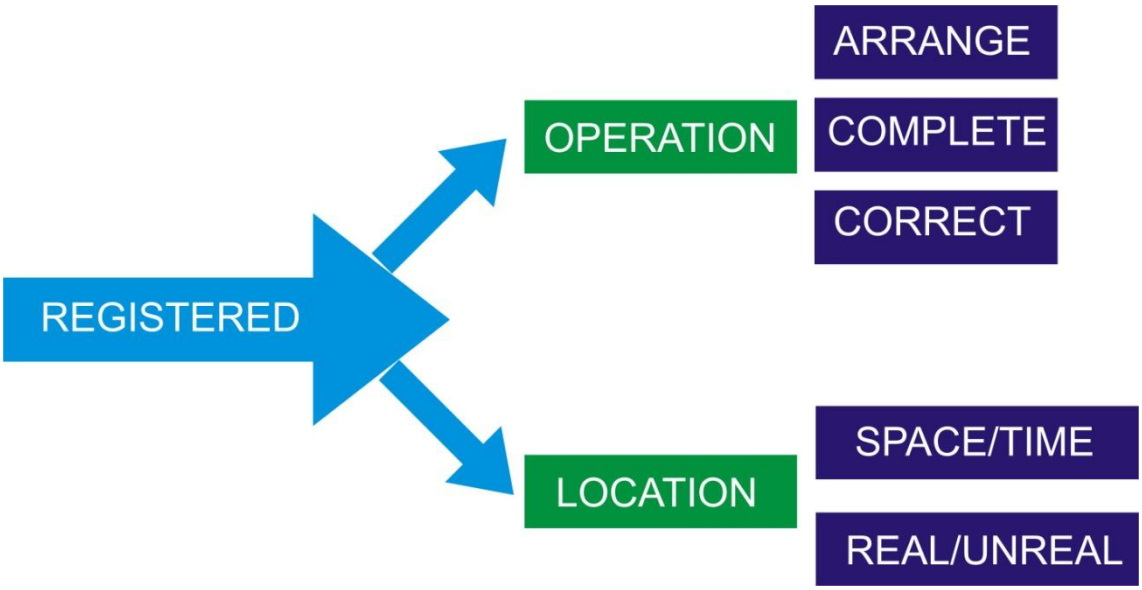

Fig.2 Type of manipulations and processes (El Imrani, 2010). Added real/unreal (Feroze et al., 2006).

Space-time location

The brain locates external information in space and in time. This process is inherent to the brain. The literature relevant to this field is extensive: from (Levy, 1968), who postulated that the left hemisphere analyzes the time, while space–the right hemisphere, up to the studies in neurolinguistics carried out from the year 2000. Lewis and Miall's article (Lewis and Miall, 2003) begins as follows: *"Every action we take and every stimulus we have a temporal dimension perceive."* It continues with an extensive list of more than 20 papers published since 2000. E.g.: (Warren et al. 2001; Mayer et al., 2001).

The justification for the inclusion of space in our scheme is due to the space-time intrinsic representation of the concept in the neural level, as in studies in neuroscience (Llináz Pellionisz, 1985).

> *The concept of space-time representation in the brain is redefined using tensor network theory. We make the following suggestions. (a) In order to deal with the external world, the brain embeds the external space-time continuum into a high dimensional internal space. External space-time events are represented within the CNS in over complete, inherently oblique, reference frames where space and time information is detected as a continuum over each coordinate axis. (b) The central nervous system may be seen as imposing a geometry on this internal hyperspace in such manner that neuronal networks transform inputs in a metric tensor-like manner* (Pellionisz & Llináz, 1985).

Pellionisz introduced the term of hyperspace into this field: the brain creates a hyperspace in which it is not only locates the perceived but also operates within the hyperspace. In cognitive linguistics Langacker defines the archetype of noun and verbs as residing primary in space in case of nouns and primary in space for verbs. (Langacker, 2008:104).

Minkowski's Space

With the dual space-time, e.g the Minkowski space, that appears incountless works of theoretical physics (Guerra and Ruggiero, 1973; Soucek, 1981; Eardley and Moncrief, 1982; Christodoulou and Klainerman, 1993; Kosiński, et al., 2000). The Minkowski space (Fig. 3) is broad enough to reflect the mental representations carried out by the brain. By the way, we will see that these representations are much more complex.

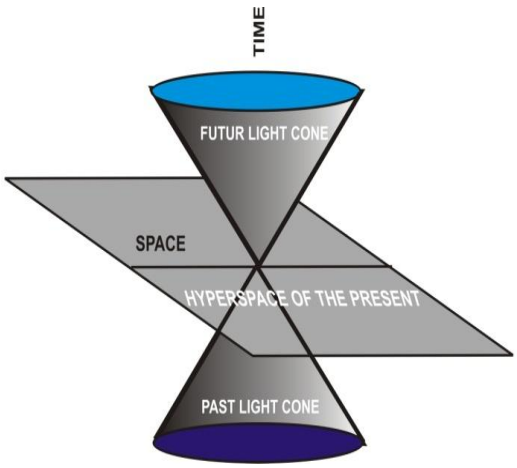

Fig.3. Representation of the space-time structure with the time cones.

The Space-time of Minkowski has three parts as we can see in Fig. 3. The pas cone, the future cone and the hyperspace of the present. In the hyperspace of the present it's located the observer. In physics the observer is a mere element of the Minkowski Space, but as we said the brain has an input and output, receives and operates with internal and external information. We locate the external information and its operation in the past, present and future cone. But we have to say that and locate the internal information in the point of the observer.

Internal and external time perception

It is important to quote that brain has an automatic two timing systems as stipulate in neuroscience: one defined by the movement: *'automatic' timing system is primarily involved in the continuous measurement of predictable sub-second intervals defined by movement.* And other cognitively controlled *The other hypothesized system, which we will designate the 'cognitively controlled' timing system, is more involved in the measurement of supra-second intervals not defined by movement and occurring as discrete epochs.* (Lewis and Miall, 2003).

And this systems processes the time always as an interval

We distinguished systems associated with encoding time intervals from those related to comparing intervals and implementing a response. Activation in the basal ganglia occurred early, and was uniquely associated with encoding time intervals, whereas cerebellar activation unfolded late, suggesting an involvement in processes other than explicit timing. (Rao, et al., 2001).

Our perception of time is the constant neurocognitive adjustment and internalization of external or physical time.

The neurological evidence we can find in the works of Meck et al.

(...) they found that the striatum, thalamus, and cortex were activated only when the timing of the taps depended upon an internal representation of time (...)

(Meck and Benson, 2001)

Here we can observe the existence of two time measuring, one external and other external. The authors suggest physical time and psychological time . (Meck and Benson, 2001).

The constant adjustments made by the brain in order to adjust its internal clock with the external experience, produced that the time is undulated. However, it should be mentioned that this is an approximate mechanism of adjustment, and in case of brain injuries doesn't take place properly Space perception and its disturbances after brain injury in man: (Teuber 1963), (De Renzi 1971).

Interestingly quantum physics gives an interesting example is the curvature of space-time.

> *"However, in 1915 Einstein presented a theory combined space and time on something called space-time. This was not flat but curved or was distorted by matter and energy contained"* (Thorne, 1994).

The hyperspace in reality as perceived by the brain without the adjustments would be as follows:

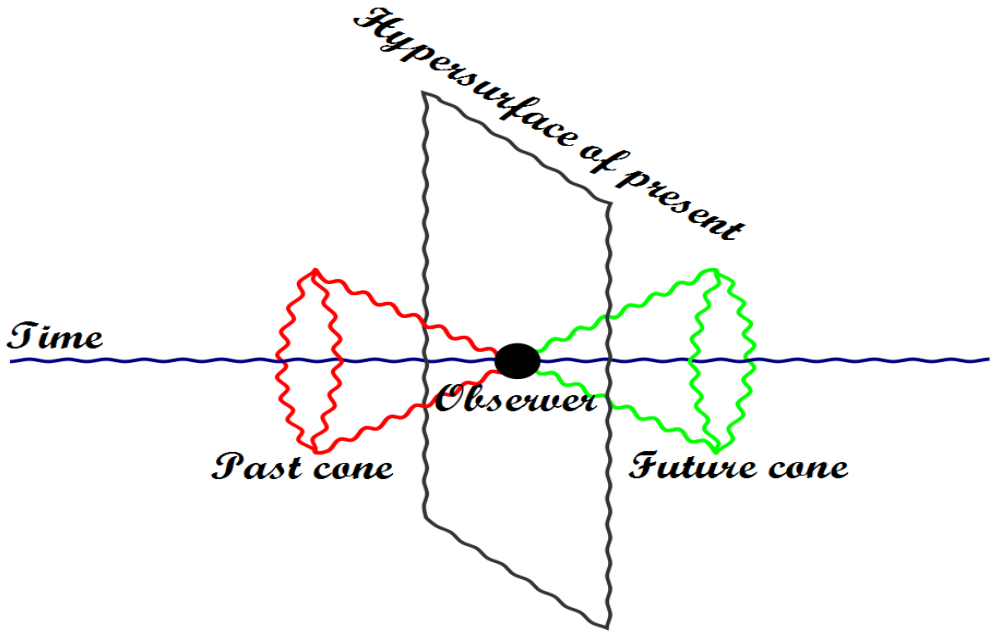

Fig.4. The brain space-time.

In the center (Fig.4) the observer is located and around this point the Hyperspace of the present where can occur simultaneous phenomena. We shall say that all the internal processes as neurocognitive and somatic elements are located in this point. On the left side (Fig.4) the past cone is located and in the right – the future cone.

Once we have recognized how the brain locates in the space-time we shall add that this hyperspace has some limitations. The first is that in the Minkowski space we have

always one observer. But for the representation of natural languages we shall have different observers.

The second limitation is due to the conception of space and time, somehow cultural. But we can say that in some cases we perceive the time as lineal, and the space time as a continuum and orthonormal (more as a Hilbert's space) (Hilbert, 1902, 1967 & 1926).

The cone in the Minkowski space, if we perceive it outside the cone as an external observer we see it as a continuous line and based on this idea we will build our hyperspace that can have multiple observers as follows:

Building our hyperspace

Representation of time

On the one of the horizontal axis (Fig.5) the time was situated, which can have both positive and negative values.

We can recognize three parts in this axis, one in which t is negative (past) one that is positive (future) and the present will place it in t °, without forgetting that the brain processes the time always as an interval.

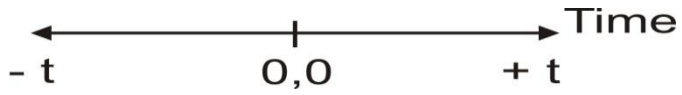

Fig.5. Representation of time

Representation of space

Moreover, the space (Fig.6) can also have negative values. Our space, keep in mind this is a three-dimensional space. The negative space matches any particle of negation. If, for example r (x, y, x) is a point, or rather a three-dimensional representation in the form

of point which would correspond to the noun "dog"; its negative value, ie -r, would be "no dog". The negative symbol (-) is in fact an operator in our space. In physics, the evidence of the existence of negative space we can find, according to our reasoning, in studies as (Soucek, 1980) and (Godoy, 2002).

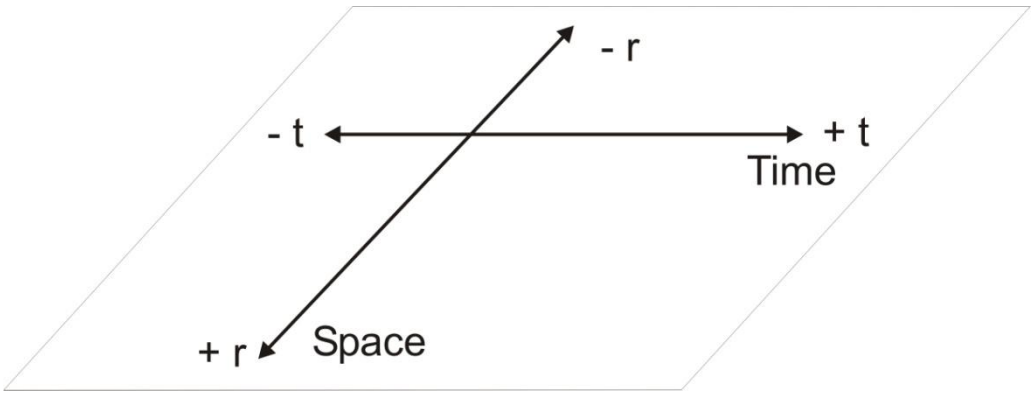

Fig.6. Representation of space.

Representation of the Scenario function

Adding the 3th axis we got our hyperspace:

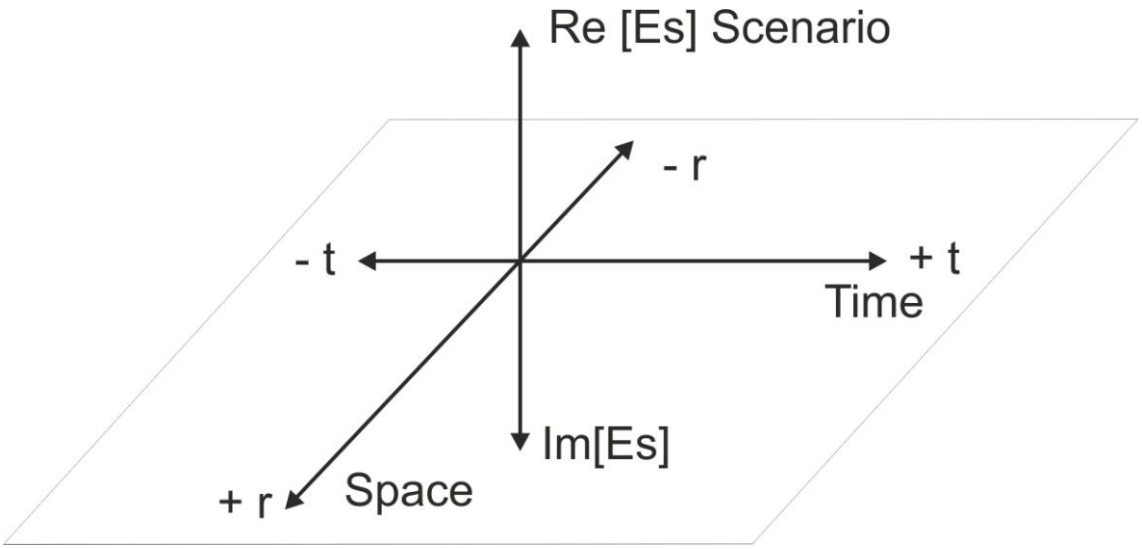

Fig.7. Our proposition of hyperspace.

The Scenario is a quantity that represents the relationship between space and time, his intervals we can name Scenes.

It should be noted also that the Scenario can acquire both positive and negative values. In the center where it is positive is located (express) real phenomena, consistent with external reality, the existence, factuality, which we perceive as real or potentially real without expressing doubt or potentiality.

In the negative axis where situate is counterfactual phenomena, unreal, imaginary, which we perceive as unreal, not consistent with reality, with internal distorting elements, etc ... Based on the works of Feroze 2006:

"During the deception process, 14 regions were found to be significantly active. (…) During truth telling, seven regions were significantly active". (Feroze et al., 2006).

We applied successfully the proposed hyperspace on the representation of the past tenses in two precedent works: In Spanish as a foreign language (El Imrani and Mendecki, 2011) and to the Spanish corpus PRESEEA. (El Imrani and Mendecki, 2012).

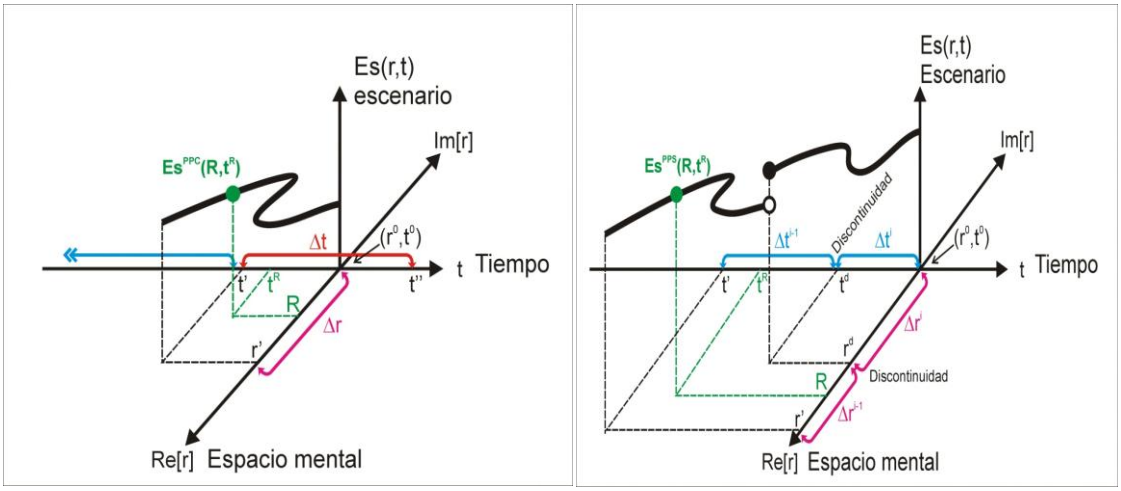

Fig. 9. Exemple of application. (El Imrani and Mendecki 2012)

Conclusion:

The postulated hyperspace is a multi-dimensional space built upon neuronal processes inherent in the nature and capabilities of the brain. It was noticed that the presented space is rather a dual space one orthonormal (Hilbert's space, linear) and other non lineal (Minkowski space). This duality permeate us to better locate any physical, internal and even every linguistic phenomenon where later can be represented from nouns, adjectives, adverbs and verbs such as definable elements on the one hand, and syntactic relations, declines, such as mathematical operators can be located.

The applications of this system are manifold, both for the mathematization of natural languages, in computer translation, etc.

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