A PERSPECTIVE OF THE INTEGRATIVE STRATEGIC MODEL OF THE SELF ON BRAIN ACTIVITY. INTERNAL WORKING MODELS

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ABSTRACT: Brain research faced and is still facing the problem if neuronal and synaptic diversity. Brain functionality is based on physical-chemical processes, thus an alteration of these processes generates consequences in information processing. The Integrative Strategic Model of the Self proposes an integrative vision of brain functionality by reconsidering the concept of internal working model (a concepts first used by Bowlby), neuronal maps and cortical modules. The hypothesis of this study is to prove that internal working models are innate; the objectives of the study resume to underlining internal working models on the psychological axes of the Model mentioned (Biological, Cognitive, Emotional, Psycho-dynamic, Familial and Existential axes) and to present the cortical activity from the perspective of internal working models (IWM), of neuronal maps (NM) from the Central, Plastic and the External Self. The study represents an integrative strategic perspective on brain activity.
KEYWORDS: internal working model (IWM), Integrative Strategic Model of the Self, neuronal maps (NM), cortical modules

1. INTRODUCTION. SELF ORGANIZATION LEVELS IN THE INTEGRATIVE STRATEGIC MODEL

Brain research is facing for a long time the problem of neuronal diversity. Different areas of the brain contain neurons with different characteristics, from pyramidal neurons to star or granular neurons.

Obviously, this neuronal diversity is also found in the synaptic diversity. The entire brain functionality has at its basis physical-chemical processes. Thus, to study nervous systems supposes to study the organization levels of the nervous system.

The Integrative Strategic Model of the Self (ISMS) (Drobot, Popescu, 2013; Vîşcu, Popescu, 2015; Popescu, Vîşcu, 2016) postulates the existence of en Self emergent from the Basic Self, the Central Self and the External Self (see Table 1). At a neuro-anatomic level, the Self consists of:

- the *Basic Self (the proto-self)* – is build of internal working models, genetically predetermined and of neuronal maps. Internal working models (IWM) can contain one neuronal map or more neuronal maps;
- the *Central Self (the core-self)* – is formed of: central beliefs or strengthened neuronal maps, contained by IWM, cortical modules (one IWM or more IWM in interaction), emotions, etc.;
- the *Plastic Self* – is formed of plastic mechanisms that sustain the content of the Central Self. From a neuro-anatomic point of view, plastic mechanisms are also found in interconnected neuronal networks (NN), but also in RN formed and strengthened through repeated interactions of cortical modules;
- the *External Self (the outer self)* – is formed of externally visible components as a consequence of a neuro-chemical and psychological functionality of the brain.

The Basic Self, Internal Working Models (IWM)

Since birth, the human brain is formed of excess neurons – or neurons expecting experience – and mirror neurons (Mayer, Damassio, 2009). Mirror neurons begin their activity immediately after birth, after a few hours the newborn is able to repeat facial movements of persons that he came into contact with. Siegel (2001) mentioned the existence of an initial excess of neurons that form the "expecting neuronal network" shaped by non-verbal experiences. External stimuli that reach the Basic Self are non-verbal during the first months of the newborn's life.

Table 1.The self at a neuro-anatomic level (The Integrative Strategic Model of the Self

Basic Self	Central Self	Plastic Self	External Self
N → NN → NM_1=>$IWM_{(1)}$ N → NN → NM_1, NM_1 → $IWM_{(2)}$	Cortical modules containing: • NM_2; • one IWM; • more than one IWM (reunion); • intersections of IWM; • one IWM and one NM_2; • the products of cortical modules: beliefs, ideas, feelings etc.	• NM_3; • mental modules; • 3 properties of the cortical module that sustain the nervous system mechanisms	External behaviour

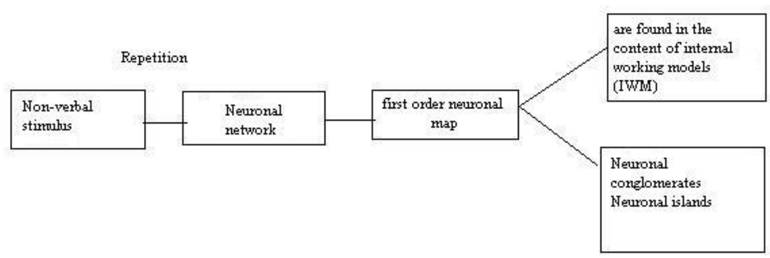

Fig. 1 Neuronal maps of the Basic Self

Non-verbal stimuli that act during this period generate neuronal connections (neuronal networks, NN), which is strengthened form neuronal maps of the first order (NM_1). In other words, there is a preference for a certain type of reaction, of emotional or cognitive processing (Figure 1).

In psychotherapy, behavioural modification, that of a reaction, thoughts, emotion etc., if it represents the consequence of NM_1 at the level of the Basic Self, it supposes a more laborious intervention, because NM_1 is build since early days.

Thus, if the client has a problem with the origins of the Basic Self at the NM_1 level, the more laborious is his behaviour in comparison to his problems, which, for example, have their origin in the Central Self. It is also postulated that the Basic Self also contains internal working models, genetically predetermined.

The concept of internal working model was first proposed by Kenneth Clark in artificial intelligence and was later used by Bowlby.

Referring to the internal working model, Bowlby (1963) suggested that, since birth, the child internalizes his attachment relation thus forming an internal working model. This model represents an unconscious system of schema, beliefs or guides for interpersonal relations, modelled through interactions with parental figures.

The internal working model (IWM) is formed of expectations, regarding the behaviours of others, strategies to face stress, which determine the manner in which the behaviours of others are perceived as typical patterns of interpersonal relations.

According to Clayman (1991) the internal working model is stored as implicit memory. The Integrative Strategic Models of the Self proposes an internal working model built of neuronal structures, genetically predetermined: neurons configured into neuronal networks (NN) and first order neuronal maps (NM_1), which can be activate even before birth and after birth.

Bowlby (1969), in the first volume of his trilogy, *Attachment*, synthesises for the first time the concept of internal working models (IWM) of attachment relations. He states that IWMs are interaction schema, custom and generalized, which are formed by humans through an attachment relation, which tend to last in time (Pallini, 2014, in Bowlby, 1969, 1973, 1980, 1988).

He also sustains that individuals interprets the IWMs of attachment relations on the basis of real experiences that children have during their daily interactions with their parents. Thus IWMs are not immutable, through interpretation; predictions on behaviours are modified together with interaction strategies and affective connections.

In a therapeutic relation, the patient's feelings towards the therapist are seen as being assimilated in a pre-existent schema, the patient has in connection to an expected behaviour from his former "career". Such previsions may persist or are annulled by experience: in the case of an annulment, IWMs suffer further modifications. Environment stimuli (marriage, the loos of a child) produce radical modification of IWMs (Bowlby, 1969).

The attachment theory also stimulated the interest for the manner in which social information is processed and why there are individual difference in the processing of social information (Dykas, 2011). Internal working models may be qualitatively favourable or unfavourable (secure or insecure), and their functions generate adaptative or maladaptative models of information social processing.

2. INTERNAL WORKING MODELS IN THE INTEGRATIVE STRATEGIC MODEL OF THE SELF

2.1. Genetic predetermination IWMs from the Basic Self. IWMs and psychological axes of the integrative Strategic Model of the Self

The starting points of this study, in a direct relation to the Basic Self are:

- IWMs are genetically predetermined in the Basic Self;
- IWMs contain excess and mirror neurons expecting experience;
- while non-verbal stimuli act, neuronal networks and first order neuronal maps are formed in the IWM of the Basic Self (see figure 1);
- NN and NM_1 from the Basic Self may be activated during an entire lifetime;
- NM_1 from IWMs can be modified through experience and learning and new NM_1 can be formed in IWMs of the Basic Self;
- besides IWMs genetically predetermined one could also observe excess neurons, expecting experience in order to form NN, reunited in neuronal maps, while the organism and the brain are stimulated;
- there is also a possibility for a configuration of only one intraneuronal map inside the Basic Self.

When talking about the Central Self the starting points used in this study are (see Table 2):

- while verbal and nonverbal stimuli act from the exterior and the interior environment on the organism, second order neuronal maps (NM_2) are formed;
- the contents of IWMs a processed, and two or more IWMs can form a cortical module;
- the content of the Central Self is formed of cortical modules;
- a cortical module can be formed of only one IWM and one NM_2;
- a cortical module can be formed of the reunion of IWMs;
- a cortical module can be formed of the intersection of IWMs;
- a cortical module can be formed of only one NM_2, specialized, without IWMs;
- the products of cortical modules are: central beliefs, representations, emotions, affects etc.

Table 2 The Basic and Central Selves composition

Basic Self	Central Self
– IWMs genetically predetermined (repeated NNs with compact circuitry or which work independently or together) – Cortical circuits or NNs →	IWM ↑ Cortical modules ↓ NM_2

It is considered that the in Integrative Strategic Model of the Self, in the Basic Self, IWMs are classified on the 6 Psychological Axes:

1. Axis B (Biological) contains:
   - IWM for a body schema (integrity and the lack of body integrity);
   - IWM for a body schema at a nonverbal level (positive and negative);
2. Axis C (Cognitive) contains - IWM for the self-esteem;
3. Axis A (Emotional) contains - IWM for all attachment types (alone/anxious/avoidant/disorganized) and for basic emotions: fear, fury, sadness, joy and surprise.
4. Axis P (Psychodynamic) contains - IWM for the fragmented/defragmented Self; for personality traits impregnated with anxiety and aggressiveness (innate traits); for the structural states of the Self (parent, adult, child); for drivers; injunctions; for the Self defence mechanisms; and for archetypes;
5. Axis F (Familial) contains - IWM for familial roles and for the familial unconscious;
6. Axis E (Existential) contains - IWM for all 4 fundamentals worries: death, freedom/responsibility; isolation and the meaning of life; for time; for spirituality; and for contact (contact disorders: Introjections, Projections, Retroflection, Conflection and Confluence).

Elder people's childhood cognitive development is correlated to cognitive plasticity. James (1981) described the humans capability to form "new set of customs" or abilities as being the definition of plasticity. It is thus considered that the learning of perceptive-motor abilities needs the adjustment of sensorial feedback, and the learning of cognitive abilities implies the acquisition of capacities to solve a problem in a manner, which wasn't possible before, without necessarily needing new perceptive-motor abilities (Rosenbaum et al, 2001; VanLehn, 1996; in Mercado, 2008).

The concept of cortical module was used defined by Mercado (2008) as being a compact circuit where neuronal networks work independently or together and are iteratively repeated. Cortical modules possess a structural nature (observable). Fodor (1983) also proposed the existence of specialised "mental modules".

Thus, according to Fodor's proposal the Integrative Strategic Model of the Self also contains mental modules which are NM_3 (3rd order neuronal maps) or maintenance mechanisms of cortical modules from the central self (see Table 3).

Table 3 Composition of the Central and the Plastic Selves

Central Self	Plastic Self
IWM ↑ Cortical modules ↓ NM_2 }	Mental modules (NM_3) Properties of cortical modules contain the mechanisms of the Plastic Self: • Availability • Reconfigurability • Personalization

Mountcastle (1998) mentioned the existence of a neuronal "calculus" or a function realized by every cortical module. For instance, the cortical modules of the Central Self for IWM from the Basic Self; IWMs for a body schema have neuronal calculi or functions to realize a body schema, respectively a body image. It was initially considered that some cortical modules facilitated the differentiation of sensorial events.

Mercado (2008) excluded this idea that cortical modules facilitate the differentiation of stimuli representation. The model described introduces the idea that cortical modules are sustained in their activity by mental modules (3rd order neuronal maps, NM_3. from the Plastic Self).

- Cortical modules from the Central Self are structural modules which can be „observed" with the help of neuronal imagery.
- Mental modules are plastic mechanisms for the maintaining of cortical modules.
- Cortical activity is the consequence of IWM activation from the Basic Self of NM_1, of cortical modules from the Central Self, of NM_2, or of mental modules or NM_3 from the Plastic Self.
- The visible expression of the cortical activity comes from the External Self

2.2. Representational resolution of stimuli and the properties of cognitive plasticity

Prefrontal activity, interactions between cortical and subcortical regions, a global dimension and the structure of cortical regions, all influence cognitive plasticity.

Studies have shown that the extension of cortical networks also determined the reduction of cognitive plasticity constrains (Gibson, 2002; Sternberg & Kaufman, 2002). Cortical processing increases cognitive plasticity through the extension of the organism capacity to represents internal and external events. Events may also be processed through the formation of multiple paralleled representations of one event (i.e. photographs realized from different angles).

While organisms learn from their experiences, a refinement of their cortical sensitivity is obtained together with the topographic representation of cortical networks (Buonomano & Merzenich, 1998; Weinberger, 2004).

Inputs from sensorial receptors are remapped in the nervous system of mammals and different mapping generated different stimuli-answer configurations. The cortical extension and the number of neurons constrain the capacity of an organism to differentiate stimuli representations.

The functional maps from the cortex also influence the capacity of the organism to differentiate stimuli representations.

(a) Neuronal availability

Neuronal availability is connected to other two characteristics: the number and the size of cortical networks – more space means a larger availability for neuronal connection and for stimuli differentiation. Big brains allow more connections in cortical regions and more specific projections in all regions.

Inputs from different regions of the brains that appear in the cortex are perpendicular on the cortical surface and are organized in columns, thus a great functional segregation possibility resulting and the reduction of terminal superposition. The six neuron layers from the cortex also allow a fine processing (Swanson, 2003) and an extended topographic structure (Striedter, 2006).

A fine topography in cortical networks increases the possibility for the input precise decomposition, which also supposes a topographic organization.

Groups of cortical columns may function together as a coherent unit.

> Cortical units represent groups of neuronal columns, with specific functions (cortical modules have IWMs), but which can function in interaction with other cortical modules (other modules belongig to other IWMs) but also with other neuronal maps.

(b) Reconfigurability of flexibility of neuronal circuits

Even if it was initially considered that the reconfigurability of neuronal circuits reflects the fact that cortical modules are similar and interchangeable from functional point of view, it was later proved that cortical modules from the same circuits have specialized functions (Crone et al., 2006).

Mesulam (1998) described the capacity of brain regions to dramatically change their affiliation from one functional network to another as *selectively distributed processing.* In any learning stage, neuronal circuits involved are *"paths with the lowest resistance"* (Reichle, Carpenter & Just, 2000).

Cognitive plasticity depends on the processing distributed in a selective manner; brain specialized cortical modules may be used in a variety of combinations in order to allow the acquisition and the performance of cognitive abilities. The variability of cognitive plasticity in individuals of different species, reflect the variability of cortical modules reconfigurability. EEGs studies on humans have shown that persons with a high intellectual capacity may be capable to configure their neuronal circuits flexibly (Jausovec & Jausovec, 2000, Thatcher, Nord, & Biver, 2005).

(c) Personalisation

Older subcortical systems control the manner in which cortical networks respond to events. When the organism is awake, neuromodulator systems underline the processing of information. The basal forebrain is also important for the activation, the formation and maintaining stimuli representations.

Another important feature of neurons from this side of the brain is that these may affect not only the manner in which cortical networks respond to events, but also the manner in which learning experiences modify cortical sensitivity (Mercado, 2008, in Zahm, 2006). Thus, neuro-motor systems responsible for the activity levels in the cortex determine the manner in which experience remodels cortical architecture and the manner in which events are represented.

Studies on development and learning regarding cortical plasticity show that the distribution of sensitivity in sensorial maps is systematically modified on the basis of sensorial events experiences by the organism. The removal of cortical regions responsible for a selective answer to stimuli implies an increase in the number of cortical modules, which respond to those stimuli. The size of a receptive cortical region for sensorial inputs is a great predictor for the organism capacity to differentiate that input.

Stimuli experiences increase the selectivity of cortical neurons, which respond to a certain stimulus (Polley, Kvasnak and Frostig, 2004), thus increasing the precision of available cortical modules. The basic idea is that neuromodulators (especially acetylcholine) freed by the basal forebrain towards cortical neurons increase answers for sensorial inputs by increasing permeability, so that these inputs may generate this potency.

These potential actions facilitate neuronal plasticity and future answers for these special inputs will also be improved. In a collective manner, the neuromodulator effects dependents on the experience will increase the capacity of sensorial cortical networks and the efficiency for the processing of relevant behaviour stimuli.

In conclusion, the three properties of cortical modules refer to availability (the number and size of neurons), reconfigurability (flexibility) and personalisation (differentiation). These properties sustain the mechanisms of the Plastic Self.

The following can be underlined as a synthesis for neuronal maps from the Integrative Strategic Model of the Self:

> - the Basic Self contains since birth and even from the intrauterine period, excess and mirror neurons; immediately after birth, due to non-verbal stimuli from the child's carers, the neurons of the Basic Self are activate; thus neuronal networks are formed, and through a repetition of stimuli 1 order neuronal maps appear , NM_1;
> - NM_1 from the Basic Self belong to internal working models (IWM), genetically predetermined and to neuronal structures; Due to a non-verbal stimulation, from the interior of the curtail activity (inter- and intra- neuronal stimulation) 2nd order neuronal maps are formed (NM_2) in the Basic Self;
> - Cortical Modules from the Central Self represent the consequence of NM2 activation or the expression of IWMs and of neuronal structures from the Basic Self; Cortical Modules from the Central Self are the expression of IWM development, of more IWMs or the interaction or reunion of IWMs. Besides the product of IWM, cortical modules are also the expression of refined neuronal structures (other NM_2) from the Central Self, as ideas, thoughts, central behaviours etc.
> - Cortical modules (IWMs and neuronal structures NM_2) interact and are in interdependence through neuronal connections.

3. CONCLUSIONS

The Integrative Strategic Model of the Self proposes and integrative vision on the Self, based on neurosciences, on developmental psychology, on learning theories etc. The basic concepts used by this model are: internal working models (IWM), neuronal maps (NM), neuronal networks (NN), the Basic Self, the Central Self, the Plastic Self, and the External Self.

The internal working model (IWM) is a concept borrowed from Bowlby, who also inspired from the artificial intelligence domain. Unlike Bowlby, the Integrative Strategic Model of the Self considers IWMs as being genetically predetermined. The IWMs are present on each psychological axis of the model.

Thus, taking into consideration methodological reasons, the Integrative Strategic Model postulates the existence of six axes: Biological, Cognitive, Emotional, Psychodynamic, Familial and existential. Thus, if Bowlby mentioned the existence of IWMs for attachment, the IWM conceived, developed, plastic and dynamic immediately after birth proves the existence of genetically predetermined IWMs not only for attachment.

The increase of stimulation from an external and an internal determines a development of IWMs complexity, their processing at the Central Self level, by organizing them into cortical modules. In the Basic Self, besides the IWMs, genetically predetermined, neuronal networks are also observed, which through stimuli repetition are transformed into 1st order neuronal maps, NM_1.

At the level of the Central Self, through the action of internal and external stimuli, NM_1 transform into NM_2, which can also be organized into cortical modules, which interact or can reunite with other cortical modules. Thus, the Central Self is formed of cortical modules generated by the content organizations of IWMs and of NM_2. The products of cortical modules of the Central Self are central beliefs, ideas, feelings etc., products found in a permanent change and which can be functional or dysfunctional, according to the individual's adapting process.

The Plastic Self is conceived, in the Integrative Strategic Model of the Self as a reunion of mechanisms. 3rd order neuronal maps (NM_3), which maintain the activities of cortical modules, also sustain the contents of cortical modules and cortical interactions. NM_3 are feedback clusters generated by external and internal stimuli and by a generated feedback: NM_3 also represent the expression of the three properties or characteristics of cortical modules: availability, reconfigurability and personalisation. The External Self is the visible expression of the neuronal mechanisms action, of the brain activity and of the Self activity.

Future study and research directions, using Imagistics, on the action of neuromodulators, may develop the architecture and functions of the Integrative Strategic Model of the Self. From this perspective, it would be interesting to study the modifications appeared at a bio-chemical level, of synapses and of neuronal maps as a result of psychotherapeutic intervention.

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