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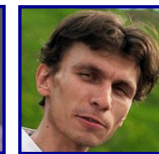


On Modeling the Creativity and the Concept of Chef-D'oeuvre. Olga Chernavskaya¹ (olgadmitcher@gmail.com), Yaroslav Rozhylo².

¹Lebedev Physical Institute, Moscow, 117335, Russia, ²Ukrainian Center for Social Data, Kyiv, Ukraine.



Olga Chernavskaya



Yaroslav Rozhylo



P.N. Lebedev
Physical Institute

ABSTRACT

The problem of modeling the creativity is shown to be entirely connected with another mysterious challenge – the “Explanatory Gap” between the concepts of “Brain” and “Mind”. The Natural Constructive Cognitive Architecture (NCCA) is employed, with its important feature being the combination of two subsystems, one for generation of new information, the other for conservation of already recorded one. Here, “Brain” is understood as records of the “raw” images of real objects (individual objective information), while “Mind” refers to individual subjective information created inside the cognitive system (symbols). We argued that creativity can be treated as “an effort to bring a piece of personal ‘Brain’ into the ‘Mind’ and ‘World’”. Specific thinking mode (intellectual panic, or *throes of creativity*) is shown to enhance the creative work resulting in over-mobilization of all resources and even enriching personal deep inside (“Brain”) experience. The concept of Chef-D'oeuvre (ChD) and the nature of Aesthetic Emotions (AE) are analyzed. It is shown that ChD should cause the “recognition paradox”, i.e., to seem both, familiar and unusual (abnormal). This paradox arises when the “Brain” does see the subtle features of an object, while the “Mind” does not realize this. Bright aesthetic emotions (AE) causing goosebumps could be interpreted as irregular excitation of implicit associations provided by weak (“gray”) connections of the halo neurons (deep inside). General formula for ChD in science and art could be expressed as “condensed capacity to see the invisible, to combine the incompatible”.

INTRODUCTION

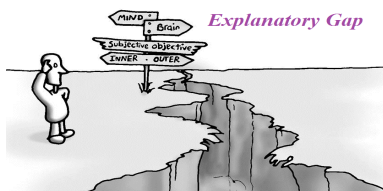


Fig.1 Illustration to the problem (extracted from [1])

The **problem of “Explanatory Gap”** between the concepts of “Brain” and “Mind” [1] can be solved if “Brain” is treated as objective information provided by Nature, with “Mind” being the subjective one created by the system itself.

- Creativity is commonly considered as an ability to generate new solutions in any form [2].

Source is hidden in the **subconsciousness**, i.e. personal, unformulated and unrealized, episodic experience (deep inside) referring to the “Brain” [2][3].

Methods [2] are based partly on professionalism, partly on *insight*, i.e. occasional recognition of the solution. This could happen in a *dream*, i.e. on the edge between consciousness (“Mind”) and subconsciousness (“Brain”).

- NCCA was developed in our previous papers [5][6]. It is based on the Dynamical Theory of Information (DTI) [7], Neuroscience [8], and Neurocomputing [9][10].
- Embedding emotions into cognitive process is another emotion and evokes great attention (see [11][12] and refs. therein). In NCCA, emotions are considered as a product of mutual interaction between neocortex and subcortical structures (neurotransmitter composition). In neocortex, it is represented by the noise amplitude $Z(t)$.
- The concept of ChD in call and science are considered. ChD in art is aimed to call AE, but the nature of personal AE represent special enigma [6]: they have no rational reasons. Of course, there is a great influence of mass media (propaganda) and commercial reasons (the cost of art ChD at famous auctions). But then the questions arise:
 - why AE are strictly individual?
 - What is the ChD, the excellent piece of art that is accepted by the entire society? how could it be made?
 - what differs a ChD from the pattern of solid professional work?

These questions are the subject of this paper.

NCCA MAIN FEATURES

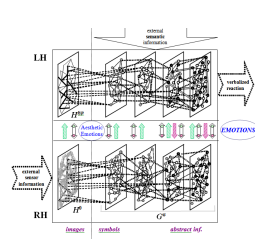


Fig. 2 NCCA Scheme

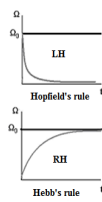


Fig. 3. Connection training

NCCA consists of two connected subsystems (*hemi*-systems), conventionally corresponding to the cerebral hemispheres, RH and LH. RH is aimed to learning and generation of new information (with mandatory noise participation), while LH is responsible for conservation of already recorded one and processing (recognition). The scheme in Fig.1 refers to modeling the *neocortex*, which is the nearest candidate for the role of Mind bearer. **Dotted line represents the virtual border between ‘Brain’ and ‘Mind’**

This is complex hierarchical combination of Hopfield- [9] and Grossberg-type [10] processors.

- Two ground (basic) levels H contain information on real objects recorded in the form of excited neuron chains (distributed memory) This represent *individual objective* information and so refers to the “Brain”.
- All other symbol levels G represent individual *subjective* information, which can be formulated (verbalized) and realized (“Mind”).
- At each α level, the same algorithm does work: an image formed in RH at the previous level, creates its symbol (convolution) at the current level. Then, these symbols create new *generalized* image in RH (image-of-symbols), which obtains (in RH again) its symbol at the next level, which form the semantic connections with its ‘parent’ image and is translated to LH for storing. This represents so called *scaling principle*.
- The symbols at the high-levels of hierarchy represent *concepts* (abstract information). They can control the entire system activity via numerous *semantic* connections with lower-level symbols (up to the image level). Such processes correspond to the concept of “*consciousness*”.
- **Subconsciousness** is hidden in the plate H⁰ in RH, which contains the most complete information on real objects presented to the system. The “typical” images reflect their *typical attributes*; further they produce their symbols and fit into entire symbolic infrastructure (“Mind”). **! Seemingly unimportant information** (such as rare and non-typical representations of the real objects) are reflected by so called *halo neurons* (non-typical attributes) with rather weak (“gray”) connections providing *vague implicit associations*. This information is hidden in H⁰ only and cannot be neither symbolized, *nor realized, nor controlled* by the system, remaining at the “Brain” level only. — hence, it can be treated as the individual unrealized (hidden) experience, i.e., **“deep inside”**. This information could be excited (*extracted*) by noise, what **provides the insight**.
- The challenge is to extract the halo-information from *deep inside* and *formulate* it by means of any common language — this can be treated as an *act of creativity*.

3. RH vs LH Specialization and Dialog

The math ground for the scheme in Fig. 1 was developed in our previous papers [5][6]. Let us discuss several principle points.

1. **Specialization** of hemi-spheres is secured by 3 factors:

- Random self-excitation (*noise*) is presented in RH only:
 - the noise is presented as $Z(t); \xi(t)$, $Z(t)$ being noise amplitude, $0 < \xi(t) < 1$ is random function.
- Different training rules for cooperative neuron connections in the two subsystems (Fig. 2):
 - Hebbian [8] principle of connection amplification in RH (providing the choice);
 - Hopfield’s [9] principle of *selecting* proper connections (“redundant cut-off”) in LH.
- self-organization by the “connection-blackening” principle: typical images (raw as well as generalized) formed in RH are translated (adopted) to LH for memorization and processing, and to the next level $G^{(n+1)}$ in RH, where new symbol is to be formed;
- this procedure repeats at each level, what corresponds to the *scaling principle*.

2. **Dialog** RH–LH is provided by the hemi-system connections $A(t)$, which are not trained, but should be controlled by certain orders (regarding the neocortex) mechanism — **emotions**:

$$A(t) = -A_0 \cdot \tanh\left(\gamma \cdot z^2 \frac{dZ}{dt}\right), \text{ where } A_0 > 0 \text{ means RH} \rightarrow \text{LH transfer, and vice versa.}$$

Mobilization of the system resources (necessity of RH activation) corresponds to increasing $Z(t)$ ($dZ/dt > 0$) and negative emotions (tension, nervousness). Vice versa, decreasing ($dZ/dt < 0$) corresponds to positive emotions (*relax, satisfaction*): no need of RH, LH records a success.

$Z(t)$ can be treated as “emotional temperature”

4. NATURE OF AE: WHAT IS ChD?

- Emotional manifestations are initiated by various patterns of the self-excitation (noise) amplitude $Z(t)$ (see Fig. 4).
- At *recognition* process (Fig. 4a) $Z(t)$ shows *damping oscillation*: around normal value Z_0 ; it means putting forward (RH) and testing (LH) certain hypothesis. If the result was successful, $Z(t)$ goes to normal value.
- The *prognosis* represents recognition of time-dependent process, with $Z(t)$ pattern being the same. In the special case of a *joke* (Fig. 4b), which represents a surprisingly incorrect prognosis at t^* , which changes by immediate recognition, $Z(t)$ demonstrates sharp *splash* (imitating the laughter).

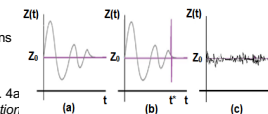


Fig. 4. Typical Z(t) patterns for: (a) recognition;

- AE arises in the conditions of calm contemplation of an art pattern. Here, $Z(t)$ behavior is controlled by the value of *discrepancy D*

$$D_{p-a}(t) \equiv \sum_i \|H_i^p - H_i^{ap}\|,$$

- i.e., the difference between RH and LH records (excited neurons):
 - If the pattern is quite familiar ($D=0$), AE are absent (indifference);
 - If it is quite unknown (now such records), AE again are absent;
 - bright AE providing the *goosebumps* (in Fig. 4c – slight trembling around normal value Z_0) are caused by the *recognition paradox*: the pattern seems familiar and unusual (*abnormal*) simultaneously, with this illusion cannot be *neither formulated, nor realized*. This implies that this pattern excites the halo-neurons and generates *vague implicit associations* (via “gray” connections). This paradox cannot be resolved, since always $D > 0$ due to halo neurons (absent in LH).
 - The essence of AE consists in fuzzy discomfort mixed with pleasure that arise when the “**Brain does know, what exactly causes the feeling of anomaly, while the ‘Mind’ cannot realize it.**” Figuratively speaking, we can infer that “**AE emerge from the Explanatory Gap**”.

- **General formula for ChD**

General recognition paradox arises in at least two cases:

- when the ChD is slightly **invisibly** different from itself,
- when it elusively reminds a lot of other **incompatible** things (*déjà vu* effect);

Both effects should appear at the *deep inside* level.
General formula for ChD in Art and Science can be expressed as:
“ChD is the condensed capacity to see the invisible, to combine the incompatible”.

5. HOW ChD COULD BE MADE

- There are at least two ways:

- by pure insight? — very rarely;
- by hard work implying mobilization of all (including emotional) resources, i.e., *throes of creativity*.

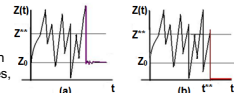


Fig. 5 Typical Z(t) patterns for panic: (a) “aha-moment”; (b) deep depression

- The intellectual panic (or throes of creativity) is usually caused by necessity to solve a problem urgently before a *deadline*. Intensive creative work requires considerable increase of the noise amplitude $Z(t)$, which increases the probability of random excitation of the desired halo neurons (i.e., the *same insight*).
- This extreme mode could be simulated by increase of $Z(t)$ up to abnormally high value Z^{**} with subsequent chaotic jumps, which imitate mood swings from euphoria to despair (Fig. 5). Here, the system falls into a *chaos*, with the noise being dominate over all recorded (by all means) information.
- This could result in activation of even “sleeping” neurons (those that never have been activated even as *halo*) and provide such unexpected solution that the system itself could not imagine even at the deep “Brain” level. This act of super-insight is accompanied by the emotional splash (“Eureka”), which is initiated by the sharp *splash* in $Z(t)$ (Fig. 5a).
- Otherwise, it could result in deep long depression (Fig. 5b).

• remember Nietzsche, **“You have to have chaos in you to be able to give birth to a dancing star.”**

EXAMPLES OF SCIENTIFIC ChD

Scientific ChD (discovery) correspond either to revealing the most important feature of a phenomenon and propose *laws* (=to see the invisible), or to resolution of the scientific paradoxes (= to combine the incompatible), or both.

1. **Mendeleev’s Table of Chemical elements** represents a “double” ChD [13]. He succeeded in combining all the elements into some groups having different atomic weights, but similar properties. Further, it appears to be in agreement with the “planetary model” of an atom, which is accepted till now and was developed long after his death (*combined incompatible*). There two points:

- the day before the discovery Mendeleev was in the state of *intellectual panic* (*throes of creativity*). The Table was supposed to be included in the chemistry textbook ordered to him, and the publisher was rushing with the deadline. But some chemical elements did not want to take needed places.
- the decision came to him in a *dream*. It was ingenious and *paradoxical*: he left empty places in the Table for elements that *should* occupy them but are still unknown. Thus, *he had seen the invisible elements*.

2. **Bohr’s Complementary principle**. Quantum Mechanics (QM) is one of the most mysterious and hardly understood scientific specialties. It is based on the mysterious paradigm called the “wave-particle duality”, which implies that any object can be considered and described as a wave and a point particle at the same time.
- Two basic postulates of QM contradict each other. The first one is Schrodinger’s *dynamical* equation for the wave function, the second postulate connects the probability of finding the entire particle with the wave-function modulus squared. Thus, it is assumed that the calculations within the dynamical system result in conclusion, which has sense for stochastic systems only.

- The QM interpretation evoked hot discussion between Einstein and Bohr [14]. Einstein objected to the second postulate since in the dynamical systems, the probability concept itself could not be applied: “*God does not play dice with universe*”. Bohr, on the contrary, considered the mixing of concepts in theory as acceptable and proposed (*created*) the “*complementarity paradigm*”: the science could contain the contradictory statements referring to different parts of the same phenomenon: “*It is not one key to open all the doors in science*”.

- The contradiction in QM was neglected, and, after Bohr, two basic postulates were simply *complemented*. This very principle is admitted as scientific ChD, since it provides (legalizes) the possibility “*to combine the incompatible*” by simple adding. However, actual solution to the problem pointed out by Einstein is still not found.

CONCLUSIONS

1. Creativity represents an effort to *realize personal deep inside experience*, i.e. “to bring a piece of personal “Brain” into the “Mind” and “World”. Genius is a person who can “dig out” from his *deep inside* something that find a response in a hidden personal experience of other people.
2. Specific thinking mode (panic, or throes of creativity) can be imitated by the chaotic jumps of the noise amplitude $Z(t)$ around abnormally high value. It is shown to enhance the creative work resulting in over-mobilization and even enriching personal deep inside (“Brain”) experience.
3. Bright AE caused by ChD arise from excitation of *individual implicit associations* provided by the *paradox of recognition*: ChD seems both, familiar and unusual, with this illusion is neither formulated, nor realized, remaining at the “Brain” level only.
- Thus, ChD represents a condensed capacity “to see the invisible, to combine the incompatible”.
- Summarizing: ChD is something allows to contact with a genius at the *deep inside* level.

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