

# A JOINT LANGUAGE-COGNITIVE COMPUTATIONAL APPROACH TO WITTGENSTEIN'S TRACTATUS

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Here we make clear a striking correlation between Wittgenstein's *Tractatus Logico-Philosophicus*, that assesses the logical relationships between language and world, and the successful Perlovsky's joint language-cognitive model, that assesses the relationships between language by one side, and the knowledge instinct correlated with basic and aesthetic emotions by another side. This allows us to appraise the invaluable but dismissed *Tractatus'* content in terms of the neurocomputational, mathematical techniques at hand. Therefore, the second Wittgenstein, who abandoned his previous philosophical framework, was wrong: the human language and the cognitive world can still be assessed in terms on the logic armor described by the *Tractatus*.

Ludwig Wittgenstein published his seminal *Tractatus Logico-Philosophicus* in 1921 (Wittgenstein, 1921). Despite its huge accomplishment, the so called "second" Wittgenstein (1953) rejected the philosophical scenario depicted in his own book and introduced the (almost) opposite theory of the linguistic jokes. Here we ask: could the *Tractatus'* content be useful in the current neuroscientific debate? How does the *Tractatus* look like, through the lenses of the neurocomputational models at hand? Is it possible to achieve a computational implementation of the *Tractatus*? Are the Wittgenstein's tenets mathematically assessable and describable, e.g., can they be treated through mathematical tools leaving apart combinatorial complexity? Here we demonstrate that a recently developed theory of language and cognition, i.e., Perlovsky's joint language-cognitive model (Perlovsky and Sakai, 2014; Perlovsky, 2016), astonishingly describes, and fits with, the very basic assumptions of the *Tractatus*. This means that the philosophical content of the *Tractatus Logico-Philosophicus* can be assessed in terms of the current neuroscientific language, giving rise to quantifiable hypotheses that can be empirically tested.

## PERLOVSKY'S EMOTIONAL CORRELATIONS BETWEEN LANGUAGE AND COGNITION

Perlovsky developed a multi-level, hetero-hierarchical model-based neural architecture that allows a mathematical description of the mental mechanisms of language, cognition and emotions (Perlovsky and Kozma, 2007; Perlovsky, 2011). A hierarchical structure occurs from sensory signals at the bottom, to highest concepts' representations at the top (Friston, 2010; Tozzi et al., 2017). Learning and recognition proceed in parallel with objects' perception (Tozzi and Peters, 2017). Concept representations stand for mental models of objects and situations: to make an example, during visual perception, a mental model of the object stored in memory projects an image (top-down signals) onto the visual cortex, where it matches an image projected from retina (bottom-up signals). The brain, according to Perlovsky, makes use of "dynamic logic", i.e., a process "from vague-to-crisp" (Ilin et al., 2014), where the degree of fuzziness is automatically set, corresponding to the accuracy of the learned models. In the process of learning, models become more and more accurate and association variables crisper, in order to increase and maximize the similarity between top-down and bottom-up messages. At each hierarchical level, concept-models encapsulate the mind's knowledge, generating top-down neural signals that interact with inputs, i.e., bottom-up signals.

Knowledge is not a static state, rather a continuous process of adaptation and learning that takes place in order to understand the ever-changing surrounding world. Humans are equipped with the "knowledge instinct", i.e., an inborn need, a drive to fit top-down and bottom-up signals and therefore improve our cognition. Cognition is inextricably linked with human language (Perlovsky, 2013), so that every mental representation consists of two model aspects: cognitive and linguistic. Meanings are

created by symbol-processes in the mind, where language plays a special role because, through its ability to accumulate cultural knowledge and communication among people, provides grounding for abstract model-concepts at the higher levels of the mind hierarchy.

Therefore, cognitive activities, language faculties, emotions, and also motivations, are mathematically assessable through a series of well-established equations, the “joint language-cognitive models” (**Figure**), able to maximize similarity without combinatorial complexity, due to the matching vagueness of similarity measures to the uncertainty of the model. In the process of learning and understanding input signals, models are adapted for their better representation, so that similarity between the models and signals increases. Such increase in similarity, which satisfies the knowledge instinct, is mentally perceived as aesthetic emotions (Perlovsky 2014; Schoeller and Perlovsky, 2016). The joint language-cognitive models are organized in parallel hierarchies of language (words, texts) and cognitive models (world’s mental representations). Near the bottom of these hierarchies, words refer to objects. Higher up, complex texts refer to complex situations. This means that words within texts refer to objects within situations (because situations are collections of objects), so that this reference at higher levels corresponds to the words-objects relationships at lower levels. Because of the multi-level hierarchical structure, maintaining meaningful relationships makes possible “the infinite use of finite means.” Possibly, the highest levels (the most general models) are predicted from lower ones, because symbols are psychical processes, creating meanings, that involve conscious as well as unconscious activities, concepts and emotions, inborn models-archetypes and models learned from culture, language and cognition.

## WITTGENSTEIN’S LOGICAL CORRELATIONS BETWEEN LANGUAGE AND WORLD

Wittgenstein establishes in his *Tractatus* an isomorphism, a correlation, a quantitative articulation between the world (and its basic components) and the language (and its basic components) (**Figure**). These relationships are located in a fixed and immutable grid, the logical armor, embedded in a logical space where isomorphisms between the world and the language occur through one-to-one projections.

Starting from the simplest terms of this relationship, we have, on the world’s hand, the things, i.e., the objects, simple and immutable, that, standing for the unbridgeable limit of the analysis, make up the irreducible substance of the world. On the language’s hand, such simplest terms of the relationship stand for the names, i.e., the words, equipped with a meaning.

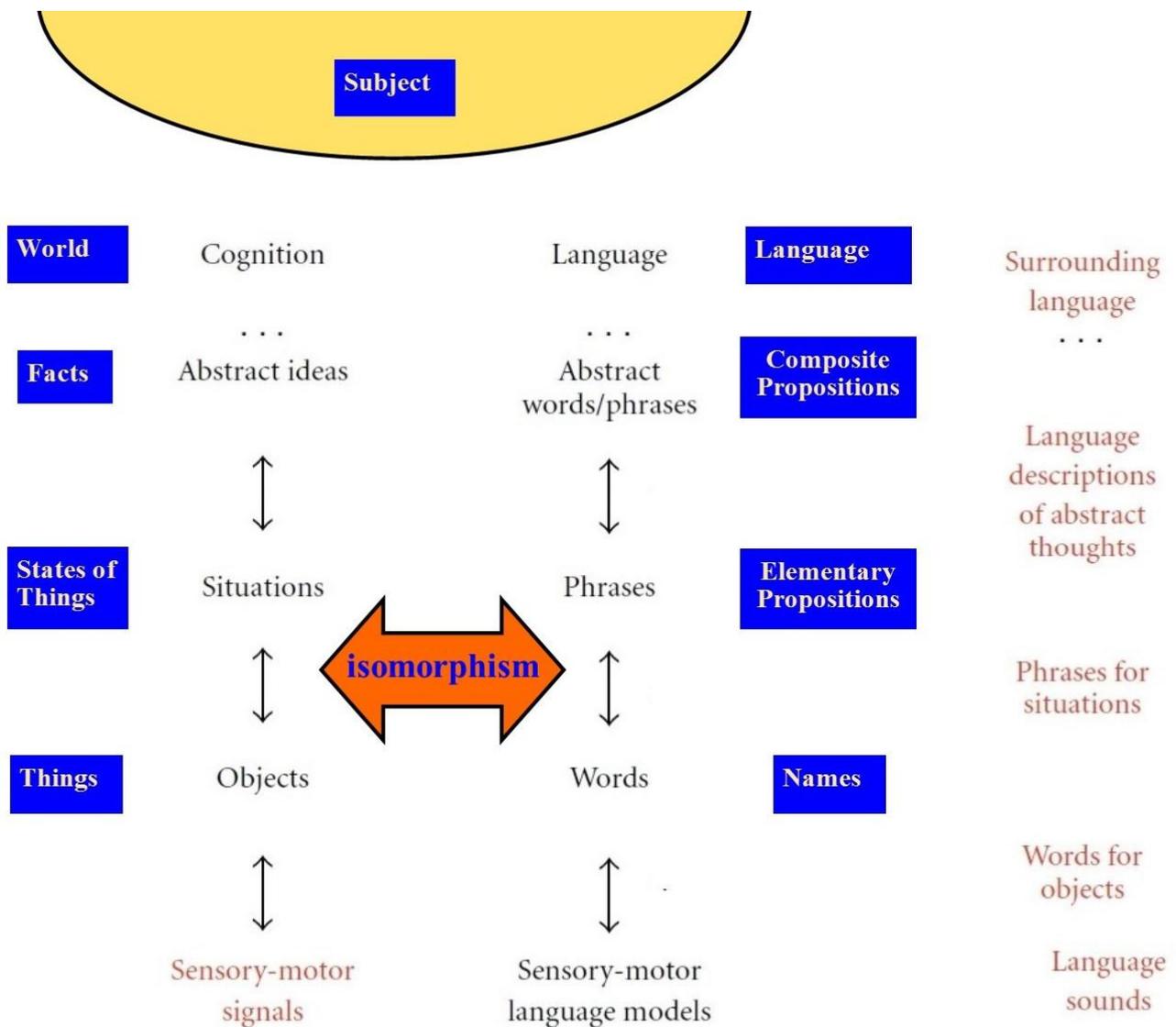
The second level, by the world’s hand, stands for the states of things, i.e., the atomic facts, the state of affairs, the logical connexions of things, the links of objects. The objects’ configuration is various, changing, irregular. On the language’s hand, the states of things stand for the elementary propositions, i.e., the atomic representations of the objects, independent from one each other, equipped with sense and characterized by truthful meaning.

The following, third higher step from the word’s hand are the facts, i.e., the configuration’s relationships, the portrayals, the logic of reality, the subsistence of the states of things. They stand, from the language’s hand, for the composite propositions, i.e., the propositions, termed “molecular”, that are the logic products of the elementary propositions: they display the logic properties of the language, but do not say anything. They do not have meaning or content, but cope just with the logic shape, unveiling the word armor. They are true and describe the real, despite they do not define a primary, naïve, direct view. Their sense depends on the elementary propositions, because they are truth functions of the latter.

The highest step is, by one side, the world itself: it is a limited whole, the logic space of the facts, a pure formal universality, a unique, essential structure that fixes up what happens. Note that the totality prevails on the simple. The world’s counterpart, at the highest level, is the language itself, that stands for the limit of the world.

Life, the subject, the I, are located outside the world and the language. Where the subject is located, the nothing occurs. The subject, being out of the world, stands for the border, the non-content of the world. In the subject’s location, experiences occur that are available not through the ordinary syntax, rather through the immediacy of feeling.

The role of philosophy is to proceed from the top to the bottom, from the language to the names. Also, a top-down approach that starts from the higher level of the world allows the analysis of the lower-levels, e.g., the states of things.



**Figure.** Wittgenstein’s isomorphic model (in dark squares) superimposed to Perlovsky’s joint language-cognitive model, that depicts an entire hierarchy from sounds to words and phrases, until the highest concepts existing in culture. Both the models display parallel hierarchies of language and cognition (or world), where lower-level concepts and things reversibly project to higher levels equipped with meanings relevant to situations.

## CONCLUSIONS

In the later period of his life, the so called “second” Wittgenstein dismissed the tenets of his own previous Tractatus, objecting that his “atomic facts” cannot be accurately described, because they just depend of the communication context in which they are formulated (he talks about “linguistic jokes”). Here we demonstrate that the late Wittgenstein was wrong, because the treasures of the forgotten Tractatus, including its precious Tables of Truth, still hold true, and can be studied through current, successful neurocomputational models. Indeed, we showed how Perlovsky’s fuzzy logic (Yoder, 2009) is appropriate not just for the evaluation of every layer of mental hierarchies, but also of cognitive as well as language models and the Tractatus’ content. Our Figure above shows a clear superimposition between Wittgenstein’s and Perlovsky’s accounts of language and

cognition. Indeed, Perlovsky's adaptation-learning of mathematical concept-models, built in order to maximize correspondence between the algorithm internal structure (knowledge in a wide sense) and objects of recognition, demonstrates that Wittgenstein's names and things, elementary propositions and states of things, composite propositions and facts, language and world, are mathematically assessable and implementable through computational techniques at hand. Therefore, the *Tractatus*' suggestions display a testable theory of knowledge and language.

We may state that, in Perlovsky's model, emotions meet logic, despite he himself says the opposite. Let's see why. According to Perlovsky, emotions are required in order to develop meanings able to connect language and cognition. He states that arbitrary signs have no grounding in real world: meanings cannot be created by unmotivated choices on the interconnections of arbitrary signs, because this type of choices leads to incomputable combinatorial complexity. Based on the problems raised by both Gödel's theorems of incompleteness and combinatorial complexity, Perlovsky suggests that the logic that dominated the thinking of mathematicians and psychologists is wrong, because it provides just a limited description of cognition and language. We may state that Perlovsky's opinion is joined also by the second Wittgenstein. However, here we demonstrated that the same experimental methodology described by Perlovsky's joint language-cognitive models can be used in order to assess the purely logical account of the world described in the *Tractatus*.

Perlovsky hypothesizes that language and cognition are two partitioned, but closely interacting mechanisms. Language accumulates cultural wisdom, while cognition develops mental representations, modeling the surrounding world and adapting the cultural knowledge to concrete circumstances of life. Despite cognition is developed from experience, the former cannot be acquired from the latter alone; language is a necessary intermediary, a "teacher". Therefore, Perlovsky achieves a general model of brain function that keeps into account all the functional subdivisions of brain activity, including the same logic that he himself excludes from his own framework: this allows us to build accurate, testable experimental scenarios based both on his joint language-cognitive scenario, and on the first Wittgenstein's philosophy.

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