ENCODING THE MIND. A small article about justification of the perspective and a Python script in that regard

”*The most complicated machines are made from words.*” - Jacques Lacan

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SUMMARY: In the first section I present a definition of life that does not contradict the natural sciences and I conclude that life should be defined according to its observable purpose, and then it would be a Self-articulated-composition-of-the-Unity, where unity is a totality of possibilities. Afterwards I appreciate that the reconstruction of large-scale neuronal populations is unlikely to take place for at least two main reasons: the energy cost of running it, and the difficulty if not impossibility of one third party holding the keys to another's neural links. If the structure of the brain, besides being extremely different from person to person, and is also indecipherable to a third-party observer, then we must turn our attention to another field of activity, to culture and language. If Hegel was right when he argued that human beings are essentially cultural beings, and the cultural pattern can be framed semiotically, then all that remains is for us to try to encode the signs into a common language and, once we are there, to take the next step of translating the signs into computer codes. In the final section I note that language works as a physical tool and a simulation of the mind is possible with the help of language.

Sections:

Section I - Life as a function of the mind. The mind as a whole

The definition of life should start with identifying the common attributes of all living beings. We should then question whether we observe all the traits of living beings and whether there are traits that we cannot observe or understand. To define life precisely and informatively, we need to create a definition that reflects our scientific knowledge of the vital phenomenon. There are numerous definitions of life formulated from different characteristics of living beings, such as replication, metabolism, evolution, energy, autopoiesis, etc. Often, definitions of life are biased by the research focus of the person making the definition. Since any definition of life must connect with what we observe in nature, our strategy should be to identify measurable attributes or characteristics of organisms, which are called traits. Trait-based approaches have been widely used in systematics and evolutionary studies.

The search results support the idea that the definition of life should start with identifying the common attributes of all living beings and that there are numerous definitions of life formulated from different characteristics of living beings. The results also suggest that trait-based approaches have been widely used in systematics and evolutionary studies.

Life is usually in the form of a list of characteristics that apply to organisms, their parts, their interactions, or their adaptation. [1] Finding fundamental organizing principles is the current intellectual front end of systems biology. [2]

According to Benner [3], any definition of life is intricately connected to a theory that gives it meaning and there are various definitions of life held in the astrobiology community by considering their connected "theories of life." These include a popular definition that holds that life is a "self-sustaining chemical system capable of Darwinian evolution" following a suggestion by Carl Sagan, at a NASA committee (1994).

We should start with a list of the main observable characteristics of life. Thus Hillis David noted in Principles of Life [4.42] that, the overwhelming evidence for the common ancestry of life lies in the many distinctive characteristics that are shared by all living organisms, and all organisms:

- are composed of a common set of chemical components such as nucleic acids and amino acids, and similar structures such as cells enclosed within plasma membranes

• contain genetic information that uses a nearly universal code to specify the assembly of proteins

• convert molecules obtained from their environment into new bio-logical molecules

• extract energy from the environment and use it to do biological work

• regulate their internal environment

• replicate their genetic information in the same manner when repro-ducing themselves • share sequence similarities among a fundamental set of genes

• evolve through gradual changes in their genetic information.

But now we are getting the point, how many components are needed for a basic life form, let's say for a minimally functional cell? According to Moger-Reischer [5], the cell is the simplest independent functional unit of life. However, even unicellular model organisms that are touted for their tractability are complex, possessing thousands of genes and proteins, many of which remain uncharacterized even after decades of in-depth investigation. Possessing only essential genes, a minimal cell can reveal mechanisms and processes that are critical for the persistence and stability of life. The complexity of a genome is reflected by the number of genes that it contains, a quantity that varies by orders of magnitude across the tree of life. Whereas some obligately endosymbiotic bacteria have fewer than 200 protein-coding genes, many plant and animal genomes contain more than 20,000 genes. In principle, the simplest organism is one that possesses only the minimum number of genes for survival and reproduction in a given environment. Any mutation in such an organism could lethally disrupt one or more cellular functions, placing constraints on evolution, as revealed by the fact that essential proteins change more slowly than those encoded by dispensable genes. Furthermore, organisms with streamlined genomes have fewer targets on which positive selection can act, therefore limiting opportunities for adaptation [id].

The cell is the simplest independent functional unit of life, but a cell is already an extremely complex organism and we need to go even deeper and deeper. So, if we could map and understand every single molecular process in a cell, we would have a better grasp of the fundamental principles of life [6].

At this point, we can turn our attention to the evolution of microbial parasites. Taking into account David Nicholson et. All [7], this evolution involves the counterplay between natural selection forcing parasites to improve and genetic drifts forcing parasites to lose genes and accumulate deleterious mutations. Here, the authors tell us that for to understand how this counterplay occurs at the scale of individual macromolecules, it is necessary to describe cryo-EM structure of ribosomes from Encephalitozoon cuniculi, a eukaryote with one of the smallest genomes in nature. Then, the extreme rRNA reduction in E. cuniculi ribosomes is accompanied with unparalleled structural changes, such as the evolution of previously unknown molten rRNA linkers and bulgeless rRNA. Furthermore, E. cuniculi ribosomes withstand the loss of rRNA and protein segments by evolving an ability to use small molecules as structural mimics of degenerated rRNA and protein segments. The authors show that the molecular structures long viewed as reduced, degenerated, and suffering from debilitating mutations possess an array of compensatory mechanisms that allow them to remain active despite the extreme molecular reduction [id].

Considering the imaginable extreme, it is possible that an array of compensatory mechanisms is added to an initial matter to generate life. This array could constitute a predetermined permanence, one so-called matrix, on various levels of complexity, and could be transmitted by a teleportation-like mechanism [8,9,10,11], but this is far from our subject. In addition to the observable characteristics of life, it is a personal observation that the transmitter of this matrix must also possess the general attributes of Omnipresence and Omnipotence. As we see below, a living agent should possess these attributes, or seek to possess them.

Here we can also mention the neutral theory of evolution [12] which has become central to the study of evolution at the molecular level, in part because it provides a way to make strong predictions that can be tested against actual data. The neutral theory holds that most variation at the molecular level does not affect fitness and, therefore, the evolutionary fate of genetic variation is best explained by stochastic processes. This theory also presents a framework for ongoing exploration of two areas of research: biased gene conversion, and the impact of effective population size on the effective neutrality of genetic variants. A stochastic process is connected with random probability but this is just another perspective, not a very wise one and especially not one that is easy to explain mathematically. Perhaps this is why it is generally accepted, as it offers only the prospect of a possible mystery, but not necessarily a logical or useful one.

In the search for general characteristics of life, it is important to mention some widely accepted stages in the origin of life. It is suggested that primitive forms of life must have had the same primary evolutionary mechanism as more advanced ones. Therefore, the more primitive forms of life would allow for an easier observation of the mechanism of evolution and, consequently, the observation of the characteristics of life.

A broad array of origin of life (OOL) models are described in the current literature, and many of them use the same general framework and are governed by common precepts, remarks Kathryn Lanier and Loren Williams in The Origin of Life: Models and Data [13]. The authors note that, Molecular Toolbox is a common set of molecular components that is fixed over time and is surprisingly restricted in composition, and Universal Gene Set of life, is a set of genes shared as orthologs throughout the tree of life, and found in essentially every living system, to be important and useful data. And then, there is no evidence that Darwinian processes can revise the Molecular Toolbox or radically alter the Universal Gene Set.
Going to the origin, for Orgel [14] it is widely believed that biology based on DNA, RNA, and proteins was preceded by the biology of an "RNA world" in which enzymes were composed of RNA alone. And then, the origin of RNA replication is thus the central puzzle of the origins of life.

Koonin Eugene in Comparative genomics, minimal gene-sets and the last universal common ancestor[15] claims that comparative genomics, using computational and experimental methods, enables the identification of a minimal set of genes that is necessary and sufficient for sustaining a functional cell. Therefore for most essential cellular functions, two or more unrelated or distantly related proteins have evolved; only about 60 proteins, primarily those involved in translation, are common to all cellular life. The reconstruction of ancestral life-forms is based on the principle of evolutionary parsimony, but the size and composition of the reconstructed ancestral gene-repertoires depend on relative rates of gene loss and horizontal gene-transfer. The present estimate suggests a simple last universal common ancestor (LUCA) with only 500–600 genes [id].

The last universal common ancestor of known life is called LUCA, and the L in the name is important because it was not the first organism, but the last before the bifurcation that led to all modern organisms. Cornish-Bowden Athel and Cárdenas María Luz in Life before LUCA[16] have observed that the last universal common ancestor of all living organisms (LUCA) already had the capacity to code for many proteins, and had some of the same bioenergetic capacities as modern organisms. Therefore an organism at the origin of life must have been vastly simpler, and authors invite the question of how to define a living organism and forces the definition of LUCA to be revised. But LUCA is an imagined organism and already it seems extremely complex, so we return to the idea that there is an array of compensatory mechanisms that allow molecular structures to remain active despite the extreme molecular reduction caused by mutations.

In summarizing the researchers' observations, it was concluded that chemical reaction automata are not designed to explain how life originated, but rather to understand better how a basic metabolism functions. They are a representation of the living world without reproductive and adaptive capacities [17.195].

In the search for general characteristics of life, it is worth mentioning that Plutarch posed the question of the chicken or the egg causality dilemma as a philosophical matter in his essay "The Symposiacs" in the 1st century CE. This dilemma raises the question of which came first: an array of compensatory mechanisms or life itself. If the array of compensatory mechanisms allows molecular structures to remain active and maintain life, then it exists before life. On the other hand, if life appeared first, it would establish compensatory mechanisms. Alternatively, it could be considered that the compensatory mechanisms themselves are a basic form of life, but in this case, there would be a rule that has no maintaining agent. The question of which came first, the array of compensatory mechanisms or life, is left unanswered, but the dilemma is formulated for consideration.

Understanding how brains evolved is critical to determine the origin of centralized nervous systems, and brains are patterned and there is evidence to suggest that brains are homologous[18]. Nowadays, despite the many advances in neurobiology, physiology, developmental and cell biology on this matter, unraveling the evolutionary history of the nervous system is still contentious, according to José M. Martín-Durán, Andreas Hejnol [19].

In partial conclusion, it appears that at the end of biology lies a set of information that is indecipherable to the observer but seems to be interconnected and presumably so, given the observable results. Now, as I will note later, there is a collection of data that can be referred to as "Mental" and is also indecipherable to a third-party observer. The interconnected information set underlying biology may be indecipherable, but by observing its characteristics, a simulation can be devised that is limited but useful.

If we were to make observations, the best results seem to be obtained not so much by observing the exact physical mechanism of functioning as by observing the metaphysical rationality of functioning. Here, it seems necessary to make some observations from philosophical approaches to the subject of the world as mental. When we formulate the term mental, we refer to a whole world arranged in the mind, not a certain, but a universal. Therefore, we should observe the reactions to store it under certain circumstances and not try to copy it. Even for an identical copy, we are not certain that we will possess the key to turn it on, and this key is hidden behind the individual mental construct. It is indecipherable to another.

There is a vast philosophical work that discusses ontological aspects, but I detail what I find interesting from a phenomenological perspective, starting and stopping at Martin Heidegger from Being And Time [20]. I then tried to establish from here some principles that I prepared, to be implemented somehow in computer code.

The philosopher said that to begin with you have to approximate superficially what life is. First, it has been maintained that 'Being' is the 'most universal' concept. It has been maintained secondly that the concept of 'Being' is indefinable. Thirdly, it is held that 'Being' is of all concepts the one that is self-evident and Being is always the Being of an entity [20. 29]. The philosopher highlights the term "Dasein", which is purely an expression of its Being [20.33]. Interpreting all entities within-the-world, however, we have always 'presupposed' the world, and even if we join them together, we still do not get anything like the 'world' as their sum. The philosopher then wonders whether, if we start with the Being of these entities, is there any avenue that will lead us to exhibiting the phenomenon of the world [20.101-102]. Among the usual things Dasein can lose itself in what it encounters within the world [20. 106-107].

Dasein is the principle of being, as the direction of formation and movement of mental entities, because it giving way, as taking a direction, belongs essentially to Dasein's Being-in-the-world. When an entity within-the-world has already been proximally freed for its Being, that Being is its "involvement" [20. 110]. The philosopher notes that it is urgent to work out the 'formal' idea of worldhood, the idea of a phenomenon modifiable [20. 113].

This modifiable phenomenon, manifests itself exclusively immanently, the rest is naturalness, food for the senses. Worldhood as a modifiable phenomenon only manifests itself in the perfect tense. Therefore when we speak of having already let something be involved, so that it has been freed for that involvement, we are using a perfect tense a priori which characterizes the kind of Being belonging to Dasein itself [20. 117].

Therefore the computer code that aims at simulating this worldhood, imagination of the natural world, must pursue this perfect tense a priori which according to the philosopher belongs to Dasein itself. Here is the tense of the verb which I call ”continuu”. As the philosopher says, Dasein, in its ontical dealings with the entity thus encountered, can thereby let it be involved in the ontical sense [20.117].

Returning to the earliest forms of life and the perspective of defining life, life can be defined as the capacity of the living agent to usefully optimize another agent with which it enters into a contract, without necessarily seeking to alter it. The compound living agent will have another agent in contact, another useful optimization, etc. The living agent and the optimized agent useful to the living agent constitute a first universality, which is relative to the living agent. Universality is also optimized by the inclusion of new agents. Life should be defined according to the observable purpose, and then it would be a Self-articulated composition-of-Unity, where unity is observed as a totality of possibilities.

As we have seen before, molecular structures possess an array of compensatory mechanisms that allow them to remain active despite the extreme molecular reduction. This first mechanism is Dasein as the principle of being, which would support the designation of the mental.

The further up the evolutionary ladder a biological entity goes, the higher its mental processing capacity. Thus, starting from the other end of observable evolution, although the nature of human uniqueness in brain evolution is generally accepted, there are also anatomical-functional cross-species comparisons of frontal areas that remain controversial. To provide a novel interpretation of the evolution of primate brains, sulcal morphological variability of the medial frontal cortex was assessed in Old World monkeys (macaque/baboon) and Hominoidea (chimpanzee/human). The authors of a study 21 show that both Hominoidea possess a paracingulate sulcus, which was previously thought to be unique to the human brain and linked to higher cognitive functions, such as mentalizing. Also, they show systematic sulcal morphological organization of the medial frontal cortex that can be traced from Old World monkeys to Hominoidea species, demonstrating an evolutionarily conserved organizational principle [21].

This principle is also observed by the researcher Koyabu*et al.* in the article Mammalian skull heterochrony reveals modular evolution and a link between cranial development and brain size [22]. These studies reveal that the multiple skeletal components of the skull originate asynchronously and their developmental schedule varies across amniotes. They present us that ossification timing of the neurocranium was considerably accelerated during the origin of mammals and cranial heterochrony in mammals has occurred in concert with encephalization but within a conserved modular organization.

Evolution is based on an outline that develops under certain circumstances, resulting from the possibility of observing the progress of common structures. This progress does not necessarily come at the expense of other biological entities but rather with the acceptance of preserving biodiversity. Relevant experiences are memorized, and the entire useful world is preserved in the mental.

Results of a study demonstrated that trait inferences were used to derive mental state inferences, and that the accuracy of trait estimates predicted the accuracy of mental state inferences. Findings are in accordance with the Mind-space theory, that representation of the Target mind is used in the inference of their mental states [23].

Looking through a narrow window, learning unpleasant things and remembering them is advantageous for the organism for avoiding future recurrences, and memories that are irrelevant to survival or adaptation tend to fade away either by graceful degradation [24]. Observable biological organisms evolve, and even within the same species, increasing body and brain size constitutes a key macro-evolutionary pattern, for example, in the hominin lineage. The mechanisms behind these changes possibly include environmental, demographic, social, dietary, and technological factors [25].

The head direction system functions as the brain's internal compass anchored to local environmental cues. Computational models of the HD network suggest that plasticity mediates the integration of visual information within the network [26]. Important to remember that experience may shape brain structure [27].

The extensive lines of bidirectional communication between the brain and visceral organs facilitate integration of internally arising interoceptive cues that are critical for survival [28]. Mental processes and their neural substrates are intimately linked to the homeostatic control of internal bodily state. There are a set of distinct interoceptive pathways that directly and indirectly influence brain functions. The anatomical organization of these pathways and the psychological/behavioral expressions of their influence appear along discrete, evolutionarily conserved dimensions that are tractable to a mechanistic understanding [29].

The whole visible development of the biological body raises the standards of the neurological system, which includes not only the brain but also any other neural structures. These neural structures create a so-called own world, serving as relevant memory ready for immediate action. As the brain evolves, it incorporates its own world of perceived experiences, which later become transmissible through cultural patterns and form relevant behavioral patterns. Moving forward, life is a function of mind, and mind is a whole. However, it is important to consider the current functional limitations of the biological support, such as limitations of action, fatigue, and decay, in order to accurately assess neural functionality in creating representations of uniformly repeated facts and facts that occur between things. If life can be defined as a Self-articulated-composition-of-Unity, which is its observable part, we will ask what generated life, if there is an evolution, and what will happen after the peak of life's evolution is reached. I limit myself to affirming that these "ends of life" cannot be spoken or written, they can only be lived.

Section II - Reconstruction of large-scale neuronal populations

In the previous section I observe life as a function of mind, and mind as a potential whole. I conclude that life should be defined according to the observable purpose and then it would be a Self-articulated-composition-of-tUnity, and unity as a totality of possibilities. For reasons related to the significant volume of existing studies and the possibility of certainty of results, I will continue with the study of the human mind in connection with its biological component, with the nervous system.

It is often rightly stated that human perception, experience, consciousness, feeling, meaning, thought, and action all require a functioning human brain operating in and through a live body that is in ongoing engagement with environments that are at once physical, interpersonal, and cultural [30.92].

The mind is complex and learning neuroanatomy is like learning both a new language and a map of a new world [31.39,3 / 1367]. Although the primitive chordate amphioxus, living in sandy ocean floors near the shore in warm regions, does possess midbrain and forebrain components of a central nervous system, we know next to nothing about connections and functions of these components [id/405,0 / 1367]. The concerted evolution of the mammalian brain is dominated by the neocortex, and also the effects of mosaic evolution of structures related to the olfactory system [id. 1278,3 / 1367].

From a different perspective, Zeno Kupper and Holger Hoffmann in a study entitled Course Patterns of Psychosocial Functioning in Schizophrenia Patients Attending a Vocational Rehabilitation Program [32], observes the dynamics of human brain function. The purpose of their study was to explore the dynamics of the psychosocial functioning of persons with schizophrenia who participated in a vocational rehabilitation program. On the basis of weekly behavioral ratings, five dynamical patterns of response to a vocational rehabilitation program could be identified: (1) high-level, (2) mid-dle-level/fluctuating, (3) middle-level/slight descent, (4) steep descent, and (5) low-level functioning. The subgroups of patients showing these patterns strongly differed in the mean, the trend, and the random fluctuations of the behavioral ratings. The dynamics of human brain function are well understood at the short timescale and the long timescale of years or decades, but almost nothing is known about how the human brain function varies across the range of days to months. This study, like many others in the field, shows that there are large differences in brain function between patients with the same conditions and perfectly healthy people, and these differences are significant over short or long periods of time.

A study [33] challenges the current textbook idea that the complex vertebrate brain evolved from a simple three-part brain composed of forebrain, midbrain, and hindbrain. The research suggests that there were probably only two major regions in pre-vertebrate nervous systems, and there was no exclusive region of cells that would later give rise to what we refer to as the vertebrate midbrain. Most research methods in human development [34] focus on studying the changes in human behavior and development over time, this study does not directly address the differences in human brains. Apparently the human brain has the same fundamental structure as most other backboned animals [35], which means it can be divided into three general regions: forebrain, midbrain, and hindbrain. However, the study also challenges the current textbook idea that there were three major regions in pre-vertebrate nervous systems. Another article [36] discusses the question of whether machines can think and argues that being regulated by laws of behavior implies being some sort of machine, and does not directly address the differences in human brains.

These search results do not provide a specific study that directly addresses the differences in human brains. However, the studies suggest that the current textbook idea of the evolution and structure of the vertebrate brain may need to be revised. The human brain, in all its staggering complexity, is the product of millions of years of evolution. The human brain is unique in many ways, and there are several factors that contribute to its distinctiveness.

The key ways in which the human brain is different are not only related to size [37] and can be summarized as follows:

1. Wiring patterns: Comparative connectomics has identified general rules of brain wiring across species. Unique facets of the human connectome have been discovered, along with changes in the cells responsible for brain wiring [38].
2. Sex differences: There are differences in brain structure between males and females. Males tend to have larger total brain volumes, while females have greater volume in certain regions of the cortex. These differences can be associated with variations in cognition, behavior, and risk for psychiatric illness [39].

3. Inter-individual differences: Even within the same sex, there can be significant variations in brain structure and function between individuals. These differences can be influenced by genetics, environment, and life experiences. Some studies have found correlations between brain structure and demographics or behavior [40].

It is important to note that the understanding of brain differences is an ongoing area of research, and there are debates and controversies surrounding the topic. The presence and significance of sex differences in the human brain, in particular, are subjects of debate within the scientific community [41, 42]. Overall, the human brain is a complex organ with unique characteristics and variations between individuals. Further research is needed to fully understand the extent and implications of these differences.

In addition to the complexity of the brain, it can change over a lifetime. Neuroimaging has become a ubiquitous tool in basic research and clinical studies of the human brain and no reference standards currently exist to quantify individual differences in neuroimaging metrics over time, in contrast to growth charts for anthropometric traits such as height and weight. Authors observe the brain structural changes, and rates of change, over the lifespan [43].

As Schneider et al. summarized, mapping behavioural actions to neural activity is a fundamental goal of neuroscience. As our ability to record large neural and behavioural data increases, there is growing interest in modelling neural dynamics during adaptive behaviours to probe neural representations. In particular, although neural latent embeddings can reveal underlying correlates of behaviour, we lack nonlinear techniques that can explicitly and flexibly leverage joint behaviour and neural data to uncover neural dynamics [44].

Observing directly a neural activity is very difficult at the moment and does not seem useful and therefore undesirable from my perspective in this article. Neurons generate and propagate electrical signals at a millisecond timescale via action potentials and the functionality of a neuronal tissue needs to be assessed at this timescale in 3D, all at a single-neuron resolution [45]. In addition to these we would add that a single structural magnetic resonance imaging (MRI) scan of a human brain contains an immense amount of information. Standard MRI-based surface reconstructions of the cortex, for example, comprise hundreds of thousands of vertices, each characterized by many features or phenotypes [46].

I observe neuron reconstruction as the process of creating digital reconstructions of the entire or only specific portions of neurons and the neuronal structure that contains the multiple neurons. Neuron reconstruction includes the creation of a digital, geometric model of the neuron. Neuron reconstruction is typically performed using light microscopy imaging, sometimes it is performed using electron microscopy imaging. The complexity of neural structures will be a problem even if large-scale reconstruction succeeds, as the unique code that makes neural connections active and then useful should also be deciphered. The unique construction of each brain seems to allow deciphering the functioning only of the owner.

For reconstruction in a fully automatic way large-scale neuron morphologies are critical for delineating the mechanism of brain function, neuronal types and circuit connectivity. The dense packing of neurite arbors, noisy and inhomogeneous signals in current light microscopic images make the automatic methods hard to produce accurate tracing. Deep-learning methods can improve accuracy and robustness, but it still has a long way to go. Given the imperfect neuronal images, one practical way might be to incorporate as much domain knowledge of neuron morphology, either from existing reconstructions or biological insights, and tracing progressively and comprehensively like an expert. The authors believe that the proposed high-throughput neuron reconstruction has greatly evolved and could be achieved in the near future. With the rapid development of imaging and automation, they believe that neuron tracing from light microscopy images can be of much higher quality in the next decade [47].

From another perspective, Zhou et al. conclude that an efficient and accurate digital reconstruction of neurons from large-scale 3D microscopic images remains a challenge in neuroscience. They propose a new automatic 3D neuron reconstruction algorithm, TReMAP, which utilizes 3D Virtual Finger (a reverse-mapping technique) to detect 3D neuron structures based on tracing results on 2D projection planes. Their fully automatic tracing strategy achieves close performance with the state-of-the-art neuron tracing algorithms, with the crucial advantage of efficient computation with much less memory consumption and parallel computation for large-scale images [48].

Even if our equations or computer codes were to describe exactly the dynamics of a person's brain, subjective experience appears to be left out of the picture [49.311] .

Many important theories dealing with higher levels of complexity such as those governing the transmission of nerve impulses can be shown not to be derivable from lower-level theories, and especially not from quantum mechanics [50.51]. Generally, the universe is now seen to be composed not so much of objects as of systems, and the components of the systems themselves are not atoms but structures defined by their relations to one another and to their environment, rather than by their primary qualities [50.77].

If the structure of the brain, besides being extremely different from person to person, and is also indecipherable to a third-party observer, then we must turn our attention to another field of activity, to culture and language.

Section III - Cultural models, language and other signs

Hegel's understanding of culture involves a process of alienation and confrontation with what is different from us [51]. This means that culture is not just about what is familiar and comfortable to us, but also about encountering and engaging with what is unfamiliar and challenging. Hegel maintains that human beings are essentially cultural beings and are essentially determined by their "In-der-Kultur-Sein" (being-in-culture) rather than simply and "abstractly" by their individuality [52]. This means that culture is not just an external influence on individuals, but an integral part of their identity and existence. Culture, according to Hegel, emphasizes the attainment of self-actualization, which begins with the person itself through self-consciousness [53], and this means that culture is not just about conforming to societal norms, but about realizing one's full potential as an individual. Hegel's "Phenomenology of Spirit" is considered a philosophy of culture, which explores the development of human consciousness and culture over time [54]. This means that culture is not just a static entity, but a dynamic and evolving process. Culture provides individuals with a standpoint from which to see the essences of things as not determined by destiny, but by a human power to form [55]. This means that culture is not just a passive reflection of the world, but an active and creative force that shapes our understanding of reality. Hegel's understanding of culture involves a complex interplay of alienation, confrontation, self-actualization, and human creativity. Culture is not just an external influence on individuals, but an integral part of their identity and existence, shaping their understanding of the world and their place in it.

Culture is seen as a theory, method, and way of life that encompasses almost all human activities, from science to art, from music to microscopy [56] . But culture not only accompanies all human activities, but together with an individual interpretation it is the only activity that presents a conforming manifestation and through language the only part of the individual that is communicable. Culture is everything that can be useful, can be communicated through language and then can be stored and reused.

Culture is the useful way of relating to anything else, to anything external. Culture does not exist and is not useful as a totality, but only as a cultural model or determined set of cultural models. Many cultural models are based on cultural traits working in isolation, independently of each other, or that are strictly competing [57]. Any cultural model, in its essence, for formation, retention, and development, needs signs for communication; therefore, it is a semiological construct.

Ferdinand de Saussure foresaw a 'semiology' of which linguistics would be at once one part and the privileged methodological guide. It was this 'science of the life of signs within society' that saw a rapid growth in France in the 1950s and 1960s, and it was the developments from this basis that led to the critique of the notion of the sign and of the structuralist method [58]. To be remembered, traditionally semiology is divided into three components, semantics (how words, phrases, and sentences convey meaning) syntactics (rules and principles that govern the structure and formation of sentences in a language) and pragmatics (use of signs in context and how they are interpreted by speakers and listeners, purposes and effects of meaningful utterances). More generally, semiology is the study of all patterened communication systems, both linguistic and non-linguistic.

When we try to conceptualize what it would mean to simulate the mind by translating it into software code, we have to refer to language. Language had a privileged place in the study of the functional organization of the brain [59.234]. The author notes Bickerton's assertion, for whom language appears not so much as a means of communication, although it is a tool that can be used for communication, but as a system of representation [59.245]. In the light of the specialization and reorganization of the parts of the human body involved in speech production over the course of hominid evolution, it is reasonable to include the brain sectors controlling those body parts in the “language areas” of the brain. [59.253]. If there is a connection between language and the part of the human body involved in speech production, then we have a sensible connection within physiological and chemical processes, even if it is only one related to neural structure. Then through language framed by a cultural model we could have access to the structure of the brain, not physical structure but as a possibility of identifying discursive identity structures.

The idea of a private language appeared in philosophy of Ludwig Wittgenstein, who in §243 88e - 89e of his book Philosophical Investigations [60] explained it thus: “But could we also imagine a language in which a person could write down or give vocal expression to his inner experiences — his feelings, moods, and the rest — for his private use? — Well, can't we do so in our ordinary language?—But that is not what I mean. The individual words of this language are to refer to what can only be known to the person speaking; to his immediate private sensations. So another person cannot understand the language.”

Language can include not only what is already conventionally established in a community, observable or possible to be shown, but also a so-called private language, as a possible way of communication between self and its outside encompassing things that a third observer cannot directly decipher. Additionally, many of the things conventionally established are erroneous, and as evidence, social practices often change. Language is conventional, a public instrument, and is linked to various cultural models. Just as language in general includes private language comprehensible only to the user, but which can become public after communication, if it is observed to have relevant content, culture includes private culture, more precisely the cultural model has a private cultural model. The language of self-referential communication, where alongside the objects of the public space are placed objects of the private space inaccessible to another and which can form the object of limited communication. It is a type of private communication, a liturgical one.

Much of the neural information, namely that which cannot be linguistically framed, is probably totally useless, or like the ballast of a submarine, only drag the ship down. Language can provide a glimpse of one's mind, but not an accurately formed one, but an approximate one. More precisely, an individual language, a private language, the version in which the public language is perceived.

The self is an entire internalized universe and therefore cannot be fully replicated, only partially. Any attempt at individual multiplication would be a failure, but usable parts can exist and utilize various external sources, which depending on the qualities of the encoder can be more or less similar to the original.

If Hegel was right when he argued that human beings are essentially cultural beings, and the cultural pattern can be framed semiotically, then all that remains is for us to try to encode the signs into a common language and, once we are there, to take the next step of translating the signs into computer codes. "The limits of my language means the limits of my world." [61.5.6.] as Ludwig Wittgenstein says in Tractatus Logico - Philosophicus and then language can communicate both public or private cultural models and language itself.

Section IV - Placing signs in software code

In the previous section I concluded that if Hegel was right when he argued that human beings are essentially cultural beings, and the cultural pattern can be framed semiotically, then all that remains is for us to try to encode the signs into a common language and, once we are there, to take the next step of translating the signs into computer codes. But culture is the attitude to everything else and then even for animals, which have no language of their own, the behavior can achieve certain values.

If man is his own private culture and we think that it is possible to translate cultural signs into computer codes, this simple thought seems to be an oddity uttered for a private purpose. But it is not so, for every being is a unique self-referential universality, and the only fear we should have would be that of using technology for manipulation to force us to do what we do not want to do.

Life cannot be defined mechanically; rather, it is a self-referential universality that exists in all or any part of it. The basic characteristics of being consist of the ability to-be-together-and-with-all-others, which are found in every part of it. Perception of another's inner world is impossible, but common reference points can be established to enable communication and, consequently, improve mundanity, and these are linked to language. As Leibnitz observed in Monadology Section 17, "we must admit that perception and everything that depends on perception is inexplicable on mechanical principles, that is, in terms of shapes and movements. If we imagine a machine whose structure allowed it to think, to feel, and to perceive, we can conceive of it as being enlarged while conserving its proportions and thus permitting us to enter it as into a mill. Supposing that to be the case, on visiting its interior we should only come across parts exerting pressure on one another and never find anything that might explain perception. So we must look for that in simple substances and not in aggregates or machines. And that is all we shall find in simple substances, namely perceptions and their changes." [62.229].

I have observed that language can communicate both public or private cultural patterns and language itself, and then we will have to look further at some extremely general and non-exhaustive features of language, to observe rules for combining words to create meaning. I consider the Self ultimately as a linguistic construct that can be stored, used and communicated.

Linguists have identified abstract properties that seem to be shared by all languages and observ that human language is found not only in the spoken modality but also in the form of sign languages has led to a reconsideration of some of these potential linguistic universals. The linguistic analysis of sign languages has led to the conclusion that universal characteristics of language can be stated at an abstract enough level to include languages in both spoken and signed modalities. Languages in both modalities display hierarchical structure at sub-lexical and phrasal level, and recursive rule application. In an article [63], authors consider several candidate domains for modality effects, in light of the overarching question if signed and spoken languages are subject to the same abstract grammatical constraints, or is a substantially different conception of grammar needed for the sign language case. They have analyzed differences between languages and the overall conclusion is that one grammar applies for human language, no matter the modality of expression [id].

From a biological perspective, neurons are specialized cells in the nervous system that play a crucial role in transmitting electrical and chemical signals. While they are not typically associated with the concept of "will" in a philosophical sense, they are responsible for representing and processing information in the brain. Studies have shown that specific brain areas, such as the prefrontal cortex and cingulate gyrus, are involved in processes related to decision-making, goal-directed behavior, and perseverance 64.

The neuroanatomy of the language structural connectome appears to be modulated by the life-long experience of speaking a specific language. One study [65] compared the brain white matter connections of the language and speech production network in a large cohort of 94 native speakers of two very different languages: an Indo-European morphosyntactically complex language (German) and a Semitic root-based language (Arabic). The authors using high-resolution diffusion-weighted MRI and tractography-based network statistics of the language connectome, we demonstrated that German native speakers exhibited stronger connectivity in an intra-hemispheric frontal to parietal/temporal dorsal language network, known to be associated with complex syntax processing. In comparison, Arabic native speakers showed stronger connectivity in the connections between semantic language regions, including the left temporo-parietal network, and stronger inter-hemispheric connections via the posterior corpus callosum connecting bilateral superior temporal and inferior parietal regions. The study suggests that the structural language connectome develops and is modulated by environmental factors such as the characteristic processing demands of the native language [id]. Another model considers the language to be processed through two distinct pathways, the dorsal stream and the ventral stream [66].

The results of another study showed that the development of dorsal language tracts is environmentally influenced, specifically by early, dialogic interaction [67].

The results suggest that language and neuron structures are closely related, as the neural language network consists of a core system representing syntactic knowledge, the lexicon, and the relevant sounds of a language. The cognitive demands of our native languages physically shape the brain, and language exposure relates to structural neural connectivity in childhood. The neural basis of language is not yet fully understood, but basic knowledge of it is still vital for neurosurgeons and further contributions to neuroscience.

Elisa De Stefani, Doriana De Marco, shows in a study [68] that spoken language is an innate ability of the human being and represents the most widespread mode of social communication. The evidence suggests that language evolved from manual gestures, gradually incorporating motor acts with vocal elements, and in this evolutionary context, the so-called human mirror mechanism (MM) would permit the passage from "doing something" to "communicating it to someone else". Under this hypothesis, the MM would mediate semantic processes being involved in both the execution and in the understanding of messages expressed by words or gestures [id].

Another study [69] noted that grounded theories hold that sensorimotor activation is critical to language processing, and such theories have focused predominantly on the dominant senses of sight and hearing. It is observed that fewer studies have assessed mental simulation within touch, taste, and smell, even though they are critically implicated in communication for important domains, such as health and wellbeing. The article review work that sheds light on whether perceptual activation from lesser studied modalities contribute to meaning in language. After that it critically evaluated data from behavioral, imaging, and cross-cultural studies and concluded that evidence for sensorimotor simulation in touch, taste, and smell is weak. It is concluded that comprehending language related to these senses may instead rely on simulation of emotion, as well as crossmodal simulation of the "higher" senses of vision and audition and the data suggest the need for a refinement of embodiment theories, as not all sensory modalities provide equally strong evidence for mental simulation [id].

As Borghi concludes [70], language works as a physical tool by impacting how we perceive our body (interoception) and how we perceive and interact with the external world (perception and action). Language shapes perception and object manipulation, extends the space we perceive as near, and modulates our perception of objects in space and finally, using an example of the concept of color, author [id] suggest that not only the faculty of language but also the different languages we use, through spoken words or signs, shape our world differently.

Sensory perceptions are shared through language, allowing individuals to communicate their experiences to others [71]. Also grounding language in the neglected senses of touch, taste, and smell can provide a more comprehensive understanding of how language is grounded in sensory experiences [id]. The entire body participates in forming the linguistic message, and so if we have external sense organs (sight, hearing, touch, taste, and smell), each part of the communicable mental construct through language should be built starting from these approximations that the senses give to what happens outside. If this is the case, then the reception of external signals by the senses should also lead to certain linguistic formulas.

In light of the above, when proposing to conceive a simulation of the mind as perceptible parts harvested with the help of language, it is appreciated that means suggested by synesthesia can be used. Then, a palette of sense perceptions can be joined to each linguistic construct to obtain a collection of data. Everything that is included in the simulation, such as objects and actions, are collections of data that interact with each other. The interaction of data foreshadows the future of what may happen to the owner of the data collection. The future sought is linked to the purpose of life, a purpose which I believe follows from the very definition of life suggested in the first section.

BIBLIOGRAPHY

1. GÓMEZ-MÁRQUEZ, J. What is life?. Mol Biol Rep 48, 6223–6230 (2021). https://doi.org/10.1007/s11033-021-06594-5

2. DHAR, P.K., Giuliani, A. Laws of biology: why so few?. Syst Synth Biol 4, 7–13 (2010). https://doi.org/10.1007/s11693-009-9049-0

3. BENNER, Steven A. Defining life, Astrobiology, 2010, DOI: 10.1089/ast.2010.0524

4. HILLIS David M. , David Sadava, H. Craig Heller, Mary V. Price, Principles Of Life, Sinauer Associates, Inc. 2012

5. MOGER-REISCHER, R.Z., Glass, J.I., Wise, K.S. et al. Evolution of a minimal cell. Nature (2023). https://doi.org/10.1038/s41586-023-06288-x

6. LACHANCE Jean-Christophe, Sébastien Rodrigue, Bernhard O Palsson, Synthetic Biology: Minimal cells, maximal knowledge, Life, Mar 12, 2019 https://doi.org/10.7554/eLife.45379

7. NICHOLSON, D., Salamina, M., Panek, J. et al. Adaptation to genome decay in the structure of the smallest eukaryotic ribosome. Nat Commun 13, 591 (2022). https://doi.org/10.1038/s41467-022-28281-0

8. HU, XM., Guo, Y., Liu, BH. et al. Progress in quantum teleportation. Nat Rev Phys 5, 339–353 (2023). https://doi.org/10.1038/s42254-023-00588-x

9. ABAACH, S., Mzaouali, Z. & El Baz, M. Long distance entanglement and high-dimensional quantum teleportation in the Fermi–Hubbard model. Sci Rep 13, 964 (2023). https://doi.org/10.1038/s41598-023-28180-4

10. ZHANG, CY., Zheng, ZJ., Fan, ZB. et al. The efficiency of quantum teleportation with three-qubit entangled state in a noisy environment. Sci Rep 13, 3756 (2023). https://doi.org/10.1038/s41598-023-30561-8

11. SHEN, S., Yuan, C., Zhang, Z. et al. Hertz-rate metropolitan quantum teleportation. Light Sci Appl 12, 115 (2023). https://doi.org/10.1038/s41377-023-01158-7

12. DURET Laurent, Ph.D. (Laboratoire de Biométrie et Biologie Évolutive, Université Claude Bernard, France.), Neutral Theory: The Null Hypothesis of Molecular Evolution 2008 Nature Education Citation 1(1):218, https://www.nature.com/scitable/topicpage/neutral-theory-the-null-hypothesis-of-molecular-839/

13. LANIER Kathryn A. and Loren Dean Williams, The Origin of Life: Models and Data, Journal of Molecular Evolution, 2017 Feb 27. doi: 10.1007/s00239-017-9783-y

14. ORGEL LE. Unnatural selection in chemical systems. Acc Chem Res. 1995; 28:109–118. DOI: 10.1021/ar00051a004

15. KOONIN, E. Comparative genomics, minimal gene-sets and the last universal common ancestor. Nat Rev Microbiol 1, 127–136 (2003). https://doi.org/10.1038/nrmicro751

16. CORNISH-BOWDEN Athel, Cárdenas María Luz, Life before LUCA, Journal of Theoretical Biology Volume 434, 7 December 2017, Pages 68-74, https://doi.org/10.1016/j.jtbi.2017.05.023

17. POPA, Radu, Between Necessity and Probability: Searching for the Definition and Origin of Life, Springer-Verlag Berlin Heidelberg 2004

18. FALTINE-GONZALEZ, D., Havrilak, J. & Layden, M.J. The brain regulatory program predates central nervous system evolution. Sci Rep 13, 8626 (2023). https://doi.org/10.1038/s41598-023-35721-4

19. MARTÍN-DURÁN José M., Andreas Hejnol, A developmental perspective on the evolution of the nervous system, Developmental Biology Volume 475, July 2021, Pages 181-192 https://doi.org/10.1016/j.ydbio.2019.10.003

20. HEIDEGGER Martin, Being and Time, translated by John Macquarrie & Edward Robinson, Blackwell Publishers Ltd 1962

21. Amiez, C., Sallet, J., Hopkins, W.D. *et al.* Sulcal organization in the medial frontal cortex provides insights into primate brain evolution. *Nat Commun* 10, 3437 (2019). https://doi.org/10.1038/s41467-019-11347-x

22. Koyabu, D., Werneburg, I., Morimoto, N. *et al.* Mammalian skull heterochrony reveals modular evolution and a link between cranial development and brain size. *Nat Commun* 5, 3625 (2014). https://doi.org/10.1038/ncomms4625

23. Long, E.L., Cuve, H.C., Conway, J.R. *et al.* Novel theory of mind task demonstrates representation of minds in mental state inference. *Sci Rep* 12, 21133 (2022). https://doi.org/10.1038/s41598-022-25490-x

24. Sierra, R.O., Pedraza, L.K., Barcsai, L. *et al.* Closed-loop brain stimulation augments fear extinction in male rats. *Nat Commun* 14, 3972 (2023). https://doi.org/10.1038/s41467-023-39546-7

25. Will, M., Krapp, M., Stock, J.T. *et al.* Different environmental variables predict body and brain size evolution in *Homo*. *Nat Commun* 12, 4116 (2021). https://doi.org/10.1038/s41467-021-24290-7

26. Ajabi, Z., Keinath, A.T., Wei, XX. *et al.* Population dynamics of head-direction neurons during drift and reorientation. *Nature* 615, 892–899 (2023). https://doi.org/10.1038/s41586-023-05813-2

27. Heidi Johansen-Berg, Structural Plasticity: Rewiring the Brain, VOLUME 17, ISSUE 4, PR141-R144, FEBRUARY 20, 2007DOI:https://doi.org/10.1016/j.cub.2006.12.022

28. Sahasrabudhe, A., Rupprecht, L.E., Orguc, S. *et al.* Multifunctional microelectronic fibers enable wireless modulation of gut and brain neural circuits. *Nat Biotechnol* (2023). https://doi.org/10.1038/s41587-023-01833-5

29. Critchley Hugo D., Neil A. Harrison, Visceral Influences on Brain and Behavior, Neuron VOLUME 77, ISSUE 4, P624-638, FEBRUARY 20, 2013 DOI:https://doi.org/10.1016/j.neuron.2013.02.008

30. Schulkin Jay, Action, Perception and the Brain Adaptation and Cephalic Expression Edited by Jay Georgetown University, USA, PALGRAVE MACMILLAN 2012

31. Schneider Gerald E., Brain structure and its origins : in development and in evolution of behavior and the mind, Massachusetts Institute of Technology 2014

32. KUPPER Zeno, Ph.D., Holger Hoffmann, M.D. Course Patterns of Psychosocial Functioning in Schizophrenia Patients Attending a Vocational Rehabilitation Program, Schizophrenia Bulletin, Volume 26, Issue 3, 2000, Pages 681–698, https://doi.org/10.1093/oxfordjournals.schbul.a033486

33. Beatriz Albuixech-Crespo et al. Molecular regionalization of the developing amphioxus neural tube challenges major partitions of the vertebrate brain, PLOS Biology (2017). DOI: 10.1371/journal.pbio.2001573

34. Kathleen W.Brown, Paul C.Cozby, Daniel W.Kee California State University, Patricia E. Worden California State University, Research Methods in Human Development Second edition, Mayfield Publishing Company 1989

35. Albuixech-Crespo et al. (2017) Molecular regionalization of the developing amphioxus neural tube challenges major partitions of the vertebrate brain. PLoS Biol 15(4): e2001573. DOI: 10.1371/journal. pbio.2001573

36. A. M. TURING, Computing Machinery And Intelligence, Mind, Volume LIX, Issue 236, October 1950, Pages 433–460, https://doi.org/10.1093/mind/LIX.236.433

37. Mai, H., Bao, J., Thompson, P.M. et al. Identifying genes associated with brain volumetric differences through tissue specific transcriptomic inference from GWAS summary

data. BMC Bioinformatics 23 (Suppl 3), 398 (2022). https://doi.org/10.1186/s12859-022-04947-w

38. Michele Solis, How Human Brains Are Different: It Has a Lot to Do with the Connections. Different mammals demonstrate common patterns in brain connections. But our own species has a few twists of its own, July 7, 2020
https://www.scientificamerican.com/article/how-human-brains-are-different-it-has-a-lot-to-do-with-the-connections/

39. Amber N.V. Ruigrok, Gholamreza Salimi-Khorshidi, Meng-Chuan Lai, Simon Baron-Cohen, Michael V. Lombardo, Roger J. Tait, and John Suckling, A meta-analysis of sex differences in human brain structure, Neurosci Biobehav Rev. 2014 Feb; 39(100): 34–50 doi: 10.1016/j.neubiorev.2013.12.004

40. Alberto Llera, Thomas Wolfers, Peter Mulders, Christian F Beckmann, Inter-individual differences in human brain structure and morphology link to variation in demographics and behavior, Jul 3, 2019, Neuroscience https://doi.org/10.7554/eLife.44443

41. DeCasien, A.R., Guma, E., Liu, S. et al. Sex differences in the human brain: a roadmap for more careful analysis and interpretation of a biological reality. Biol Sex Differ 13, 43 (2022). https://doi.org/10.1186/s13293-022-00448-w

42. Richard J. Haier, Rex E. Jung, Ronald A. Yeo, Kevin Head, Michael T. Alkire, The neuroanatomy of general intelligence: sex matters, NeuroImage, Volume 25, Issue 1, 2005, Pages 320-327,
https://doi.org/10.1016/j.neuroimage.2004.11.019

43. Bethlehem, R.A.I., Seidlitz, J., White, S.R. et al. Brain charts for the human lifespan. Nature 604, 525–533 (2022). https://doi.org/10.1038/s41586-022-04554-y

44. Schneider, S., Lee, J.H. & Mathis, M.W. Learnable latent embeddings for joint behavioural and neural analysis. Nature 617, 360–368 (2023). https://doi.org/10.1038/s41586-023-06031-6

45. Wysmolek, P.M., Kiessler, F.D., Salbaum, K.A. et al. A minimal-complexity light-sheet microscope maps network activity in 3D neuronal systems. Sci Rep 12, 20420 (2022). https://doi.org/10.1038/s41598-022-24350-y

46. Sebenius, I., Seidlitz, J., Warrier, V. et al. Robust estimation of cortical similarity networks from brain MRI. Nat Neurosci 26, 1461–1471 (2023). https://doi.org/10.1038/s41593-023-01376-7

47. Neuron tracing from light microscopy images: automation, deep learning and bench testing, Yufeng Liu, Gaoyu Wang, Giorgio A Ascoli, Jiangning Zhou, Lijuan Liu Author

Notes Bioinformatics, Volume 38, Issue 24, 15 December 2022, Published: 27 October 2022 Pages 5329–5339, https://doi.org/10.1093/bioinformatics/btac712

48. Zhou, Z., Liu, X., Long, B. et al. TReMAP: Automatic 3D Neuron Reconstruction Based on Tracing, Reverse Mapping and Assembling of 2D Projections. Neuroinform 14, 41–50 (2016). https://doi.org/10.1007/s12021-015-9278-1

49. Alwyn C. Scott, Neuroscience: a mathematical primer, Springer-Verlag New York, Inc. 2002

50. Nancey Murphy and Warren S. Brown, Did My Neurons Make Me Do It? Philosophical and Neurobiological Perspectives on Moral Responsibility and Free Will, Oxford University Press 2007

51. Vasiliki Karavakou, HEGEL ON CULTURE AND GLOBALIZATION, Department of International and European Studies, University of Macedonia, Thessaloniki, Greece, https://globalization.icaap.org/content/v5.2/karavakou.html

52. Viik, Tonu (2003). Hegel's Phenomenology of Culture. Dissertation, Emory University, https://philpapers.org/rec/VIIHPO

53. Joseph O. Bernal, Hegel’s Philosophy of Culture on Education towards Self-Actualization, International Journal of Science and Research (IJSR) ISSN: 2319-7064 Volume 8 Issue 12, December 2019 www.ijsr.net

54. Levi, Albert William. "Hegel's Phenomenology as a Philosophy of Culture." Journal of the History of Philosophy, vol. 22 no. 4, 1984, p. 445-470. Project MUSE, doi:10.1353/hph.1984.0048.

55. Novakovic, A. (2017). Culture. In Hegel on Second Nature in Ethical Life (pp. 69-105). Cambridge: Cambridge University Press. doi:10.1017/9781316809723.003

56. Przemysław Bursztyka, Eli Kramer, Marcin Rychter, and Randall Auxier, Volume Editors, Philosophy of Culture as Theory, Method, and Way of Life
Contemporary Reflections and Applications, Philosophy as a Way of Life, Volume: 2, E-Book (PDF), BRILL 2022

57. Jansson F, Aguilar E, AcerbiA, Enquist M. 2021 Modelling cultural systems and selective filters, Phil. Trans. R. Soc. https://doi.org/10.1098/rstb.2020.0045

58. Rosalind Coward and John Ellis, Language and Materialism Developments in Semiology and the Theory of the Subject, Routledge & Kegan Paul Ltd 1977

59. ALLEN John S. , The Lives Of The Brain Human Evolution and the Organ of Mind, Harvard University Press 2009

60. WITTGENSTEIN Ludwig, Philosophical Investigations, translated by G. E. M. Anscombe, Basil Blackwell Ltd 1958

61. WITTGENSTEIN Ludwig, Tractatus Logico-Philosophicus, first published in German in 1921, Michael Beaney translation, Oxford World's Classics 2023

62. Savile Anthony, Leibniz and the Monadology, Routledge 2000

63. Diane C Lillo-Martin and Jon Gajewski, One grammar or two? Sign Languages and the Nature of Human Language, 2014, doi: 10.1002/wcs.1297

64. Parvizi, Josef & Rangarajan, Vinitha & Shirer, William & Desai, Nikita & Greicius, Michael. (2013). The Will to Persevere Induced by Electrical Stimulation of the Human Cingulate Gyrus. Neuron. 80. 10.1016/j.neuron.2013.10.057.

65. Xuehu Wei, Helyne Adamson, Matthias Schwendemann, Tomás Goucha, Angela D. Friederici, Alfred Anwander, Native language differences in the structural connectome of the human brain, NeuroImage, Vol. 270, 2023, doi: 10.1016/j.neuroimage.2023.119955

66. Masazumi Fujii, Satoshi Maesawa, Sumio Ishiai, Kenichiro Iwami, Miyako Futamura, Kiyoshi Saito, Neural Basis of Language: An Overview of An Evolving Model, Neurologia medico-chirurgica Volume 56 Issue 7 Pages 379-386 2016 doi: 10.2176/nmc.ra.2016-0014

67. Rachel R. Romeo, Joshua Segaran, Julia A. Leonard, Sydney T. Robinson, Martin R. West, Allyson P. Mackey, Anastasia Yendiki, Meredith L. Rowe and John D.E. Gabrieli, Language Exposure Relates to Structural Neural Connectivity in Childhood, Journal of Neuroscience 5 September 2018, 38 (36) 7870-7877; doi: https://doi.org/10.1523/JNEUROSCI.0484-18.2018

68. Elisa De Stefani, Doriana De Marco, Language, Gesture, and Emotional Communication: An Embodied View of Social Interaction, Front. Psychol., 24 September 2019
Sec. Cognition Volume 10 - 2019 | https://doi.org/10.3389/fpsyg.2019.02063

69. Laura J.Speed and Asifa Majid, Grounding language in the neglected senses of touch, taste,and smell, Cognitive Neuropsychology 2020, VOL.37,NOS.5–6,363–392 https://doi.org/10.1080/02643294.2019.1623188

70. Borghi, A. (2023). Language as a Physical Tool. In *The Freedom of Words: Abstractness and the Power of Language* (pp. 15-51). Cambridge: Cambridge University Press. doi:10.1017/9781108913294.003

71. Rosario Caballero, Carita Paradis, Sharing Perceptual Experiences through Language
J. Intell. 2023, 11(7), 129; https://doi.org/10.3390/jintelligence11070129

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