Philosophy Study, February 2023, Vol. 13, No. 2, 60-67
doi: 10.17265/2159-5313/2023.02.002

The Human Mind

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The development of speech may have been the critical step in the development of the mind. In parallel with biological evolution, with the accumulation of gene differences, cultural evolution, the accumulation of experiences and ideas in symbolic form, began. Undoubtedly, the most significant stage of development is the development of the cerebral cortex. There are estimated one million cortical modules in each hemisphere. Sensory cells and sensory organs have well-determined centers, quasi "representative sites" in the brain; the stimuli of a sensory organ always flow into the corresponding center. The cortical projection of the main moving field is similar to the sensor field—a moving homunculus. Muscles involved in fine movements are represented over a larger area than muscles of other parts of the body. Remembering is a process of selection: only the memories that are important, interesting, significant for us are kept—the rest we forget. Speech, language, is central to the development of the ability to think and to the biological success of the human species. One of the most beautiful features of humankind is that they can live in a world of fantasy. They can imagine things they have never seen or never experienced.

Keywords: knowledge, human brain, sensory cells, speech

Introduce

With the emergence of the human, a new force appeared on Earth: the human mind. This unique achievement allowed a species for the first time to not only change its relationship with its environment by migrating elsewhere, but also to consciously shape the world around it, and ultimately perhaps even its own heredity. But the human mind has created something even more wonderful: it has created art to express individual emotions in a collectively meaningful form. The physical power achieved through technology and the emotional experience achieved through art are the fruits of consciousness and imagination.

The development of speech may have been the critical step in the development of the mind. Human language, speech, is an extraordinary, unique tool. The flexibility and creative power of human language is also unique. It allows for the abstract reflection of objects and relationships, which can then be transformed into memory, imagination, anticipation, and planning. Language has become a means of symbolic knowledge of the world because knowledge has become transferable. It was no longer necessary to acquire all experience individually (Colling et al., 2019). Personal experience could be passed on to others by word of mouth, wonder could be aroused, warnings could be communicated, important practical knowledge could be shared, and this communication not only established a link horizontally, between members of a generation, but also vertically: by teaching, accumulated experience could be passed on to young people. In parallel with biological evolution, with the accumulation of gene differences, cultural evolution, the accumulation of experiences and ideas in symbolic form, began (Vincze, 2010).

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In *Homo sapiens*, a new way of adapting has evolved that is much faster than the slow natural selection. The accumulation of knowledge has given humans the opportunity to change their environment, and not just to let the environment choose from the types that exist. The evolution of intelligence, coupled with the dizzying development of the most delicate and sensitive tool in the world, the human hand, has enabled the human race to spread from the tropics to the Arctic and take over the entire globe (Vincze, 2015a).

During the many millions of years of evolution of the nervous system, three basic stages of development prevailed: (1) increasing centralization of the nervous system; (2) conglomeration of nerve elements and sensory organs in the head; (3) the increasing development of the cortical areas of the cerebrum, the growth of the gray matter—the cerebral cortex consisting of neurons. In humans, the brain has reached a mass of 1,300-1,500 g. When we place humans at the peak of the phylogeny and evolution of the living world, we primarily rely on the extraordinary development of their nervous system and brain (Vincze, 2015b).

The Phylogenetic Development

At the stage of phylogenetic development, stimulus-receiving receptors appear first and then connect to the executing cells, leading to the formation of the diffuse nervous system. The cells conglomerate, and ganglia appears, which consist primarily of unipolar neurons. The connection between two neurons is realized through a synapse. A chain-like connection of the ganglia is formed, followed by their fusion in the head, and thus the segmental spinal cord and, in its anterior part, the brain is formed (Von Bertalanffy, 1968). Their rapid development was made possible by the fact that the neuron with multiple projections had become predominant in them. The spinal cord and brain fragments determine the development of the brain, and at the peak of evolution, due to the determinant nature of the cerebrum, humans appear.

Some parts of the central nervous system, such as the cerebellum, can be seen as computers programmed for a single task: the cerebellum processes sensory information, primarily to coordinate and control movements. Others, such as the thalamus, can be understood as a kind of giant “switchgear”, centers connecting parts of the brain; all the information from the outside world flows through them, is processed, partially stored, and transmitted to the cerebrum. Anatomically, several parts of the brain are distinguished in the continuation of the spinal cord: the medulla, the bridge of Varolius, the midbrain, the cerebellum, the diencephalon, the basal ganglia, and the cerebral cortex.

Undoubtedly, the most significant stage of development is the development of the cerebral cortex. This is where the sensory information of the centers under the cortex flows in, it develops the appropriate motor responses, and learning processes are usually related to this as well. The cerebrum and especially the cortex grew particularly huge in humans. Nine-tenths of the approximately 25 billion neurons in the human nervous system are in the cerebral cortex. It is estimated that an average of 9 trillion, extremely complex connections were developed between the neurons of the brain that have not yet been fully explored in detail. This, in principle, means the formation of a completely new nervous system structure, and it indicates that the cerebral cortex is not only the terminating area of sensory systems or the starting point of descending motor paths, but also the center of other higher neurological activities (Vincze & Vincze-Tiszay, 2020a).

In the cerebral cortex, nerve cells are organized in modules. A module contains about 5,000 nerve cells and the input goes into this module, and the output goes out from here. Within the layers, modules of 500-600 pm diameter and 3 mm height perpendicular to the surface can be distinguished structurally and functionally. There are estimated one million cortical modules in each hemisphere. So the brain has subsystems of modules, and the subsystems of modules are the neurons, and each of the three systems has its own functions.

By studying the functioning of the cerebral cortex, it has been concluded that some areas of the cortex receive afferent information of perception (receptor or sensory neocortex), others control voluntary movement (motor or effector neocortex), and others have neither a motor nor a sensory function (associative neocortex).

One of the most beautiful features of humankind is that they can live in a world of fantasy. They can imagine things they have never seen or never experienced, and sensory organs have well-determined centers, quasi "representative sites" in the brain; the stimuli of a sensory organ always flow into the corresponding center. We also know that from there, they reach many other areas of the brain. Because the center receives a lot of stimuli at once, there are many neurons operating at all times. Depending on how many cells are stimulated in the brain at the same time and what brain cells are operating in space and time, ever-varying stimulus "patterns" are created. It depends on these stimulus patterns—we do not yet know how—the subjective feeling of stimuli. And this feeling also means that the received, basically completely identical stimuli—of action voltage series—have already regenerated the original information, the feeling of the stimuli in the brain already imitates again, faithfully reflecting their different nature (color, smell, hardness, etc.).

The body sensory field is located in the posterior central convolution of the parietal lobe. This is the projection of the fibers of the thalamus that carry the impulses of conscious skin sensation and proprioception. Every part of the body has a cortical projection. The cortical aspect of perception (the sentient homunculus) can be represented in the form of a "manikin", whose parts are deformed because the different parts of the body are represented in proportion to their importance, not to their surface area. The most extensive cortical representation is in the most sensitive parts of the body (lips, tongue, hands, etc.).

The primary sensory field is functionally related to the adjacent motor field, so cortical field stimulation elicits a motor response in 20% of cases, and motor (moving) field stimulation is sometimes accompanied by sensory responses. These findings led to the conclusion that the primary sensory and motor cortical fields form a functional unit—a sensory-motor field. A secondary body sensory field is described in the upper wall of the lateral fissure, where the pathways of protopathic sensation are presumably projected (Vincze & Vincze-Tiszay, 2020d).

Specific sensing pathways are projected onto different sensory cortical fields. The primary visual field of visual perception is in the occipital lobe, the auditory fields are in the temporal lobe. The taste field is located near the cortical projection of the facial sensory cortex, the olfactory field is localized on the inner surface of the cerebral hemispheres, the vestibular projection field is located in the posterior part of the frontal temporal cortex, and the visceral sensation is projected to the whole sensory zone.

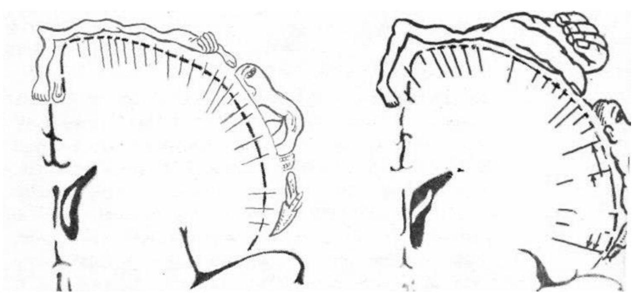

Figure 1. Sensorial (left) and moving homunculus.

The motor neocortex comprises the fields from which pyramidal and extrapyramidal pathways originate. The main movers are located in the anterior wall of the central fissure and in the adjacent part of the anterior coil of the central fissure. About a quarter of the fibers forming the pyramidal tracts originate from here. Neurons in the main motor field control the voluntary, rapid, precise, and coordinated movement of the skeletal muscles on the opposite side of the body. The cortical projection of the main moving field is similar to the sensor field—a moving homunculus. Muscles involved in fine movements (e.g. muscles of the hand, etc.) are represented over a larger area than muscles of other parts of the body (body, lower limb, etc.).

Based on the results so far, researchers agree that a distinction should be made between momentary, short-term, and long-lasting, i.e. solidified, memory traces. This classification refers to the time interval between recording and the still possible retrieving. Even the thus divided memory traces can be of two kinds: pictures and words. Images are recorded in both hemispheres of the brain, while words are recorded primarily in the left hemisphere. This may also explain the asymmetry of the cerebrum. According to the latest results, it is possible to record memories only in words, only in pictures, or both, regardless of the time interval of recording (Kumark & Clark, 2019).

Analysis and synthesis of stimulation are major functions of the cerebral cortex. Synthesis of stimuli consists in the association, generalization, and unification of excitation arising in different areas of the cortex owing to the interaction of different neurones and groups of neurones. It is expressed in the formation of the temporary connections on which every conditioned reflex is built.

Analysis of stimuli consists in discrimination between different stimuli, and differentiation of the various influences on the organism. It begins right in the receptor apparatus, the different elements of which react to stimuli of a different character; it also takes place in the lower divisions of the nervous system. But the process is most developed in the cortex.

The nerve pathways and the sensory areas of the cortex enable impulses from each type of receptor to be conveyed to definite groups of its nerve cells. In addition, the number of cells involved in a reaction, and the frequency of impulses in each of them, vary widely with the strength, duration, and rate of increase of a stimulus. Thus the conditions are provided in which every peripheral stimulation has its corresponding temporal and spatial pattern of excitation, its own dynamic structural complex. Thus stimuli with similar characteristics can be differentiated. The form of analysis specific to the cortex consists in differentiation of stimuli according to their importance as signals, which is secured by internal inhibition. Analysis and synthesis are inseparably interconnected (Vincze & Vincze-Tiszay, 2020b).

During the action of two separate stimuli on the organism the most primitive forms of analysis and synthesis are observed. An idea of the more complex forms can be gained from study of complex stimuli consisting of several components. For this purpose several signals are used following one another in a definite sequence; in a second sequence the same signals are used but not reinforced. The phenomenon of differentiation indicates that the cortex not only perceives each signal separately and summates them but also perceives the way they alternate and the sequence in which they are applied.

Our brains receive information about the external environment and the internal environment of the organism every second. If it always processed only these and gave instructions only for actions that correspond to current information, it would become almost impossible for living organisms to adapt to ever-changing conditions. Living beings would be forever tied to the current situation, their actions would always be controlled by the stimuli that were flowing in at the time, and their organisms would be “imprisoned” in the power of the present. Remembering (memory) allows us to control our behavior and adaptation not only by momentary information, but also by our past experiences and feelings from the present.

The momentary memory image is probably closely related to the annihilation of excitation and inhibition, so it is a biopotential change because this form of activity in the brain can last only a few seconds or minutes. Thus, the stimulus acting for a fraction of a second remains in the brain, but due to new stimuli, its memory becomes increasingly blurred and disappears completely within a short time (Vincze, 2018).

For example, the formation of some systems with circular excitation (so-called reverberation circuits) between different groups of neurons can be the basis for short-term memory. These stimulus circles can then be the starting points for the formation of lasting memory traces, which can also be related to learning processes. In long-term memorization, several neurons become interconnected and form a special fast-passing pathway—made up of several neurons—that becomes consolidated with frequent recall or disappears with no recall.

Remembering, in a broader sense, can mean a whole series of operations on the nervous system: encoding, storing, retrieving, and recognition. Of course, these four processes are not sharply separated. After all, the encoding phase, for example, necessarily involves storing and even retrieving the material learned in the previous phase. If the memory cannot be recalled anymore, we speak of forgetting. There is no one who would remember everything, but no one who would forget everything (Vincze & Vincze-Tiszay, 2020c). Remembering is a process of selection: only the memories that are important, interesting, significant for us are kept—the rest we forget. But this rule is also unfortunately very relative. Forgetting therefore has both positive and negative roles. It is positive in that it frees our consciousness from retaining many subsidiary perceptions, and it is negative in that we forget knowledge that we may still need. The degree of retention can always be examined in parallel with forgetting. Initially, the degree of forgetting is much greater than later. So a lot of the received material is “lost” in a short time; what remains does not change much.

A single encoding, storing, and retrieving is not yet sufficient to preserve the memory trace. To preserve it, we need to repeat this process several times, as the saying goes, “repetition is the mother of all learning”. The problem of the frequency of repetitions over time arises here. The repetitions are distributed in time, and carried out over several occasions, because recalling what has been learned is always only possible on the basis of some kind of association.

Because stimulus patterns from the sensory organs run into different parts of the brain and settle in different areas, their connections can only be imagined as the stimulus spreads upon reception and settlement, and thus the different centers come into contact with each other. These relationships represent the physiological background and basis of the association, the process of memory. Since virtually any kind of stimuli can come into contact with each other, memory is based on the unified functioning of the entire brain. Although there is no clear explanation of the biological mechanism of memory yet, we can gain psychological, medical, and pedagogical experiences from it that may be remarkably necessary and useful in our practical lives.

So the biological basis of the process that created human consciousness was the explosive evolution of the brain, presumably due to selection towards ever more perfect skills. The relative weight of the human brain alone is unmatched, but even more so is its complexity. Above all, the part of the brain—the cerebral cortex—that carries out the higher cognitive and coordination functions has evolved greatly. You could almost say that in the relatively recent evolution of humans, practically everything else has taken a back seat to increasing brain efficiency. The human brain has evolved, with its language, thought, and consciousness.

Speech, language, is central to the development of the ability to think and to the biological success of the human species. This suggests that the speech centers in the left hemisphere have been continuously refined as the human brain has evolved. We know the exact location of some of these centers from the symptoms that follow a stroke or localized brain injury accident. This type of injury can cause a variety of speech disorders called aphasias, the nature of which depends on which part of the brain is damaged.

When people form mental or verbal images of the world around them, the mind analyzes the perceptions in the context of certain property schemas. Because we approach logical structures using linguistic tools, this brain substrate of logic is an integral part of the structure of language. The improvement of these brain structures has obviously been brought about by their increasing usefulness for successful reproduction. Language has become an ever better means of expression and communication. In terms of general logical structures, the selection process favoured more efficient "thinking". When we say that language or the basic network of logical thinking is embedded in the structure of the brain, we do not mean that it is encoded in the brain in English or some other language. Our ability to learn to play chess also does not mean that the rules of chess are inherent in the neural network. The brain is just a web of connections, programmed by experience. One is a powerful tool of written or spoken language, the other is a tool of mathematical logic.

The brain compares, groups, combines, and stores information from the outside world and the internal world of the organism for a shorter or longer period of time. These functions can be seen as sources of consciousness, thinking, behavior, and memory. With the help of the information obtained in this way, it regulates and coordinates the functioning of the living organism in accordance with the incoming stimulus pulses. The brain can also develop ideas, suggestions, solutions on the time scale of thought and action. In reality, it can also be interpreted as if our brains manipulate the information stored, create competing ideas, and the randomness of this competition results in the more effective or less effective guess (Vincze, 2018).

Language gave humans a culture, and this culture began to develop. Cultural evolution is superposed on biological evolution. Cultural selection is based on the transmission and teaching of knowledge acquired through experience. That is why it is such a fast process. But for all their cultural achievements, humans could not escape the laws of biological evolution, but only modified their effects. On a collective level, language-based consciousness created culture and its evolution. At an individual level, consciousness has developed behavioural traits that are unique to humans. There must therefore be neural connections in the brain which, in response to an imagined representation of the possible consequences of alternative choices, ensure that a sequence of actions takes place by inhibiting or stimulating the appropriate neurons. It is acquired through learning.

Learning and memory are a basic feature of the central nervous system. Our whole behavior is a learned process that evolved on the basis of unconditional reflexes and instincts, being built around them. Learning is closely related to other brain processes, especially attention and cortical activity. Based on these, the cortex is able to capture and process information in such a way that in the event of a repetition of the same stimulus, the response is consistent with the previous event. In humans, learning is possible without an external event, through the mental recalling of events and the new logical association of concepts, given that memorization and the storage of information are mandatory conditions for any type of learning (Leake, 2016).

Learning is a phenomenon related to the cerebral cortex. The cerebral cortex is home to all the mechanisms capable of the fastest and most finely differentiated stimulus analysis, as well as the determination of the appropriate response. Similarly, the cerebral cortex is the site for comparing and storing data recorded on various information channels and stored in memory. Learning occurs only when the perceived information differs from what is stored, that is, as opposed to the individual's prior experience. Other areas of the central nervous system are also involved in the learning process: the limbic system, the thalamus, the reticular formation, all of which are necessary because they transmit sensing-sensory information to the cerebral cortex. In the context of this paper, we do not address the issues of natural and artificial intelligence.

Epilogue

A characteristic feature of human thinking is that it takes the ordinary phenomena of the world for granted. My aim was to show the dynamics of the development of the "image of life" and to shed a collective, investigative light on its characteristics. This is now made possible by interdisciplinary research, which, despite of its seven decades of history, has given a strong impetus to modern life sciences (Rishikesh & Agarwal, 2019). Because the more scientific methods we use to research a problem, the more solid the information they provide. To study the phenomena of life, I drew on the scientific arsenal of cybernetics, internet science, systems theory, and category theory, and used the results of the frontier sciences (biomathematics, biophysics, biochemistry, etc.) to sketch a spatio-temporal map of life, where time is measured in billions of years and distance in billions of light years (Vincze & Vincze-Tiszay, 2020e). To achieve this, I disrupted the classical forms of editing and adapted them to the content.

The recognition of the dialectical harmony between the general, the particular, and the specific signs of life ensures correct analogies and conclusions. Studying living systems thoroughly and continuously means describing, analyzing, measuring, and evaluating differentiating, specific features with increasing precision. In this respect, the synthesis of life phenomena extends to the foreseeable vector of the future through the emergence of interdisciplinary sciences.

One of the most beautiful features of humankind is that they can live in a world of fantasy. They can imagine things they have never seen or never experienced. Therefore, the universe unfolds ever wider and wider and invites them to move back and forth in space and time. They try to travel into the past and the future. What is humanly the most significant, they see life as a form that is ubiquitous. Of course, they can be mistaken, and often and increasingly their faith is undermined by newer and newer discoveries in science.

There is a planet, Earth, where the only life that we know of and that we can understand has evolved, with a dominant mammalian species blessed with the beauties of mind and soul, and blessed with the ability to speak and think abstractly. Throughout its long, long history, humans have "owned" this planet through successive civilizations that have built on each other and surpassed each other technologically. And finally, by reducing its natural resources in relation to its population, by deliberately destroying its environment without realizing the extreme danger it poses, it is slowly creating the conditions for the species to become impossible.

Life is narrowed to a very small part of the universe, namely to the planets (the probability of other forms is minimal). But even very few of the planets have the conditions that allow life to appear and evolve. Here, however, due to various constraints, civilizations of sentient beings develop in a very short time in space and time. They are ephemeral, but they pop up in different parts of the universe and at different times. Therefore, we can consider life as one of the inner qualities that make up the material of the universe, because it does not disappear permanently, but temporarily passes through a latent state and then reappears. Will wildlife be able to adapt to this artificially induced rapid change? The contradiction between the five billion years of future potential and the human activity that risks everything every decade is like a rigid bow. Adam was cast out of Paradise. Will humanity also banish itself from the Earth? Let's hope not, and that the Intelligent Human will find a way to harness their most hidden adaptive skills!

Homo sapiens, the newest and most unstable species on this Earth, has undertaken its responsibility to live LIFE!

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