Ideas before Words

Can language express our thoughts unequivocally?

The problem of expressing one's ideas outside the conceptual sphere of our synapses has certainly represented, for any attempt at interpersonal communication, both a necessity and a problem that has always required, for a better solution to both motivations, theoretical and technical approaches by human beings.
In fact, communication is everything in social life and this, to be honest, is certainly not a novelty for nature, which has based the survival and evolution of species on the most diverse forms of transmissible information.

Communication in plant species

Apparently, since we do not have natural sensors to perceive the chemical and electrical signals emitted by plants, it has always seemed to us that plants are incapable of communicating. In reality, this is not the case: in fact, research has shown that, although in a substantially different way from animal species, even plants possess information transmissible to others. These include chemical, electrical, and mechanical signals, which constitute a network of direct and indirect communication: in fact, multiple volatile organic compounds have been detected that are propagated in the environment in response to attacks by insects or other pathogens. When perceived by the surrounding flora, a chain defense mechanism is activated that protects the entire plantation, a phenomenon known as "chemical communication between plants".
In a direct mode, it has been shown, for example, that trees are able to generate electrical signals through the root and vascular network, which are used to transfer information about environmental conditions or available resources. This phenomenon, although mainly involving the propagation of such impulses within the same trunk (allowing the coordination of physiological and behavioral responses at a local level), can also extend into the soil: in fact, such signals are detectable by others belonging to the species nearby. This can also occur in a mechanical way: in fact, transmitting sensors react to touch or movement by emitting electrochemical responses perceptible by the foliage nearby.
In indirect communication, reagents released by leaves eaten by parasites or predators have been detected, starting from the same cut tissues that are carried by the wind, up to the production of specific chemical traces in response to damage: once captured by the plantation, a series of defense responses are activated in the neighboring areas, even if they have not yet been directly attacked. It has been observed:
- Increase in the production of substances toxic to parasites or predators.
- Activation of the innate defense system: this includes a series of responses such as the production of phytoalexins (antimicrobial aromatic compounds), synthesis of anti-parasitic proteins and electrical signals that stimulate a preventive defensive propagation throughout the receiving area.
- Production of resinous or milky compounds that mechanically hinder access to damaged leaves through viscosity or toxicity.
- Attraction of natural predators: emissions of olfactory signals that attract bird predators of parasites, thus contributing to increasing the protection not only of the infested species but also of the entire thicket, a particularly effective method in woodland areas.

All this has certainly ensured, at an evolutionary level, greater resilience and adaptability to changing environmental conditions and resources, ensuring the survival of the species that have come down to the present day.

Communication in Animal Species

Communicative forms in the animal world are multiple and diverse in nature: here are some examples, in a brief overview, of how complex and elaborate these mechanisms are, which are still the subject of study, as they are not yet fully understood or decoded.

- The dance of bees (Apis mellifera) is an example of high-level communication used by these social insects to indicate the distance and direction of food sources through choreographed movements within their hive. Its use is also crucial in mapping potential geolocalized points of interest during the important swarming phase, where scout bees map the route to guide others to the best location for building a new hive.
- In ants (Family Formicidae), antennal contact is essential: pheromones are released from the mandibular glands, which are perceived by other members of the same colony, transmitting information about colony membership, food, danger, or the presence of the queen. In the leafcutter ant subfamily (Genus Atta), ants communicate through chemical signals released during leaf cutting (hence the name) and during the construction of new underground nests. These chemical compounds allow ants to coordinate collection, defense, and reproduction activities within the community.
- Ultrasounds emitted by bats (Order Chiroptera) are used for hunting and communication within colonies. These high-frequency vibrations allow bats to navigate, locate prey, and communicate with their peers the presence of obstacles or intruders in their territory.

Songbirds like the European robin (Erithacus rubecula) use song to establish their territory, attract a mate, or warn of potential threats. This type of vocal communication is very complex, as it includes variations in tone, length, and intensity: a true language currently being studied by biologists and breeders.

- Elephants (Family Elephantidae) communicate through a combination of visual, tactile, and acoustic signals: they use powerful trumpeting to call their companions or signal imminent dangers; these calls can also propagate as vibrations through the ground, being perceptible by other members of the herd for long-distance communication.
- Dolphins (Family Delphinidae) use a series of complex sounds and vocalizations to communicate and coordinate hunting activities. These marine mammals are capable of emitting high-frequency sounds that can propagate optimally through water and can be heard at scientifically proven distances of up to 20 kilometers.
- Whales (Order Cetacea) communicate through long and complex songs that can last for several hours. These sounds are used for courtship, navigation, food search, and to maintain contact with other group members. A special mention goes to their exceptional propagation frequencies: researchers (using hydrophones often adapted from their military use, originally designed to track submarines) have scientifically demonstrated a propagation capacity of up to 3000 kilometers, not excluding the possibility of even greater distances, branching from one shore to the other across the ocean. In addition to providing information on the composition of songs, the data have also allowed the tracking of migration routes during the mating season (aptly named "singing"). Due to the complexity of these mechanisms, which have marked the evolution of these ancient mammals, scientific opinion tends to believe that this peculiarity goes far beyond current understanding and plays a fundamental and vital role in the survival of the cetacean species themselves. It is no coincidence that this communicative system was chosen, due to its uniqueness and functionality, among the soundtracks stored on the "Voyager Golden Record" disc, sent into space in the Voyager program.

Communication in Primates

Let's now shift the focus to non-human primates: species that are closest to us, such as monkeys, gorillas, chimpanzees, bonobos, orangutans, and others: these animals possess extremely complex and varied communication systems, playing a fundamental role in social interactions, group dynamics, and the maintenance of relationships within communities, including:

- Vocal communication: many primates use a variety of vocalizations to express emotions, needs, threats, or to coordinate group activities. For example, gorillas emit low, deep vocalizations to communicate their presence and emotional state, while chimpanzees can produce a wide range of sounds, including warning calls, alarm calls, or requests for help.
- Gestural communication: widely used through mechanical signals of the limbs to communicate intentions, emotions, dominance, or submission. Gestures like hugs, caresses, threatening postures, and recognition of social rank are important for communication within social groups.
- Facial expressions: these expressions (common to the human species as well) are often used by primates to communicate emotions such as fear, joy, anger, or aggression. For example, gorillas may bare their teeth to express a threat, while bonobos may smile to indicate a bond of reassurance and cooperation.
- Olfactory communication: many primates also use olfactory signals to communicate information about reproductive status, health status, or group membership. Orangutans, for example, may mark territory with scent glands to communicate their presence or establish territorial boundaries.
- Tactile communication: reciprocal physical contact is equally fundamental for communication, which, in addition to promoting hygiene and physical well-being, strengthens social bonds and cohesion within the group.

Studying and understanding these different expressive systems is essential to understand the foundations of human communication, as we are closely related species. In fact, research on the evolution of language has started from studying the methods used by our "cousins", spanning fields such as anthropology, primatology, and evolutionary biology. Currently, various evidences and scientific studies support the idea that communication among non-human primates has played a significant role in the development of our own social evolution. Theories endorsed by the following scientific studies:

- Animal communication theory: studies conducted by researchers such as Frans de Waal, Jane Goodall, Dian Fossey, and other primatologists have highlighted similarities in gestural, vocal, facial, and social communication between non-human and human primates. These similarities suggest that human communication has common evolutionary roots with that of all primates.
- Language study: studies on chimpanzees and bonobos have shown the ability of these primates to use complex sounds to communicate concepts and interact with humans. These studies, like those conducted by Herbert Terrace, have shown that primates can learn to communicate by receiving and modulating multiple acoustic forms, paving the way for understanding the evolutionary basis of human language, as well as the evolution of our vocal system, which some closely resemble the calls of chimpanzees due to its unique phonetic characteristics.
- Cognitive and social aspects: scientifically proven how communication among primates is closely linked to cognitive and mental processes and social dynamics within groups. It has also been highlighted how their dynamics are fundamental in understanding the mental states of the group, cooperating, sharing information, and expressing empathy, incorporating many aspects of human communication.

Human Communication Ways

From all this emerges the fact that communication was certainly not "invented" or "discovered" by humans; rather, we have tried to adapt our increasingly articulated and complex ideas to the natural communication tools that we have always had at our disposal, evolutionarily speaking. Therefore, it should not be surprising that these tools, being a legacy of our evolutionary past, are sometimes technically inadequate to express complex or abstract thoughts: in fact, as the variables that can conceptualize an idea or concept exponentially increase, the number of communicative units we will need to use for their description also increases. If this task is entrusted to natural language, it becomes very evident that a basic set of words will not be sufficient to communicate such an idea in a detailed manner. Indeed, despite the richness and complexity of human language, there are situations where it may be limited in expressing thoughts. This problem arises when attempting to communicate concepts that involve a detailed and precise descriptive interconnection. Since language is made up of a finite set of words, it may be lacking in certain aspects and nuances in some fields. Furthermore, the ability of language to precisely describe complex concepts is often limited by the ambiguity and polysemy of words themselves, which can be interpreted differently by different people or in different contexts, leading to misunderstandings and misinterpretations – that is, a multiplicity of interpretations of thoughts and ideas. Therefore, we are forced to make choices regarding the words to use and the organization of discourse. This selection and simplification of concepts can lead to a loss of informative units, as part of the complexity and subtlety of thought may be lost in the process of choosing words and formulating sentences.

Human inventiveness, however, has sought to address this issue by compensating for the complexity and abstractness of concepts through more sophisticated and specialized communication tools compared to natural language, such as specialized language, mathematics, formal logic, graphic representation, or computational modeling.

For example, to describe an object, we could break it down into dimensional equations to place in a space (called vectorial, a technique currently used in computer graphics): the more vector polygons surrounding the number of polygons corresponding to the object itself, the more accurate its rendering will be to the real object. If these polygons also apply a coloring as faithful as possible to the original, the final result will not only be far superior to any verbal description that can be made of it, but also greater than a drawing, portrait, or photograph, as none of these descriptive forms come close to representing the object itself like the polygonal representation, which thus better represents reality.

As another example, we could provide the biological representation of a life form: for instance, we could describe a living entity through the complete cataloging of all its cells at a given moment of its biological state. We could also go to a lower level by integrating its complete genome: in this way, we would provide a definitely more complete picture than any scan (radiographic, electromagnetic, or otherwise) which, no matter how detailed, would not come close to the previously proposed level of cataloging.

If we were to combine all these advanced technical descriptive forms into a single long equation, we would certainly have a better system to define the world around us in a much more precise and less ambiguous manner. Of course, such a system does not even come close to the speed of transmission of our words, estimated on average at about 100-120 words spoken per minute or about 200-300 words written per minute processed by our minds. From here emerges the limitedness and primitiveness of our language as a tool for modern communication.

The Idea as Information Thought Unit

All that has been discussed previously, however, does not take into account that whatever the nature or form of the object of our communication, it will necessarily be converted by our senses (which, until we have others, are always sight, hearing, touch, smell, and taste) to flow into our synaptic apparatus in what we define as an "idea."

There are multiple studies and hypotheses on what an idea is physiologically, that is, what physical or chemical basis it is composed of; however, as of the present date, we still do not have the necessary instrumentation to measure it, i.e. we do not have a definite conceptualization of it, nor do we have the means to understand at the cellular-biological level how the set of ideas could constitute our conscious thought. Obviously, steps forward in locating our thought have been made since the dawn of civilizations, and it is a common scientific belief that:

- The ideas in our mind are the result of complex neural processes that occur in our brain; biologically, they are the expression and interaction of specialized cells of the nervous system (the so-called neurons) that transmit electrical and chemical signals between them through synapses, which are the connections allowing information to pass from one neuron to another.
- The electrophysiology of the human brain is a complex (some believe it to be the most complex in nature) system based on communication between neurons through a series of countless biochemical and biological processes. The transmission of neural signals occurs through a combination of ion concentration gradients, action potentials, and neurotransmitters, which act synergistically to modulate neuronal activity and form the basis of ideas in the brain.
- Neurons are the functional units of the nervous system and are essential for transmitting brain signals. They are composed of three main parts: the soma, the axon, and the dendrites. The soma contains the cell nucleus and the essential cellular components for their functioning. The axon is the part of the neuron that extends from the cell itself and transmits nerve impulses to other cells. The dendrites receive signals from other neurons through synapses and integrate information to generate other response impulses.
- The transmission of neural signals occurs through the generation of action potentials, i.e. impulses that propagate along the neuron's axon. These potentials are triggered by stimuli that induce depolarization of the cell membrane: this process involves the passage of ions through their respective channels that regulate an ionic flow, generating an electrical impulse.
- At a chemical level, the transmission of neural signals occurs through a series of neurotransmitters, chemical substances that act as messengers between neurons and allow communication between them. Neurotransmitters are released in the synapse, the microscopic space between two neurons, in response to the arrival of the action potential. Once released, neurotransmitters bind to receptors on the membrane of the postsynaptic neuron, activating ion channels and generating the potential that changes the electrical potential of the membrane, called postsynaptic.
- The main neurotransmitters involved in the transmission of neural signals include glutamate, which acts as an excitatory neurotransmitter and promotes neuronal activation, and gamma-aminobutyric acid (GABA), which acts as an inhibitory neurotransmitter and reduces neuronal activity. Other neurotransmitters, such as dopamine, serotonin, and acetylcholine, play specific roles in mood regulation, sleep, and cognitive functions.

Despite these scientific advancements, they do not yet meet the need to define a single and complete model that can accurately and completely extract a memory or idea from a brain in a precise and replicable manner. The complexity and diversity of the neural and cognitive processes involved in the formation, storage, and recall of ideas and memories make this process still poorly understood and the subject of active research in various scientific fields, such as neuroscience, cognitive psychology, and artificial intelligence.

Where Current Research is Leading

It should come as no surprise that current research is focused on delving into what actually happens inside the neuron and, since we lack the necessary tools, technology is heading towards neuroprocessors that can be implanted directly into the human brain. It is hoped that such neural chips are not only able to provide a corresponding view of how a memory and thus an idea is physically composed. Experimental projects already exist with partial positive results, such as interfacing a brain with a computer, inputting visual impulses, and regulating brain synaptic emissions in order to control electronic devices; however, we are only at a starting point and amidst researchers who believe that real connectivity beyond motor or sensory neurons (easier to interpret than hippocampal neurons where our memories are presumed to be located) is impossible, and other more optimistic scientists, it is still a ground of open conflict.

Consider, however, the advantage that would be gained through a direct neural connection, both between individual to individual and between individual to machine:

Firstly, we could exponentially increase the communicative units expressed in a predefined time frame, meaning we could transmit many more words than we are currently able to speak. This would solve (at least in part) the problem of the amount of data needed to describe a concept or object through the aforementioned multidimensional representation, involving various informational elements, allowing for a more precise and rigorous expression of complex or abstract concepts, avoiding ambiguities and limitations of natural language.

- It would also enable the communication of thoughts arising from what is defined as "advanced heuristics," i.e. homo sapiens has the ability to surpass linear logic through an association that, although always linked to our experiences and information stored in our synapses (as it has been widely demonstrated that our memories are sensually stored in our brain and our thoughts arise from these memories), has a much higher level of abstraction being able to hypothesize concepts not yet detected or directly detectable by our measuring instruments (natural or artificial). Until now, expressing such thoughts is certainly more difficult and complex, as they go beyond our direct sensory experience.
- It would solve the problem of the "transformation of the idea," meaning:
- The idea arises from a synaptic source process.
- The idea is converted into communicative units that, not having the physical characteristics of the original, will inevitably degrade it to some extent (whether in large or small quantities).
- The idea is recomposed in the synapses of a recipient system.

This problem of error or imperfection in informational transmission would be overcome as there would be no transformation of the idea into any natural language or other sensory means, but rather its reception as the sole and unique native informational unit of our thought (once it is understood of what form and substance it is). Some also believe that a "complete" reception of our synaptic flow could transmit units that practically do not contain the informational entropy strictly necessary for the object of communication: think, for example, of the mood, physical condition, any problems that, being intimate to each of us, however condition the genesis of the synapse but are not formulated in natural language, i.e. not included in the final message. Personally, I am instead of the hypothesis that every detail, no matter how non-fundamental to the understanding of the model we have developed, simply exists, so why, if it does not cause problems to add it to the stored data, should we exclude it? Are not details part of the whole?

These are, of course, just discussions for now, but they do make us reflect on much more complex themes that involve our very conception of life. Already now, we point towards a trans-humanism, ethical implications, remote control of individuals and masses, a technology that is feared to be within the reach of the powerful, the wealthy, and not for everyone. It is always hoped that science and technology will be used for the good of humanity and not to undermine expectations; however, history teaches us otherwise, as it seems that the predominant mammalian matrix of the "sapiens" species is far from being abandoned. It is precisely for this reason that we should strive from now on to establish a historical, civic, and social consciousness that ranges from a more than complete understanding of science and technology to culminate in a constructive ethics that goes beyond our territorial nature, that is, to reverse the historical trend where scientists have always constituted a minority and the majority has simply followed their limited biological programming of birth, life, reproduction, and death.

Odd or Even?

Ideally Yours… Mike Yoshi

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