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Comparison of Brain Activation State (BAS) and Artificial Intelligence (AI)

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Abstract

Scholarly exploration into the origin and nature of human consciousness spans more than two millennia. Disciplines including philosophy, sociology, physics, biology and psychology have put forward diverse definitions and interpretations, yet no consensus has been reached to date. The inherent complexity of consciousness prevents any single discipline from fully, rationally and adequately revealing its essence, making it a core puzzle in humanity's pursuit of self-understanding. This article interprets consciousness based on the history of cosmic development, analyzes its origins, explains its definition, and proposes the theory of Brain Activation States (BAS). The core argument defines consciousness as the activated state of material information in the brain, composed of energy (E), complexity (C), and orderliness (O) of material information, and establishes a semi quantitative formula for Consciousness Ability (CA): $CA \propto E \times C \times O$. Based on the development history of Artificial Intelligence (AI) and its similarity to BAS, the following conclusion can also be drawn: the complexity (C) and orderliness (O) of material information in AI entities determine the level of intelligence, AI Ability (AA) ∝ Energy (E) × Complexity (C) × Orderliness (O). The more complex and orderly it is, the higher its level of intelligence. Obviously, for industry professionals in the field of artificial intelligence, the only job they do is to continuously improve the complexity and orderliness of material information in AI entities.

Keywords: Material Information, Complexity, Orderliness, Energy, Brain Activation State (BAS), Attributes, Artificial Intelligence.

Introduction

Artificial Intelligence (AI) is a new technological science that studies, develops, simulates, extends, and expands the theory, methods, techniques, and applications of human Intelligence. It is a branch of computer science that produces an intelligent entity that can react in a manner similar to that of human intelligence. Research in this field has included robotics, language recognition, image recognition, and expert systems. Since the concept of "AI" was officially proposed at the Dartmouth Conference in the 1950s, its development has gone through multiple peaks and winters. In recent years, owing to breakthroughs in deep learning technology, the explosive growth of internet big data and the rapid improvement in GPU computing power, AI technology has ushered in an unprecedented wave of development. From defeating the top human chess player AlphaGo to the stunning performances of generative AI models ChatGPT and Midjourney, AI has moved from the laboratory to every aspect of social life, becoming one of the core driving forces behind socio-economic development. However, research on the underlying logic of artificial intelligence is limited to computer science. Overall, the integration of data, algorithms, and computing power forms the basic logical basis of an operating system. It is still at the scientific level and has not risen to a higher multidisciplinary dimension. Starting from the inference and origin of human consciousness development, this paper summarizes its definition, essence, and attributes, providing strong guidance for the field of artificial intelligence.

Consciousness

The origin of consciousness began with the birth of the universe, followed by the production of inorganic and organic matter, and finally evolved into living organisms, until the birth of human consciousness.

Origin of Consciousness

Production of Inorganic Substances

Based on evidence, such as hydrogen abundance, cosmic background radiation, and interstellar redshift in astrophysics, it is shown that the universe was created by a singularity (point 0) with immense energy before 13.8 billion years, which passed through Big Bang and produced everything in the universe, such as various substances, energy, time, and space. The first substances formed are simple elements such as hydrogen and helium, which then undergo processes such as nuclear fusion, nuclear fission, galaxy explosions, and neutron mergers to form various inorganic substances such as simple elements and compounds, until the formation of galaxies. 4.5 billion years ago, solar power systems emerged.

Currently, the main substances on Earth are inorganic substances, such as simple elements and compounds, all of which contain certain material information, the information possessed by matter. Examples include the particle distribution, size, ranking, velocity, mass, energy, intensity, sound, and electromagnetic fields. Information on this type of substance determines its distribution and ordering characteristics under the action of energy, which in turn determines the type, properties, and attributes of the substance.

In addition, material information for these substances can only exist under the action of force (energy). Although material information does not occupy space, it requires matter as a carrier and energy to support it. For example, hydrogen atom (H) and sodium chloride (NaCl) compounds are produced by ionic bonds between sodium cations (Na+) and chloride anions (Cl-), and the solar system is formed by the gravitational pull of eight major planets. Because the essence of forces (such as electromagnetic forces, covalent bonds, ionic bonds, and gravity) is energy, different forces (energies) determine the distribution and ordering of material information in these substances. In other words, energy is the root determinant of information and ordering of these substances [1].

The ancient Greek mathematician and philosopher Pythagoras (around 580 BC-500 BC) once said, "All things are numbers," in which "all things" is matter, and "Number" is information, which can be understood as "all things are material information". In short, material information is the state of distribution and ordering of material existence, which does not occupy space, and does not have energy, but requires energy support. Energy determines the distribution and ordering of material information in various substances, as well as their types and properties. Therefore, the type and properties of substances are determined by their internal material information. This stage of evolution is a process of material information from nothing to simplicity, and its orderliness from nothing to low. This process is performed from zero (energy) to one (inorganic matter).

Production of Organic Compounds

About 3.8 billion years ago, inorganic substances on Earth were subjected to environmental factors such as sunlight, lightning, water, and oxygen to form more complex organic compounds through physical and chemical processes, such as phosphoric acid, ribose, deoxyribose, and bases. Then, ribonucleotides and deoxyribonucleotides were synthesized, and finally the genetic material deoxyribonucleic acid (DNA) and ribonucleic acid (RNA) evolved in an epic way. RNA (ribonucleic acid), an organic molecule that can self-replicate, gradually combines with other substances to form more complex substances, ultimately forming single-cell organisms.

This process is crucial to the transition of living systems. Genetic material can be passed down from generation to generation, giving rise to the embryonic form of low-level life and becoming a milestone in the evolution of the biological world.

The key is the genetic information in the genetic material, that is, material information. For example, different structural RNAs such as messenger RNA (mRMA), ribosomal RNA (rRNA), transport RNA (tRNA), small nuclear RNA (snRNA), microRNA (miRNA), long noncoding RNA (lncRNA), small interfering RNA (siRNA), siRNA, and circular RNA (circRNA) determine the different roles and functions of RNA.

In other words, different material information in RNA determines its structure, type, and function [2]. The evolution process is a process of material information from simple to complex, and its orderliness changes from low to high on the Earth during this stage. The process was performed from step 1 (inorganic substances) to step 2 (organic substances).

Birth of Life

About 3.5 billion years ago, because of the production of new substances such as proteins, sugars, fibers, DNA, RNA, phospholipids and enzymes, as well as trace elements such as Na and K that already exist on Earth, under certain conditions (such as volcanic eruptions), single-cell life forms gradually formed through continuous arrangement, combination, and survival of the fittest. At this point, single-celled organisms cannot yet be recognized as conscious despite their ability to respond to external changes, which are only some instincts required during evolution to adapt to their environment.

For example, the paramecium is a single-celled organism that, despite lacking neurons and nervous system, can perceive environmental changes and reactions through its own functions (such as chemical and physical reactions), including ciliary oscillation and chemical reactions. These reactions are achieved through the internal signaling system of the paramecium, including a series of proteins and ion channels, that transmit information within the cell and regulate the cell's ability to seek benefits and avoid harm.

Although current scientific theories are insufficient to fully explain these principles, this process involves electrical signals, conduction, molecules, ions, and physical and chemical reactions. This process must be completed using material information (electrical signals, molecules, ions, chemical and physical reactions, etc.) and energy (thermal energy, mechanical energy, electrical energy, chemical energy, etc.), including information generation, transmission, reception, and processing. In other words, the profit-seeking and harm avoiding function of a single cell is the production of material information in its body supported by energy.

Subsequently, some jellyfish organisms have begun to exhibit peptogenic cells that are very close to neurons and possess functions, such as sensing, transmission, processing, and response. With the continuous evolution of organisms, the nervous system gradually develops until multicellular organisms such as flatworms, fish, and animals including monkeys and apes emerge. The evolution process of the nervous system is from dispersion to concentration, becoming a relay station for transmitting information, where nerve cells are concentrated in the ganglia and nerve fibers gather into bundles. Several ganglia in the anterior part of the animal body fuse together to form a "brain", gradually evolving into fish, other animals, and primates [3].

Neurons form the basis of brain operations, and their structures are composed of cell bodies, dendrites, axons, synapses, and nerve endings. The component information of these units is a type of material information, and their structure is composed of this basic material information. Different neuronal connections and functions generate different functional blocks, such as visual, memory, and computational functions. The connections and functions of these blocks generate a conscious animal system. The evolution from organic substances to animal life forms is a process that increases the complexity and orderliness of material information. The process was performed from step 2 (organic substances) to step 3 (life).

Birth of Humanity

Approximately 3 million years ago, owing to various reasons (changes in geographical conditions), primates began to leave primitive forests and enter planes. To survive, they continuously participate in unique social activities, such as hunting, labor, cooperation, living, communication, and learning. These advanced and complex activities constantly stimulate and update material information in the brain. In addition, food has changed from raw and omnivorous to cooked meat, accelerating digestion and nutrient absorption.

Driven by the principle of "survival of the fittest" and genetic variation, the basic capacity of the brain has expanded, almost doubling, resulting in an increase in the complexity of the brain's basic structure (material information) as well as the stimulation of various social activities unique to humans.

The orderliness of material information in various functional areas of the brain has greatly improved, leading to the upgrading and replacement of brain functions, such as the birth of language, and ultimately the modern human consciousness system.

The essence of this evolutionary process is the increase in the complexity and orderliness of material information in the brain, that is, the change in material information. This information includes the number of neurons in the brain, neurotransmitters, structure, electromagnetic fields, voltage, current, signals, distribution, sorting, and transmission as well as various forms of physical and chemical reactions, including their static and dynamic states. The ancient Chinese philosopher Laozi once said, "Nothing gives birth to existence, but existence gives birth to the Tao. Tao gives birth to one, one to two, two to three, and three to all things". This "nothing" represents "energy" the "Tao" represents principles, and "all things" refer to various living organisms (humans) [4]. Obviously, this process is the continuous complexity and orderliness of material information in the brain. This stage is the process in which material information goes from more complex to the most complex and from higher to the highest orderliness of material information. The process was performed from step 3 (life) to step 4 (humans).

Definition and Ability of Consciousness (BAS)

The term "Consciousness" comes from the Latin word "Conscience", which means cognition and refers to advanced neural activity. Currently, the term consciousness is adopted by many disciplines, but each discipline has a different understanding and interpretation, such as philosophy, biology, medicine, and psychology.

Below are Definitions from Different Fields.

- **Definition of Idealism**

The ancient Greek philosopher Plato believed that consciousness originates from the soul, such as reason, will, and emotion. The phenomenon of consciousness is an attribute of the soul, which is the original thing that existed before form and can control the movement of form. They lived in a world of ideas prior to the formation of humanity [5].

- **Definitions of Materialism**

The human brain's reflection of the objective material world is also the sum of various psychological processes such as sensation and thinking [6].

- **Definition of Psychology**

Understanding consciousness in the field of psychology can be divided into two categories: broad and narrow. The broad concept of consciousness refers to the brain's reflection of the objective world. This definition is similar to that of materialism. The narrow concept of consciousness refers to the degree to which people perceive and pay attention to their external world. In modern psychology, the discourse on consciousness mainly refers to the narrow concept of consciousness [7].

- **Biological Definition**

Human consciousness originates in the brain and comprises the cerebellum, thalamus, hypothalamus, and the basal ganglia. It can transmit various sensory information, such as vision, hearing, touch, smell, and taste through brain neurons and analyze them step-by-step as samples. The thalamus synthesizes them into the thalamus and distributes them to the brain's communication area, causing the brain to produce consciousness-that is, human consciousness [8].

Obviously, the above definitions of consciousness have not been universally recognized in various disciplines. Therefore, it is necessary to elaborate on this more deeply and reasonably, hoping to gain recognition from people from all walks of life. According to the previous introduction to the evolutionary process of consciousness in living organisms, consciousness is the process of forming complex and ordered material information supported by energy, including the formation of various neural networks in the consciousness system, thus completing the entire life journey from zero (energy) to all things (humans).

The Following Definition of "Consciousness" can be Derived for this Purpose:

Consciousness

The Activation state is formed by material information under the support of energy in the brain. Abbreviated as Brain Activation

State (BAS).

- **Operating Principle:** Information from both internal and external sources is input into the BAS and processed by a neural network (e.g., induction, encoding, storage, computation, extraction, and transmission) and then outputs them to various organs of the human body, commanding their activities with the support of energy A further explanation is as follows.

Material Information

The ancient Greek mathematician and philosopher Pythagoras once said, "All things are numbers." and the essence of "numbers" is material information, which can be understood as "all things are material information.".

Material information exists dependent on matter. It is not equivalent to matter but requires matter as its carrier; nor is it energy, yet it cannot function without energy support. In the BAS theory, material information refers to the spatio-temporal state formed by the combination of matter and energy.

- **It Falls into two Categories:** static information (fundamental material information) constituted by brain structures including neuron quantity, classification, distribution, synaptic density, topological patterns of brain networks and cortical folding; and dynamic information (signal-related material information) composed of various signals such as synaptic strength, electrical potentials, chemical neurotransmitters, synaptic transmission efficiency and neural oscillation phases etc. The human brain has 86 billion neurons and approximately 10 trillion synapses. The Salk Institute estimates that the information storage capacity of a single synapse is about 4.7 bits, and the total storage capacity is estimated to be greater than 1 PB bit (1 PB=1000TB), indicating that its information content is much larger than typical computer storage. This information belongs to analog signals, which have higher complexity compared to digital signals. Static information determines the complexity of BAS, while dynamic information determines its orderliness.
- **Complexity (C):** It refers to the complexity of basic material information in BAS, similar to the "hardware" of the brain, such as the number of neurons and synapses; Neural network connection density; Degree of folding of cerebral cortex; Cortical differentiation, etc. The quantity is not necessarily the determining factor, for example, cetaceans have more neurons than humans, but the human brain has higher network complexity and cortical differentiation, and the C-value of the human brain is higher.
- **Orderliness (O):** It describes the rationality, effectiveness and logicality of programs composed of signal-related material information in BAS, including the logic of signal transmission, efficiency of neurotransmitter release and synchronization of neural oscillations. It acts as the "software" of the brain. Orderliness is inversely correlated with thermodynamic entropy: a higher degree of order corresponds to lower system entropy, and vice versa. For instance, high-level cognitive activities such as reading and learning rely on millisecond-scale synchronized firing of neuronal clusters across brain regions, a typical manifestation of a high O value.

Energy

This mainly refers to heat. The telencephalon in the brain is composed of approximately 14 billion cells, weighing approximately 1400g, with a cortical thickness of approximately 2-3 millimeters and a total area of approximately 2200 square centimeters. The main component of the human brain is blood, which accounts for 80% of the brain. Although the brain accounts for only 2% of the body's weight, it consumes 25% of the body's oxygen, and blood flow accounts for 15% of the heart's output. The brain uses blood sugar as an energy source for normal operations.

During aerobic respiration, oxygen is inhaled from the lungs and enters the bloodstream through the capillaries. It combines with hemoglobin in red blood cells to form oxygenated hemoglobin, which transports oxygen to necessary tissues and organs. Oxygen is then separated from hemoglobin and sent to various cellular tissues in the body through physical reactions (diffusion). When combined with glucose, it undergoes a chemical reaction to produce energy adenosine triphosphate (ATP) [9].

If there is no input of energy or oxygen, the BAS composed of neurons in the brain loses vitality and enters a state of brain death. Therefore, people rely on eating and breathing to provide energy for the brain, because all movements require energy. Without energy, there was no movement, posture, activity, or consciousness. The brain also needs energy when it is in a vacant state (newborn baby) and a dormant state (sleeping or sitting), to maintain a minimum energy level, because it still has a certain level of activity.

Activation State

Activation State: It is a state of activity that occurs when a substance (including an electromagnetic field) is excited by energy. They exhibit three characteristics: excitation, activity, and state. The state itself is material information. From a spatial perspective, BAS can be divided into three types: unit-activated states, function- activated states formed by the synthesis of connections and interactions between unit activated states, and system-activated states formed by the integration of connections and interactions between functionally activated states. These activation states are all connected by neurons into different combinations of activation states, known as neural networks. From a temporal perspective, by year classification: BAS can be divided into infancy, adolescence, adulthood, and old age; Classified by day: A person's BAS can be divided into dormant state, stable state, and activated state during a day.

Input Information

A BAS can process input information (e.g., encoding, storing, and extracting) and output information. The input information comes from both external and internal perception organs. There are many classification methods, generally divided into three categories based on the location of the sensory organ and the source of the received stimuli: first, external receptors are distributed in the skin, mucous membranes, visual and auditory organs, etc., receiving stimuli from the external environment, such as touch, pressure, cutting, temperature, light, and sound; secondly, internal receptors are distributed in the internal organs, brain, and blood vessels, and receive stimuli applied to these organs, such as pressure, osmotic pressure, temperature, ion and compound

concentration, as well as activated overflow information stored in functional blocks of the brain; and proprioceptors are distributed in muscles, tendons, joints, and the inner ear, which receive stimuli generated during body movement and balance [10].

For example, color vision can be used. External objects reflect light and enter the human eye. Light passes through the cornea, enters the pupil, and is refracted by the cornea and lens before being focused onto the retina. Over one million photoreceptor cells in the retina convert light into electrical pulses that are transmitted along the optic nerve to the BAS. After processing (such as compilation and transmission), the electrical pulses form an image perception, generate vision, and store this information. Input information consisted of the optical and electrical signals.

Output Information

A BAS can process input information (e.g., sensing, encoding, storing, transmitting, and extracting) and output information. The output information is the result of processing the input information in the BAS and inputting it into other organs of the human body to generate activity with the support of energy and the nervous system conduction. For example, perception and response; perception of various sensations such as pain, sourness, and pleasure; and response to various human activities, such as language, behavior, and sleepwalking.

BAS Capacity

The capacity of BAS is inseparable from energy and material information. Consciousness Ability (CA) is positively correlated with energy (E), complexity (C) and orderliness (O), expressed as: $CA \propto E \times C \times O$. Human intelligence (I) is positively correlated with C and O, namely $I \propto C \times O$. Higher combined values of C and O correspond to greater intelligence, and vice versa. Energy exerts a profound influence on CA. For example, insufficient blood glucose or oxygen reduces ATP supply, weakens the activity of the activation state and lowers the overall O value, leading to decreased CA (including impaired intelligence). Manifestations include slow thinking, inattention, clouded consciousness and even coma, which can be reversed after energy replenishment and the recovery of O and CA values.

Aging also affects BAS performance. Reduced cerebral blood flow and impaired glucose metabolism cut down ATP production, slow down sodium-potassium pump activity and synaptic transmission. Massive irreversible neuronal apoptosis reduces synaptic quantity, cortical atrophy and functional dissociation of brain regions increase neural signal noise, cause transmission delay, memory disorder, broken logical chains, inattention and weakened inhibitory control. All these phenomena can be explained by the simultaneous decline of E, C, O and synchronization, which results in reduced CA.

Traumatic Brain Injury (TBI) represents another typical case. Local brain damage directly destroys neural networks and synaptic pathways, leading to incomplete information transmission. The reduction of C, O and energy transmission efficiency jointly lowers CA, presenting as bradykinesia and confused consciousness. General anesthesia offers further evidence. Under normal conditions, sodium ions flow into neurons to generate electrical signals, which transmit pain sensations to the brain. Anesthetic agents bind to neuronal membrane proteins and block sodium channels, interrupting peripheral pain signals and reducing effective energy input.

The entire neural network enters a low-power standby state with suspended neural circuits and suppressed excitatory receptors. Spinal signal conduction is also blocked, so pain signals cannot reach the brain, and no pain perception is generated. Anesthesia minimizes the O value of the neural circuit responsible for pain transmission, inducing numbness. The anesthetic effect is a reversible temporary suppression of neural functions without neuronal necrosis or brain cell damage. After the anesthetic is metabolized, ion channels and neural functions recover fully, and the O value of pain-related activation states returns to normal [11].

Neuronal plasticity is closely associated with BAS operation. Long-term learning stimulates continuous neuronal firing, promotes synaptic proliferation, myelin sheath thickening, neural circuit optimization and cross-regional coordination. These changes accelerate information transmission, expand storage capacity and enhance integration ability.

Fundamentally, the optimization of neural network structures raises C and O values, thereby improving CA, which is externally reflected in improved cognitive competence (e.g., children learning language, writing and musical instruments). Conversely, long-term disuse of a certain brain function leads to synaptic atrophy and disconnection, accompanied by decreased C, O and energy consumption, resulting in functional degradation.

Additionally, chronic anxiety reinforces and solidifies negative neural circuits, continuously raising the O value of these pathways. The vicious cycle exacerbates subjective anxiety and strengthens the corresponding CA, defined as "negative consciousness ability". In conclusion, supported by energy, the complexity and orderliness of material information in BAS form diverse neuronal and functional activation states that regulate somatic activities and ensure the efficient operation of the entire BAS system.

Attributes of Consciousness (BAS)

Derived from the definition, essence and operational principles of BAS, consciousness possesses eight core attributes: innateness, materiality, complexity, systematicity, dynamism, individuality, subjectivity and selfhood. Detailed explanations are as follows.

Innateness

Innateness means that genetic genes determine the inborn structure of the brain and neural networks at birth. Genes, consisting of complete nucleotide sequences for RNA synthesis, encode the basic structures and functions of life and store all biological information related to species, blood type, gestation, growth and death. The basic brain architecture, layout of neural circuits, neuronal differentiation and synaptogenesis are all genetically determined.

Evidence includes the inherent capabilities of newborns for arousal, perception and emotional processing, high similarities between monozygotic twins, and congenital neurological malformations leading to brain dysfunction. Genes feature both ma-

teriality (as the physical carrier) and informational nature (as the functional state), which together constitute the material information of genes [12]. Innate genetic information shapes individual differences and exerts long-term impacts on people's thinking and behaviors.

Materiality

The operation of BAS is grounded on physical substances including neurons, synapses, neurotransmitters and electrical signals.

- **Chemical Evidence:** Depression is closely linked to neurotransmitter dysfunction. Dopamine mediates information transmission between neurons. Insufficient dopamine reduces energy utilization efficiency, lowers the C and O values of neural networks and impairs emotional representation capacity, collectively decreasing CA and triggering depressive symptoms such as low mood, cognitive retardation and hypoactivity. Supplementing dopamine can alleviate emotional disorders, proving that subjective experience (consciousness) directly corresponds to specific material information (neurotransmitter concentration).
- **Physical Evidence:** EEG (Electroencephalography) and MEG (Magnetoencephalography) can directly capture electromagnetic signals associated with conscious activity. Combined with the evolutionary process of consciousness elaborated above, this confirms the material basis of consciousness. The materiality of consciousness verifies that human thinking and behaviors originate from natural matter, pointing out a clear direction for future research.

Complexity

The complexity of BAS derives from its fundamental material information, including the enormous quantity of neurons, intricate synaptic structures and highly sophisticated neural networks. The human brain contains approximately 86 billion neurons and 84.6 billion glial cells, totaling around 170 billion brain cells. Each neuron forms 100 trillion to 1 quadrillion synaptic connections, generating an infinite number of state combinations. The extremely high C value enables the brain to process complex nonlinear and multivariate problems, making humans highly intelligent creatures [13]. The profound complexity of consciousness indicates that research in this field is endless and cannot be fully explored from a single disciplinary perspective.

Systematicity

Systematicity refers to the holistic mechanism where distinct neural network functions operate independently and collaboratively, conforming to the principle that the whole is greater than the sum of its parts. The term "system" originates from Ancient Greek σύστημα, initially used to describe celestial arrangements, grammatical structures and political organizations. Aristotle first applied this concept to natural systems, with the core idea of the whole surpassing individual components. Consciousness is not the product of isolated activities in single brain regions, but the integrated outcome of multi-band neural oscillations, cross-regional synchronization and dynamic network coordination. Different brain wave bands cooperate to form the neurodynamic foundation for human awareness, information binding and global broadcasting, constituting the complete consciousness system.

The split-brain experiment conducted by Roger Sperry and Michael Gazzaniga in the 1960s provides solid evidence. In patients with epilepsy who underwent corpus callosotomy (severing the nerve bundle connecting the left and right hemispheres), two independent conscious functional systems emerged within a single brain. This proves that the holistic function of consciousness relies on the integrity of BAS neural networks. Therefore, consciousness is inherently systematic. The systematic nature of consciousness requires comprehensive and systemic research perspectives.

Dynamism

Dynamism refers to the continuous movement of signal activities, physicochemical reactions and neural plasticity within BAS. As defined earlier, consciousness is an energy-excited activation state with inherent dynamism. The human brain maintains ongoing neural signal transmission and biochemical reactions, with around ten million biochemical reactions occurring every second. Uninterrupted neuronal signaling, synaptic transmission, neural oscillations and energy metabolism sustain diverse brain states including wakefulness, concentration, fatigue and sleep.

While fundamental material information in BAS remains relatively static, signal-related material information is inherently dynamic. Subjective conscious perception emerges from dynamic signal activities, endowing consciousness with continuous dynamism. The dynamism of consciousness implies that answers to related research must be explored through dynamic information analysis.

Individuality

Individuality refers to differences in brain connectivity patterns shaped by innate genetics and acquired experience. First, the massive volume of static and dynamic material information in BAS generates unique combinations of C and O values for each individual, resulting in innate differences in brain connectivity. Second, external social environments continuously stimulate neural oscillations throughout life, altering the structure of C and O and signal characteristics. These changes differentiate individual CA values, leading to variations in cognitive ability, personality, physical condition, subjective experience, thinking patterns and value judgment. In addition, aging, brain injury and diseases modify E, C and O values and further reshape CA. Individuality is one of the core sources of contradictions in human society.

Subjectivity

Subjectivity refers to the subjective perception generated after BAS processes internal and external input information, especially through information representation. Consciousness arises when BAS processes input information across multiple activation states, which is essentially the combined operation of E, C and O. Many subtle differences between input information cannot be directly distinguished by the brain, so further processing including encoding, amplification, integration, broadcasting and representation is required to convert objective signals into subjective experience. By analogy, humans cannot perceive binary codes (0 and 1) in computers directly but can recognize processed information such as images. Visual perception of color is a typical example. Visible light with wavelengths ranging from 380 to 780 nanometers is converted into electrical signals by ret-

inal photoreceptors. After encoding, simulation and amplification in BAS, these signals form the subjective perception of colors. For instance, a red apple appears red because its skin reflects red light and absorbs other wavelengths. Under pure blue light, the same apple appears black. Hence, color is a subjective product of BAS processing objective light waves; only the frequency and intensity of visible light are objective physical properties [14]. The same principle applies to taste, smell, touch, human knowledge and experience. In general, human perception is the brain's subjective reflection of the objective world. Processed objective information differs substantially from the original reality, which defines the subjectivity of consciousness. Subjectivity is another major source of social contradictions among humans.

Selfhood

Selfhood refers to the centralized first-person perspective formed with BAS as the core.

The "center" of the system is characterized by high energy, abundant material resources and powerful information processing capacity, occupying a dominant position and generating the concept of "self", such as the cognition of "I am the center", "I am right" and "I am superior". All these manifestations belong to self-oriented consciousness.

- **Neural Basis:** Selfhood relies on the Cortical Midline Structures (CMS) and the Default Mode Network (DMN). When humans are not engaged in external tasks, the DMN activates automatically to support self-referential thinking, memory retrieval and future planning.
- **Operational Mechanism:** Selfhood is a dynamic model constructed by the brain. It integrates scattered sensory inputs, emotional experiences and memories into a coherent narrative centered on the "self". Sufficiently high O values (effective information integration) are a prerequisite for maintaining selfhood.
- **Mainstream Theories of Consciousness have Discussed Selfhood:** IIT attributes the self to highly integrated and unified information, regarding it as an innate property of consciousness; GWT views the self as a global information scheduler that filters and regulates conscious content; HOT holds that consciousness arises from self-reflection, with the self as the logical subject of perception. Selfhood is a fundamental component of human nature and also a key cause of social contradictions.

Artificial Intelligences (AI)

The foundation of artificial intelligence is the computer's operating logic, which uses binary encoding to encode all information, and then collaborates with hardware based on the von Neumann architecture to implement CPU execution instructions and run operating systems and applications to achieve various functions. Obviously, its running process is a combination of various programs formed by "0" and "1" information. This is the foundation of computer science and the theoretical basis of artificial intelligence, which generates functional blocks through various logical circuits to form programs and eventually systems.

Definition of AI

Firstly, as "numbers" are one of the three core elements of artificial intelligence, and they themselves are a form of material information, this is because in cloud networks, all "numbers" are information generated by attaching to matter, and their essence is a combination of "0" and "1", which belongs to the category of material information. Therefore, it is not ambiguous to call them "material information". Secondly, the "algorithm" and "computing power" of the core elements of artificial intelligence are programs written in various computer languages, which are essentially a combination of "0" and "1" and belong to the category of material information.

Again, "algorithm" and "computing power" are essentially a set of programs, consistent with the definition of "consciousness" as "forming various neural networks". This is because the ultimate results of the algorithms and computing power are reflected in the form of functionality, and the running results of neural networks are also reflected in the form of functionality. For example, when a robot detects an obstacle ahead, after big data analysis, calculation, and determination, it performs the action of lifting its foot to cross, which is the implementation of the crossing function. Similarly, the implementation of other functions such as turning, running, and emergency stopping is the ultimate manifestation of algorithms and computing power, and the collection of all these functions forms the system.

In addition, the implementation process of artificial intelligence requires energy (such as electricity), which is consistent with the definition of "energy" in "consciousness". Both must operate with energy support.

Based on the above Introduction, Comparing the Definition and Similarity of Consciousness, the Definition of Artificial Intelligence is as Follows:

Artificial Intelligence

An Entity that generates various functions through program control formed by material information under the support of energy in the computer. Energy refers to electrical energy; material information refers to information in computer hardware and software, for example: operating systems (OS) and application programs (APP), and an entity can be a unit, a functional block, a system, or a combination thereof, such as robots, language recognition systems, image recognition systems, and expert systems.

The Essence of AI

According to the definition of artificial intelligence, its essence is material information. This information includes the cloud data and underlying computers. These pieces of information depend on the matter.

Attributes of AI

Since artificial intelligence and consciousness have a high degree of similarity, they possess similar attributes.

According to the Definition of Artificial Intelligence, it has the Following Attributes

1. Materiality

Because of its essence as material information, it possesses materiality This information can also be divided into static material information and dynamic material information. The former refers to hardware and software configuration information, while the latter refers to software operation signal information (0 and 1).

2. Systematicity

The combination of various units and functions of artificial intelligence in a complete operating system clearly exhibits systematicity. For example, various AI entities.

3. Complexity

The higher the level of intelligence, the greater the amount of data required is. The development of various algorithms and computing power requires a large amount of information, resulting in complexity.

Despite the complexity of both artificial intelligence and human consciousness, there are still differences between the two. The algorithms and computing power of artificial intelligence are controlled by computer programs, whereas human consciousness is controlled by neural networks in the human brain. The lowest level of computer language in artificial intelligence can only be 0 or 1, whereas the lowest level of language in human consciousness is the "combined encoding of electrochemical signals" in the brain neurons.

Its operation is based on the transmission of information in the neurons, starting with the generation and transmission of electrical signals. The most basic unit is the action potential. The core is to convert information into computable bioelectric signal patterns through ion channels, synaptic transmission, and group activity, directly mapping physical characteristics such as stimulus intensity, temporal relationships, and spatial patterns. Obviously, the operation of neural networks (such as the generation and transmission of electrical signals) is not only a state of 0 (off) and 1 (on), but also a combination with chemical signals.

Neurons use "frequency, time, and network cooperation of electrical pulses" as their "language", which efficiently and flexibly processes relevant information to generate activities such as perception, movement, memory, and decision-making. And so far, there is no clear and reasonable definition of the basic unit of BAS, which is still a mystery. However, it can be preliminarily determined that it is an analog signal rather than a digital signal Therefore, from this perspective, the complexity of consciousness is much higher than that of artificial intelligence. This is the reason why artificial intelligence cannot replace human consciousness at present.

Besides, it does not have attributes of subjectivity and selfhood for far.

Abilit of AI

General material information has no value. However, if it is combined with a certain degree of order and complexity, its value increases significantly. For example, a pile of pebbles in the desert presents chaotic information and has no value, but if someone puts in effort (energy) to stack it into an orderly "SOS" shape, it will have a distress function and obviously has value; There is no value in a massive pile of data, but if highly ordered algorithms and powerful computing power are added, highly intelligent entities can be produced, which obviously have value.

Therefore, the development trend of artificial intelligence is to simultaneously make material information (including data and algorithm programs) more complex and orderly at the same time. The most important step in the process of orderliness is systematization; it determines the intelligence level of AI, that is, AI Ability $\propto$ Energy (E) × Complexity (C) × Orderliness (O), E: electrical energy; C: complexity of hardware and software; O: Degree of orderliness software, including their rationality, effectiveness and logicality.

There is a relationship between complexity (C) and orderliness (O). For example, the higher the complexity of AI entities, the more logical circuits need to be computed, resulting in improved computational efficiency and logic, and thus enhancing orderliness (O), and so on.

Comparison of BAS and AI

Based on the above introduction, the following conclusions can be drawn: The differences and relationship between BAS and AI are presented in Table 1.

Table 1: "Differences and relationship between BAS and AI"

Definition	Control Area	Material Information	Energy	Operating	Complexity (C)	Orderliness (O)
BAS	Human Brain	Analog signal	Bioenergy	Neural Network	High	High
AI	CPU	Digital signal	Electrical Energy	Programs	Medium	Medium

The ability of AI may be higher than BAS in certain fields, such as Go games, but overall, its complexity and orderliness have not yet reached the level of BAS, so its comprehensive ability is still inferior to BAS, unless AI focuses on extremely complex material information (hardware and software configuration) and extremely high software orderliness.

Conclusions

BAS (Consciousness)

1. **The Essence of BAS:** Is material information (static information and dynamic information);
2. **The Attributes of BAS:** Include innateness, materiality, complexity, systematicity, dynamism, individuality, subjectivity and selfhood;
3. **The Ability of BAS:** Consciousness Ability (CA) $\propto$ Energy (E) × Complexity (C) × Orderliness (O).

AI

1. **The Essence of AI:** Is material information (hardware and software).
2. **The Attributes of AI:** Include materiality, complexity, and systematicity. With the improvement of AI, "Selfhood" will gradually be reflected.
3. **The Ability of AI:** AI Ability (AA) $\propto$ Energy (E) × Complexity (C) × Orderliness (O).

The level of ability depends on the degree of utilization of the

complexity and orderliness of material information in the process of entity development. The most important step in the process of orderliness is systematization.

Comparison of BAS and AI for Complexity (C) and Orderliness (O)

So far, the complexity (C) and orderliness (O) of BAS are higher than those of AI. In short, the birth and development of humanity are based on information and strengthened by information, including artificial intelligence.

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