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Life and Plato's One

Kazuhiko Kotani

Department of Psychiatry, Iryo Hojin Soshindo Sakamoto Hospital, Higashiosaka, Osaka, Japan
Email: kotanikazuhiko@gmail.com

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Abstract

Plato's concept of "One" is a fundamental philosophical idea characterized by indivisibility, invariability, and equality. This paper explores the relationship between Plato's One and modern scientific disciplines, including digital information theory, biology, and neuroscience. Firstly, the paper examines how numerical representation and digital data processing reflect the properties of Plato's One. Secondly, the paper extends this discussion to biological systems, arguing that life exhibits the characteristics of Plato's One through natural selection. Thirdly, the paper examines how natural selection gives highly conserved DNA bases properties close to Plato's One. Finally, the paper analyzes how neural activity, specifically action potentials, aligns with the properties of Plato's One and serves as the foundation for neural activity. By integrating insights from philosophy, evolutionary biology, and cognitive neuroscience, this study proposes that Plato's One is not merely a metaphysical abstraction but an intrinsic principle underlying information processing, life, and cognition. The implications of this perspective suggest a deep structural connection between classical philosophical thought and contemporary scientific understanding. In conclusion, this paper provides the concept of Plato's One as a common ground for philosophy, mathematics, information science, biology, and neuroscience.

Keywords

Plato's One, Digital Information, Natural Selection, Numerical Cognition, Action Potential, Anamnesis

1. Introduction

We live in the computer age, where computers digitize and process all information. What is important is to note that computers can only manage digital information. Digital data is discrete data; mathematically, digital information consists of data constructed from natural numbers. While the concept of natural numbers is familiar to everyone, we might wonder where natural numbers came from and why everyone inherently understands this concept.

The ancient Greeks thought most deeply about this question. Among them, Plato particularly deeply contemplated the number one, the fundamental building block of natural numbers, and documented its properties in detail. Plato describes the three fundamental properties of the one as follows: the one is equal, invariable, and indivisible (Plato, 2007b: 526a). Let us call the ideal one with these three fundamental properties Plato's One. However, since Plato talks about an ideal one, nothing in reality perfectly meets these three conditions. Therefore, we can only say that what exists is similar to Plato's One.

Next, let us take examples of how one is used: one person, one object, one event, one movement, one revolution, one time, and one concept. As shown in the examples, one can be abstracted from any concept. Thus, the pure one itself has no specific physical or sensory properties. So Plato says that Plato's One can only be conceived by thought and has no sensible property. Then Plato's One cannot be written or pronounced. Thus, pure numbers are an abstract concept, and there are difficulties for the average person to handle. Numerals and number names were created to make numbers accessible to everyone. Therefore, we use number names and numerals to correspond to pure numbers. Number words and numerals are the verbalization of numbers, which makes numbers easier to handle. So, language is the foundation of human civilization.

Next, human civilization is thought to have begun with the use of language. Notably, authentic civilizations used letters. Then, we compare them to Plato's One, using the alphabet as an example. Firstly, "A" is indivisible. Secondly, "A" is invariable. Thirdly, "A" equals "A". The difference between Plato's One and the alphabet is that there are 26 letters, and one type of letter only equals the same type of letter. In addition, any writing system, whether hieroglyphic or phonetic, consists of a finite number of characters. Furthermore, various letters of different civilizations have common characteristics. Firstly, a writing system consists of a finite number of characters. Secondly, a character is indivisible, invariable, and equal to the same character. The same applies when representing text on a computer, where 0 and 1 are two different characters.

Next, Shannon was the first to analyze the alphabet as digital information, and Shannon defined the bit as a unit of information (Shannon, 1948). Shannon's work marked the beginning of the modern information age. Nowadays, not only text but all information, including images and music, is expressed using the two characters 0 and 1. For example, the alphabet "A" has an ASCII code of 41 in hexadecimal, which is easier for humans to understand than binary numbers. Furthermore, many characters of many languages are encoded by Unicode.

Next, digital information corresponds to natural numbers, and natural numbers are a collection of Plato's Ones, with a natural number having the properties of being Plato's One. So, Plato's One is the base of digital information.

Why was Plato, an ancient Greek philosopher, able to develop such profound ideas? The key clues to this question can be found in Plato's writings. In *Phaedo* and *Meno*, Socrates presents the theory of anamnesis (Plato, 2007a: 72e-78b; Plato, 2021: 81b-81d). Let us consider the concept of equality: when we look at physical objects that we can perceive with our senses, there are no two perfectly equal things. Since the concept of equality cannot be learned through sensory experience, it must be innate. Similarly, since Plato's One has no sensory property, Plato's One must be an innate concept.

When viewed from the perspective of modern biology, innate concepts are understood as concepts that are genetically encoded in the brain's structure. This hypothesis is corroborated by a substantial body of recent research demonstrating mathematical capabilities in babies, infants, and non-human animals (Dehaene, 2011: pp. 3-52; Butterworth, 2022). Moreover, research has demonstrated mathematical capabilities in plants, extending this phenomenon into the plant kingdom (Devlin, 2005: pp. 100-112).

The presence of mathematical capabilities across such a broad spectrum of living organisms suggests, from an evolutionary standpoint, that numerical cognition may be intrinsically linked to the fundamental nature of life. Let us consider bacteria, which represent primitive forms of life. Most fundamentally, bacteria can be enumerated using natural numbers: one bacterium, two bacteria, etc. Furthermore, one bacterium always splits into two, and bacterial conjugation occurs one-to-one. In this way, natural numbers are related to the foundation of life and natural numbers are constructed from Plato's One. Therefore, we will continue to examine the relationship between life and Plato's One (Kotani, 2017).

2. Plato's One as the Target of Natural Selection

The most fundamental fact is that life is countable using natural numbers. In the case of human beings, we are one person from birth to death and do not change into another person. Nor can one human being be divided into two human beings. Similarly, many living organisms are countable, so the individual appears to be the unit of life. However, multicellular organisms are composed of many cells, which are indivisible because dividing a cell causes the death of the cell. Furthermore, in unicellular organisms, one cell is one life. Also, in the case of human beings, organs can be taken from a dead body, and the organs can be kept alive and transplanted into another human being. Organ transplantation is possible because the individual cells that make up the organ are alive. Therefore, the cell is the smallest unit in any living organism.

Subsequently, we compare the cell with Plato's One. Since, as noted above, the cell is indivisible, we consider whether the cell is invariable and equal. Dawkins says living organisms are vehicles for genes (Dawkins, 2006). If we accept Dawkins' view, we can regard the difference in life as the difference between genes and gene products. From an evolutionary perspective, all living organisms on earth can be considered descendants of a single unicellular organism called the last universal common ancestor (Woese, 1998). Therefore, we can regard all cell vehicles for genes as indivisible, invariable, and equal. That is, the cell has the characteristics of Plato's One.

Next, let us consider why the human being, a collection of many cells, has properties as Plato's One, and each cell has properties as Plato's One. Consider Dawkins' claim that living organisms are vehicles for genes to address this question. Dawkins' claim means that the vehicle is subject to natural selection because Dawkins proposed the evolution of selfish genes by natural selection in living organisms. The individual multicellular organism is subject to natural selection, so when an organism dies, one individual dies, and when organisms multiply, countable individuals multiply. Therefore, individuals are subject to natural selection and have the properties of Plato's One. Furthermore, an individual is composed of many cells, and each cell has properties of Plato's One. This relationship is isomorphic to the relationship between Plato's One and the natural numbers, a collection of Plato's Ones.

Next, consider the beehive. While individual honeybees are subject to natural selection, the entire hive is also subject to natural selection as a colony. Only the queen bee has reproductive ability in a beehive, and the worker bees desperately protect the queen bee. If the queen bee dies, the worker bees rush to raise a new queen bee from the larvae. Therefore, only the queen bee has reproductive capability, making the beehive subject to natural selection. Therefore, cells, individuals, which are collections of cells, and populations of individuals are all subject to natural selection. The subject of natural selection is a whole entity; the entire entity must die when it dies. Here, let us reconsider Dawkins' term "gene vehicle." Despite the existence of very different vehicles, they are all products of genes: cells, multicellular organisms, and populations of individuals.

A recent experiment supporting the above claim is Venter's experiments with artificial bacteria (Gibson et al., 2010). In this experiment, the entire DNA of natural bacteria is replaced with artificial DNA. When bacteria with only artificial DNA from this experiment are cultured for 30 generations, the original natural bacterial components are diluted a billion times. The authors argue that the bacteria after 30 generations can be called artificial bacteria because they are composed almost entirely of artificial gene products. If we accept their claims, then the physical substance of life is genes and gene products.

Next, the plant pathogen viroid is the RNA molecule subject to natural selection (Lostroh, 2019: p. 423). Even though viroids are naked RNA molecules, they also evolve by natural selection and mutation. In the case of viroids, the genes themselves serve as the vehicles for the genes. As mentioned, there are many different genetic vehicles: the genes themselves, cells, individuals, which are collections of cells, and populations of individuals. However, their common feature is that they have the properties of Plato's One.

3. Natural Selection Preserves Genetic Information

According to the second law of thermodynamics, entropy tends to increase in a closed system. This principle might suggest that genetic information in living organisms should gradually degrade with each replication. However, natural selection acts as a powerful counterforce. Natural selection effectively removes this ‘disordered’ genetic information from the gene pool by eliminating individuals with genes detrimental to survival. The death of these individuals is an irreversible process, preventing the return of these disadvantageous genes. This irreversibility allows natural selection to maintain and even increase the order and complexity of genetic information within a population despite the general tendency toward increasing entropy (Kotani, 2019).

Darwin stated that a prerequisite for evolution is that the population of living organisms grows exponentially (Darwin, 2019: pp. 55-72). However, the number of living organisms remains within a specific range. Thus, natural selection eliminates many individuals through death. Many mutations are detrimental to survival, so natural selection removes many mutants. Consider what would happen if natural selection did not exist. Since a perfectly accurate copy is impossible, information is inevitably lost if it is copied multiple times. If the accuracy of the copy is r and the number of copies is n, then Equation (1) holds since r is less than 1.

$$\lim_{n\to\infty} r^n = 0\left(r<1\right) \tag{1}$$

Therefore, genetic information would be lost without natural selection, and life would become extinct.

Next, consider the case where genetic information is copied perfectly. In the case of genes essential for survival, all mutations are lethal, and all mutants die. Since miscopies are eliminated, r equals 1, and Equation (2) holds.

$$\lim_{n\to\infty} r^n = 1\left(r=1\right) \tag{2}$$

Equation (2) holds for genes critical for survival. In a famous example, the amino acid sequence of the eukaryotic nucleoprotein Histone H4 differs only 2 out of 104 between cow and pea (DeLange et al., 1969). In this example, the amino acid sequence is tightly conserved because most mutations in the amino acid sequence are lethal. Another example is the base sequence of ribosomal RNA genes, which serves as the basis for domain classification because it is conserved in all three domains of life (Woese, 1998; Alberts et al., 2002a: pp. 13-28). Therefore, for genes that are important for survival, natural selection acts to preserve the amino acid or base sequence.

As noted above, the amino acid and nucleotide sequences of genes necessary for survival are robustly conserved. Conserved amino acid residues and bases have properties similar to Plato’s One. Subsequently, we will examine the three properties of Plato’s One for conserved DNA bases of ribosomal RNA. Firstly, Plato’s One is indivisible. Indeed, the conserved DNA bases of ribosomal RNA are indivisible. Secondly, Plato’s One is invariable. The conserved DNA bases of ribosomal RNA predate the division of organisms into three domains. They have been invariable for a very long time in the history of living organisms. Thirdly, Plato’s

One is equal to each other. Thus, adenine equals adenine, thymine equals thymine, guanine equals guanine, and cytosine equals cytosine.

Next, we consider fibrinopeptides not subject to natural selection (Alberts et al., 2002b: pp. 235-238). Fibrinopeptides are discarded when fibrinogen is activated to form fibrin during blood clotting. Thus, natural selection tolerates any amino acid sequence of the fibrinopeptide. As a result, the amino acid sequences of fibrinopeptides vary randomly. Most proteins are intermediate between the highly conserved histone H4 and the rapidly changing fibrinopeptides. The rate of change in the amino acid sequences of many proteins was examined, and it was found that the amino acid sequences of proteins that are more important for survival are more conserved. Furthermore, many amino acid sequence mutations were found to be deleterious. These facts led to the idea of the neutral theory of molecular evolution (Kimura, 1968). Most tolerated mutations are evolutionarily neutral and do not affect the survival rate of individuals. Finally, advantageous mutations for survival are very rare, but if a beneficial mutation occurs in a certain gene, the previous gene becomes deleterious, and evolution occurs.

Next, we consider the relationship between information and energy. Schrödinger states that living organisms maintain order (Schrödinger, 1992: pp. 67-68); they need information and energy to maintain order. Human civilization similarly maintains order using information and energy, so let us consider the automobile as an example. Raw materials are transported and processed using energy to make car parts, and finally, the car is built using energy based on the blueprint. Cars can break down or be destroyed in accidents, but they can be repaired using auto parts and energy. Subsequently, consider living organisms. Most living organisms get energy from food, and photosynthetic plants get energy from sunlight. The blueprint of living organisms is written in DNA, so living organisms read it and use energy to synthesize proteins. When proteins break down or become old and degraded, living organisms use energy to make new proteins based on the blueprints in their DNA. As mentioned above, living organisms use energy and information to maintain order.

Furthermore, maintaining order by life does not contradict the second law of thermodynamics (Avery, 2021: pp. 139-143). Gibbs free energy is used in biology. Gibbs free energy G is defined by Equation (3), where H is enthalpy, T is temperature, and S is entropy.

$$G = H - TS \tag{3}$$

At constant temperature and pressure, the reaction proceeds to minimize the system's Gibbs free energy. Therefore, order can be maintained by supplying Gibbs free energy. For example, putting hot water and ice in an insulated container becomes lukewarm water. Suppose you know the weight and temperature of the original hot water and ice and have energy at your disposal. In that case, you can use a refrigerator and electric kettle to regenerate hot water and ice of the same original temperature and weight. Therefore, using information and energy to maintain order does not contradict the second law of thermodynamics.

Schrödinger said that life resists the increase of entropy (Schrödinger, 1992: pp. 68-69). Indeed, life, which is based on cells, uses Gibbs free energy to prevent the increase of entropy. However, the virus and viroid lack the ability for energy metabolism and cannot resist the increase of entropy. Therefore, these self-replicators are not included in life. However, there is also the replicator-centric view of Dawkins, so it is unclear how we will view life in the future.

4. Discussion

In this paper, we have discussed the relationship between Plato's One and life, and for a better understanding, we will discuss Socrates' anamnesis from the perspective of modern science. As the introduction mentions, Plato's One does not have a sensory nature. Since all human perception is sensory-based, Plato's One must be an innate concept rather than an external input. Furthermore, as mentioned so far, since life itself has the nature of Plato's One, Plato's One must be deeply embedded in the nervous system. Then, the neuron's action potential is common to the nervous system and has properties similar to Plato's One. As described below, the action potentials of neurons are indivisible, invariable, equal, and have no sensory properties. The characteristic of the action potential is universality, so sensory signals such as vision, hearing, smell, pain, and temperature, as well as motor commands that cause muscles to contract, are all transmitted by the action potential.

Research on number perception in animals has advanced, and action potentials of nerve cells that respond specifically to numbers have been found in monkeys (Nieder, Freedman, & Miller, 2002; Sawamura, Shima, & Tanji, 2002). Thus, the basis of the number perception of animals is the action potential. So, the action potential is behind the numerical perception of animals, but it is invisible. Similarly, we are unaware that action potentials are behind our everyday perceptions. Also, when we watch videos, listen to music, or look at images on a computer, we do not notice the 0s and 1s behind them. However, there are action potentials behind our spinal reflexes, which will be discussed with an example.

Let us consider the spinal reflex, the flexion-withdrawal reflex, in which a limb is quickly withdrawn from a painful stimulus. The reaction increases with the degree of stimulation. Kandel's textbook states (Kandel, Schwartz, & Jessell, 2021: pp. 1646-1647): "Touching a stove that is slightly hot may produce moderately fast withdrawal only at the wrist and elbow, whereas touching a very hot stove invariably leads to a forceful contraction at all joints, leading to rapid withdrawal of the entire limb." In flexion-withdrawal reflexes, the intensity of noxious stimuli is converted into the strength and range of muscle contractions. A certain proportional relationship exists between muscle contractions and noxious stimuli, which are entirely different in nature.

The flexion-withdrawal reflex described above is a reaction that protects the body from noxious stimuli. Therefore, the stronger the noxious stimuli, the stronger and larger the range of muscle contraction. Because action potentials mediate the reflex, there is a certain proportionality between muscle contraction and noxious stimuli. The same is true for judgments made by the cerebrum: if an ape spots a lion, it will run away as fast as it can. In this case, the degree of danger is proportional to the escape speed. If an ape finds its favorite food, it will hurry to eat it. In this case, the deliciousness of the food is proportional to the speed at which the ape goes to eat. In these two examples, the input is a visual stimulus, and the output is a muscle contraction. Harmful and beneficial stimuli cause behavior to move in opposite directions, and there is a certain proportional relationship between the strength of the stimuli and muscle contraction. Thus, in these two cases, action potentials seem to mediate stimulation and behavior.

Next, we consider the activity of neurons until the monkey finds and takes the fruit. First, information from the retina travels through the optic nerve to the primary visual cortex. Second, information from the primary visual cortex splits into two pathways: the ventral pathway and the dorsal pathway. The ventral pathway goes to the temporal lobe for object recognition, and the dorsal pathway goes to the parietal lobe for spatial recognition. Thus, monkeys first recognize fruits using the ventral pathway and then identify their location using the dorsal pathway. Finally, the monkey uses this visual information to pick up and eat the fruit. During this process, information is transmitted via action potentials, and visual information is converted into motor commands. The universal nature of action potentials enables the conversion.

So far, we have discussed latent numbers in animal nervous systems. Subsequently, let us consider human studies where action potentials lead to explicit numbers. Quiroga studied the action potentials of neurons in the medial temporal lobe that respond to various images in eight epilepsy patients (Quiroga et al., 2005). The results showed that the human medial temporal lobe contains neurons that respond to specific people, specific landmarks, and specific objects. For example, the neuron that responded to a particular person responded to the person viewed from different angles, to the person's drawing, and to the letters of the person's name. The results indicate that there are neurons that respond to specific persons. So Quiroga says, "Our data are compatible with an abstract representation of the identity of the individual." The action potentials of the neurons corresponding to a particular person would represent a person.

Furthermore, Quiroga has shown that neurons that respond to individuals also respond to names in speech and text (Quiroga et al., 2009). The important point is that the cells that respond to individuals react to names. Verbalization of names means that individuals are explicitly identified.

Next, by comparing humans and monkeys, let us consider facial recognition, which is very important for human recognition. Many previous studies have established that the face-processing systems of humans and macaques are homologous based on two criteria: anatomical location and functional specialization (Freiwald, Duchaine, & Yovel, 2016). Since both humans and macaques are social animals, their facial recognition systems are excellent at recognizing familiar faces and identifying close individuals. However, at least in macaques, the face processing system identifies individuals but is nonverbal and implicit. Even in humans, facial recognition is thought to be nonverbal and implicit. Therefore, this facial recognition system has limitations compared to linguistic, explicit systems. For example, the system is inaccurate for unfamiliar faces, and eyewitness testimony of a crime perpetrator is often unclear, sometimes leading to miscarriages of justice. The testimony's credibility increases significantly if the witness hears the criminal's name. Thus, an explicit system that includes language is more effective than the face recognition system common to monkeys and humans for person recognition. The linguistic explicit recognition system can also recognize many things other than humans. Therefore, linguistic and explicit recognition systems can recognize humans, animals, objects, and landmarks as one thing. This system is the basis for human linguistically explicit number recognition.

Language gradually led to civilization, which fostered philosophy, culminating in Plato's One in ancient Greece. Next, let us consider the relationship between Plato's One and the action potential. Plato's One is idealized, so it has no physical substance. The trouble is, if Plato's One has no physical substance, it cannot interact with the real world. To solve this problem, we assume that the ancient Greeks did not know about physical entities without sensory properties. Then, the ancient Greeks had no idea that our thoughts have a physical entity called an action potential. So, abstract concepts take on a physical form when we think in the brain. Also, a computer's electrical signal is closer to Plato's One than an action potential but has a physical substance. The ancient Greeks thought so profoundly about thought, cognition, sensation, and movement that they may have discovered something like Plato's One behind all human activity. However, they probably did not know about physical entities without sensory properties.

Next, to consider the relationship between action potentials and genetics, let us consider the egg-laying of digger wasps from Souvenirs Entomologies (Fabre, 1917: pp. 106-112). During the egg-laying season, a digger wasp digs a burrow. Subsequently, she finds a cricket and paralyzes it after a fierce struggle by sticking her poisonous stinger into three of its nerve ganglia. She then carries the paralyzed crickets into the burrow, stacks them three or four together, and lays an egg in one of them. Since crickets are alive, they do not decay, so the larvae grow by eating them. Amazingly, she knows the location of the cricket's nerve ganglia from the beginning and can sting with precision. This miracle was programmed into her DNA before she was born. Therefore, it is inevitable that the action potential has the properties of Plato's One and a discrete digital signal.

Next, the behavior of the digger wasp described above strongly supports Plato's anamnesis. From the beginning, the digger wasp knows the location of the cricket's ganglia and knows that crickets will serve as food for the digger wasp larvae. This knowledge is written into her DNA as digital information. Therefore, she knew everything before she was born. Additionally, the program is flexible. To win a fight with a cricket, she needs to see the cricket's movements, and her nervous system uses visual information to make calculations and sends appropriate commands to her muscles. Therefore, the digger wasp's nervous system is hard-wired and flexible.

This paper provides Plato's One as a common foundation for philosophy, mathematics, information science, biology, and neuroscience. However, there are many arguments against Platonism in the field of philosophy of mathematics (Linnebo, 2017). Platonism considers mathematics innate, while many opposing views regard it as a human invention. The predominant view among them is formalism, which builds mathematics from axioms and definitions in a language. However, human babies recognize numbers before language acquisition, and non-human animals without language also recognize numbers. Thus, Plato's One, the element of the natural number, predates language. Furthermore, as argued in this paper, Plato's One is a fundamental element of human cognition. Therefore, mathematics should be built on Plato's One. However, since geometry is closely related to visual cognition, I have previously reported on an attempt to construct geometry by linking Plato's One with human visual cognition (Kotani, 2020).

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

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