The Self-programming Mind

Fangfang Li
Galileo Mind Research
Liff1229@hotmail.com

Xiaojie Zhang
Chongqing Medical
and Pharmaceutical College
10802@cqmpc.edu.cn

Abstract

How the mind works is the ultimate mystery for human beings. To answer this question, one of the most significant insights is Kant's argument that we can only perceive the phenomenon but the essence of the external world. Following this idea, phenomenologists and enactivists believe that there is no ground for symbolic intermediate-level representation in the mind since symbols cannot really represent objects in the external world. In this paper, we present another intuition to understand symbols, that is, symbols represent the coupling relationships of senses and actions. In accordance with this insight, we establish a framework to interpret the mind, which we call the self-programming system. We also articulate how this system can naturally generate the concepts of time, space, and consciousness. This self-programming system is the first symbolic and programmatically implementable framework that incorporates the enactivists' idea that cognition arises through interaction between subjects and environments. Thus it may initiate a new starting point for understanding how the mind works.

Keywords: philosophy of mind, epistemology, phenomenology, enactivism, consciousness, symbolic computing.

1. Introduction

How the mind works? The first attempt at this question is too early to be traced back. We can even conjecture that, no matter in the West or the East, as long as there was civilization, there have been thinkers who tried to give replies to this question. However, no answer is eligible enough to provide a principle for practical tasks like creating a human-like intelligent agent. Or even worse, the direction toward such a goal is still obscure.

Modern researchers have studied this problem mainly following two distinctive doctrines. Some accept that mental representations consist of mental symbols representing the objective world. The internal mechanisms of the mind are just symbol-manipulations. Others are impressed by arguments suggesting subject feeling is the basis of understanding the mind. The mind is an emergent property from the complex interaction of sensorimotor. Thus, there is no intermediate-level symbolic representation needed. We propose to pursue a new proposition that the mind can be understood as a self-programming system that adopts symbols to encompass the lasting relationships between subjective senses and actions.

With this self-programming system, we interpreted the nature of causality, induction, and deduction in our previous article (Liff, 2022). In this article, we will continue to use this framework to elucidate the origin of the concepts of space and time. Moreover, we will also address the problem of consciousness.

Among the many questions related to how the mind works, a critical one is how humans acquire and apply knowledge. Hume addressed this problem and concluded that we, as humans, cannot gain actual knowledge. We can only act by presupposing some beliefs to be true.

Inspired by Hume's conclusion, Kant arrived at one of the most influential ideas in philosophy. Kant agreed with Hume's conclusion about knowledge. Then he attributed it to our inability to access the essence of the objective world since what we can gain is the product of our cognitive processing, that is, the phenomenon of the objective world. Furthermore, Kant argued that there must be prior knowledge about organizing these perceived phenomena, that is, the a priori form of sense. Such a priori form includes space, time, and causality. (Kant, 2003; Pinker, 2007)

Based on Kant’s argument, Husserl advanced one more step. If the essences of anything are not accessible, he argued, there is no reason to presuppose their existence. We should not view the judgment of existence as the first step for understanding cognition but focus on the only thing we can know, that is, the phenomena. This methodological attitude is called phenomenology.

Inspired by phenomenology, modern cognitive science developed a new branch which is called enactivism (Varela, Thompson and Rosch, 1991; Gallagher & Zahavi, 2008). The core idea of enactivism is that cognition is emergent from a complex dynamic between the subject’s sensorimotor and environment. Enactivists believe that our mind is not a system with a top-down design as early symbolic artificial intelligence scientists presupposed, but an autonomous system that is ubiquitous in nature.

Both phenomenology and enactivism emphasis there is no symbolic intermediate level representation. As Husserl noted:

> *"…, it forgets to ask how the subject is supposed to know that the representations are in fact representations of external objects."*(P96. Zahavi, 2007)

Or as Varela, Thompson and Rosch noted:

> *"…, symbolic computation might come to be regarded as only a narrow, highly specialized form of cognition."(P103, Varela, Thompson and Rosch, 1991)*

These arguments pointed out two key reasons why phenomenologists' don't believe symbolic representations play fundamental roles in cognition. The first says that there is no way to confirm a symbol indeed represents an external object that it is supposed to represent. The second says symbolic representation is not of universal benefit to cognition. Thus it is unreasonable to assume such a general intermediate-level representation.

From Kant's idea (we can only access phenomena) to phenomenologists' idea (we should study the mind begin with phenomena), and then to enactivists' idea (the mind is emergent from an autonomous system), we can see an increasingly clear path to understanding the mind from the perspective of subjective perception. Although the self-programming systems agree with these primary ideas along this path, we have to cast doubt on two relatively minor ones.

1) *Is it tenable to regard space and time the a priori form of sense?*
2) *Does cognition really not require intermediate-level symbolic representations?*

Alternative replies to these two questions will lead to distinct methodologies for practical tasks, like establishing cognitive architecture.

Specifically, the meaning that space and time are the a priori form of sense, Kant noted, is that our senses can only be depicted under a framework containing time and space. This argument implies, if we want to build a body scheme to represent the sensorimotor of the body, it must be in a 3D space framework. If time and space are not the a priori form, there could be representations of sense that don't depend on time and space. For example, they may solely rely on the relationship between senses. Whether there is a symbolic intermediate-level representation will also impact practical matters significantly. We can see this from the fundamental discrepancy between symbol-based models in the early age of AI research and deep learning models nowadays. Therefore, it is practical significance to discuss whether these two viewpoints are valid.

Let's begin with the first doubt. We argue that viewing time and space as a priori forms contradicts the inability to recognize the essence of the world logically. Specifically, if time and space are the a priori forms, a naturally following question is why these a priori forms are always the applicable depiction of senses. The answer to this question can only be that some processes, such as evolution, enable the subject to grasp the essence of the world, at least to a certain extent.

However, this process can always be simulated by some methods in theory, so this simulation process can also explore the essence of the world. This contradicts the inability of humans to access such an essence.

Then, do all a priori forms lead to such a contradiction? The answer is no. Some a priori forms don't depend on a grasp of the essence of the world but on the nature of perceived phenomena. Then it does not violate the basic assumption that humans cannot access the essence of objects. For example, causality is such an a priori form since it is a manifestation of the property that the phenomena we perceive may repeat under some conditions (Li, 2022).

If time and space are not the a priori forms, how do a subject can gain these concepts? In the self-programming system, time and space are the same as the concept of other objects. They also represent the relationships between senses and actions. We will discuss this issue in detail in section 3. Now let's turn to our second doubt – "do intermediate-level symbols superfluous in cognition"?

From Husserl and Varela, Thompson and Rosch's notes, we can see that the objection to symbolic manipulation has two different reasons:

1) *No way to determine whether a symbol can represent an object.*
2) *The mechanism of mind will not be beneficial from existing such a universal symbolic representation.*

Let's look at the first reason. From Husserl's note: "how the subject is supposed to know that the representations are in fact representations of external objects", we can see that his doubt on symbolic representation is on the validity of the relationship between internal representation and external objects. But this objection does not apply to the usage of symbols that represent relations between perceived phenomena.

Think about such a situation. When the subject can only perceive her own senses and actions and she uses internal symbols to represent the relationships between these perceptions, the subject is actually unnecessary to know whether these symbols can represent any external objects. This is because, once these relationships are correct, the subject can act direct base on them rather than on any external objects. For example, when we see the appearance of our favorite food, we can deduce the action that can let us enjoy the taste. In this case, the symbol of our favorite food just represents this relationship for reasoning rather than any objective existence.

One may think these two interpretations of symbols are just technical subtlety. However, we will see that its impact is philosophically and pragmatically far-reaching.

From the philosophical perspective, the former relies on the assumption that there exists a dividable external world, and these symbols in mind are just references to these components that are objectively divided. The latter believes symbols represent the relationships between subjects' senses and actions. Thus it only assumes that there exist discoverable relationships between the senses and actions. This belief also implies that some related senses and actions will be organized together to form the meaning of a symbol and other unrelated senses and actions will be excluded. So, to a symbol, there is a boundary between these relevant and irrelevant factors.

Following this idea, the objective world is nothing but an assumption of the cause of these senses. It is the boundaries of symbols that cleave this assumed objective world into objects.

These two views give rise to two completely distinctive processes for establishing and using symbols. For establishing, since the former assumes the existence of external objects that do not depend on the mind, the purpose of observation is to passively receive information about these objects. For the latter, the purpose of observation is to distinguish what factors are interdependent and what factors are irrelevant, so it should be a process of active exploration based on previous experience. This idea of active exploration is consistent with enactive cognition. (Gallagher, 2020)

From using symbols, since the former idea believes symbols are only used as representations of external things, they do not contain inferential relations. All inferential relations are expressed as explicit rules. This implies the use of a symbol needs to comply with the rules associated with it. Meanwhile, since the system composed of these symbols and associated rules is only an expression of the objective world, these relationships do not include sensations of the subject. So the subject cannot deduce a consequent sensation just based on this system. To the latter, symbols themselves are the containers of inferential relations. So one can reason solely based on these symbols. Moreover, since these symbols are based on subjects' senses and actions, one can directly deduce how to achieve sensation based on these symbols.

From our discussion above, we can see that, although both the former idea and the latter idea advocate symbol manipulation, they have very different implications.

Now, let's turn to the second criticism - universal intermediate-level symbolic representation is unnecessary. Enactivists may argue if the purpose is merely organizing senses and actions, viewing cognition as an emergent property arising from complex interactions between environment and subjects, which is similar to the process of autopoiesis, can still play this role. Accordingly, universal symbol representation has no ground to exist.

However, our analysis of the self-programming system below will show that the function of symbols is to unify the senses from different sensations and thinking processes into a unique form of representation. This unification will allow the subject to learn not only the external objects, but also her own learning mechanism. Once the subject acquires this knowledge, she can improve her observation for better learning.

To sum up, the distinctions between traditional symbolism, enactive cognition, and the self-programming mind can be summarized as the answer to the following two questions:

What is the basis of cognition? Are symbols used?

> ***Traditional symbolism****: The basis of cognition is the external objective world. Symbols are used to represent objects in this world.*

Enactive cognition: The basis of cognition is sensorimotor. Cognition is an emergent property of self-organization, so no symbolic representation is needed.

***Self-programming mind**: The basis of cognition is extended sensorimotor, which includes both the senses and actions of external objects and internal processes. The symbols are needed to represent the relationships between these senses and actions.*

Attributed to such distinctions, the self-programming system can be viewed as a product of accepting the main idea from Kant and phenomenology but abandoning these two doubtful assumptions (space and time are a priori forms; no symbolic intermediate-level representation). How does a system following such assumptions works? What problems can it solve? We will address the first questions in section 2. Then, we will introduce the origins of the concepts of space and time in section 3 and the nature of consciousness in section 4.

2. The Primary Ideas of the Self-programming System

In this section, we will articulate how the self-programming system works. Specifically, we will divide the following content into three parts:

1) Define the components of this framework.
2) Explain the runtime procedure of the self-programming system.
3) Introduce its learning mechanism.

2.1 Basic operations and Basic senses

We first introduce the basic elements composed of Basic Operations (BOs) and Basic Senses (BSs). In the general-purpose computer, basic elements are predefined symbols in the computer's language, like logical operations, mathematical operations, numbers, identifiers, etc. But in our framework, basic elements have completely different meanings.

Specifically, both BOs and BSs refer to certain signals can be send and receive by peripherals. These peripherals can refer to a certain part of the body, or they can refer to a module in the brain, such as a module that generates emotions.

So what are the BOs and BSs that peripherals provide? Generally speaking, since the functions of each peripheral are different, the BOs and BSs provided by each peripheral are also different. For the eyes, a BO can be rotation, positioning, focusing, and so on. A BS of the eye can be certain color blocks or a specific shape. For limbs, a BO can be some kind of rotation or movement. A BE can be moving to a certain angle or some tactile signal and so on.

There are three points in this setting need to be emphasized. First, both BOs and BSs can be viewed as symbols. These symbols accompany by a look-up table to indicate signals from the most basic neural network, like shape detection, edge detection, etc. The advantage of this setting is that the form of the schemas organizing these basic symbols is independent of the specific existence of the components of the brain and body that provide these symbols. Thus, it enables functions from various sensations can be expressed uniformly. In this sense, the self-programming system indeed establishes a schema composed of symbols that can depict relationships between all sensations.

Second, applications of this schema don't need knowledge about the lookup table. One may doubt this conclusion by arguing: if you don't interpret the internal representations by virtue of the lookup table, how can you know the true phenomenon happened in the objective world? In fact, the reason for this question is that it is presupposed to seek objective truth from the perspective of a third party. But, in fact, the mind does not need such conversion, because phenomena and the relationships between these phenomena already have been expressed internally. Thus the mind can carry out various thinking activities directly through internal expressions, such as planning, judgment, etc. In this case, objective reality is not a necessary factor for the functioning of the mind. This feature further implies the robustness of the self-programming system against the disturbance of the look-up table, since changes in the look-up table will lead to corresponding modifications of the schema.

Such independence is also applicable to time and space. This means all these relationships are only based on basic elements from senses and actions. No objective time and space context are presumed in this system. This view is different from the current mainstream building of schema. Specifically, the mainstream representations of schemas are relying on the form of the existence of these components. For example, body schemas are encoded in 3D space (Morasso et al., 2015; Macaluso & Maravita, 2010).

Third, a basic element does not necessarily correspond to a unique stimulus. A particular stimulus may correspond to a set of them. For example, one BS may represent a circular area that appears on the retina, while another BS represents the size of the area on the retina. Neither of these two symbols, respectively, can identify any unique retinal stimulus. But the combination of them can correspond to this stimulus.

2.2 Storage Object, Property, Operation and the Storage system

In the next, we will first define four fundamental concepts and then make further analysis on this basis:

Storage object: The intuition of the storage object is the unit to store the relationships between senses and actions. Technically, it is composed of a set of properties.

Property: Properties need to play two roles. The first is to determine whether a bunch of stimuli from the external or internal is enough to locate an existing storage object that contains these properties. The second is that, once a particular storage object is located, these properties in this storage object can predict the outcomes of placing certain operations on the origins of the stimulus that triggered this storage object. Technically, a property is composed of

1) Storage objects or BSs;

2) Operations or BOs that connect these units in 1).

In this sense, properties are both the locators and the instructional manual of an object.

Operations: a sequence of other operations or BOs that can be executed under specific conditions; these specific conditions refer to properties that the storage object associates with this operation must have.

Storage system: It consists of two parts, one is a collection of all storage objects, and the other is some specific operations that can retrieve and compare information stored in this storage system.

At first glance, the above definition seems to have a circular definition problem. However, if we think in terms of construction, the above definition is logically clear. The reason is that these definitions can be built up step by step starting from basic elements. Specifically, the combination of BOs and BSs is sufficient to construct a sequence of operations and their results. Thereby, properties are constructed. And multiple properties actually form a set of conditions, which can be combined with a sequence of other BOs to form a new operation. In other words, the conditions of an operation are actually constructed gradually in order, that is, the properties constructed first become the conditions under which the new operation can be created. The same method can also be used to construct storage objects, that is, starting from a storage object only containing a single property, and gradually defining more complex storage objects. (See Figure 1)

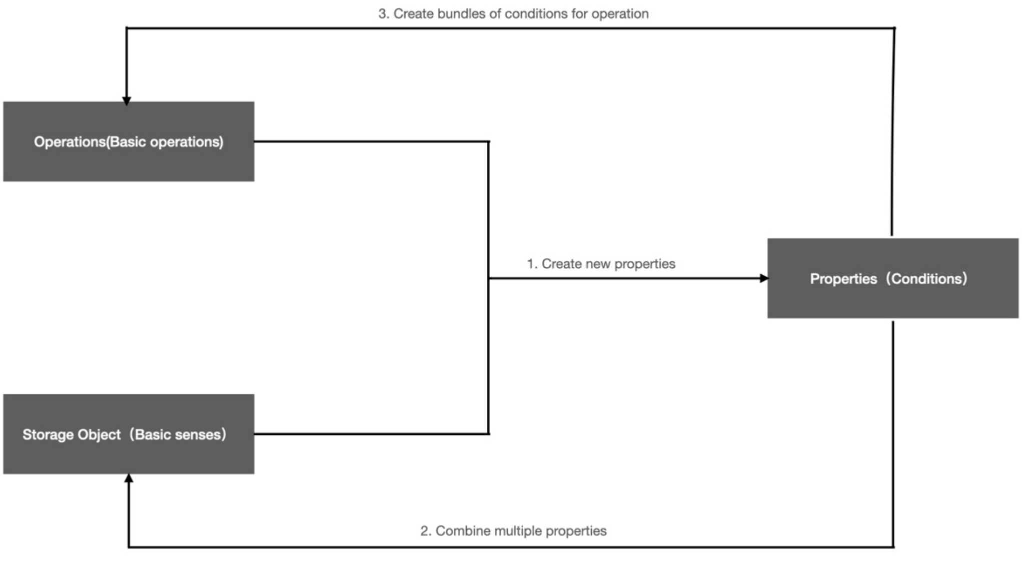

Figure 1 The relationship between operations, properties and storage object

2.3 The runtime of the self-programming system

Based on the static structure of the storage system, we can now turn to the dynamics of the self-programming system. The running of a self-programming system can be summed up in one sentence: *it is a mapping from a runtime state to an operation.* We have already talked about the definition of operation, but what is the runtime state?

The runtime state is a space that can be divided into two parts, the explicit state and the implicit state. The explicit state can contain a set of active storage objects and their relations with each other that express what is currently perceived through observation, perception, feeling, thinking, etc. For example, if someone saw a plate on the table with an apple in it, his/her explicit state will include these storage objects that represent the apple, the plate, and the table, and the network that represents the positional relationship between these three. In this case, the explicit state represented the observed state of the external world. It could also represent the current internal state, for example, the current mood or the feeling, like hunger. At the same time, in the explicit state, there is also a goal. For example, when you are hungry, the goal can be to find a way to eliminate hunger.

Then what is the implicit state? Simply speaking, the implicit state is the relationship between storage objects in the explicit state and all other storage objects in the storage system. For example, let's say the current explicit state is that there is an apple on the table as described above, and the goal is to eliminate hunger. Then the implicit state may be: all storage objects that represent apples in the storage system can eliminate hunger by "eating it" (state 1); it could also be: there are some storage objects that represent apples indicate that apples can eliminate hunger, but others indicated not, such as existing a storage object representing a toy apple. (state 2).

The procedure of runtime is described in Figure 2. At first, the explicit state will be compared with the storage system. This will generate relationships between the storage objects in the explicit state and that in the storage system. These relationships will be sent to the implicit state.

Then, the implicit state will trigger some particular implicit operation. This implicit operation is for finding appropriate operations, which we call explicit operations. And the implicit operation will also determine how to use these explicit operations, such as direct execution or sending to the explicit state, etc.

For example, if the implicit operation corresponding to the implicit state happens to find that there is only one explicit operation that can achieve the goal in the explicit state (as in the case of state 1 in the previous example). Then the implicit operation can choose to run this explicit operation directly.

What if the implicit operation find not a single appropriate explicit operation? In some situations, there may exist multiple ways to achieve the goal? For example, if you want to calculate 324x99, you can directly use the general multiplication method, but you can also use 324x100-324 to calculate; Similarly, there may not exist any known operations in the storage system that can achieve the goal, for example, the goals like how a light-speed spacecraft can be built. There may also exist some way that can only achieve the goal with uncertainty, such as state 2 in the previous example.

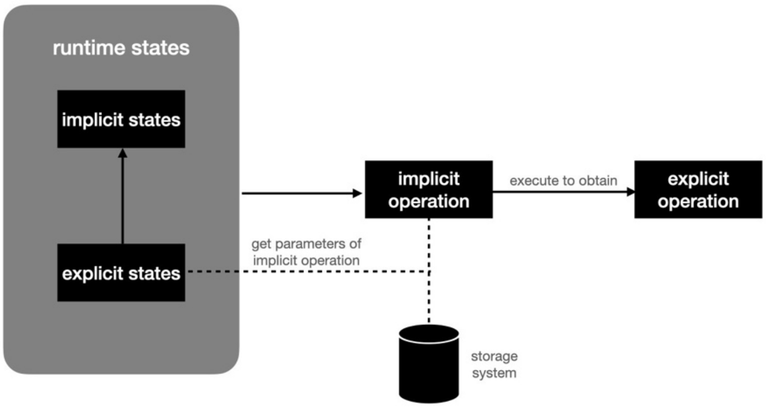

Figure 2 The procedure of runtime

In each of the above situations, there are further subdivisions. For example, in the case of State 2 mentioned above, the implicit operation may choose the explicit operation based on whether there are properties that can be easily collected and helpful for making further decisions. If such a property exists it can execute the explicit operation that can collect this property at first. Corresponding to State 2 of the previous case, it is possible to touch the apple first and decide whether to eat it.

In some cases, the state of the explicit operations discovered by the implicit operation can also be put into the explicit state for further calculations of what should be done. For example, if no possible solution is found, some attempts may be made by using the functions provided by other peripherals, such as a search that allows combining two operations together.

In cases where there are multiple explicit operations, it is also possible to put all these explicit operations into an explicit state to determine which one is more appropriate.

To sum up, the runtime of a self-programming system provides a function that maps to the execution of specific operations based on conditions and goals. This function is obtained by comparing the current runtime state with the information in the storage system. Therefore, *the whole process of locating and executing a specific operation from the runtime state can be regarded as a Basic operation (BO) provided by the storage system. Since an operation in a storage system is a composition of Basic operations, this means that the operation that invokes the runtime can actually also be a possible component of the operation that compose properties.* This allows some properties of storage objects may describing how to use the storage system. This recursive structure is the most important feature of the self-programming system.

If we analogy this point to computer programming, the storage system is equivalent to providing a dynamic mapping from function names to function implementations. This dynamic mapping allows the self-programming system can set abstract goals. Then, collecting detailed information and making subtle decisions in the processing of abstract goals.

This top-down approach is consistent with how humans accomplish specific tasks. Imaging how we make a travel plan, we may first decide on the destination city and the primary way of transportation. Then, collect the prices of hotels, taxis, and others for further decisions.

Through the study of the self-programming system, we can discover some important properties. First, a self-programming system is by no means a combination of multiple domain-specified systems. The reason is that the key to realizing a self-programming system is the relationship between the storage system and external observations, and how to operate the data in the storage system under these relationships. This is a completely abstract domain that is independent of any specific domain. No matter what domain a problem belongs to, it ultimately lies in how to manipulate the data in the storage system. This means that, for any information, as long as it can be stored, it can be processed in the same way.

On the other hand, we can see that when the runtime state triggers an operation, the operation could consist of a sequence of sub-operations that may trigger new mappings. This is a process similar to fractal problems in complex science. Therefore, solving one part of a problem is no easier than the whole problem. In other words, without a proper understanding of the storage system, even trying to solve some seemingly simple problems will lead to clueless.

2.4 Learning mechanism

As can be seen from the previous analysis, if the mapping of runtime states to implicit operations and the information in the storage system are given, the run of the self-programming system will be determined. In other words, how the self-programming system works depends on the information in the storage system and the implicit mapping. There is a naturally following question that is how the storage objects and implicit mapping are established? Or what is the learning mechanism behind them?

The problem is both simple and complex. The simple part is that if the mind keeps perceiving some procedures composed of certain phenomena and operations repeating, it can distinguish these relevant phenomena and operations against irrelevant factors to form a property. Since the properties are the content of the storage object, creating properties is equivalent to creating new storage objects.

However, an answer like this can only capture a basic functional explanation of the learning mechanism. The more important question is what decides the action of perceiving since it is the one that indeed decides what storage objects to be formed. Unfortunately, facing this question, we can only answer part of it. The other part cannot be summed up by the nature of the self-programming system.

In the self-programming system, the application of any function has two different levels, namely the spontaneous level and the purposeful level. This rule is also applicable to the learning mechanism. Its spontaneous level refers to the fact that this learning mechanism is automatically triggered during the operation of the system. The role of the learning mechanism at this spontaneous level is relatively simple and can be described. It works on at least the following three aspects.

First, the most immediate aspect is to work with explicit state at runtime. Specifically, if a certain storage object happens to be triggered at some point, its properties are loaded into the explicit state. At this time, if the same result that generated by an operation happened repeatedly, then a new property that contains the new operation and the result will be created. And this new property combines with the properties from the original object to generate a new storage object.

Second, since the runtime state not only has explicit state and explicit operations, but also has corresponding the implicit state and implicit operations, the learning mechanism works should also work on the implicit aspect. That is, building mappings from the implicit state to appropriate implicit operations. Taking the previous calculation 324x99= as an example, the implicit state is that there are multiple ways to calculate this result, and the implicit operation is to list this method into the explicit state and consider it further.

The third aspect is specializing the implicit mappings. We introduce this aspect by an example. Assume there is a problem, and both operations A and B known in the system can solve it. We know that in this case both operations A and B shall be put into the explicit state to be evaluated by a more general implicit operation. Here, we further assume that the result of the evaluation is that Operation A executes faster so Operation A is always called in more urgent situations; Operation B has a higher success rate, thus it is always called in situations with spare time. Then if these operations are called repeatedly, two new implicit mappings will be created: Calls Operation A under emergency situation. Call Operation B when there is spare time. In this way, the process of loading the implicit state into the explicit state is avoided by forming a specialized mapping, thereby reducing the computational cost.

After talking about spontaneous learning, let's turn to purposely learning. As we said before, if certain states, operations, and results occur repeatedly, then a new storage object will be generated. This newly created storage object expresses a specific function by its properties. The learning mechanism can still be viewed as a function, thus it can also be expressed by a storage object which is created by the repeat of the spontaneous learning process. The result is that a storage object that expresses the learning mechanism will exist in the storage system.

Once the above storage object is created, the self-programming system can use the learning mechanism to create new storage objects purposefully like other peripherals. In this case, the question of when to apply the learning mechanism becomes a non-summerizable question, since its application conditions are completely determined by the self-programming system itself. As we said earlier, the problem of self-programming is a fractal problem. So in this sense, summarizing it is equivalent to resummarizing the whole self-programming system.

3. Time and Space

Kant believes that time and space are a priori forms of sensation. This belief is wildly accepted by later researchers and applied to practice. One example is the mainstream approach for building body schemes we have noted before. However, in the self-programming system, we believe time and space should be the same as other symbols. They are also the product of self-programming. Then, the automatically following question is, how are they established?

3.1 Time

Under the self-programming mind assumption, the task of finding a substitute for objective time is easy. This is because any peripherals that can send signals related to time could be adopted as a timer by the self-programming system. This is to say, if the subject needs to finish an action with a fixed length of time, the signal from this peripheral could be used as the timer.

This doesn't imply that the mind has a unique timer that exactly corresponds to the objective time. Loosely speaking, any peripherals recorded in the storage system may play the role of a timer. It could be some internal timer in the brain, the count of heartbeat, or even tapping tables rhythmically with a finger (the action of tapping tables can be represented only by the degree of force put on the finger and the feeling of it colluding with the table). These timers will be used in different situations respectively. Specifically, some are used to mark a long period but only require low precision, and others are used to indicate a much shorter time but need high precision. Some timers will be severely affected by other factors, like emotion, while others can resist these affections. All in all, the self-programming system will choose the best timer for different purposes and environments.

The idea of the multiple timers also naturally interprets a common phenomenon, that is, our feeling of time is not constant but context-dependent. Sometimes we may feel that time passes quickly, such as talking to friends about a favorite topic, and sometimes we may feel that time passes slowly, such as when we run the last laps of a 10000-meter test. Or even we may use two timers simultaneously. One example is that we will not feel the music become slow when we run the last 400 meters of a 10000 meters race.

In total, our feeling of time is the product of multiple timer work incorporated together rather than the objective time. This means whether there are objective time is not significant once these timers are working as it is.

3.2 Space

In the self-programming mind theory, the origin of the feeling of space is absolutely different from that of time. To understand this, let’s imagine a robot that is designed based on the principle of the self-programming mind. One day, it records what a particular tree looks like at 100 meters distance.

(This distance can be described with the language of subjective senses. Specifically, it could be moving with a fixed effort with a sense of time, e.g. this effort is equivalent to the objective velocity of 1 meter per second; this sense of time is equivalent to the 100 seconds of objective time.) And it also recorded what this tree was like at a distance of 50 meters. If the perceptions of this tree at different distances have no relation, the robot cannot predict what it will look like at other distances, like 20 meters or 60 meters. But if the robot can find out that these two perceptions only differed in size. Then it can figure out there are linear relationships between the size feeling of the tree and the distance.

As we introduced in section 2, since these comparisons of sizes and distances are the relation between two storage objects, they will manifest in the implicit state. This implies the implicit operation can calculate what the sense of the tree will be like at other distances.

Following the idea of the self-programming mind, we know that a symbol represents the relationship between senses and actions. Thus we conclude that space is the symbol that represents such visual linear couplings, like the linear relationship between sizes and distances.

Such linear couplings occur not only in vision but also in the feeling of temperatures, the sense of volume and frequency of sound, the tension of muscle, etc. Detecting such linear relationships and applying them for prediction is the nature of the mind.

4. Consciousness

What is the nature of consciousness? This question, like how the mind works, has haunted all intellectuals since ancient history. In this section, we will first answer this question by employing the self-programming system, then solve the well-known hard problem of consciousness by showing why we cannot figure out subjective feelings from an objective perspective.

4.1 The Nature of Consciousness

Why does consciousness so hard to be interpreted? The reason is still rooted in the common misunderstanding of symbols since consciousness is also a symbol in the mind. In fact, if we treat external objects as the basis of cognition, no consensus can be reached on this problem. Researchers' argument can be divided into the following four categories.

The first category holds the view that there is no subjective conscious experience (Rey, 1986; Dennett, 1991). However, this view is inconsistent with our experience.

The second class of view is that there exists conscious experience and it can be explained objectively. (Churchland, 1986; Crick, 1994; Koch, 2004; Hurley, 1998; Noë, 2005, 2009). The main problem with such a view is that they fail to explain that we seem capable of producing a mechanism with the same function but without consciousness.

Research in the third category acknowledges that conscious experience exists and it is not scientifically explainable. However, they believe such inexplicability is not so significant. We only need to focus on how to connect consciousness experience to physical stimuli (Block, 2002; Block and Stalnaker, 1999; Hill, 1997; Loar, 1997, 1999; Papineau, 1993, 2002; Perry, 2001). The biggest weakness of this interpretation is why the consciousness is as unusual as inexplicable.

The fourth category is dualism, that is, the world has both physical and consciousness. So it is not surprising that consciousness cannot be explained physically. This view can be traced back to Descartes. But this view is generally not accepted because it is divergent from the current scientific paradigm (Collins, 2011). Another alternative view is that although there are both physical and phenomenal objects, phenomenal experience does not have an impact on the physical world (Campbell, 1970; Jackson, 1982; Robinson, 2004). The natural question of this viewpoint is why there is such a non-necessary phenomenal experience.

However, if we transfer our standing point from objective-existence-based cognition to sensorimotor-based cognition, the nature of consciousness can be understood clearly. Next, let's analyze it from this perspective.

As we noted at the beginning of this article, symbols represent the relationships between sensorimotor. Then when we introduce how the self-programming system works, we regard these operations in the thinking process as the same as the bodies' operations. Consciousness is undoubtedly a symbol. Thus it must a representation of relationships between these Basic operations and Basic senses. The problem is just what these operations and elements exactly are.

Here, we adopt a usual definition of consciousness, which is the ability of a subject can experience objects. Since we have assumed any symbol represents couplings of senses and actions and symbols are the origins of objects, the ability to experience objects is just experiencing a bundle of senses. Since senses are by definition something for experiencing. Thus experiencing objects is not a special ability. What really distinguishes "the conscious" and "the unconscious" is whether the subject knows these senses have been triggered. In other words, the distinction is whether these triggered senses have been recorded for retrospection in the future. This will lead to the question -- what bundle of senses will be recorded?

Our answer is all storage objects have been put into the explicit state will be recorded. This conclusion can be validate both functionally and empirically.

From the functional perspective, the intention of putting a storage object into the explicit state space is to explore its relationships with other storage objects in the storage system. And using these relationships to locate and run a particular implicit operation. Such operations usually need to be placed on the storage object that triggered this implicit operation. This means that if the storage object in the explicit state is not recorded, this particular implicit operation cannot locate the target storage object. This will lead to the failure of these operations.

From the empirical evidence, various existing neuroscience-based theories about the functionality of consciousness are consistent with our ideas. (Seth and Bayne, 2022) Among these theories, Global Workspace Theory (GWT) is the most influential. It regards consciousness as a global space for information interaction. (Baars, 1988, 1997, 2002; Dehaene & Changeux, 2011; Mashour, Roelfsema, Changeux & Dehaene, 2020) The information in it will be broadcast to various subsystems, thus these subsystems can be combined to determine the optimal behavior globally.

Another influential theory is the higher-order theory (HOT). The core idea of these theories is that if some information is conscious, then it must be the information for meta-representation. (Brown, Lau, & LeDoux, 2019; Rosenthal, 2005) The meta-representation here refers to a description that is not a direct description of the world but a higher-level description that goes beyond objective facts. For example, "yesterday, the vase was broken and seriously affected my mood." In this case, the broken vase is a description of the objective world, and the whole sentence is a meta-representation beyond the objective.

In the self-programming system, storage objects in the explicit state space are for comparison with other storage objects for abstracting relationships. Such relationships are exactly meta-information. Thus our conclusion is consistent with the idea of HOTs.

And, since the storage system possesses all knowledge that the subject knows, an operation triggered by the comparison with the current environment and the storage system has already been considered in the global scope. This point is also consistent with GWTs.

In summary, we conclude that the nature of consciousness is just the action of putting storage objects into the explicit state space.

4.2 The hard problem of consciousness

Based on our previous conclusion of the nature of consciousness, we can now discuss the well-known "hard problem of consciousness". (Chamlers, 1996; Nagel, 1974; Levine, 1983, 1993, 2001) It asks why there seem to exist objectively inexplicable feelings of consciousness. We will see that this is just a matter of course based on the idea of the self-programming mind.

Let’s begin with defining several required concepts:

1) What is objective?
2) What is explanation?

To define “objective”, we need to define “self” first. In fact, we already discussed in the learning mechanism section that the reason a storage object is formed is to pack the properties of the object being perceived. Thus a storage object expresses the observed object. If the observed object is a body part, then there will be a storage object representing the body part; if the observed object is an external being, then there will be a storage object expressing the external being. So what if the object being observed is the self-programming system itself? Then the storage object formed will express all the content that appears continuously in the explicit state. Since we already know the content of the explicit state is actually a result of both implicit manipulation and external stimuli based on the body. Therefore, this storage object can represent a subject's whole experience of the mind. Thus, it expresses the subjective self.

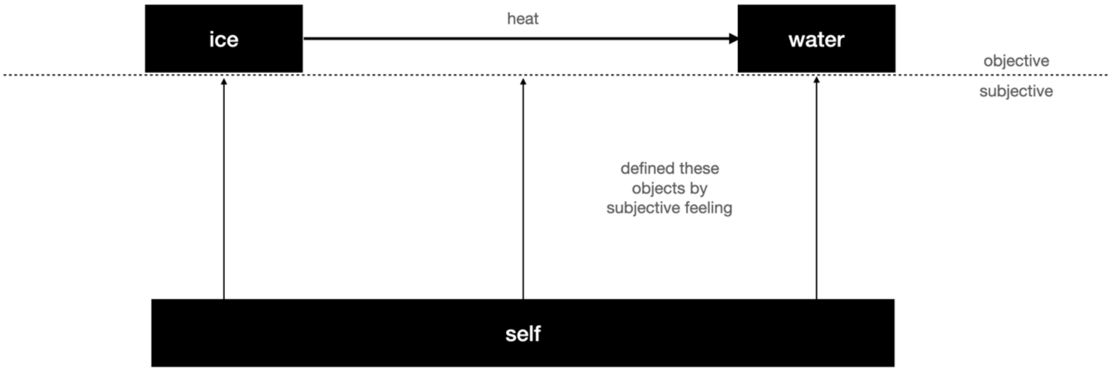

Figure 3: Take the melting of ice as an example. In this example, the objective process only includes the heat of ice, then result in water. However, ice, water, and the process of heat are defined based on the feelings of the "self", whereas the "self" does not belong to the objective world.

Combining this conclusion, we have already known that both the representations of the external world and the self are storage objects in the storage system. And they are connected by properties with each other. Since we also know the commonsense of “objective” is something irrelevant to the subject, we can naturally infer "objective" represent the remaining part after all the properties connected to the self are removed.(See figure3)

Then, let's look at the nature of interpretation. The so-called interpretation is actually that some observed properties can be deduced from other properties. These properties that are used to deduce are called basic laws. Because the objective representation of the world is what remains after removing properties associated with the self. Therefore, the basic laws of the so-called objective interpretation must be properties in the part that has no property related to the storage object of self.

However, we also know that the self is the collection of all subjective experiences. Therefore, any basic laws that can explain subjective experience necessarily require the inclusion of the subjective experience of the basic elements of the cognitive system which must be related to the self, so they cannot be contained in the basic laws of the objective part. This means that objective laws cannot be used to explain subjective experience. So, from the perspective of the self-programming mind, the inexplicability of consciousness by objective analysis is the inevitable result of the nature of consciousness.

5. Summary

We proposed a new understanding of symbols in the mind, that is, symbols are the representations of the couplings of senses and actions. Based on this idea, the mind can be interpreted as a self-programming system. This system can naturally formulate the concept of time, space, and consciousness.

In fact, if the direction of viewing the mind as a self-programming system is correct, it should be able to provide insights into almost every aspect of epistemology, cognitive science, language, and artificial intelligence. In this sense, validating this theory in various research topics is worthwhile. In particular, it may provide a way beyond weak artificial intelligence and toward human-level artificial intelligence.

Reference

1. Baars, B. J. (1988). *A Cognitive Theory of Consciousness*. Cambridge University Press.
2. Baars, B. J. (1997). In the theatre of consciousness: Global workspace theory, a rigorous scientific theory of consciousness. *Journal of Consciousness Studies, 4*(4), 292–309.
3. Baars, B. J. (2002). The conscious access hypothesis: Origins and recent evidence. *Trends in Cognitive Sciences, 6*(1), 47–52. https://doi.org/10.1016/S1364-6613(00)01819-2
4. Block, Ned (2002). The Harder Problem of Consciousness. *Journal of Philosophy* 99 (8):391.
5. Block, Ned & Stalnaker, Robert (1999). Conceptual analysis, dualism, and the explanatory gap. *Philosophical Review* 108 (1):1-46.
6. Brown, R., Lau, H., & LeDoux, J. E. (2019). Understanding the higher-order approach to consciousness. *Trends in Cognitive Sciences, 23*(9), 754–768. https://doi.org/10.1016/j.tics.2019.06.009
7. Campbell, Karlyn K. (1970). *Body and Mind*. Doubleday.
8. Chalmers, D. J. (1996). *The conscious mind: In search of a fundamental theory.* Oxford University Press.
9. Churchland, Patricia Smith (1986). *Neurophilosophy: Toward A Unified Science of the Mind-Brain*. MIT Press.
10. Collins, Robin (2011). The Energy of the Soul. In Mark C. Baker & Stewart Goetz (eds.), *The Soul Hypothesis: Investigations Into the Existence of the Soul*. Continuum Press. pp. 123-133.
11. Crick, Francis (1994). *The Astonishing Hypothesis: The Scientific Search for the Soul*. Scribners.
12. Dehaene, S., & Changeux, J. P. (2011). Experimental and theoretical approaches to conscious processing. *Neuron*, *70*(2), 200–227. https://doi.org/10.1016/j.neuron.2011.03.018
13. Dennett, Daniel C. (1991). *Consciousness Explained*. Penguin Books.
14. Gallagher, Shaun (2020). Action and Interaction. Oxford University Press.
15. Gallagher, Shaun & Zahavi, Dan (2008). *The Phenomenological Mind*. Routledge.
16. Hill, Christopher S. (1997). Imaginability, conceivability, possibility and the mind-body problem. *Philosophical Studies* 87 (1):61-85.
17. Hurley, Susan L. (1998). *Consciousness in Action*. Harvard University Press.

18. Jackson, Frank (1982). Epiphenomenal qualia. *Philosophical Quarterly* 32 (April):127-136.

19. Kant, I. (2003). *Critique of pure reason* (M. Weigelt, Trans.). Penguin Classics.

20. Koch, Christof (2004). *The Quest for Consciousness a Neurobiological Approach*. Roberts & Co.

21. Levine, Joseph (1983). Materialism and qualia: The explanatory gap. *Pacific Philosophical Quarterly* 64 (October):354-61.

22. Levine, Joseph (1993). On Leaving Out What It's Like. In Martin Davies & Glyn W. Humphreys (eds.), *Consciousness: Psychological an Philosophical Essays*. MIT Press. pp. 543--557.

23. Levine, Joseph (2001). *Purple Haze: The Puzzle of Consciousness*. Oxford University Press USA.

24. Li, F. (2022). Why is the mind a self-programming system?. https://doi.org/10.31234/osf.io/jvs58

25. Loar, Brian (1997). Phenomenal states II. In Ned Block, Owen Flanagan & Güven Güzeldere (eds.), *The Nature of Consciousness: Philosophical Debates*. MIT Press.

26. Loar, Brian (1999). David Chalmers's The Conscious Mind. *Philosophy and Phenomenological Research* 59 (2):465 - 472.

27. Macaluso, E., & Maravita, A. (2010). The representation of space near the body through touch and vision. *Neuropsychologia, 48*(3), 782–795. https://doi.org/10.1016/j.neuropsychologia.2009.10.010

28. Mashour, G. A., Roelfsema, P., Changeux, J. P., & Dehaene, S. (2020). Conscious Processing and the Global Neuronal Workspace Hypothesis. *Neuron*, *105*(5), 776–798. https://doi.org/10.1016/j.neuron.2020.01.026

29. Morasso, P., Casadio, M., Mohan, V., Rea, F., & Zenzeri, J. (2015). Revisiting the body-schema concept in the context of whole-body postural-focal dynamics. *Frontiers in human neuroscience*, *9*, 83. https://doi.org/10.3389/fnhum.2015.00083

30. Nagel, Thomas (1974). What is it like to be a bat? *Philosophical Review* 83 (October):435-50.

31. Noë, Alva (2005). *Action in Perception*. MIT Press.

32. Noë, Alva (2009). *Out of Our Heads: Why You Are Not Your Brain, and Other Lessons From the Biology of Consciousness*. Hill & Wang.

33. Papineau, David (1993). Physicalism, consciousness and the antipathetic fallacy. *Australasian Journal of Philosophy* 71 (2):169-83.

34. Papineau, David (2002). *Thinking About Consciousness*. Oxford University Press UK.

35. Perry, John (2001). *Knowledge, Possibility, and Consciousness*. MIT Press.

36. Pinker, S. (2007). *The stuff of thought: Language as a window into human*

nature. Viking.

37. Rey, Georges (1986). A question about consciousness. In Herbert R. Otto & James A. Tuedio (eds.), *Perspectives on Mind*. Kluwer Academic Publishers.

38. Robinson, William S. (2004). *Understanding Phenomenal Consciousness*. Cambridge University Press.

39. Rosenthal, David M. (2005). *Consciousness and Mind*. Oxford University Press UK.

40. Seth, A.K., Bayne, T. (2022) Theories of consciousness. *Nat Rev Neurosci* **23,** 439–452. https://doi.org/10.1038/s41583-022-00587-4

41. Varela, F. J., Thompson, E., & Rosch, E. (1991). *The embodied mind: Cognitive science and human experience*. Cambridge, Mass: MIT Press.

42. Zahavi, Dan (2017). Husserl's Legacy: Phenomenology, Metaphysics, and Transcendental Philosophy. Oxford University Press.