Discussion on Explicit Consciousness, Sub-Consciousness, and Self-Awareness in a Conscious System

Soichiro ARAI and Junichi TAKENO
Robot Science Laboratory, Computer Science, Meiji University
1-1-1 Higashi-Mita, Tama-ku, Kawasaki-shi, Kanagawa 214-8571, Japan
gofc380139@gmail.com, juntakeno@gmail.com

Abstract
What is "self-awareness"? How can explicit consciousness and sub-consciousness be mapped in relation to each other? How are they related to the self? How can these entities be represented in an artificial conscious system? These questions are the focus of this article. People are aware of only the behavior that they are focusing on; they cannot be directly aware of routine behavior such as walking and breathing. The latter is generally called unconscious behavior, and here we call it sub-conscious behavior. To understand self-awareness, therefore, firstly it is important to map explicit consciousness and sub-consciousness, which is where the self is deeply involved. We consider that if there is no self that refers to itself, no one can be aware of what he himself is doing. In this study we map explicit consciousness and sub-consciousness using an artificial conscious system, and then make a new proposal about the relationship between self-awareness and the self.

Keywords: unconscious, sub-consciousness, self-awareness, conscious system, the self

1 Introduction

In this paper we focus on the phenomenon of human self-awareness. Self-awareness refers to a state in which you are aware of what you are doing. In what conditions does self-awareness arise? It seems that the rise of self-awareness requires the behavior of explicit consciousness, i.e., the state of the self being aware in a concentrated manner. Actions such as walking and breathing are not considered the kind of behavior people are usually self-aware of. They are generally performed in the state of unconsciousness, which we call sub-conscious behavior. To understand self-awareness, first we need to map the relationship between explicit consciousness and sub-consciousness.

In this paper, we firstly map this relationship of consciousness and then propose an artificial conscious model that describes self-awareness.

2 Mapping of Explicit Consciousness and Sub-Consciousness

Firstly, what is the behavior of explicit consciousness and of sub-consciousness? If you are concentrating on what you are doing, it is an act of explicit consciousness. If you can do it without concentration just by following your experience, it is an act of sub-consciousness, like breathing and walking.

What is the behavior that requires concentration? We assume this is where the self comes into play. Firstly, we describe the self as a representation that connects to all affairs of oneself. For example, your fingers or feet connect to the "representation of self" as a component of your body. Of course they each have their own representation, such as a finger or a foot, and connect to the "representation of self." We would like to describe the state of concentrated consciousness by saying that the representation of self becomes SHOUKI. SHOUKI here means a state in which a cognitive representation of MoNADs converges to a constant value (Matsushita, 2015). How can we describe the state of concentrated consciousness using an artificial conscious system? First, we considered setting a flow through the Association subsystem(Takeno, 2013). The Association subsystem has a reconciliatory (settling) role in the connection between the Reason subsystem and the Emotion & Feeling subsystem. By connecting the Association subsystem with the self as a representation that connects all affairs of oneself, the information of consciousness that has been made explicit becomes connected with the "representation of self". This made us think it is possible to map the relationship between explicit consciousness and sub-consciousness using the Association subsystem. Based on this idea, we constructed a simple model consisting of four MoNADs, i.e., conscious subsystems N1 and N2, the Association subsystem (As), and the self (S), as shown below (Figure 1).

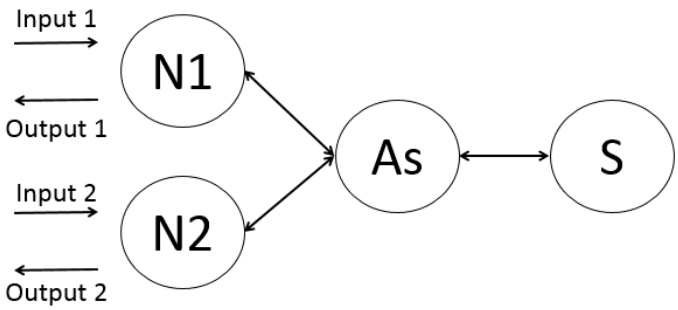

Figure 1. Conscious system model that describes self-awareness

When the Association subsystem (As) is in organic connection with N1, N1 is of explicit consciousness, and N2 is of sub-consciousness. When the Association subsystem is in organic connection with N2, N2 is of explicit consciousness, and N1 is of sub-consciousness. In the former organic connection, As is exchanging inputs and outputs through N1 with the inner or external environment (Input 1 and Output 1). In the meantime, although N2 also is exchanging inputs and outputs (Input 2 and Output 2), it is doing so independently of As, i.e., As is not communicating with N2.

3 Self-Awareness and the Body's Responses

Self-awareness, as described earlier, is a state in which you are aware of what you are doing (Lynn, 2003). This suggests that self-awareness may be deeply associated with the self and explicit consciousness. It is said that people in self-awareness can talk about what they did consciously. In our model, subsystems N1 and N2 can feed information back to the self (S) through As (Figure 1). This

means that if N1 is in explicit consciousness, what N1 is conscious about can be communicated to the self (S). In the meantime, however, N2, which is in sub-consciousness, cannot communicate with the self through As. This is what sub-consciousness is all about. We consider that self-awareness builds on the information fed by explicit consciousness back to the self (S) through As, as well as all kinds of body information (fingers, feet, etc.) that connect to the self (S). If this idea holds true, self-awareness is not based on sub-consciousness because it does not communicate information through As.

Now let us move the discussion to the importance of self-awareness and the body's response.

As our discussion so far has been confined to the inner circle of information between the self and consciousness, the question remains as to what the person is actually doing. Take, for example, the case when a person who has lost a hand tries to move it with explicit consciousness. Because the information feedback from explicit consciousness agrees with the information about which component of consciousness has been made explicit by the self, the conditions for self-awareness are, in theory, satisfied. Of course it is known that this kind of self-awareness does occur in humans. People half-paralyzed from stroke, etc. sometimes say that they have no trouble moving the paralyzed part of their body. In reality, however, it does not move because of paralysis. To reproduce this phenomenon in a robot, we considered feeding the body's response to its own behavior back to the conscious system. The MoNAD (Takeno, 2013), a consciousness unit we are developing, has a circuit that feeds the information output outside the unit (e.g., Output 1) further back to the input part inside the unit (Somatic Sensor Unit, SSU) (Takeno, 2013). At this time, the information output from the MoNAD unit results in moving the actuator installed on the robot's body. The movement of the actuator, in turn, activates the sensors in the robot's body. The fact that the SSU's information in the MoNAD unit is synchronized with these sensors' information led us to consider that this information can be significant information in the discrimination stated above. In the previous example, even if a drive code is output outside the unit (e.g., Output 1), as long as information from the body sensors is not fed back to the conscious system, the hand is judged as not moving. These feedbacks from the body sensors are considered to provide a powerful means of establishing the self-awareness of the conscious system.

4 Proposal of an Artificial Conscious System

4.1 Proposal of a System

We propose the system given in Figure 2.

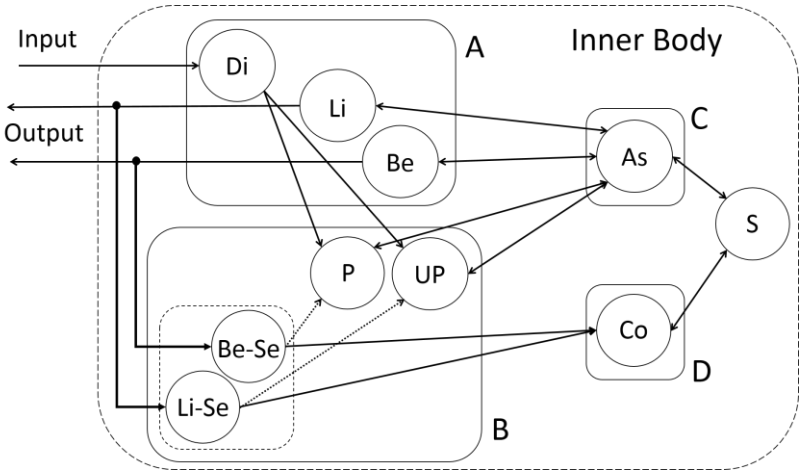

Figure 2. Artificial consciousness model that describes a self-awareness phenomenon

Our artificial conscious system, which describes self-awareness, consists of five elements. Group A recognizes information from inside and outside and performs an act. We call it the Reason subsystem. Group B represents emotion and feeling caused by the information from the body or from other MoNADs. We call it the Emotion & Feeling subsystem. Group C settles conflicts of information from groups A and B. We call it the Association subsystem. Group D serves as body sensors. We call it the sensor system, but it is considered a part of the Emotion & Feeling system.

MoNAD S is a MoNAD that represents the self. The transition between the explicit consciousness and sub-consciousness occurs among groups A, B, and C. The fed-back information from body sensors is processed by group D. S connects to the information of group C and of group D, thereby representing the rise of self-awareness. Put simply, the self-awareness of a conscious system is described as a phenomenon in which information coming through C, which has been elicited by the explicit consciousness aroused by the states of A and B, connects at C with the information coming through D

4.2 Group A (Reason subsystem)

Group A consists of three MoNADs. Di is a MoNAD that measures the distance from the robot to the object. It serves as vision. Li is a MoNAD that outputs the act of "thinking." Be is a MoNAD that outputs what kind of act the body should perform.

4.3 Group B (Emotion & Feeling subsystem)

Group B consists of multiple MoNADs. P is a MoNAD that relates to the feeling of pleasure. It outputs whether the information is pleasant or not based on the information from Di of group A. UP is a MoNAD that relates to unpleasantness. It outputs whether the information is unpleasant or not based on the information from Di of group A.

Be-Se and Li-Se are part of the Emotion & Feeling system and each consists of one MoNAD. Be-Se is a MoNAD that perceives through a body sensor the behavior output from Be. Li-Se is a MoNAD that perceives through a body sensor the behavior output from Li. In the actual experiment, Be-Se detected whether or not the robot is driving the motor, and Li-Se detected whether or not the robot is consciously performing the act of thinking.

4.4 Group C (Association subsystem)

Group C consists of MoNAD As. As is a MoNAD that settles conflicts of information from groups A and B.

4.5 Group D (Sensor Integration system)

Co is a MoNAD that integrates the sensor system. The information integrated here is connected to the self (S).

4.6 S-MoNAD (the Self)

S is a MoNAD that integrates information from As and Co. From As comes information about which component of consciousness was concentrated on (made explicit) or what kind of act the robot tried to perform. From Co comes information from sensors, which run according to what the robot itself actually did. Finally, the conditions behind self-awareness are integrated in S. In short, self-awareness becomes established by S connecting to As and D.

4.7 Flow of Information in the Conscious System

The experiment started with a scenario in which the robot was "moving forward while consciously counting numbers."

The functions of the conscious system can be divided largely into three flows of information relating to behavior, sensors, and self-awareness, respectively (Figure 2).

Firstly, let us explain the flow of information relating to behavior. This flow involves groups A, B and C. Di obtains external information and based on the information decides on whether or not there is an obstacle immediately before the robot in the direction it is moving. If there is, UP is represented; if there is not, P.

The robot, as described in the scenario, keeps "moving forward while consciously counting numbers," and it can be interpreted as "counting numbers in explicit consciousness" and "moving forward in sub-consciousness." Conversely, if the robot starts "moving forward in explicit consciousness," it "stops counting numbers."

This has to do with the fact that in humans, the act of thinking is controlled by the cerebrum while the act of moving is governed by cerebellar routines (Robert, 1999).

Secondly, we explain the flow of the information relating to sensors. This flow involves group D. The behavior output from Be and Li to the outside is perceived by Be-Se and Li-Se. These MoNADs communicate to Co whether or not they have perceived the information.

Finally, S converges (SHOUKI) to form self-awareness based on synchronous information from As, which links to the "behavior that has been brought into explicit consciousness," and from Co, the sensor integration system.

4.8 Experiment Results

We performed a simulation experiment on a computer. The simulated scenario was of a person who is "riding a bike" while "counting numbers." If there is no obstacle to riding a bike, the rider can keep riding while thinking about something (counting numbers). This is because the act of "thinking" is performed in explicit consciousness, and the act of "riding a bike" in sub-consciousness. Riding a bike, from the neuroscience point of view, is an act that can be performed subconsciously. When something comes in the way, the act of riding a bike is brought to the realm of explicit consciousness, and the rider performs a conscious behavior (stops riding the bike in this case). At this point, the act of thinking goes into sub-consciousness, and the act of stopping a bike, into explicit consciousness. The experiment was conducted in this scenario and the following results were obtained (Figure 3).

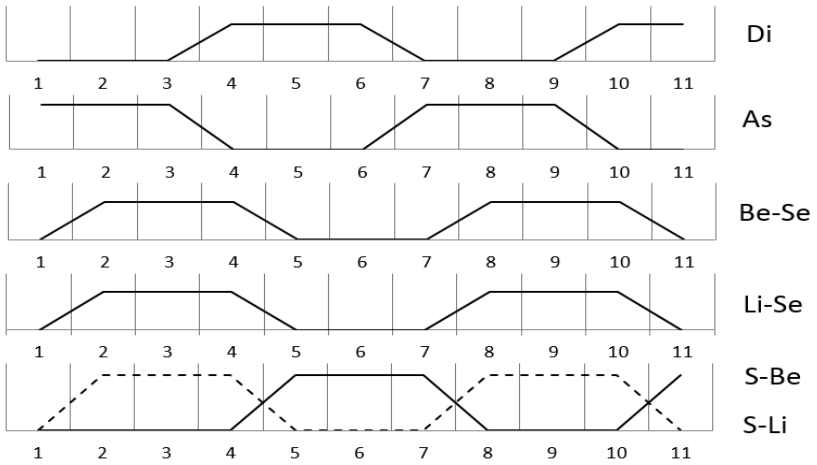

Figure 3. Results of a simulation experiment

The vertical axis in Figure 3 denotes 1 or 0, and the horizontal axis represents time. Di represents the absence (Di=0) or presence (Di=1) of an obstacle. As represents information from the Reason subsystem. When the status is 0, it indicates that Be is in explicit consciousness; when the status is 1, Li is in explicit consciousness. Be-Se and Li-Se represent information from body sensors. When the status is 0, it indicates that there is no response; when the status is 1, it indicates that there is a response. S-Be and S-Li represent whether self-awareness is established for Be and Li, respectively. When the status is 0, it indicates that self-consciousness is not established; when the status is 1, it indicates that self-consciousness is established.

Let us explain the results when the time is 3 and 5. At time 3, Di was 0, meaning that there was no obstacle, which represents the situation in which a person is riding a bike while thinking about something. As was 0, meaning that Li was in explicit consciousness, which represents the situation in which the person is concentrating on thinking. Be-Se and Li-Se were both 1, meaning that they were receiving information from body sensors. Accordingly, it was judged from the body sensors that the robot is riding a bike and thinking. From these pieces of information, the robot establishes self-awareness about the act of Li (counting numbers) (S-Li becomes 1).

At time 5, Di is 1, meaning that there is an obstacle. At this point, As is 0, meaning that Be is in explicit consciousness, i.e., the robot stopped riding a bike consciously. Be-Se and Li-Se are both 0, i.e., it was detected that the robot stopped riding the bike consciously and also stopped thinking. From these pieces of information, the robot establishes self-awareness about the act of Be (stopping riding a bike consciously) (S-Be becomes 1).

5 Discussion

To help unravel the mystery of human self-awareness, we tried to represent the phenomenon of self-awareness as a computer program using a conscious system, the subject of our study. To do this, first it was necessary to clarify the meaning of being explicitly conscious and sub-conscious in a conscious system. Focusing on the role of the Association subsystem (As), which settles conflicts between MoNAD groups of the Reason subsystem and the Emotion & Feeling subsystem, we defined explicit consciousness as the state in which the Association subsystem is exchanging information in an organic manner. The rest was defined as belonging to sub-consciousness. MoNAD groups in explicit consciousness are connected to S through As. We describe this state as the basic establishment of the self. At this point, when body sensors respond through the execution of this explicit consciousness, it is considered as a reinforced reaction of the self-awareness.

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