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The Double Homunculus model of self-reflective systems

Koji Sawa [a,*], Abir U. Igamberdiev [b]

[a] Senior High School, Japan Women's University, Kanagawa 214-8565, Japan
[b] Department of Biology, Memorial University of Newfoundland, St. John's, NL A1B 3X9, Canada

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ABSTRACT

Vladimir Lefebvre introduced the principles of self-reflective systems and proposed the model to describe consciousness based on these principles (Lefebvre V.A., 1992, J. Math. Psychol. 36, 100–128). The main feature of the model is an assumption of "the image of the self in the image of the self", that is, "a Double Homunculus". In this study, we further formalize the Lefebvre's formulation by using difference equations for the description of self-reflection. In addition, we also implement a dialogue model between the two homunculus agents. The dialogue models show the necessity of both exchange of information and observation of object. We conclude that the Double Homunculus model represents the most adequate description of conscious systems and has a significant potential for describing interactions of reflective agents in the social environment and their ability to perceive the outside world.

1. Introduction

The Law of Self-Reflection, which has been introduced by Vladimir Lefebvre, is a concept in which subject's consciousness is described via simple algebraic rules (Lefebvre, 1987, 1992, 2002). Lefebvre (1987) has established the combinatorial rules of Boolean algebra on the set of reflective mental structures, which allowed him to discover the modes of their operation. The striking feature of this theory is a reflective introduction of the image of the self in the image of the self. According to Lefebvre, reflection is "the human ability to represent mentally one's own thoughts and feelings" (Lefebvre, 2002). The model can be summarized as follows. Firstly, there are three components: readiness, actual pressure, and intention. Readiness is a choice into the future of the subject itself. Actual pressure is the influence of environment of the subject. And the subject has an intention in its inside. These three are distinguished and represented by three variables. The three variables are combined into one equation on the ground of logical and probabilistic thoughts. Secondly, the composed equation is recursively adopted. This reduplication is the most distinctive feature of Lefebvre's schematization. One equation corresponds to one reflective action of the subject, therefore, this reduplicated equation indicates "the image of the self in the image of the self" described above.

Lefebvre presented a comparison of his model with the observed psychological features of human behavior and suggested an explanation of them from his own standpoint (Lefebvre, 2002). In addition, Lefebvre also showed a resemblance between his theory and the other physical schemes, e.g., with internal combustion (Lefebvre, 1997). This resulted in the development of the formalized concept of reflective psychology. In fact, by developing the concept of reflective psychology Lefebvre formalized the tripartite structure of subject introduced in psychoanalysis (Igamberdiev, 2008). This new field resulted in novel original interpretations of the modes of human behavior and in important predictions of trends of social interactions. The original tripartite relationship of readiness, actual pressure and intention assumes that all three components of the relation form a hierarchical structure in which each component keeps relative dependence on the remaining two others in its functional capacity within the internal semiotic relation. This relation internalizes the interaction between all three components in a way that the actual pressure itself becomes internal through acquiring the capacity of being receptive to the outside influences, and the subject acquires the capacity of orientation in the world resulting in the adaptive behavior.

In our opinion, Lefebvre's formalization can be further developed. As we described above, the readiness and intention are treated as distinguished ones. Actually those two are similar. Conceptually, readiness is outside of the subject and it is attributed to the future. On the other hand, intention exists inside the subject and attributed to the present moment of time. Lefebvre coordinated the readiness and intention by an algebraic equation, though they are regarded as the independent two matters. In this paper,

* Corresponding author.
E-mail addresses: kjsw@live.jp (K. Sawa), igamberdiev@mun.ca (A.U. Igamberdiev).

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we connect readiness to intention by a difference equation. Thus, these two become to be related more loosely than formalization by Lefebvre. In spite of the looseness of our formalization, some important features are retained. In addition, by virtue of the difference equation, our formalization acquires a temporal feature, which allows describing the evolutionary patterns based on time rescaling (Igamberdiev, 2014) and generativity (Igamberdiev and Shklovskiy-Kordi, 2016). The difference equations relate to differential equations as discrete mathematics relates to continuous mathematics, therefore our models preserve the discreteness of Lefebvre's algebraic equations.

In this we paper, we introduce three models. The first model is composed of a difference equation, that is, it represents the reduplicated feature. The model is called the Double Homunculus model (DH). The second model is non-reduplicated one, called the Single Homunculus model (SH). The third model, which is called DH', is a slightly modified DH model. DH has a constant value, while DH' has two constant values because of the structural reason. We compare these three models numerically. In addition, we also examine them further via the inspection of analytic solutions of the three models.

By using these consciousness models, we construct a dialogue model between two agents. In the model, two agents try to understand what an object in front of the agent is. In general, the dialogue in which the agents understand each other completely is too idealistic, which can never be realized in the actual situation. If this complete understanding is realized, the dialogue becomes actually mere monologue (Bakhtin, 1981). According to this position, we set our dialogue models in which an agent makes a choice between the observation of an object in front of the agent itself and the acceptance of an opinion of the other agent. This setting of the model realizes two concepts simultaneously. The first is an assumption that two agents of dialogue may not have a completely same view of the world (Sawa and Gunji, 2007). The second is nondiscrimination between an object and a subject. They can be generally understood as discriminated concepts, that is, the former is an observed thing, and the latter is an observer. This non-discrimination form is connected with the internal measurement (Matsuno, 1989).

The paper is organized as follows: at the beginning (Section 2), we introduce the summary of Lefebvre's formalization of the Law of Self-Reflection with algebraic equations. Then we clearly point out an equation from Lefebvre's model which we focus on. Then we replace this equation by the difference equations. We have three variations of difference equations that correspond to the models DH, DH', or SH, respectively. We compare these three models, and show the priority of DH. In Section 3, we also show the priority of DH by the algebraic analysis. In Section 4, we define a dialogue model between these two self-reflective agents. The dialogue model between two DH agents indicates more universal feature than one between SH agents. In Section 5, we discuss the connection between the results obtained in this paper and the existing concepts including the internal measurement.

2. The Law of Self-Reflection

Lefebvre's representation of reflection is expressed via the assumption of bipolar choice. It is assumed that in the reflective act the situation takes place in which a subject faces a choice between the two alternatives: one of them plays the role of the positive pole for the subject and the other one that of the negative pole. Then, three variables are introduced as

X_1: readiness (choice of the positive pole),

x_1: an actual pressure in the framework of a given situation,

x_2: intention (subjective desire) to choose the positive pole.

All three variables can change their values on the interval [0,1]. Each of the values represents the probability of the choice of the positive pole. These three variables are connected with one another by following equations:

Table 1
Table for the calculation of the value of $F(x_1, x_2)$. The value is the sum of the values that the truth values of $x_2 \to x_1$ are T.

x_2	x_1	$x_2 \to x_1$	Probability
T	T	T	$x_2\, x_1$
T	F	F	$x_2(1-x_1)$
F	T	T	$(1-x_2)x_1$
F	F	T	$(1-x_2)(1-x_1)$

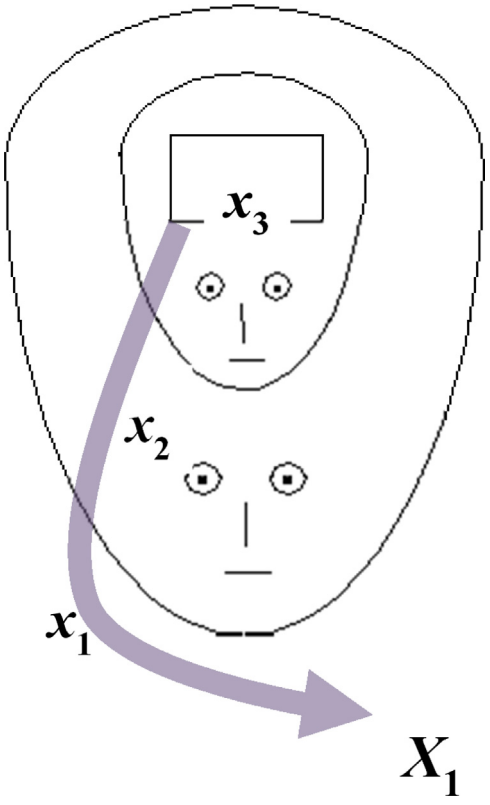

Fig. 1. Diagram of the duplicated reflection proposed by Lefebvre. This figure is originally presented in Lefebvre (2002), and slightly modified by the authors.

$$X_1 = F(x_1, x_2), \tag{1}$$

where

$$F(x_1, x_2) = 1 - x_2 + x_1 x_2. \tag{2}$$

The Eq. (2) is introduced by probabilistic and logical reasons. That is, the value of $F(x_1, x_2)$ is regarded as the probability of implication $x_2 \to x_1$. Thus, the value is calculated as shown on Table 1.

Actually, Lefebvre introduced the conscious model as duplicated consciousness. It is realized by the following Eqs. (3) and (4), in addition to the Eq. (2):

$$X_1 = F(x_1, F(x_2, x_3)), \tag{3}$$

$$X_1 = x_3, \tag{4}$$

where X_1: readiness (choice of the positive pole), x_1: an actual pressure in the framework of a given situation, $x2$: the subject's expectation of such pressure as determined by his previous experience, x_3: intention (subjective desire) to choose the positive pole.

Fig. 1 represents the diagram of this formulation. The most distinguishing feature is the reduplication of reflection realized by the Eq. (2):