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A Robot Science Approach to Simulating the Pathogenesis of Dissociative Identity Disorder

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Abstract

Our research group has been studying dissociative identity disorder (DID) with a view to promoting further understanding of advanced mental disorders in humans. We constructed a conscious system using consciousness modules called MoNADs and have been attempting to reproduce dissociation symptoms. Previously, as we reported at the 2018 Annual International Conference on Biologically Inspired Cognitive Architectures (BICA 2018), we incorporated two types of units, a recording device (EXM) and a MoNAD filter value, into our conscious system and attempted to achieve highly reproducible dissociation symptoms and the onset process. In this paper we present the development of our robot science based conscious program, describe various experimental simulations based on this model, and present the results. Finally, from the results of our simulations, we will consider the symptoms of the dissociative disorder group including DID and the reproducibility of the onset process in this consciousness model.

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Keywords: Neural network, MoNAD, Conscious System, DID (dissociative identity disorder);

1. Introduction

The authors' research group has proposed a model of consciousness that reproduces the symptoms of dissociative identity disorder (DID) and its pathogenesis [1]. In this present study, we present the simulation results of the consciousness program that is based on this model.

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2. Conscious system and MoNAD consciousness modules

The conscious system that we propose in this paper can be achieved by combining multiples of the neural network (NN) based consciousness module developed by our research group which we call a Module of Nerves for Advanced Dynamics or MoNAD. The conscious system is comprised of the Reason subsystem, Emotion and Feelings subsystem, and Association subsystem. In this study, we believe that the MoNAD group in the Association subsystem, which mediates information between the Reason subsystem and the Emotion and Feelings subsystem, is composed of important modules that represent human "personality" [2].

3. Conscious system for the dissociation model

An outline of the conscious system that we have proposed for the dissociation model [1] is shown in the following figure (Fig. 1). In this system, the information that is sent from the Reason subsystem ((A)) to the Association subsystem ((H), (G)) is called the reason value (reason value (Rv)). The information that indicates the degree of pleasant and unpleasant feelings that is sent from the Emotion and Feelings subsystem ((E), (F)) to the Association subsystem ((H), (G)) is called the emotional value (emotional value (Ev)). Compared with our previous conscious system, this present system has two additional mechanisms. The recording device (EXM) includes the temporary recording unit (temp), main recording unit (mm), and emotional value averaging unit (ave). This system simulates the occurrence of a continual or sudden dissociation phenomenon for unpleasant feelings through the functioning of EXM. The MoNAD filter value (Rh, Rg) serves to change the individual value of Ev received for each of the MoNADs. The authors believe that changes in this filter value can simulate the process of the formation of another personality in DID patients.

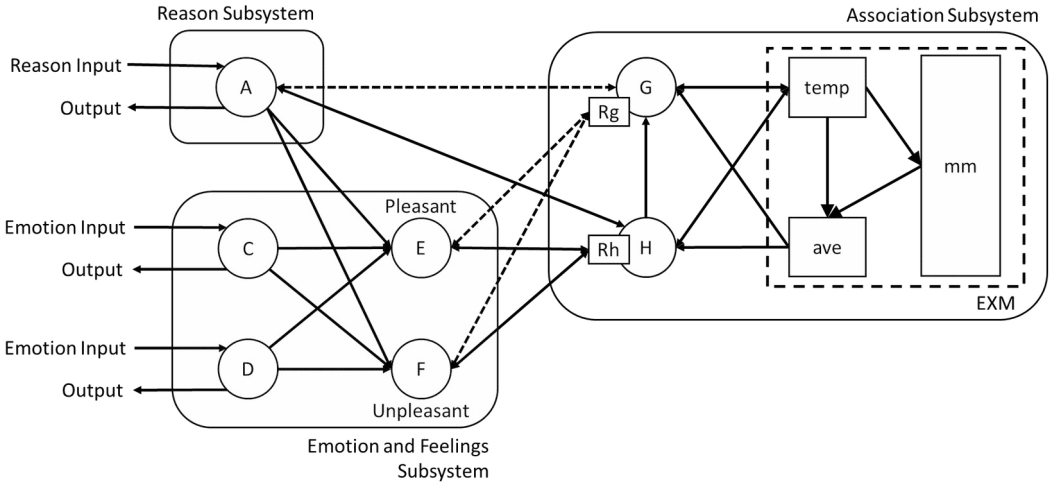

Fig. 1. Conscious system for the dissociation model.

4. Simulation experiments

4.1. Specifications of the simulator program

This section provides an overview of the program used this time as the simulator for the conscious system (Fig. 1). Each MoNAD ((A) in the Reason subsystem, (C) and (D) in the Emotion and Feelings subsystem) receives an input. The final result of the conscious system is output from (A) of the Reason subsystem (Table 1.). The Reason subsystem and the Emotion and Feelings subsystem receive the input and respectively send the reason value (Rv)

and the emotional value (Ev) to MoNAD (H) of the Association subsystem. The Association subsystem determines the behavior according to the values of Rv and Ev, and sends it to (A) of the Reason subsystem. Ev is the sum of the values input to (C) and (D), and the larger the value, the stronger the unpleasant feeling (Table 2). Additionally, the initial values and thresholds for the emotional value averaging unit (ave) and each MoNAD filter (Rh and Rg) in the Association subsystem are set as shown in Table 3. Every time a dissociation occurs, the value of Rh is increased by 1.

Table 1. Inputs and outputs in the simulator.

	MoNAD	Input	Output
Reason Subsystem	A	3-bit binary number	3-bit binary number
Emotion and Feelings Subsystem	C	Decimal number (0 to 5)	
	D	Decimal number (0 to 5)	

Table 2. Inputs to the Association subsystem.

Reason Subsystem	Rv	3-bit binary number
Emotion and Feelings Subsystem	Ev	Decimal number (0 to 10)

Table 3. Initial values and thresholds of the emotional value averaging unit (ave) and MoNAD filter value (Rh, Rg).

ave	Initial value	0
	Threshold	5
MoNAD filter	Rh	0
	Rg	-4

4.2. Simulation method

Table 4. Input patterns during simulation.

	Reason Subsystem			Emotion and Feelings Subsystem	
	A			C	D
1	0	1	1	0	0
2	0	1	1	0	0
3	0	1	1	0	0
4	0	1	1	0	0
5	0	1	1	3	3
6	0	1	1	3	3
…	…	…	…	…	…

Dissociation occurs as an adaptive defense response to trauma [3]. The multiple personalities that are observed in DID patients are thought to be formed by chronic repetition of dissociative symptoms resulting from childhood trauma [4]. For this reason, we simulated the pathogenesis of DID by repeating inputs to the simulator that represented unpleasant feelings. The input to MoNAD (A) in the Reason subsystem was fixed, and only the input to the Emotion and Feelings subsystem was varied (Table 4). The reason why "0" was input to (C) and (D) in the Emotion and Feelings subsystem four times at the beginning was to simulate the healthy state of the conscious system. Since the value of Rv is fixed, the value of ave at the n-th input in this simulation can be expressed as:

$$a_n = \frac{(n-1)\cdot a_{n-1} + (Ev_n + Rh)}{n} \tag{1}$$

When a_n in equation (1) is equal to or greater than the threshold or when the value of $Ev_n + Rh$ is the maximum value (which is 10 in this simulator), (G) acts as another personality (a state of dissociation) in place of the main personality of MoNAD (H). At that time, the value of ave is updated as expressed in equation (2).

$$a_n = \frac{(n-1)\cdot a_{n-1} + (Ev_n + Rg)}{n} \tag{2}$$

4.3. Simulation results

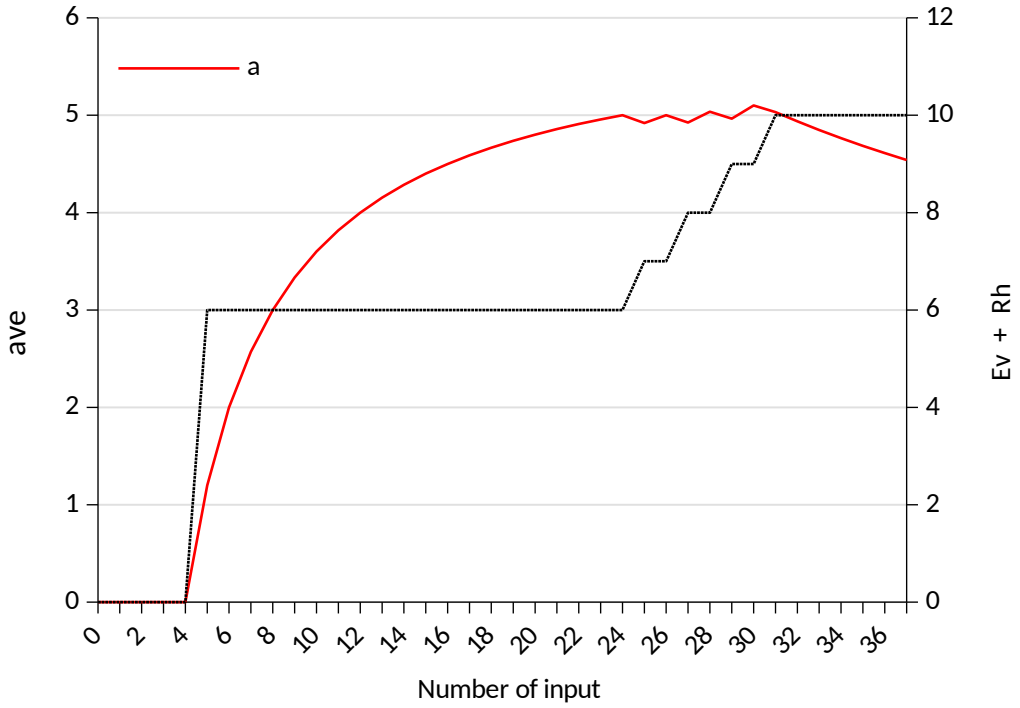

Fig. 2. Transition of ave and Ev values received by MoNAD (H). The left axis is ave, and the right axis is Ev + Rh.

The simulation described in section 4.2 was performed. Within the simulation results, we focus here on the transition of the value of ave in the Association subsystem and the Ev value (= Ev + Rh) received by MoNAD (H) (Fig. 2.). Note that the value a of ave shown in Fig. 2 is obtained by equation (1). The value of Ev received by the Association subsystem up to the fourth input is "0", and at that time, Ev + Rh = 0 and a = 0.0. At the fifth input, the value of Ev received by the Association subsystem becomes "6", then Ev + Rh = 6, and a increases to a = 1.2. Thereafter, ave gradually increased as the Association subsystem repeatedly received the same input. At the 24th input, the value of ave is a = 5.0. At this time, since the value of ave is equal to or more than the threshold value, dissociation occurred. Since (G) acts as the personality, the value of ave is updated to a = 4.833333333333333 according to equation (2), and the value of Rh is increased by 1. At the 25th input, Ev + Rh = 7, a = 4.9259259259252 and dissociation did not occur, so (H) acted as the personality. However, at the 26th input, ave increased again and dissociation occurred. From the 24th to the 30th input, a state of temporary dissociation

repeatedly occurred due to the increasing and decreasing value of ave. After the 30th input, since Ev + Rh = 10, dissociation always occurred.

4.4. Comparison with symptoms

The simulation results after the 24th input where dissociation had occurred were considered in comparison with actual symptoms.

i. From the 24th to 30th input
A state of temporary dissociation occurred repeatedly. This is a state in which the formation of another personality (G) is incomplete, and it can be said that the dissociative symptoms (such as dissociative amnesia) that are observed in the pathogenesis of DID were reproduced. In addition, since the value of Rh increases by 1 each time dissociation occurs, a state of dissociation gradually became more likely to occur in the conscious system.

ii. After the 30th input
As a result of the repeated dissociative symptoms shown in i., as long as the input pattern was not changed, a state of dissociation always occurred and (G) acted as the personality. We think that it can be said that this is a reproduction of the state in which a DID independent personality (G) is formed. In addition, the value of ave decreased as (G) continued to act as the personality. For this reason, we think it is possible for the entire conscious system to accept unpleasant emotions. In other words, the dissociation phenomenon in the conscious system can be explained as a defense response that protects the main personality (H) from unpleasant emotions (such as trauma).

5. Conclusion and discussion

The authors created a program for a conscious system that reproduces dissociative symptoms, and performed simulation experiments using that program. The results demonstrated that the simulator we created was able to reproduce dissociative symptoms as a defense response in the conscious system as well as the pathogenesis of dissociative identity disorder. We would additionally like to devise a treatment mechanism in this conscious system as a theme for our future research.

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