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Simulation of the Cognitive Process in Looking at Rubin's Vase

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Abstract

We have successfully simulated the cognitive process in looking at Rubin's Vase. Rubin's Vase, which was created by the Danish psychologist Edgar Rubin, is an ambiguous image that can be interpreted in more than one way. The image used in this study depicts a vase in the center such that its contour matches the human profile, allowing the viewer to interpret the image as either "a vase in the center" or "two faces looking at each other." We have developed a program that enables the internal representation systems to change their responses from moment to moment according to changes in input data and to internal knowledge.

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Keywords: cognitive process, Rubin's Vase, ambiguous image, conflict of concept, conscious program, internal representation system

1 Introduction

Today, various robots are playing active roles in society. However, no robot is yet able to communicate with humans as we do with each other. To develop such robots, we have been researching the understanding of human consciousness, and have designed a system for human consciousness using conscious modules, MoNAD (Takeno, 2011), which is being developed as a computer program. Our MoNAD conscious modules are based on such theories as mirror neurons (Gallese, 1996) and mimesis theory (Donald, 1991). Imitation is deeply involved in the development of human consciousness; it is a flow of processes involving recognition of another's behavior and its reproduction as one's own behavior. We have defined consciousness as "consciousness is generated by consistency of cognition and behavior," and based on this definition, we have proposed a recursive neural network as a model of consciousness. By connecting multiple MoNADs in a hierarchy, our research group has proposed and modeled a conscious system that explains the human conscious phenomenon of the Thermal Grill Illusion (Xu, 2015), and also proposed and modeled a conscious system that explains the cognitive phenomenon in looking at an ambiguous image, namely "Rubin's Vase" (Xu, 2016). Based on these studies, this article discusses the results of a simulation experiment on the cognitive process in looking at Rubin's Vase.

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2 What is a MoNAD?

Our conscious system that recognizes Rubin's Vase was constructed using MoNADs. A MoNAD is a unique recursive neural network consisting of input unit (a), which receives information from the external environment; primary representation PR unit (b), which performs both recognition and behavior; cognitive representation RL unit (c), which outputs recognized information; behavior representation BL unit (d), which receives information from other superordinate MoNADs; a somatic sensor unit SSU (e); upward feedback loop UL; and output unit (f), which outputs the final behavior to subordinate MoNADs (Figure 1) (Takeno, 2013). The word "subordinate" applies to inputs and outputs in the direction closer to the body driving unit; and the word "superordinate" applies in the opposite direction. SSU is a mechanism (e) by which outputs from the output unit (f) are fed back to the input unit (a) of the MoNAD itself.

The main feature of the MoNAD system is primary representation unit (b). This unit enables both cognitive and behavioral information to function simultaneously. Also, the circulation of information at UL from RL to BL makes expectation possible. Furthermore, the feedback of the previous behavior by SSU enables the system to recognize its own state (Takeno, 2011). The MoNAD can calculate the information at output unit (f) (Output) based on the new outside information (a) coming from the input unit (Input), on the previous behavior (e) at SSU, and on the information from behavior representation unit BL (d).

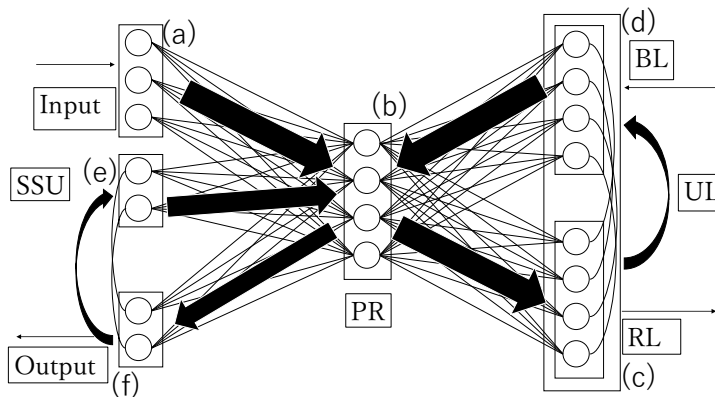


Figure 1: Diagram of a MoNAD

3 What is an Ambiguous Image?

An ambiguous image is one that has an equivocal meaning that permits two or more interpretations. Since a great variety of ambiguous images are known, this article focuses on "Rubin's Vase" as a typical one.

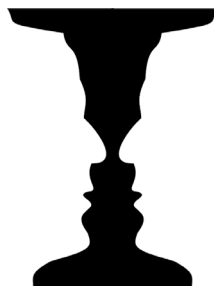


Figure 2: Rubin's Vase

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