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Connectionist interpretation of the association between cognitive dissonance and attention switching

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HIGHLIGHTS

- A novel connectionist model accounting for cognitive dissonance is described.
- The concepts of self and attention switching are considered.
- The model fits experimental data of major paradigms of cognitive dissonance.
- The model demonstrates that attention switching hinders cognitive dissonance reduction.
- The selective exposure phenomenon is interpreted on the basis of the operation of the model.

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ABSTRACT

A novel connectionist model accounting for cognitive dissonance is described, in which the concepts of self and attention switching are considered. The model is composed of a unit corresponding to self, a bistable pair comprising two units relevant to two dissonant cognitions, and links whose weights correspond to cognitive evaluations. The model makes it possible to use mathematical formulas to represent the cognitive-dissonance process. Analysis reveals that the model fits experimental data of major paradigms in cognitive dissonance theory. The model shows that attention switching, which is produced by internal and external stimuli, causes building-up of cognitive dissonance and retardation of its reduction. The psychological phenomenon of selective exposure is interpreted on the basis of the operation of the model.

1. Introduction

Cognitive dissonance theory insists that dissonance is a psychological state of tension that people are motivated to reduce (Festinger, 1957). Dissonance causes feelings of unhappiness, discomfort, or distress. Festinger (1957, p. 13) asserted "These two elements are in a dissonant relation if, considering these two alone, the obverse of one element would follow from the other". To reduce dissonance, people add consonant cognitions or change evaluations for one or both cognitions to make them more consistent.

Cognitive dissonance theory makes a clear prediction when a firm expectancy is involved as one of the cognitions in question (Aronson, 1969). A well-known example of this is the famous Aesop's fable "The fox and the grapes". In the story, a fox wanted to get some grapes hanging high on vines and leaped with effort, but could not get them. Walking away, the fox said "The grapes are surely sour, and I do not need them". Since the expectation and experience were inconsistent, the fox had cognitive dissonance, which he reduced by convincing himself that the expectation was not appropriate.

Shultz and Lepper (1996) proposed a connectionist model accounting specifically for the mechanism of cognitive dissonance. A constraint satisfaction network model was used to simulate data from the several major cognitive dissonance paradigms (Shultz, Leveille, & Lepper, 1999). In it units correspond to cognitions of one of three categories: behavior, justification, or evaluation, and weights between units to causal implications among the cognitions. Activations of the units are continuously changed and the weights are fixed. Dissonance is defined by a formula that is a function of activations of units and weights applied to links in the network. Networks tend to settle into a less dissonant state as activations of units are changed according to updating rules. Simulations are carried out for some cognitive dissonance paradigms and their results are confirmed to coincide with experimental data. Another connectionist model was proposed by Van Overwalle and colleagues (Van Overwalle & Jordan, 2002; Van Overwalle & Siebler, 2005). They represented attitudes in a feed-forward neural network with the delta-learning rule in which weights are al-

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lowed to change. Input nodes represent the features of the environment and two output ports represent behavior and affect. Dissonance is defined as the discrepancy between expected and actual outcomes. They also simulated the experimental results of major cognitive dissonance paradigms. Several other computational models have been reported that deal with attitude phenomena through simulation using constraint-satisfaction or non-constraint-satisfaction networks (Mosler, Schwartz, Ammann, & Gutsher, 2001; Petty & Cacioppo, 1986; Read & Miller, 1994; Read & Monroe, 2008; Spellman, Ullman, & Holyoak, 1993).

People are motivated to prioritize to protect their self-system. Self-consistency theory (Aronson, 1969; Thibodeau & Aronson, 1992) emphasizes that self is involved in dissonance arousal and that not merely two inconsistent cognitions, but rather self-concept needs to be considered in discussing dissonance. Self-relevant cognitions are regarded as key elements for dissonance arousal. Steele (1988) reported experiments in which self-affirmation manipulations eliminated dissonance and investigated the effect of self on dissonance phenomena.

On the other hand, attention is an important phenomenon of information processing in cognitive systems (Pisapia, Repovs, & Braver, 2008). It is a function for selecting and enhancing a limited area of information, while suppressing other areas. Cognitions are included in these areas of information.

In this paper, a novel connectionist model for cognitive dissonance adopting the functions of the neural networks is described, in which self and attention switching are taken into account. To the author's knowledge, connectionist models having such concepts have not been presented so far. Following the introduction, in Section 2, a connectionist model accounting for cognitive dissonance is proposed and cognitive dissonance is quantitatively defined on the basis of the parameters of the model. Weights in the model are regarded to correspond to the cognitive evaluations. In Section 3, change of the weights is analyzed according to the modified Hebbian learning rule of neural networks. In Section 4, validity of the model is confirmed by comparing theoretical results of our analysis with major experimental results of cognitive dissonance reported in the literature. In Section 5, attention switching is discussed on the basis of the proposed model. Endurance of cognitive-dissonance reduction due to attention switching is presented and the relationship between attention-switching frequency and the retardation of dissonance reduction is examined. The psychological phenomenon of selective exposure is interpreted from the viewpoint of attention switching. Finally, conclusion of the paper is described in Section 6.

2. Connectionist model

2.1. Cognitive dissonance and connectionist model

Cognitive dissonance is a phenomenon of mind caused by the operation of the brain. Since brain is composed of neurons, it is preferable for a connectionist model for cognitive dissonance to be as similar to neural networks as possible. That is, units in the model are assumed to have characteristics similar to those of a neuron and thus take two operational states, i.e., excited and inhibited states. Links in the model are assumed to transmit signals between the units similarly to the axons of neurons. Links are assumed to have weights corresponding to the synaptic conductances between neurons. According to the plasticity of synapses, the weights are assumed to vary with time following the learning process. Such a concept, which is widely accepted in the research of neural networks, is adopted in the connectionist model in this paper.

Psychological and physiological stabilization is represented by the term homeostasis (Cummins, 1998). Cognitive and homeostatic functions are keys in discussing psychological phenomena

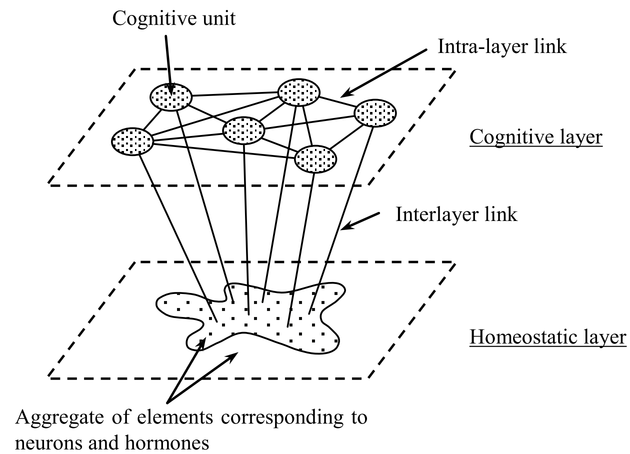

Fig. 1. Two-layer representation of psychological mechanism of brain.

(Cummins & Nistico, 2002; Turrigiano, 1999). In considering the mechanism of cognitive dissonance, we assume that the neurons in the related region of the brain belong to either cognitive layer or homeostatic layer which are shown in Fig. 1. In the cognition layer, the units are assumed to correspond to cognitive elements (Gross, 2002). They are linked to each other and the weight applied to a link represents the relation between the cognitive elements. Cooperative or opposing relation existing between them is given by the value (polarity) of the weight. In the homeostatic layer, aggregate of the elements corresponding to relevant neurons and hormones in the actual brain supports psychological equilibrium or stability. Feedback mechanisms are embedded in the layer (Poon, 1993). Although the neurological boundary between the two layers might be obscure in the actual brain, it is clearly depicted in Fig. 1 for the sake of explanation. For the interaction between the two layers, we assume there are links intervening between them.

The units in the cognitive layer have various operational states and the links between the two layers have various weights. Therefore, operational states of the cognitive units in the cognitive layer variously affect the homeostatic layer (Cummins & Nistico, 2002). When activation of a unit corresponding to a cognitive element reinforces the homeostasis, the cognitive element might be regarded acceptable or valuable by the subject. In contrast, when activation of a unit corresponding to a cognitive element weakens the homeostasis, the cognitive element might be regarded unacceptable or valueless by the subject (Craig, 2003). Thus, it can be mentioned that the links between the two layers play an important role in determining the feeling and evaluation for a specific cognitive element.

Aronson asserted (1969, p. 27) "Dissonance theory makes a clear prediction when a firm expectancy is involved as one of the cognitions in question" and "behavior can be dissonant with our expectancy". Since "expectancy" is a psychological state produced in the brain, it might be an imagination-based cognition. On the other hand, since "behavior" is experience or actual situation, it might be a reality-based cognition. For example, when we interpret the case of the previously mentioned fable, since the fox expects to obtain some grapes, the imagination-based cognition held by the fox might be "I want to get grapes". On the other hand, since the fox cannot realize the expectancy, the reality-based cognition might be "I get no grapes". In our connectionist model, such two cognitions, i.e., imagination-based and reality-based cognitions, are taken into account.

Since the implications of two cognitions interpreted in the classic theory of cognitive dissonance seem to be rather coarse, we break down the cognitions and analytically consider their expressions. In general, two cognitions in dissonance can be represented