Bridging Block and Bundesen

A Functionalistic Account of Consciousness

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A Functionalistic Account of Consciousness

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SHORT ABSTRACT

Consciousness seems to present a special challenge for scientific investigation. Much research has been done on the so-called "easy" aspects of consciousness such as perception, attention, and memory. The "hard problem", however, still seems to elude scientific methods. In this paper I argue that some fields in cognitive science are already gaining ground on the hard problem. An interesting model is Claus Bundesen's (1990) Theory of Visual Attention (TVA) that seems to be compatible with Ned Block's (1995) distinction between access consciousness and phenomenal consciousness. TVA proposes a two-part stochastic model where 1) every stimulus is given a weight in terms of belonging to a certain visual category and 2) every stimulus then enters a race for a place in a limited-capacity visual short-term memory store. TVA seems to be a good model to describe access consciousness; by expanding this model to account for how we learn categories we may advance our understanding of the "harder" problems of phenomenal consciousness.

INTRODUCTION

Many scientists have tried to explain consciousness, especially in recent years. Somehow, however, consciousness always seems to elude systematic investigation due to some special nature that it possesses. That special "something" is what philosophers have termed *qualia*: why, for example, does it feel a certain way to see a red apple? This is what David Chalmers (1995) defines as the "hard problem" in the science of consciousness, contrary to the more "easy problems" of perception and memory.

CONSCIOUSNESS

Ned Block (1995) has made a distinction between two types of consciousness – *access consciousness* and *phenomenal consciousness* – which is closely linked to Chalmer's distinction between easy and hard problems. Access consciousness can be compared to short-term memory as described by William James (1880), whereas phenomenal consciousness is the experiential quality of a given stimulus – the *likeness* to use Thomas Nagel's (1974) term.

Access without Phenomenal Consciousness

This may be a purely conceptual possibility and to illustrate this condition Block suggests examples like the philosophical zombie and the super-blindsight patient.

Phenomenal without Access Consciousness

More interestingly, Block suggests real-world events that seem to isolate phenomenal consciousness from access consciousness. The classic example is the famous study by George Sperling (1964) where subjects were briefly shown a matrix of three by four letters; even though the subjects had an experience of all twelve letters, they were only able to report three to four letters.

ATTENTION

Within the field of attention research, Claus Bundesen (1990) has proposed a Theory of Visual Attention (TVA) which is a mathematical account of visual attention. TVA proposes a two-part stochastic model where 1) every stimulus is given a weight in terms of belonging to a certain visual category in visual long-term memory and 2) every stimulus then enters a race for a place in a limited-capacity visual short-term memory store.

This is described by the two central equations of TVA; the rate equation (Equation 1) and the weight equation (Equation 2).

Equation 1

The rate equation basically calculates the rate of processing on the basis of three elements: 1) the strength of the sensory evidence; 2) the bias for a certain categorization; and 3) the relative weight of the stimulus. The evidence or eta (η) value is seen as a template-matching process. The visual stimulus is matched with categories in visual long-term memory and assigned a probability match to every possible category - the probability that stimulus x belongs to category i. The eta value is further modified by the bias (β) value for a given categorization. Whereas η is a rather objective parameter, β is set by the subject so that the most relevant stimulus categorization will receive a high bias and irrelevant stimulus categorizations will receive a low bias. These two parameters are then further modified by the weight (w_x) which in turn is held in relation to the sum of the combined weights of the elements in the visual field (Σw_z).

Equation 2

The value of the attentional weights are calculated on the basis of two elements: 1) again the strength of the sensory evidence, and; 2) the pertinence of the object. As with the rate equation, η values are calculated on the basis of a template-matching. In this equation, the sum of η that x belongs to category i is modified by the pertinence (π_j) of a given feature of the stimulus.

Central equations of TVA

$$v(x,i) = \eta(x,i)\beta_i \frac{w_x}{\sum_{z \subset S} w_z}$$

Equation 1: The Rate equation of TVA or the categorization of objects (Bundesen, 2005).

$$w_x = \sum_{j \subset R} \eta(x,i)\pi_j$$

Equation 2: The Weight equation of TVA or the selection for features (Bundesen, 2005).

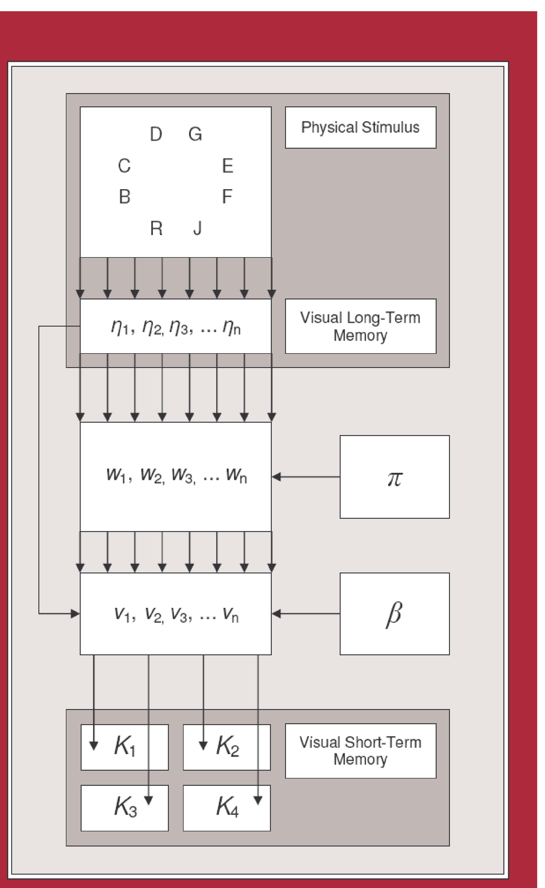

FIG 1: Graphical representation of the TVA model.

Block and Bundesen

If we look back at the study by George Sperling (1964), what happens in TVA terms is that the letter matrix is matched up with representations in long-term memory. Because, however, visual short-term memory has a limited capacity, only the winners of the stochastic race are accessible for report. Thus access and phenomenal consciousness seem to correspond to different stages in TVA. Furthermore, TVA would predict phenomenal consciousness without access consciousness but not the other way around, thus supporting the real-world examples of Block. It seems that what we experience as phenomenal consciousness corresponds to very early visual template-matching (η), and access consciousness, in turn, corresponds to our visual short-term memory capacity (K elements).

CATEGORY LEARNING

Whilst most people would agree that access consciousness plays a vital role in selection (e.g. Baars & Franklin, 2003), fewer seem to view phenomenal consciousness as a selection mechanism, regarding it instead as a mysterious "extra" dimension to cognition. Some investigations in risk-taking behaviour, however, have shown that optimal solutions can be learned without any explicit *access* to the rules – only a phenomenal awareness of the right choices that cannot be explained in words (e.g. Bechara *et al.*, 1994, 2000).

In a different range of studies, moreover, Gregory Ashby and colleagues (e.g. 2005) have elegantly shown that subjects use different cognitive systems in different learning tasks. Subjects are shown different stimuli (see fig. 3 and 4 for examples) and they are then instructed that the stimulus belongs to either category A or B. In the rule-based task, subjects have to learn one feature, e.g. bar width (fig 3). In information-integration tasks, however, subjects have to integrate more than one feature and it is not possible to make any explicit or meaningful rule to describe what belongs to category A or B - e.g. "if bar width is less than orientation, then assign category A" (fig 4). Although subjects cannot access any explicit rule in this task, they still have a *phenomenal* feeling of the correct category.

Rule-Based Category Learning

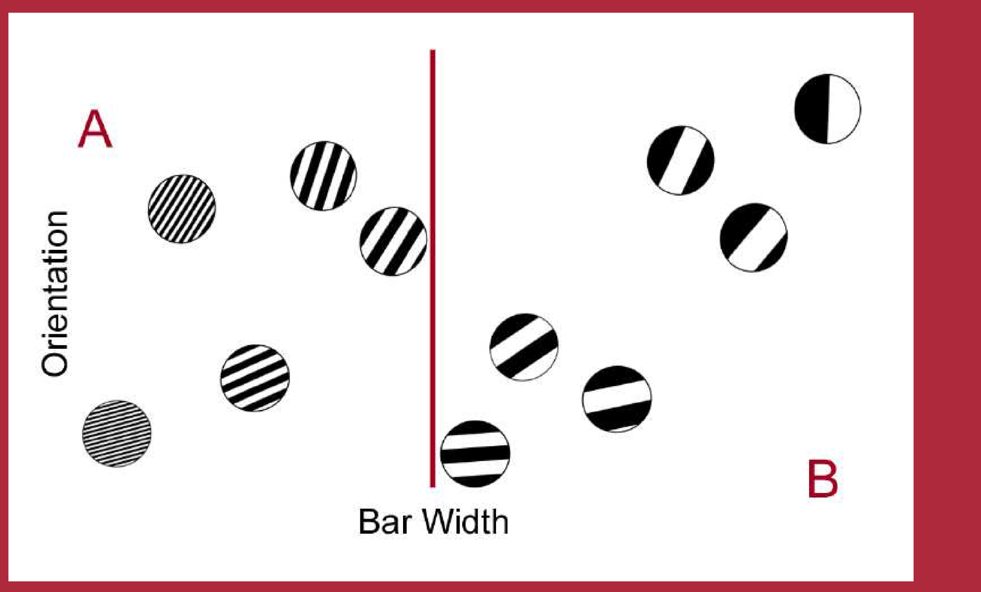

FIG 3: Example of a Rule-Based Category Learning task (adapted from Ashby & O'Brien, 2005).

Information-Integration Category Learning

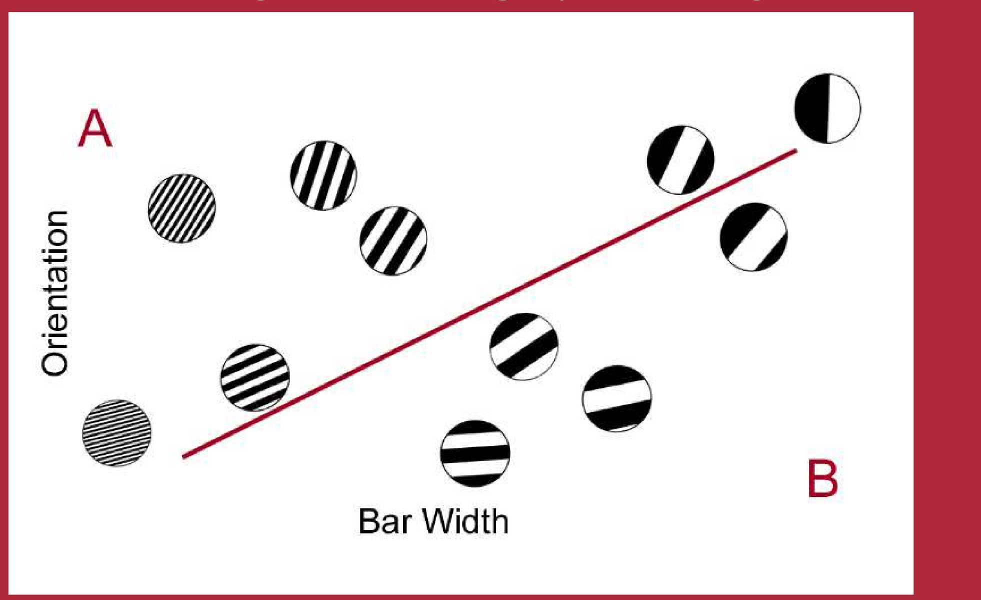

FIG 4: Example of a Information-Integration Category Learning task (adapted from Ashby & O'Brien, 2005).

Furthermore, different brain regions seem to underlie different types of category learning. Rule-based learning has been associated with the prefrontal cortex and the basal ganglia, whereas information-integration tasks have been associated with the basal ganglia only.

CONCLUSION

In this paper, I have proposed that an attentional model like TVA can be used as an accurate model for access consciousness. Furthermore, if models like TVA are extended to include a description of category learning, then we might even make progress on the harder problem of phenomenal consciousness.

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