Unveiling the Cognitive Mechanisms of Eyes: The Visual Sensor Vs. the Perceptive Browser of the Brain

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ABSTRACT

Eyes as the unique organ possess intensively direct connections to the brain and dynamically perceptual accessibility to the mind. This paper analyzes the cognitive mechanisms of eyes not only as the sensory of vision, but also as the browser of internal memory in thinking and perception. The browse function of eyes is created by abstract conditioning of the eye’s tracking pathway for accessing internal memories, which enables eye movements to function as the driver of the perceptive thinking engine of the brain. The dual mechanisms of the eyes as both the external sensor of the brain and the internal browser of the mind are explained based on evidences and cognitive experiences in cognitive informatics, neuropsychology, cognitive science, and brain science. The finding on the experiment’s internal browsing mechanism of eyes reveals a crucial role of eyes interacting with the brain for accessing internal memory and the cognitive knowledge base in thinking, perception, attention, consciousness, learning, memorization, and inference.

Keywords: Artificial Intelligence, Cognitive Computing, Cognitive Informatics, Cognitive Mechanism of Eyes, Cognitive Model, Eye Movement, Human Sensory, Internal Browser, Memory Access, Perception, Thinking Engine, Vision

1. INTRODUCTION

Eyes are commonly recognized as the window of the mind and eye movement is the primary sign of life in neuropsychology and cognitive science, because over 70% of the sensory information to the brain is captured by the vision receptors of eyes (Marieb, 1992; Smith, 1993; Sternberg, 1998; Reisberg, 2001; Carter et al., 2009; Wang, 2003b, 2005, 2009c, 2009d, 2012b, 2013; Wang et al., 2006). Among the five primary sensors such as vision, hearing, smell, taste, and touch, eyes transfer the largest portion of sensory information greater than the sum of others. Eyes are featured as the only sensory that possesses both direct connections to the central nervous system of the brain via three neural pathways known as the sensory, motor, and tracking pathways. The other sensors have only part of them or are not directly connected to the central nervous system rather than being relayed by the pons before entering the brain (Marieb, 1992; Coren et al., 1993; Woolsey et al., 2008; Wang, 2003b, 2012b, 2013).

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The visual information captured by eyes is represented in symbolic or semantic forms in the brain after being processed (Hubel & Wiesel, 1979; Pinel, 1997; Sternberg, 1998; Wang, 2009c). Hubel and his colleagues discovered in 1959 that the basic unit of vision is a bar-like area known as hypercolumns (Hubel & Wiesel, 1959, 1979) where an image frame is represented by a set of $50 \times 50$ hypercolumns. The size of a visual frame has been calibrated as about 2,363 pixels according to the property of the invariant resolution hat is inversely proportional to the distance of visual objects (Wang, 2009e), although there are about 125 million visual sensory nervous in the eye (Marieb, 1992; Carter et al., 2009).

There are a number of fundamental questions yet to be answered in order to rationally explain the brain identified in cognitive informatics (Wang, 2002, 2003a, 2006, 2007a, 2012a, 2012d, 2014; Wang & Fariello, 2012; Wang et al., 2009a, 2009b) and abstract intelligence (2008, 2009a, 2010a) such as follows:

- How does the brain physiologically carry out thinking and perception?
- How are thinking and perception controlled and directed in the mind?
- Are all thinking mechanisms consciously or intentionally controllable?
- What is the role of eye movement for browsing and accessing the internal cognitive knowledge base in thinking?

The cognitive mechanisms of eyes beyond its conventionally recognized roles as for vision sensory are a key for seeking answers to the above list of fundamental questions about the brain and the mind, because almost all answers to them pinpoint to the eyes as both the visual sensor and the perceptual browser of the mind as the 6th sense of human brain.

Recent investigations into the cognitive functions of eyes have led to the discovery of the eye’s perceptual browser mechanism for internal memory access in mental processes (Wang, 2003b, 2012b; Wang & Wang 2006). This finding is in line with the principles of abstract intelligence and general real-time systems where almost all system behaviors are triggered by three types of external stimuli known as trigger, timing, and interrupt events (Wang, 2009a, 2009b; Wang et al., 2013). So do the brain and the mental processes where eye movements play a crucial cognitive role as the perceptual driver in attention, memory access, and thinking.

This paper presents the cognitive mechanisms of eyes as both the visual sensory of the brain and the perceptual browser of the mind. It focuses on the internal and perceptual cognitive mechanisms of eyes. A fundamental hypothesis on the perceptual browsing mechanism of eyes is introduced, which is supported by evidences and experiments on eye movements, thinking, and sleeping in neuropsychology and cognitive informatics. In the remainder of this paper, the neurophysiological and cognitive foundations of eyes are described in Section 2 based on anatomic structures of eyes, visual nervous, motor control muscles, and the sensory receptors of vision. On the basis of the anatomic and cognitive models, the triple pathways of eyes known as those of sensory, motor, and tracking are analyzed. Cognitive mechanisms of eye browsing functions are elaborated in Section 3 based on the theory of abstract conditioning between eye movements and internal memory access. The cognitive functions of eye movements are contrasted in the conscious and unconscious modes. The internal browsing mechanism of eyes via abstract conditioning explains a wide range of cognitive roles of eye movements in thinking, perception, attention, consciousness, learning, memorization, and inference.

2. THE COGNITIVE MODEL OF EYE MOVEMENT

The cognitive functions of eyes play a central role in explaining the brain and human senses. This section explores the neurophysiologic and cognitive foundations of eyes. The functional model of eye movement and the triple pathways of eyes are analyzed based on the anatomic model of eye control.
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