Editor's Note

Attention as a Cognitive Neurosystem

An important contribution of cognitive neuroscience during the last 15–20 years has been an explication of attention at the cellular (Wise & Desimone, 1988) and neurosystem levels (LaBerge, 1990). The theme of this issue of the Journal and of the Oregon Center is a view of attention as involving specific computations carried out by networks of defined anatomical areas (see LaBerge, 1990; Posner & Petersen, 1990). This view conceives of attention in much the same way as the study of the visual system as involving anatomy, circuit tracing, development, and pathologies. In this issue of the Journal we present studies that build on the network idea to understand how adults perform skilled tasks (word reading, velocity perception), how attention develops, and the nature of attentional pathologies. This issue also summarizes progress in the major effort by our Center to examine the degree of convergence between different methodologies (PET, ERP, cognitive tasks, development, lesions) for linking cognition to neurosystems. In addition to the work described here our Center is also working to develop methods to understand attentional mechanisms at cellular and synaptic levels.

There is considerable evidence that attention amplifies visual computations as involving color, form, motion, and even visual word forms (Corbetta, Miezin, Dobmeyer, Shulman, & Petersen, 1990; Mangun & Hillyard, 1990). PET studies suggest very specific areas of the occipital lobe are activated by words but not by letter strings and portions of the frontal lobe are activated when subjects categorize words (Petersen, Fox, Posner, Mintun, & Raichle, 1989; Petersen, Fox, Snyder, & Raichle, 1990). Our first two papers build on these PET findings, by use of reaction time and scalp electrical signals to determine how attention interacts with word processing in real time. The two papers (Compton, Grossenbacher, Posner, & Tucker; Nakagawa) confirm aspects of the PET anatomy and suggest how attention influences the activation of semantic information.

Three papers deal with computations performed by the attention system when orienting toward visual stimuli. These computations involve a vertical network that includes the superior colliculus. By patching one eye in normal subjects it is possible to explore collicular contributions to attention shifts as is done by Rafal, Henik, and Smith. Sustaining attention over time appears to involve dominance by the right cerebral hemisphere. Whitehead shows how this asymmetry emerges in normals and Rothlind, Posner, and Schaughency explore deficits found in children that they attribute to problems in this vigilance network.

Is the attentional system fully present at birth or does it mature during infancy? The ability to disengage from a visual stimulus (Johnson, Posner, & Rothbart) and the tendency to inhibit a return to already inspected locations (Clohessy, Posner, Rothbart, & Vecera) are major computations of the posterior attention system that appear to develop between 3 and 6 months. On the other hand, the voluntary control of overt movement seems to involve more anterior attention mechanisms that develop later (Vecera, Rothbart, & Posner).

There are very close connections between attention networks and mechanisms controlling voluntary actions. The cerebellum has long been thought of as part of the motor system, but Ivry and Diener show clearly that it is also involved in visual perceptions that require timing operations. These new insights into the computations of the cerebellum and basal ganglia are applied by Lundy-Ekman, Ivry, Keele, and Woollacott to diagnosing clumsiness in children.

These ten papers illustrate how accumulating knowledge in cognitive neuroscience can be applied to illuminate questions of how complex skills are performed by normal adults, how they develop in infancy, and their pathologies. We realize the importance of continuing to develop methods for probing mechanisms of attention at the cellular and synaptic levels. However, we think this issue shows it is also of value to explore how these attentional networks can influence central aspects of human thought and behavior.

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