Section 3: Memory and Higher-Order Cognition

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The central thought preoccupying our conscious experience can vary greatly from moment to moment. At one moment we are preoccupied with trying to remember where we left our keys; at another moment we are wondering why the traffic seems slower in our lane. Just as varied are the different approaches taken to studying how the brain enables the higher-order thinking that leads to these conscious experiences. This section highlights a sampling of those approaches; using event related potentials (ERPs) to study various elements of remembering the past (Graham & Cabeza), using functional magnetic resonance imaging (fMRI) to study anatomical differences between memory and decision making (Miller, Handy, Cutler, Inati, & Wolford), using ERPs to study how we semantically integrate spatial reference frames (Taylor, Faust, Sitnikova, Naylor, & Holcomb), and comparing nonhuman primates to young children in order to study our drive to seek explanations (Povinelli & Dunphy-Lelii). Each contribution builds on what we know about our conscious experiences by asking new and interesting questions.

We know that remembering the past involves retrieval of specific items from an event as well as retrieval of the context of an event. We also know from previous patient and neuroimaging studies that a particular brain region may be more associated with item retrieval, whereas other regions may be more associated with context retrieval. Many of these studies rely on word recognition. Graham and Cabeza (this volume) contribute an ERP study that investigates the electrical signatures of item and context retrieval of faces. They suggest that a parietal ERP effect implicates medial temporal lobe involvement in item retrieval, whereas a frontal ERP effect implicates prefrontal cortex involvement in context retrieval.

We know that retrieving the past produces specific patterns of blood-flow activations in the prefrontal cortex. Regions of the prefrontal cortex are differentially activated depending on the retrieval manipulation, such as making the retrieval task more effortful or more successful. We also know that retrieval is influenced by factors other than memory, such as the bias to respond in a particular manner. Yet, little is known about blood-flow activations associated with manipulations of decision criteria on a recognition test. Miller et al. (this volume) contribute a fMRI study that independently manipulates decision criterion and memory strength. They demonstrate that brain regions associated with criterion shifts are anatomically distinct from regions associated with memory-based retrieval processes.

We know that judgments about the spatial relationship between objects are either egocentric (i.e., relative to our own coordinate position), or intrinsic (i.e., relative to the object's coordinate position). Often egocentric reference frames contradict intrinsic reference frames leading to ambiguous situations (e.g., saying that object A is to the right of object B may be judged as either to your right or object B's right). We also know that semantic anomalies evoke a specific electrical potential, known as the N400 component. The connection between these two bits of knowledge is not immediately obvious. Yet, Taylor et al. (this volume) have made the connection in an ERP study that measures evoked potentials underlying reference frame processing. They found a larger N400 component when reference frames other than intrinsic ones were used, suggesting that reference frames are semantically integrated and that intrinsic reference frames require less cognitive processing than egocentric reference frames.

We know that humans are driven to seek explanations. We seem to have a fundamental psychological need to find causal relationships between events, whether the events are observable or not. And we know that this psychological need develops very early in humans. A child seems to learn to ask "why" soon after learning to speak. What we do not know is whether this drive is uniquely human. Many researchers debate the mental states and causal thinking of nonhuman primates. In their contribution to this

section, Povinelli and Dunphy-Lelii test both chimpanzees and 5-year-old children on whether they seek to find a cause for the failure of a simple task. Although both species fully explore the objects used in the task and persist in completing the task, only the human children seem to seek an explanation for the failure of the task. The authors postulate this difference between species as parallel paths in evolution, one system developing an explanatory drive and the other system developing something more dependent on object exploration and manipulation.

Our memory of the past, our relative position in the world, our unique drive to seek explanations, are all critical components of our conscious experience. The intent of this section is to demonstrate the variety of techniques used to examine the relationship between the mind and the brain, and, more importantly, to demonstrate how the conscious experience is being explored in new and interesting ways.