How the brain copes with shifty eyeballs

April 18 2007

Neurobiologists have pinpointed brain regions critical to one of the brain's more remarkable feats—piecing together a continuous view of the world by integrating snippets of visual input from constantly moving eyes. Since the eyeball has only a narrow field of clear view, it must continually make tiny shifts to sample the visual world. And during these shifts, which last thousandths of a second, people are essentially blind.

Marvin Chun of Yale University and colleagues published their studies in the April 19, 2007 issue of the journal *Neuron*, published by Cell Press.

The researchers' experiments with human volunteers used an illusion known as "boundary extension" to establish brain regions involved in piecing together scenes. In boundary extension, the brain tends to perceive more of a visual scene than is actually presented—a critical ability if the brain is to stitch together a continuous visual world from discontinuous snippets of a scene transmitted from the eyes.

The boundary extension illusion means that if people are presented with a close-up view of a scene followed by a wider view, they will not notice the difference. Their brains have already "assumed" the wider view, and they falsely remember it. On the other hand, people shown a wider view first will readily notice the appearance of the close-up view.

In their experiments, the researchers showed subjects paired scenes in which a close-up view was followed by a wider view, or in which a wider view was followed by a close-up view. They also showed the subjects paired scenes in which the same close and wider views were presented twice. The repeated pairs acted as controls to test whether only presentation of scenes would cause a response.

As the subjects were viewing the scenes, their brains were scanned using functional magnetic resonance imaging. In this technique, harmless radio waves and magnetic fields are used to image blood flow in brain regions, which reflects brain activity.

The researchers concentrated on two brain areas known to process visual information in scenes—the "parahippocampal place area" (PPA) in the medial temporal lobe and the "retrosplenial cortex" (RSC) in the cerebral cortex.

If these two areas are involved in extrapolating scenes, the researchers reasoned, they should see an attenuation of activity in these regions when subjects were presented with close-wide pairs, indicating that these brain areas were initially performing a boundary extension such that the close view was "remembered" as the wide view. In contrast, the PPA and RSC should show no attenuation of activity when presented with wide-close pairs. The researchers found that the two brain regions, indeed, showed activity patterns consistent with their involvement in the brain's process of "extending" the scenes.

In contrast, another area of the brain involved in processing images of objects showed attenuation of activity in response to all of the scene pairs. That finding, said the researchers, showed that the processing of scenes does not extend to other brain areas responsible for processing objects or surfaces.

Chun and colleagues concluded that their findings "provide novel evidence that high-level visual mechanisms extrapolate spatial layout beyond the confines of a given view." They wrote that "Extrapolation of layout may thus provide a means by which the visual system can integrate discrete samples of surrounding space that are drawn from successive movements of the eyes and head, enabling perception of a richly detailed and continuous world."

Source: Cell Press