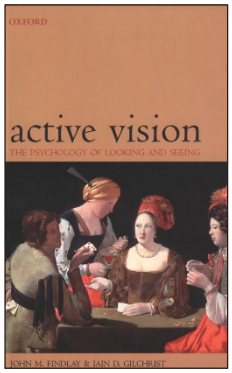
The eyes have it



Active Vision: The Psychology of Looking and Seeing

by John M Findlay and Iain D Gilchrist

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Reviewed by Melvyn A Goodale

Cognitive neuroscientists, emboldened by recent and spectacular successes in functional brain imaging, are a rather confident lot. Almost every day, leading journals, including *Nature Neuroscience*, publish new findings about how the brain enables us to perceive, think and make decisions. These findings also feature prominently in popular science magazines and TV documentaries. Cognitive neuroscientists appear to be making real progress in understanding the workings of our inner mental life, and how our brains make that inner life possible. But in all this excitement, we sometimes forget that the ultimate reason we have brains is not so much to think about the world as it is to act upon it. Our thoughts can affect the world only insofar as they affect our actions.

It is a particular version of this idea that motivates Findlay and Gilchrist's new book, *Active Vision*. To understand the dynamics of seeing, they argue, it is necessary to look directly at how people move their eyes. After all, we spend a good part of our waking lives moving our gaze around the scene before us, trying to make sense of what we see. We have active vision. Yet the history of research on vision has largely ignored this basic fact and has instead treated the visual system as a passive recipient of incoming information—a reactive rather than a proactive system that simply registers objects and events rather than seeking them out. Even when researchers study how we move our attention from one location to another in the visual world, they often concentrate more on mental rather than physical shifts of attention. In other words, researchers have been studying covert rather than overt attention. But Findlay and Gilchrist are not interested in simply redressing the balance by emphasizing the need for work on overt shifts of attention; they want to put eye movements, particularly saccades, at the center of what they call a 'theory of vision'. It is their contention that visual perception (and cognition in general) is shaped by the way in which our saccadic activity extracts visual information from the world. This is a bold claim, but one that they defend with data from a broad range of studies from neuropsychology to psychophysics.

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A good part of the early chapters of *Active Vision* is devoted to discussing the issues and theoretical ideas surrounding the relationship between shifts of attention and shifts of gaze. Findlay and Gilchrist discount those theories that have suggested that the brain mechanisms mediating shifts of attention are functionally distinct from those generating saccades. Instead, they put forward a view not dissimilar to a premotor theory of attention, which argues that a covert shift of attention to a stimulus is nothing more than activity in brain systems that are preparing to generate a saccade. After all, as Findlay and Gilchrist point out, the most common way that we shift our visual attention from one thing to another is by shifting our gaze, an action that puts the object of interest on the fovea, the part of the retina with the greatest acuity. Of course, as they acknowledge, some sort of attentional modulation of processing of a peripheral target must precede the shift in gaze; otherwise, we would not move our eyes toward the stimulus. But rather than seeing this as evidence that covert attention is primary, Findlay and Gilchrist argue that covert and overt attention are "inextricably linked" and are both essential components of active vision.

In later chapters, Findlay and Gilchrist marshal an impressive array of evidence that highlights the crucial role of active vision in human activities from reading to looking at natural scenes. But what is most remarkable is that Findlay and Gilchrist actually manage to keep all of this interesting. Let's not forget that this is a book about eye movements—one of the most stolid subjects in all of cognitive neuroscience—so keeping the reader engaged is in itself quite an achievement!

One of the most fascinating things that Findlay and Gilchrist discuss is the case of AI, a woman who cannot move her eyes. Despite the fact that her eyes have been paralyzed by peripheral damage since she was an infant, AI shows a pattern of overt shifts of attention that mirrors that seen in individuals who have normal control over their eye movements. It's just that when AI shifts her attention, she moves her head instead of her eyes. Although there are some things that AI clearly cannot do, such as converge her gaze on a close object, she manages quite well without being able to move her eyes. Nevertheless, the fact that she routinely uses head movements to shift her gaze underscores the importance of overt attention in the processing of visual information. Just as is the case for most of us, overt and not covert attention is her modus operandi.

In developing a theory of active vision, Findlay and Gilchrist have completed the thinking–action cycle. As emphasized earlier, an isolated thinking brain is of little use. Only by causing us to act can our thoughts have consequences (and thus be subject to natural selection). Findlay and Gilchrist also remind us that our actions in turn influence our percepts and the thoughts they engender. The movements of the eyes and head determine where we are looking, how images flow across the retina and how the images on the two retinas are aligned. Thus, the patterns of eye movements we generate have profound implications for how we see the world and act upon it. One hopes that Findlay and Gilchrist's book will encourage cognitive neuroscientists to study active vision—and to move beyond the passive models of visual processing that have characterized most of the research in this field. ■