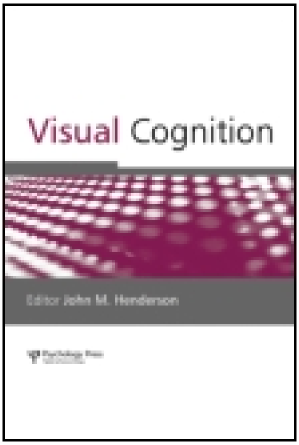

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Introduction to “Computational Approaches to Reading and Scene Perception”

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Introduction to "Computational Approaches to Reading and Scene Perception"

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What we see and understand about the visual world is tightly tied to where we direct our eyes. High-resolution visual information is acquired from only a very limited region of the scene surrounding the fixation point, with the quality of visual input falling off precipitously from central vision into a low-resolution visual surround. The high resolving power of central vision is partly a consequence of the optical and anatomical structure of the eye and retina. It is also the result of preferential mapping of central vision onto visual cortex, ensuring that more computational power is devoted to fixated regions. There is also a very tight link between internal attentional systems and fixation. Although the focus of covert visual-spatial attention can be dissociated from where the eyes are fixated, attention is typically tightly tied to fixation. This relationship between internal attention and eye gaze appears to be mandatory, in part due to the tight neural integration of systems that control covert attention and those that control eye movements. Because of this tight integration, fixation location and duration provide a readily measured reflection of the allocation of attention. Indeed, eye movements are often referred to as overt attention.

Over the past several years an explosion of research has been directed towards understanding how overt attention is directed in real time through complex visual stimuli and real-world tasks, including reading, visual search, and scene perception. This work has brought together new eyetracking methods with sophisticated computational modelling and simulation. The

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focus of this enterprise has been to develop theories of eye movement control that can account for the messy complexities of real-world viewing behaviour. The present Special Issue of *Visual Cognition* brings together cutting-edge research from eight research groups around the world whose work is focused on these important topics. The goal of this Special Issue is to facilitate a constructive convergence of theory and data.

The vast majority of papers in this Special Issue measure and model attention as an overt process. That is, they focus on the control of eye movements as a behavioural extension if not homologue of the attentional system. This approach is consistent with the more general metatheoretical perspective that visual and cognitive systems are actively deployed in the service of the current task, and that this deployment is fundamentally related to active information seeking. This is not to say that the models reported here discount covert attention. Many of the models give an explicit role to covert and internal attentional systems and describe precise relationships between covert and overt attention. Nevertheless, the modelling across the contributions tends to be focused particularly on the control of overt attention.

The first three papers in the Special Issue start from the perspective of the control of eye movements in reading. The two leadoff papers describe extensions and amplifications of two of the most prominent models of eye movement control in this domain, the E-Z Reader model and the SWIFT model. The competition between these two models has led to some of the most vigorous debates and greatest advances in the eye movement control literature. In "Eye Movements in Reading versus Nonreading Tasks: Using E-Z Reader to Understand the Role of Word/Stimulus Familiarity", Erik Reichle, Keith Rayner, and Alexander Pollatsek explore the general role of familiarity in the E-Z Reader model. Next, Daniel Schad and Ralf Engbert report on "The Zoom Lens of Attention: Simulating Shuffled versus Normal Text Reading Using the SWIFT Model". Both of these papers represent important attempts to extend central models initially developed to account for the control of attention and eye movements in reading to other domains. These studies represent important new explorations of these models. The final paper in this trio, "The Utility of Modelling Word Identification from Visual Input within Models of Eye Movements in Reading", reported by Klinton Bicknell and Roger Levy, further explores eye movement control in reading by focusing specifically on the nature of contextual constraint in controlling eye movements.

The next two papers in the Special Issue switch gears from reading to scene perception. The paper by Antje Nuthmann and John Henderson represents a transition between the reading and scene perception topics. In their paper, "Using CRISP to Model Global Characteristics of Fixation Durations in Scene Viewing and Reading with a Common Mechanism", the authors explore whether a common framework represented by the CRISP model can account for aspects of eye movement control in both of these domains. The following paper by Michael Dorr, Eleonora Vig, and Earhardt Barth seeks to extend the work on eye movement control even further, with an investigation of eye movement control in dynamic images as represented by video. The issue of eye movement control in moving images is in its formative stages, and this paper, "Eye Movement Prediction and Variability on Natural Video Data Sets", is an important contribution in laying the groundwork for what is likely to become a highly active research area in the coming few years.

The final three papers in the Special Issue drill down into specific critical issues in eye movement control. In the paper "TAM: Explaining Off-Object Fixations and Central Fixation Tendencies as Effects of Population Averaging during Search", Greg Zelinsky reports an application of the TAM model to the specifics of fixation locations during visual search. Along with reading and scene perception, visual search is an important test-bed for models of attention and eye movement control. Next, Tom Foulsham and Alan Kingstone present work investigating how central and peripheral vision contribute to eye movement control during scene viewing. This work, reported in "Modelling the Influence of Central and Peripheral Information on Saccade Biases in Gaze-Contingent Scene Viewing", explicitly attempts to account for eye movement biases when viewers are restricted by gaze-contingent moving windows, a popular method used in this literature. Finally, Sophie Marat and Laurent Itti investigate the topic of contextual constraint in object perception within scenes. This work, reported in "Influence of the Amount of Context Learned for Improving Object Recognition When Simultaneously Learning Object and Contextual Cues", harkens back to the paper by Bicknell and Levy in reading and represents a fertile general area for future exploration across both reading and scene perception.

In sum, all the papers in this Special Issue of *Visual Cognition* use a convergence of behavioural data and computational modelling to explore the fundamental nature of attention control, and particularly eye movement control, in viewing complex visual input. These papers start with the fundamental idea that both the meaning of the visual stimulus and the nature of the viewing task are key to this understanding.