Eye movements during Chinese reading

Simon P. Liversedge
University of Southampton, UK

Jukka Hyönä
University of Turku, Finland

Keith Rayner
University of California, San Diego, USA

Chinese written language is different from alphabetic written languages in many respects, and for this reason, interest in the nature of the cognitive processes underlying Chinese reading has flourished over recent years. A number of researchers have used eye movement methodology as a measure of on-line processing to understand more about cognitive processing during Chinese text comprehension. This Special Issue focuses on current eye movement research investigating Chinese reading and this paper provides a brief background to this research area and a concise overview of the papers that appear in the Special Issue.

Over the last 40 or so years, eye movement methodology has been increasingly used to investigate the cognitive processes that underlie reading. Experimental psychologists have long realized that one of the most valuable characteristics of eye movement methodology as a tool to examine reading is that it provides an on-line measure of processing difficulty. When people read they make fixations where the eye pauses and is quite still (usually for about a quarter of a second), followed by saccades which are very fast rotations of the eyes in order to position the point of fixation elsewhere in the text. When people read, they make a succession of fixations and saccades in order to visually process the words of the sentence incrementally from left to right. During a fixation on a word, the reader is cognitively processing that word, as well as partially pre-processing words to the right of the fixated word that lie in the parafovea. Furthermore, when text becomes difficult to read, fixations become longer and readers make more of them. Also, readers may often make regressive eye movements in the text, that is, saccades backwards in the text in order to reread a portion of text that they have already read once. Thus, by conducting carefully controlled experiments and by very accurately measuring the duration and location of fixations in relation to the particular words of sentences, it is possible to establish which portions of a sentence cause a reader difficulty. Furthermore, and very importantly, the eye movement methodology allows insight into the time course of any such processing difficulty.
Of course, this Special Issue is not simply about eye movements and reading per se, but instead is concerned with eye movements and Chinese reading. So, why focus on Chinese reading? Over the last decade or so, there has been something of an explosion of eye movement research investigating Chinese reading. Prior to this period, only a handful of studies had used eye movement methodology to try to understand Chinese text comprehension. However, in 2004, the first China International Conference on Eye Movements (CICEM) was held at Tianjin Normal University. This conference was organised by Professors Deli Shen, Xuejun Bai and Guoli Yan and their aim was to engage researchers from the West in eye movement research in China. A significant proportion of that eye movement research focused on reading, and the Guest Editors of this Special Issue (Liversedge, Hyönä & Rayner) were fortunate to be invited as Keynote Speakers at the first CICEM conference. The conference is biannual, and has taken place regularly after the inaugural event. The quality of the work that is presented at CICEM has improved dramatically over subsequent years and it is fair to say that the work that is presented there now is of a very high standard. Indeed, much of it features eye movement papers on Chinese reading that are published in very high-impact international journals. The eye movement research described in this Special Issue is from researchers who presented their findings at the CICEM conference. In putting the Special Issue together we have tried hard to select good-quality work from the conference to provide a representative sense of the kind of Chinese reading research that is currently underway.

It may not be immediately clear why Chinese reading is receiving so much attention at the moment. One reason that Chinese has been the focus of such an amount of work recently is because the properties of the language allow us to investigate numerous questions that it is simply impossible to investigate in English. Chinese is unspaced, and hence, the issue of how readers compute boundaries between words comes to the fore. Clearly, this issue never arises for spaced languages like English. Chinese is character based rather than alphabetic, meaning that the relationships between orthography, phonology, morphology and semantic meaning are quite different to those that exist for English and other alphabetic languages. There is a wealth of other characteristics of written Chinese that affect cognitive processing during reading in different and often unique ways. Experimental psychologists have realised that this is the case and have therefore started to explore Chinese reading in detail. In fact, research investigating Chinese reading has itself started to define and shape some of the key questions concerning human written language comprehension that remain unanswered in the field.

Six papers are included in this Special Issue, each focusing on a different aspect of reading. All of them use eye movement methodology as a tool to investigate on-line processing. The first paper by Xuejun Bai and his colleagues investigates how adult readers learn new words in Chinese, and particularly whether the insertion of spaces between the words facilitates that learning. The second paper by Jinmian Wang reports an investigation of parafoveal processing in Chinese, that is, the extent to which Chinese readers pre-process upcoming characters in the sentence located to the right of the fixated character. In the third paper, Hsueh-Cheng Wang and his colleagues report an experiment in which they delete portions of Chinese characters in text to see which constituent parts of a character are most important for undisrupted reading. Wei Zhou and his colleagues describe analyses of eye movement data in which they use linear mixed modelling to investigate semantic pre-processing of parafoveal words. This comprises the fourth paper of the set. In the fifth paper, Xingshan Li and Wei Shen report an experiment in which they investigate saccadic targeting to words that have spaces before or after them. Finally, Chuanli Zang and her colleagues report an experiment that, again, investigates saccadic targeting, but in this study
the critical issue concerns whether there is a vertical component to such targeting (in some characters component radicals appear on top of each other) in Chinese reading.

All of these studies are interesting and together they provide a cross-section of some of the work from research groups that are currently most actively involved in eye movement research investigating reading in China. It should be clear from these studies that there is a broad spectrum of work currently underway, that this work is high quality and provides significant insight into aspects of eye movement control during reading. In our view, eye movement research investigating Chinese reading will significantly inform current theoretical understanding of the nature of reading.

In memory of Deli Shen who passed away March 2013.

**Address for correspondence:** Simon P. Liversedge, School of Psychology, University of Southampton, Southampton, SO17 1BJ, UK. E-mail: s.p.liversedge@soton.ac.uk