

Chapter 2

Using Eye Movements to Study Reading Processes: Methodological Considerations

Anne E. Cook
University of Utah, USA

Wei Wei
University of Utah, USA

ABSTRACT

This chapter provides an overview of eye movement-based reading measures and the types of inferences that may be drawn from each. We provide logistical advice about how to set up stimuli for eye tracking experiments, with different level processes (word, sentence, and discourse) and commonly employed measures of eye movements during reading in mind. We conclude with examples from our own research of studies of eye movements during reading at the word, sentence, and discourse levels, as well as some considerations for future research.

METHODOLOGICAL ISSUES

Since the mid-1960's, researchers from education and psychology interested in reading have focused not only on the outcome of reading comprehension, but also on the processes that must take place in order for comprehension to occur. These two aspects of reading comprehension – product and process – are naturally related but tend to be studied with different measures and focus on different aspects of reading comprehension theory (van den Broek & Espin, 2012). Research on reading comprehension outcomes, or the product of reading, largely uses off-line measures that are designed to capture the mental representations encoded in long-term memory after reading has occurred. These may include tests that are designed to assess readers' overall understanding of the information in a text, or tests that specifically assess recall of text information (e.g., Hua & Keenan, 2014; Carlson, van den Broek, McMaster, Rapp, Boh-Gettler, Kendeou, & White, 2014). Studies that focus on reading processes, however, utilize online measures that record differences in processing speed over the course of a text. Information from these

DOI: 10.4018/978-1-5225-1005-5.ch002

measures can then be mapped onto different sub-processes within reading from perception to word-level processing to syntactic analysis to discourse comprehension. These online measures have ranged from relatively general measures of processing time (e.g., reading rate; e.g., Bolanos, Cole, Ward, Tindal, Hasbrouk, & Schwanenflugel, 2013; Hiebert, Samuels, & Rasinski, 2012; Veenendaal, Groen, & Verhoeven, 2015), to more specific measures that allow for a fine-grained view of what occurs during reading (e.g., word or sentence reading time; Cook, Myers, & O'Brien, 2005; Mitchell, 2004; Taraban & McClelland, 1998). Eye tracking based measures of reading behavior, which will be the focus of our chapter, provide the most detailed view of moment-by-moment processing, mapping readers' fixations and their durations and locations onto specific words and phrases within a text to allow researchers to draw inferences about the cognitive processes that occur during reading.

According to Rayner (1978; see also Rayner, Pollatsek, Ashby & Clifton, 2012), eye movement research in reading has experienced three eras. The first was from 1879 to 1920, when researchers investigated basic characteristics of eye movements. Early work was conducted by Huey (1908), who provided the foundation for much of what is known today about eye movements during reading. These early studies used tachistoscopes (affectionately termed t-scopes) to control the amount and duration of exposure of a stimulus to a participant. Through clever experimentation, Huey and others (e.g., Cattell, 1886; Erdmann & Dodge, 1898) revealed critical information about readers' perceptual span and basic word recognition processes (for a review, see Rayner et al., 2012). The second era of eye movement research fell between 1920 and 1960, during the behaviorist revolution in psychology, and focused more on observable applications of eye movements, with less attention toward understanding the underlying processes involved in reading. Instead, research was oriented more toward use of eye movements as measures of reading ability (e.g., Anderson & Swanson, 1937; Luckiesh & Moss, 1941; Tinker, 1936).

Rayner (1978; Rayner et al., 2012) claimed that the third era began in the 1960's, with the onset of the cognitive revolution in psychology (see Chomsky, 1957; 1959), and continues to the present day. Modern eye movement research in reading has focused on the cognitive processes involved in several sub-components of reading, as well as how these processes may be influenced by both individual variables (e.g., age, reading skill, native language, etc.) and text variables (e.g., orthography, word frequency, predictability, etc.). After perception processes, the cognitive sub-components of reading can be loosely categorized into the areas of: word recognition, syntactic processing, and discourse comprehension. The remainder of this chapter focuses on methodological issues associated with the use of eye movements in these three areas of reading research. Our goal is to provide an overview of eye movement-based reading measures and the types of inferences that may be drawn from each. We will provide some logistical advice about how to set up stimuli for eye tracking experiments, with different level processes (word, sentence, and discourse) and commonly employed measures of eye movements during reading in mind. We will conclude with some examples from our own research of studies of eye movements during reading at the word, sentence, and discourse levels.

Eye Movements during Reading: Basic Characteristics and Measures

In order to understand how eye movements of reading are measured, it is first important to review some basic properties of eye movements. This includes information about fixations, saccades, and the perceptual span. Our review of this information is considerably condensed; for a more thorough review of these topics, see Rayner et al. (2012).

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