Chapter 4
Eye Movement Behavior and Individual Differences in Word Identification During Reading

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ABSTRACT

This chapter provides an overview of how the observation of eye movement behavior can be used to study how words are identified during reading in different populations. The chapter begins with a discussion of different eye movement behaviors, the perceptual span, and parafoveal processing. After providing the reader with a basic understanding of terms and methodology, the authors discuss how eye movements in reading change across the lifespan, individual differences in eye movement behavior in lower-skill and higher-skill adult readers, and eye movement patterns in special populations. This discussion highlights what is known about changes in eye movement behaviors from developing readers to older adult readers. It also includes a discussion of the role of eye movements in dyslexia and eye movement behavior in readers who are deaf.

INTRODUCTION

For more than 100 years, researchers have been studying eye movement behavior in order to understand the cognitive process involved in reading (Huey, 1908). Over this time, advancements have been made in our methodologies, theories, and understanding of reading. Early reading researchers would peer over the shoulders of participants to observe eye movements in a mirror. Today, researchers have sophisticated eye-tracking technology that measures eye positions 1,000 times per second. Early researchers barely understood the connection between eye movements and cognitive processing, but advanced computational models are now used to explain the connection between the two. The purpose of this chapter is to provide the reader with a broad understanding of how the observation of eye movement behavior can

be used to study word identification in reading, how this process changes across the lifespan, and how this process is different for special populations.

The chapter begins by providing the reader with basic information about fundamental eye movement behaviors, the perceptual span, and parafoveal processing. These topics are the basis for many of the individual differences in eye movement behavior in different populations. The second part of the chapter includes a discussion of differences in developing readers, less-skilled readers, and older adult readers, as well as the role of eye movements in dyslexia and eye movement behavior in readers who are deaf.

BASIC EYE MOVEMENT BEHAVIORS

Many of our eye movements involve gliding movements similar to when we watch a bird fly across the sky. These smooth pursuit eye movements are used to track objects in our environment (Robinson, 1965). However, when we are reading, instead of gliding, our eyes make short quick movements, which are ballistic in that they cannot be changed once they are initiated (Rayner & Pollatsek, 1989). These ballistic movements are referred to as saccades. Fixation is the term used to describe when the eyes briefly stop on a word in order to process the available information. Most fixations during skilled silent reading last from 100ms to 500ms, averaging 250ms. However, this can be impacted by many factors. After a fixation is made, the eyes must move, or make a saccade, in order to make a new fixation. Saccades happen very quickly and take about 25-30ms to execute. Each saccade generally moves the eyes forward about seven to nine characters (Rayner & Pollatsek, 1989). Again, this can be impacted by many factors. When a saccade is made, no new visual information is encoded, even if something new is flashed on the screen during the saccade (Wolverton & Zola, 1983).

Most saccades move the eyes forward in the text to process new information. However, the eyes move backwards about 10% of the time to re-process information. This backwards saccade is referred to as a regression. Regressions are often made when a word or phrase has been misidentified or the wrong meaning was selected (Folk & Morris, 1995; Frazier & Rayner, 1982; Rayner & Frazier, 1987). One common type of sentence that causes regressions is a garden-path sentence. Garden-path sentences contain ambiguous phrases that are often misinterpreted during the first pass through the sentence. A disambiguating region in the sentence contains information that lets readers know that they selected the wrong interpretation. The sentence below is a garden-path sentence:

The government plans to raise taxes were defeated.

In the first pass through the sentence, you most likely read the word *plans* as a verb. However, once you encountered the disambiguating word *were* you had to reinterpret the word *plans* to be a noun. The eye movement behavior would have likely showed a regression out of the word *were* and into the word *plans* so that it could be reinterpreted correctly.

Recent research indicates that regressions are essential for comprehending and understanding text. Schotter, Tran, and Rayner (2014) had participants read ambiguous garden-path sentences that often cause confusion, as well as sentences with an unambiguous syntactic structure. They used a novel method called the trailing mask paradigm, which is a type of gaze-contingent eye-tracking method. In gaze-contingent designs, what is presented on the screen depends on where the reader is fixated. In the trailing mask paradigm, once readers have moved their eyes forward in the text, all characters to the left of the fixation are replaced with Xs. Therefore, if a reader makes a regression back to confusing

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