Science Education Collection

Eye Tracking in Cognitive Experiments

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Abstract

Eye tracking as the name suggests involves tracking of eye-movements. It is a non-invasive, sensitive tool that quantifies and measures eye-movements to describe an individuals' cognitive state. An eye-movement between two fixation points is called a saccade, which is one of the fastest motor movements in our body. By observing the profiles of these eye movements, scientists can better understand neural deficits in patients with cognitive impairments.

In this video, we will first look at an overview of different eye movements that eye tracking can capture and the type of data that can be collected. Then, the basic setup and experimental design are reviewed, including different types of eye trackers and details to optimize the eye tracking equipment. Finally, we will take a look at a few specific experiments utilizing eye tracking as a tool to study cognition.

Transcript

Eye tracking is one of the most useful methods in behavioral research for studying cognition. This method is a non-invasive tool that provides highly sensitive information about deficits in cognition, which are common in neurological disorders. This video will provide an overview of the eye-tracking method, the types of eye-movements typically measured, and the use of this tool in different areas of research.

Let's begin by learning a couple types of eye-movements that eye-tracking captures. The eye makes the fastest movement in your body, which is called a saccade. A saccade, shown by the blue lines, can be made in any direction, typically moving from one fixation point to another, on a millisecond timescale. Once a task is completed, the total duration of each fixation on a given target can provide cognitive insight into how long the brain takes to process fine details within a target. The time spent making a saccade from one fixation point to the next, is known as saccadic reaction time or latency. These reactions can be fast or slow and latency analysis can provide evidence related to cognitive deficits.

Two types of saccades commonly captured in behavioral research are the anti-saccade and pro-saccade. A voluntary eye movement, or "anti-saccade," occurs when the eyes move *away* from a target. An involuntary eye movement, or "pro-saccade," occurs when the eyes move *toward* a target. The reaction times and latencies of these movements are key components in understanding underlying neural function.

Eye tracking also captures vergence eye movements, which are changes in the angle of your eye to maintain binocular vision. These eye movements can be captured during tasks with simultaneous target presentations, in order to better understand visual performance when vergence is disrupted.

Now that you have an idea of what type of information is recorded, and how it is analyzed, let's review how the eye tracking system should be set-up.

Before beginning, gather all of the relevant equipment, such as an eye tracker, computer, and head or chin brace. There are multiple options for eye tracking hardware that can be used, such as a head mounted eye tracker, one that is mounted on a desk, and one that can be used inside a magnetic resonance scanner during fMRI experiments.

Explain the purpose of the study to the subject, and obtain a signed consent form. For desk- mounted systems, begin by having the subject adjust the chair, and make sure they can lean in comfortably into the chin rest. Focus the camera to ensure optimal imaging and tracking. Adjust the infrared sensitivity threshold of the camera so it can capture the subject's pupil reflection, in order to track eye position.

Next, instruct the subject to fixate upon each dot that appears across the screen until it disappears. Nine fixation points will appear on the screen, in order to properly calibrate the eye tracking software. Provide instructions for the task either verbally or with text on the subject's computer screen.

Have your subject become familiar with the task by completing a practice trial. Then, begin the task by providing the text or images on the screen. Once a subject has completed the task, check to see that the eye movements, and the fixation points, were captured correctly.

Now that you have an idea of how eye tracking works, lets look at a few studies in which this method would provide valuable cognitive and behavioral information.

For example, there are many complex processes involved in reading, and eye tracking is a sensitive way to assess text comprehension. Comprehension can be tested by showing the subject a sentence on a computer, and having them read it to themselves. Then, the researcher can analyze the direction of the saccades and the sequence of fixations during each text appearance.

In addition, eye tracking can help understand how the brain perceives faces. The visual system extracts individual components, such as the eyes, nose, and mouth, and combines them in such a way that you ultimately perceive one face as a whole. Individuals with neurological diseases such as autism perceive faces differently than healthy controls. Their eye movement patterns can be compared to control populations to grasp at the cognitive underpinnings of this disorder. Furthermore, the brain processes inverted faces differently from upright faces, and eye tracking is a perfect tool to grasp at what subjects attend to the most in each instance.

Finally, many driving simulations are paired with eye trackers to accurately capture reaction times to the sudden onset of objects on a screen to better understand individuals suffering from visual deficit disorders. The eye tracker can specifically detect visual deficits, such as a hemianopia,

or when an individual is not able to see anything in their peripheral vision. This is easily captured during analysis by looking at the lack of fixation points on either side of the visual field.

You've just watched JoVE's video on eye tracking in cognitive experiments. In this video, we've demonstrated that eye tracking is a sensitive and non-invasive tool that is very useful when studying human behavior and cognition. Thanks for watching!