Literature Review ▸ Cognitive Functioning and Eye Movements

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Sudo K, Mito Y, Tajima Y, et al. Smooth-Pursuit Eye Movement – A Convenient Bedside Indicator for Evaluating Frontal Lobe and Intellectual Function. In vivo 2010;24:795-8.

Dysfunctions in smooth-pursuit eye movements are thought to be related to higher brain functions, and because of this, the authors speculated that smooth-pursuit eye movements may be similar to primitive reflexes. The frontal lobe and cerebellum are involved in smooth-pursuit eye movements; lesions in either of these areas may cause problems with eye tracking. Brain damage that occurs within the cerebellum is likely to cause eye tracking problems but may not be associated with primitive reflexes because these reflexes are involuntary and are not involved with cerebellar functioning. Lesions outside of the cerebellum may cause problems with muscles, peripheral nerves, and the spinal cord, resulting in involuntary, spontaneous movements similar to primitive reflexes. In this article, the authors wanted to investigate the relationship between dysfunctions of smooth-pursuit eye movements and frontal lobe functioning.

The study looked at 305 patients who were admitted to the Department of Neurology at Sapporo City General Hospital in Japan for routine rehabilitation programs. The patients were divided into four different categories based on the presence and location of the neurological lesion: group A had 20 patients with cerebellar lesions; group B had 159 patients with a brain lesion outside of the cerebellum; group C had 58 patients with lesions outside of the brain, such as in the spinal cord, peripheral nerves, and muscles; group D had 68 patients who had non-organic functional dysfunction, such as dizziness, vertigo, and epilepsy. Smooth-pursuit eye movements were evaluated on all patients by asking them to track a smoothly moved finger horizontally and vertically. The examiners determined whether the patient was making smooth pursuit eye movements or whether they were defective. If the patient used saccades to track the object, the smooth-pursuit eye movements were considered to be defective. An occupational therapist assessed for three primitive reflexes (sucking, snout, and hand grasp) and the elbow flexion response (EFR). The EFR is a spontaneous, involuntary gradual flexion of the elbow when handling the forearm in patients with intellectual or frontal lobe dysfunction.

The relationship between defective smooth-pursuit eye movements and the presence of the primitive reflexes and EFR were analyzed using the Fisher's exact probability test. The results show that defective smooth-pursuit eye movements are correlated with the presence of the tested primitive reflexes and the elbow flexion response for patients who have brain injuries outside of the cerebellum (group B) and patients who have non-organic functional dysfunction (group D). The results correspond with the authors' theory that deficits of smooth-pursuit eye movements are related to impairments in frontal lobe function, as tested via the presence of primitive reflexes. When the lesion was in the cerebellum, the eye tracking was strongly impacted, which showed a relatively weak influence from the frontal lobe. As well, when the lesion was in an area outside of the brain, the smooth pursuit deficits and presence of primitive reflexes were not correlated. There was a correlation between smooth-pursuit deficits and the presence of primitive reflexes when there was a non-organic brain lesion, and the authors postulated that this was related to brain dysfunction from aging.

Overall, this article looked at the relationship between deficits of smooth-pursuit eye movements and impairment of intellectual and frontal lobe functioning. This study showed a relationship between these two areas. It can be further postulated that in situations of intellectual and/or frontal lobe impairment, the patient is likely to show deficits of smooth-pursuit eye movements.

Halliday J, Carpenter RSH. The Effect of Cognitive Distraction on Saccadic Latency. Perception 2010;39:41-50.

The authors investigated the role that cognitive loading had on the latency of saccades and percentage of saccades made incorrectly. Higher cognitive control plays a role in deciding whether saccades should be made and in the suppression of reflexive saccades. Tasks that involve higher cognitive processing increase the role that the superior colliculus plays in generating saccades, which tend to be more reflexive, short-latency saccades. The superior colliculus is typically under control from cortical areas, but when the person is presented with cognitive tasks, there is less control of the superior colliculus.

In this study, the authors measured the saccadic eye movements of nine participants. The subjects were told to look at a central red light. When a green light turned on in their side vision, they were to make a saccade to it. However, if the peripheral light was red, they were not to make a saccade. This set-up was used in three different testing situations: 1. No cognitive task; 2. Background pink noise; 3. Words being heard by the subject and the person had to respond with antonyms to the word that was said. The latency of saccades and the percentage of saccades made to a red peripheral target (no-go saccades) were measured.

In situations 1 and 2, there were few to no cognitive tasks occurring. There was no difference found in the latency or percentage of no-go saccades between these two situations. With situation 3, there was a statistically significant difference in the percentage of no-go saccades made compared to situations 1 and 2. The authors suggest that this is related to the cognitive demand on the subject in this testing situation.

Overall, this study showed that when a person is in a situation where they have additional cognitive tasks, there tend to be more reflexive movements, such as reflexive saccades. A person is less able to suppress the reflexive saccades. This can play a role for patients in distracting environments or situations with demanding tasks because they have less cognitive control over saccades.