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An Underappreciated Consequence of the COVID-19 Pandemic: Excessive Screen Time Disrupts Normal Oculomotor Development

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Description

A child's gaze changes up to three times per second using complex eye movements, including jerks, fixations, convergences and divergences [1]. These movements are used to capture visual information present in the child's environment, which ultimately allows her to read, learn, make decisions, move around her environment, and even to simply keep balance.

Though these movements are essential to navigating our external world, their binocular coordination is an incredibly complex process based on the integration of sensory and motor signals that are processed at the cortical and sub-cortical level. First, the visual pathway relays information about visual stimuli to the visual cortex in the occipital lobe. From there, an extended neuronal system throughout the neuraxis (from frontal and parietal regions of cerebral cortex to the midbrain and pons of the brainstem) translates sensory information into a motor command that is sent to the eye muscles, neck muscles, and other stabilizing muscles of the body on which our posture and balance depend. The more complex part of the oculomotor system consists of the binocular coordination of the eye movements that continues to develop in adolescence [1,2]. As this complicated integration of binocular sensory motor information is so complex, it is easy to understand the importance of these intricate eye movements on the cognitive and physical development and well-being of the child. As they mature, children learn how to exercise and fine-tune this complex system through tasks at school; for example, in reading, each child must use this system so that their two eyes are targeting at the same letter. At younger ages, this system is not fully developed and can be easily disturbed.

Because this system is so fragile in developing children, caution should be exercised when screens are used as learning tools. By fixating for long periods on screens, it is difficult for children to develop this complex system in a normal way. Prolonged use of screens has been shown to greatly increase the rigidity of these motor skills (in particular, accommodation) and prevent children from developing skills that will allow them to make faster movements from one space in depth to another [3-5]. Indeed, an ongoing study from our lab has shown, for the first time, that even two hours of screen time in ten healthy students is sufficient to deteriorate the binocular coordination of saccades, decrease the speed of the saccades, decrease divergence capacity (i.e. the ability to move the eyes from a near space to far), and, in turn, increase accommodative convergence. These findings are based on binocular eye movement testing with the REMOBI device (*patent* US8851669, WO2011073288) and AIDEAL software analysis (patent, DSO2020003510, 2 March 2020) at near distances of 20 and 40 cm [6]. Given these findings were shown in adults, it is plausible these effects could be more dramatic in children and adolescents.

Screen use can also especially exacerbate problems in those that have already fragile systems, such as those who may have underlying or previous diagnoses of dyslexia, dyspraxia, or other movement disorders. These children may be at increased risk for exposure, given they indicate an increased preference for screen learning [7-9]. In fact, targeted school treatment plans towards these pupils often use a computer to facilitate reading and writing. Indeed, in life outside of the pandemic, we have found that dyslexic adolescents spend more time on the computer than non-dyslexic children (30.80 hours vs 13.54 hours, p=0.000), while simultaneously reporting increased visual stress and demonstrating abnormal vergence movements (Convergence Insufficiency Symptom Survey, score of 24.40 vs. 17.68, p=0.008) [10,11]. These children have also demonstrated a decreased capacity to move the eye appropriately between depths (decreased vergence velocity) and a decreased ability to keep vergence stable during the fixations following the saccades, which ultimately impacts quality of vision, attention, and reading. Of course, children and adolescents retain their neuroplasticity which can help overcome these problems, but this requires specific eye neuro rehabilitation programs. Indeed, Kapoula & Depreux have demonstrated an improvement in eye movements and reading scores after only two sessions of neuro rehabilitation in dyslexic teenagers [12]. The method used for binocular eye movement rehabilitation was identical to that previously described for adults [13].

Though screen time in adolescents and children has been increasing in the past two decades as we interact more with our online world, COVID-19 has forced us to facilitate our social and educational interactions through a screen. Indeed, many children's health organizations have written bulletins advising parents on how to navigate increased screen time during the pandemic [14]. In these unusual times as we try to keep our physical distance while quarantining, we are all abusing screens to stay social and retain some semblance of normal life. Our children are no exception. Therefore, as we use technology to remain closer, we must nevertheless take caution and pay attention to our children so that they do not damage their fragile visual system. Especially during this time, as countries across the globe debate the risks and benefits of reopening schools for the coming term, we call on you, as parents, to be vigilant. We encourage alternative methods of teaching that do not rely on a screen in order to ensure our children's physical and mental development remains on track. For more information, the film "Eye movements, school learning, and creativity" offers greater insight into the issues raised above [15,16].

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