



ORIGINAL ARTICLE

Visual function and color vision in adults with Attention-Deficit/Hyperactivity Disorder

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Abstract

Purpose: Color vision and self-reported visual function in everyday life in young adults with Attention-Deficit/Hyperactivity Disorder (ADHD) were investigated.

Method: Participants were 30 young adults with ADHD and 30 controls matched for age and gender. They were tested individually and completed the Visual Activities Questionnaire (VAQ), Farnsworth-Munsell 100 Hue Test (FMT) and A Quick Test of Cognitive Speed (AQT).

Results: The ADHD group reported significantly more problems in 4 of 8 areas on the VAQ: depth perception, peripheral vision, visual search and visual processing speed. Further analyses of VAQ items revealed that the ADHD group endorsed more visual problems associated with driving than controls. Color perception difficulties on the FMT were restricted to the blue spectrum in the ADHD group. FMT and AQT results revealed slower processing of visual stimuli in the ADHD group.

Conclusion: A comprehensive investigation of mechanisms underlying visual function and color vision in adults with ADHD is warranted, along with the potential impact of these visual problems on driving performance.

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Función visual y visión de color en adultos con trastorno de déficit de atención con hiperactividad

Resumen

Objetivo: Se investigó la visión de color y la función visual en la vida cotidiana auto-reportada de los jóvenes adultos con trastorno de déficit de atención con hiperactividad (TDAH).

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Método: Participaron 30 jóvenes adultos con TDAH y 30 controles equiparados por edad y sexo. Fueron evaluados individualmente, debiendo completar el "Vision Activities Questionnaire (VAQ)-Cuestionario de Actividades Visuales, la prueba de 100 tonalidades de Farnsworth-Munsell (FMT) y una prueba rápida de velocidad cognitiva (AQT).

Resultados: El grupo de TDAH reportó una proporción superior de problemas en 4 de las 8 áreas del VAQ: percepción de profundidad, visión periférica, búsqueda visual y velocidad de procesamiento visual. Los análisis adicionales de las cuestiones del VAQ revelaron que el grupo de TDAH reflejó más problemas visuales asociados a la conducción que el grupo de control. Las dificultades de percepción del color en la prueba FMT se restringieron al espectro del azul en el grupo de TDAH. Los resultados de FMT y AQT revelaron un procesamiento más lento de los estímulos visuales en el grupo de TDAH.

Conclusión: Está garantizada una amplia investigación sobre los mecanismos subyacentes de la función visual y la visión de color con TDAH, junto con el impacto potencial de estos problemas visuales sobre la conducción.

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Introduction

Attention-Deficit/Hyperactivity Disorder (ADHD) is one of the most frequently diagnosed childhood psychiatric disorders, with worldwide prevalence rates estimated at 5.3%.¹ A longitudinal study shows that approximately 65% of children with ADHD continue to show symptoms in adulthood.^{2,3} While adults with a history of ADHD may not meet the full criteria of symptoms listed in the DSM-IV, they continue to exhibit clinically significant symptoms.⁴ These continued symptoms are costly to society and the individual.⁵ For example, ADHD individuals were found to engage in higher risky driving behaviors and have more frequent car crashes.⁶⁻¹⁰

Current theories posit that executive function deficits account for poor outcomes in ADHD including driving problems. By contrast, we investigate a novel hypothesis that poor visual function might contribute to some of the negative outcomes. A review of the literature revealed several reports of ophthalmological problems in children with ADHD (see [Table 1](#)). For example, numerous studies report a significantly higher incidence of ADHD among children with convergence insufficiency.¹¹⁻¹³ The ADHD trait was also found to be common in children with intermittent exotropia.¹⁴ Various visual function and ocular features including visual acuity, strabismus and ocular motility, near point of convergence and near point of accommodation were also tested in children with ADHD.¹⁵ The authors report that children with ADHD had a higher frequency of ocular and visual abnormalities, suggesting an early alteration of the development of neural and vascular tissues in central nervous system. Although Grönlund et al.¹⁵ found no effect of stimulant medication on visual function, another study reported that stimulant treatment seemed to improved visual field and best corrected distance visual acuity in children with ADHD.¹⁶

Not only have ophthalmological abnormalities been reported among individuals with ADHD, but also so have color perception deficiencies (see [Table 2](#)). Specifically, children with ADHD score poorly on clinical tests of blue

color perception, but not red-green.^{17,18} Furthermore, children with ADHD show poorer game performance in a virtual environment when important on-screen information is displayed predominantly in blue-yellow colors compared to red-green colors.¹⁹ Several studies show decreased speed in color processing in ADHD population.^{20,21} Notably, the "retinal dopaminergic" hypothesis of color vision²² speculates that a deficiency in central nervous system (CNS) dopamine in ADHD may induce a hypo-dopaminergic tone in the retina, which in turn would have deleterious effects on short-wavelength ("blue") cones. Blue cones are very sensitive to dopamine (as well as other neurochemical agents) and relatively scarce in number, so that the purported low dopaminergic tone in ADHD²³ may affect blue-yellow color perception.

Numerous studies have reported possible visual deficiency including color perception in children with ADHD. However, it is unknown whether adults with ADHD also manifest problems in color vision or whether any visual problems have any functional impact in their everyday life. Accordingly, the aims of this preliminary study were to investigate visual function in everyday activities and color vision in adults with ADHD. Based on the retinal dopaminergic hypothesis, we hypothesized that adults with ADHD would show a specific color discrimination problem with blue colors.

Materials and methods

Participants

Thirty young adults with a previously confirmed diagnosis of ADHD (mean age of 27 years; 47% male) and thirty healthy controls (mean age of 25 years; 50% male) participated in the study. Participants with ADHD were recruited from two sources: a student population registered with a local university's accessibility services, which requires documented evidence of a confirmed diagnosis, and a national advocacy group for ADHD. In addition to the previously confirmed

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