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ORIGINAL ARTICLE

Effect of defocus on response time in different age groups: A pilot study

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KEYWORDS
Presbyopia;
Reaction time;
Defocus

Abstract
Purpose: To assess the response time associated with visual performance (VP) tasks in the presence of defocus in different presbyopic populations.
Methods: 58 eyes between the ages of 35 and 50 years were studied. Subjects were categorized as pre-presbyopic (35–39 years), early-presbyopic (40–45 years), and mid-presbyopic (46–50 years). VP measurements obtained monocularly included distance and near high contrast (HC) and low contrast (LC) optotype recognition, and contrast threshold at 12 cpd for different defocus magnitudes between 0D and 3D in 1D steps. Response time defined as the time taken to recognize and verbalize an optotype, was compared among different presbyopic age groups.
Results: From 58 eyes, mean (SD) response time for high contrast distance visual acuity for 0D through 3D ranged between 1.48 (0.23) and 1.87 (0.31) s, whereas low contrast distance visual acuity ranged between 1.5 (0.22) and 2.09 (0.49) s. Mean response time for high contrast near visual acuity for 0D through 3D ranged between 1.56 (0.19) and 2.23 (0.45) s. However, for low contrast near visual acuity it ranged between 1.75 (0.32) and 2.71 (0.94) s. Mean (SD) response time for 12 cpd ranged between 2.11 (0.50) and 5.72 (1.09) s. ANOVA revealed a significant difference in response time for distance, near visual acuity and contrast sensitivity as a function of defocus for different age groups.
Conclusions: Response time is increased in the presence of increasing defocus for both distance and near visual acuity and could impact on performance for critical tasks. Full correction of visual acuity at distance and near in presbyopes is warranted always.

PALABRAS CLAVE
Presbicia;
Tiempo de reacción;
Desenfoque

Efecto del desenfoque en el tiempo de respuesta en diferentes grupos de edad: estudio piloto

Resumen
Objetivo: Evaluar el tiempo de respuesta asociado a las tareas del desempeño visual (DV) en presencia de desenfoque, en diferentes poblaciones présbitas.

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Métodos: Se estudiaron 58 ojos de personas en edades comprendidas entre 35 y 50 años. Se clasificó a los sujetos conforme a las siguientes categorías: pre-presbicia (35−39 años), presbicia temprana (40−45 años), y presbicia media (46−50 años). Las mediciones del desempeño visual obtenidas de forma monocular incluyeron el reconocimiento de optotipos cercanos y lejanos de alto y bajo contraste y el umbral de contraste a 12cpd para las diferentes magnitudes de desenfoque, entre 0D y 3D, a intervalos de 1D. El tiempo de respuesta es el tiempo empleado en reconocer y verbalizar un optotipo, y se comparó entre los diferentes grupos de edad de los individuos présbitas.
Resultados: De los 58 ojos, el tiempo de respuesta media (DE) para la agudeza visual de la distancia a alto contraste, entre 0D y 3D, osciló entre 1,48 (0,23) y 1,87 (0,31) segundos, mientras que la agudeza visual de la distancia a bajo contraste osciló entre 1,5 (0,22) y 2,09 (0,49) segundos. El tiempo de respuesta media para la agudeza visual cercana de alto contraste entre 0D y 3D osciló entre 1,56 (0,19) y 2,23 (0,45) segundos. Sin embargo para la agudeza visual cercana de bajo contraste osciló entre 1,75 (0,32) y 2,71 (0,94) segundos. El tiempo de respuesta media (DE) para 12cpd osciló entre 2,11 (0,50) y 5,72 (1,09) segundos. ANOVA reveló una diferencia significativa en cuanto al tiempo de respuesta para la distancia, agudeza visual cercana y sensibilidad de contraste como función del desenfoque para los diferentes grupos de edad.
Conclusiones: El tiempo de respuesta se eleva al incrementarse el desenfoque en la agudeza visual lejana y cercana, pudiendo repercutir sobre el desempeño de ciertas tareas esenciales. La corrección plena de la agudeza visual cercana y lejana en individuos présbitas debe de ser siempre garantizada.

Introduction

By 2020, an estimated 1.4 billion people will be affected by presbyopia.[1] Uncorrected refractive error is the leading cause of visual impairment in adults over the age of 40 years,[2] with the prevalence of refractive visual impairment increasing significantly with age.[3] However, uncorrected presbyopes are at a bigger disadvantage. Presbyopia refers to the slow, normal, naturally occurring, age-related, irreversible reduction in maximal accommodative amplitude sufficient to cause symptoms of blur and ocular discomfort or asthenopia at the customary nearworking distance.[4] The exact mechanism of presbyopia is not well understood. Prior research suggests a loss of elasticity of the crystalline lens, although changes in the lens's curvature from loss of ciliary muscle function have also been proposed as its cause.[4] As one ages to presbyopia, there is a progressive change in the optics of the eye[5] with the possibility of an increase in the optical aberrations.[4,5] In addition, the oculomotor components that decrease with age include amplitude of accommodation, tonic accommodation, CA/C ratio, as well as positive and negative fusional vergence recovery values at distance.[6] In contrast, the components that increase in magnitude with presbyopia include: subjective depth of focus, accommodative latency, disparity vergence, etc.[6] These changes play a very important role in both spatial and temporal visual information processing. Hence, age related decline in visual function will be observed in all adults.

The first signs of presbyopia include eyestrain, difficulty in seeing in dim light, problems focusing on small objects and/or fine print and are usually first noticed between the ages of 35 and 40 years.[7] Visual acuity[8] and contrast sensitivity[9] is degraded in the presence of blur. When dioptric blur is introduced it also alters the background luminance. Legge et al.[10] reported on the various stimulus factors that influenced reading speed and found that diffusive blur was one such factor. Later, Johnson and Casson[11] studied the interactions of luminance, contrast and blur on visual acuity. They reported that the visual acuity is reduced in the presence of blur levels up to 2D and a gradual decrease occurs with higher levels of blur. Thorn and Thorn[12] studied the effect of induced blur on reading accuracy of television captions and reported that blur and fast presentation rate reduced reading speed dramatically. So, blurring of the visual system does impact any visual performance task.

While visual acuity is the most commonly used clinical metric to assess vision, contrast sensitivity function (CSF) provides a more comprehensive assessment and serves as the building block for the succeeding steps of visual information processing.

Blur typically increases during presbyopia with a progressive deterioration in the clinically measured visual acuity during the same period.[13] While plus lenses are prescribed for 2-months to alleviate the symptoms associated with presbyopia, a recent investigation[14] reported that after a period of wearing near vision glasses, three metrics of the accommodative convergence function, namely, the slope of the stimulus response function and the accommodative convergence/accommodation (AC/A) and convergent accommodation/convergence (CA/C) ratios did not change significantly. In addition, a hyperopic shift of the stimulus response function was also reported thereby reducing the far-point refraction. There were no age-related changes with these components. Visual acuity and contrast sensitivity of uncorrected presbyopes decrease at near due to