Threshold exposure duration for recognition of test objects in children with various refractive statuses

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Backup: *The speed of visual information processing is of primary importance today.*
Purpose: *To determine the threshold exposure duration for recognition of test objects (TEDRTO) values in children with various refractive statuses.*
Materials and Methods: *Seventy one children (22 hyperopes, 26 myopes, and 23 emmetropes; 142 eyes totally) aged 7 to 13 years underwent TEDRTO measurements with the electronic apparatus. A child fixated on a test object (TO) subtending 160, 40 or 8 minutes of arc (ma).*
Results: *The monocular TEDRTO values in emmetropes, hyperopes and myopes were 1.0 ms with a TO subtending 160 ma; 1.4±0.2 ms, 1.8±0.2 ms and 1.8±0.2 ms, respectively, with a TO subtending 40 ma; and 7.8±1.1 ms, 14.9±1.3 ms, and 7.9±1.0 ms, respectively, with a TO subtending 8 ma. Binocular TEDRTO values tended to be lower than monocular ones for optotypes subtending 40 and 8 ma.*
Conclusion: *TEDRTO values were found to increase significantly as the visual angle subtended by the TO decreased, which could be explained by a longer time required for recognition of a high-frequency image compared to that of a low-frequency image. Significantly higher TEDRTO values in hyperopes compared to emmetropes and myopes (P<0.05) might be explained by the involvement of accommodation in the mechanism of TO recognition in hyperopes.*

Key words: threshold exposure duration for recognition of test objects, refractive anomalies, emmetropia, hyperopia, myopia

Introduction

The speed of visual information processing, the ability to assess a situation and to make a decision in an instant are crucial for a person living under rapidly changing conditions. This feature is important not only for adults, but for children as well.

Visual acuity (VA) is the standard test for assessing visual function. The most common way of measuring VA in clinical practice is through tests of static VA, with static test objects (TOs) presented at optimum conditions (maximum contrast, optimum illumination, and unlimited exposure duration). However, this index does not always make it possible to assess subtle alterations in the visual system; additionally, it gives no indication of the speed of visual information processing. Dynamic examination methods are more appropriate for this purpose, and boil down to using the stimuli with variable parameters. Mesopic VA measurements (those at various illumination conditions), kinetic or dynamic VA measurements (those at various velocities of optotypes), VA measurements at various contrast sensitivities of optotypes, and VA measurements at various TO exposure durations (expositional visual acuity (EVA) tests) [1-7] can be classified as dynamic VA examination methods.

Our previous studies have focused on determination of both EVA values and values of another time-based parameter, Threshold Exposure Duration for Recognition of Test Objects (TEDRTO). Age norms for EVA in children of the 4 to 15 years age range have been established for the first time. Additionally, it has been demonstrated that investigation of time-based parameters of visual acuity would be helpful for (a) differential diagnosis between alternating and unilateral strabismus, and (b) for the prognosis and the assessment of treatment outcomes for amblyopia [8, 9]. Further investigation of TEDRTO vlaues for presentation of test objects of different size in children with refractive anomalies is required.

The study purpose was to determine TEDRTO values in children with refractive anomalies and normal fundus appearance and to compare them with those in healthy emmetropic children.

Materials and Methods

Seventy one children (22 children with hyperopia of 1.5 to 4.5 D, 26 children with myopia of 1.0 to 4.0 D, and 23 emmetropic children; 142 eyes totally) aged 7 to 13 years were included in the study and underwent TEDRTO measurements. Evaluation of visual acuity, refraction, ocular position and mobility, binocular vision, biomicroscopy and ophthalmoscopy were performed. In all pediatric eyes, VA (or best corrected VA for cases with refractive anomalies) was 1.0 or better. Additionally, binocular vision was assessed with a four-dot test (using the TST-1 apparatus), and the ocular motility, media and fundi were within normal limits. The TEDRTO was assessed with BRIZ 2.1 apparatus [10]. The apparatus was used to expose a TO (an illuminated Landolt's ring with a gap randomly at one of the eight positions) against a black background, with the TO presented for 1 ms to 20-25 ms, and 1-ms gaps between presentations. If the

child failed to identify the gap position with the minimum exposure duration, the duration was increased until he could identify the position fairly reliably (i.e., making at least 5 correct responses in succession). The ring size was 10 mm, and the ring gap size was 2 mm. Examination in each child was performed in the morning hours, at three distances, 35 cm, 1.4 m and 7 m, with test objects subtending 160, 40 or 8 minutes of arc (ma), respectively. In children with refractive anomalies, TEDRTO values were determined under optical correction.

Results

Table 1 presents the data obtained during the study of monocular and binocular TEDRTO values in children with various refractive statuses. It demonstrates that, with the TO subtending 160 ma presented, the TEDRTO values did not differ between subjects with various refractive statuses, and were equal to 1.0 ± 0.0 ms. With the TO subtending 40 ma presented, (a) the monocular TEDRTO values in emmetropes, hyperopes and myopes were 1.4 ± 0.2 ms, 1.8 ± 0.2 ms and 1.8 ± 0.2 ms ($P > 0.3$), respectively, and were statistically significantly higher than ($P < 0.05$) with presentation of the TO subtending 160 ma, and (b) the binocular TEDRTO values in emmetropes, hyperopes and myopes (1.0 ± 0.1 ms, 1.0 ± 0.2 ms and 1.2 ± 0.2 ms, respectively) were lower than monocular TEDRTO values, and hyperopic and myopic eyes demonstrated a statistically significant difference between the binocular and monocular values ($P < 0.05$). Monocular TEDRTO values in eyes with any refractive condition were statistically significantly higher ($P < 0.001$) with the 8-min arc test objects than with 40-min arc test objects. Additionally, with the 8-min arc test objects, the monocular and binocular TEDRTO values in hyperopes (14.9 ± 1.3 ms and 11.8 ± 1.1 ms, respectively) were higher than those in emmetropes (7.8 ± 1.1 ms and 6.0 ± 0.8 ms, respectively) and myopes (7.9 ± 1.0 ms and 6.9 ± 1.0 ms, respectively). This might be explained by the involvement of accommodation in the mechanism of TO recognition in hyperopes. Binocular TEDRTO values tended to be lower than monocular TEDRTO values.

Conclusion

First, TEDRTO values were found to increase significantly as the visual angle subtended by the TO decreased, which could be explained by a longer time required for recognition of a high-frequency image compared to that of a low-frequency image.

Second, with the TO subtending 8 ma presented, the monocular TEDRTO values in emmetropes were significantly higher than in hyperopes and myopes. This might be explained by the involvement of accommodation in the mechanism of TO recognition in hyperopes.

Finally, the fact that binocular TEDRTO values tended to be lower than monocular TEDRTO values agrees with the well-known fact that binocular static visual acuity is superior to better eye monocular static visual acuity [11], and could be explained by the idea of probability summation in the receptive fields of the visual cortex (for assessment of contrast) [12].

Table 1. Threshold exposure duration for recognition of test objects (TEDRTO) values, with the test objects subtending various visual angles, in children with various refractive statuses

Refractive statuses	TEDRTO values (ms) with the objects subtending various visual angles (arc minutes)						Number of children (eyes)
	160		40		8		
	Monocular	Binocular	Monocular	Binocular	Monocular	Binocular	
Emmetropic	1.0 ± 0.0	1.0 ± 0.0	1.4 ± 0.2	1.0 ± 0.1	7.8 ± 1.1	6.0 ± 0.8	23 (46)
Hyperopic	1.0 ± 0.0	1.0 ± 0.0	1.8 ± 0.2	1.0 ± 0.2	14.9 ± 1.3	11.8 ± 1.1	22 (44)
Myopic	1.0 ± 0.0	1.0 ± 0.0	1.8 ± 0.2	1.2 ± 0.2	7.9 ± 1.0	6.9 ± 1.0	26 (52)

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