Maximum Colour Contrast Sensitivity Assessment in Monozygotic and Dizygotic Twins

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Introduction. Contrast sensitivity has an important role in ophthalmological examination because this diagnostic tool gives us an exclusive information on retinal function when changes in visual acuity are minimal (two letter loss, or logMAR 0.04) [1]. Deficient contrast sensitivity may arise from dysfunction at multiple points along the visual pathways, from the lens and retina to primary visual cortex and higher cortical areas [2]. Contrast sensitivity is strongly associated with daily functioning among older adults, but the genetic and environmental contributions to this ability are unknown. [3]. If there is evidence of genetic influence on contrast sensitivity, this could indicate that contrast sensitivity may be considered a possible endophenotype for some disorders [4].

Aim. To determine colour perception differences between monozygotic and dizygotic twins by the maximum color contrast sensitivity (MCCS) test.

Materials and methods. Visual function was assessed in 15 participants which comprised of 5 monozygotic twin pairs and 3 dizygotic twin pairs. (6 males and 10 females, 36.75±12.98 years; one participant was excluded due to severe retinal disease). All patients underwent a comprehensive ophthalmic examination followed by biomicroscopy and fundus photography.

In the computer test of maximum color contrast sensitivity (Fig. 1), a subject had to determine the correct direction of a bar in a circle. The subject had to press a button with a bar matching the direction of a bar in the circle. If the direction was unclear, blank button was pressed. After a button was pressed a, blank screen appeared, and then after one second, a circle with a randomly chosen direction of bars was shown. If the direction of the bar in the circle was chosen incorrectly, its color was automatically highlighted. After the correct choice of the direction of the bar, the intensity of its color was automatically dulled and in the presence of this chromatic contrast of the bar, brightness of background of the circle was changed. The first correct answer after a series of incorrect answers or the first incorrect answer after a series of correct answers was accepted as subject's maximum sensitivity to the target color of the bar. When subject's maximum sensitivity to the target color of the bar had been

assessed, the color of the bar was changed and everything started from the beginning again. The bar could be of six colors: red, green, blue, greenish blue, violet, or yellow. Once subject's sensitivity to all these colors had been assessed, all the findings were recorded in a database, and the results of the test were presented in a result window. Color contrast sensitivity tests were performed with best-corrected visual acuity.

The test was carried out under artificial daylight illumination. Light was at about an angle of 90º from the patient`s side, the angle of viewing was about 60º, at about 45° to the plate surface and the monitor was free from glare.

Fig. 1. Maximum color contrast sensitivity (MCCS) test

Statistical analysis was performed using the computer program SPSS / W 13.0. T test was used for the comparison of the two groups. A statistically significant difference was considered if $P<0.05$.

Results. The results of MCCS test in MZ and DZ twins showed that there was no statistically significant difference between MZ and DZ twins (1.70±0.513 vs. 0.146±0.637, t=1.156; p=0.258). (Fig.2, Tab. 1).

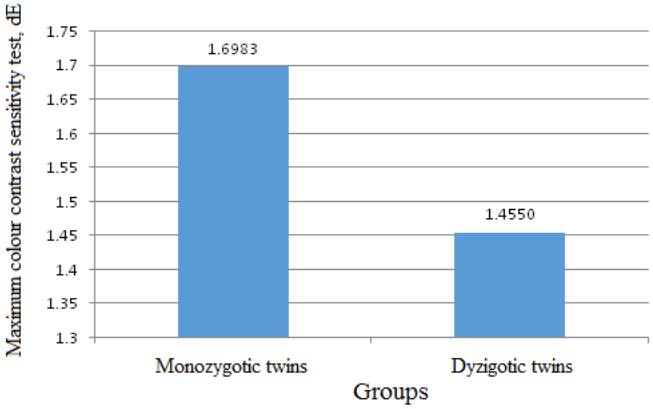

Fig. 2. Maximum color contrast sensitivity (MCCS) test results in monozygotic and dyzigotic twins

We found statistically significant difference in comparison of age groups: ≤40 years vs. ≥ 40 years (t=4,615; p=0.000; p<0,001) (Fig. 3, Tab. 2).

Table 1. The results of MCCS test in monozygotic and dizygotic twins

Test	**Monozygotic twins**	**Dizygotic twins**	**p-value**
Maximum colour contrast sensitivity test, mean±SD	1.70±0.513	0.146±0.637	0.258

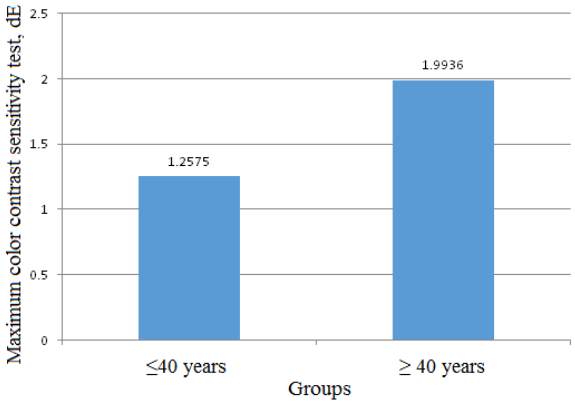

Fig. 3. Maximum colour contrast sensitivity (MCCS) in age groups

Table 2. The The results of MCCS tests in age groups

Test	**≤40 years**	**≥ 40 years**	**p-value**
Maximum colour contrast sensitivity test, mean±SD	1.258±0.430	1.994 ±0.443	p<0,001

Differences between males and females were no statistically significant (Tab. 3). Both groups of twins showed the best result in green colour sense. The highest error score of all participants was in the blue colour range. (Tab. 4)

Table 3. The The results of MCCS tests in males and females

Test	**Males**	**Females**	**p-value**
Maximum colour contrast sensitivity test, mean±SD	1.389±0.417	1.743 ±0.621	0.095

Table 4. Best and worse colour sense discrimination using MCCS test. Group 1 – monozygotic twins, Group 2 – dyzigotic twins

Best colour sense discrimination using MCCS	**Eyes, n (%)**		**Worst colour sense discrimination using MCCS**	**Eyes, n (%)**	
	Group			**Group**	
	1	**2**		**1**	**2**
Blue colour	2	0	Blue colour	8	9
Green colour	5	4	Green colour	0	2

Conclusions. Colour contrast sensitivity is important visual function related with age. We observed no statistical significant differences between twins and their gender when they performed MCSS test. Participants showed the best result in the green colour sense – 5 eyes of monozygotic twins group (16,7 % of all participants) and 4 eyes of dizygotic twins group (13,4 % of all participants). The blue colour range was considerably the hardest to distinguish for twins – both groups made mistakes in this colour range (8 eyes of monozygotic twins group (26,7 % of all participants) and 9 eyes of dizygotic twins group (30% of all participants). Contrast sensitivity is an important visual function because of its role in predicting cognitive and functional decline in normal aging and in common age-related disorders. The low heritability and the relatively strong influence of individual-specific environmental events for contrast sensitivity suggests that a focus of future research should be on identifying the types of individual-specific environmental experiences that influence this ability [3]. MCCS test are suitable for evaluation of colour vision deficiency. Further research including more participants is required.

References

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Aim. To determine colour perception differences between monozygotic and dizygotic twins by the maximum color contrast sensitivity (MCCS) test. Materials and methods. Our pilot study comprised of 5 monozygotic twin pairs and 3 dyzigotic twin pairs. All participants underwent ophthalmic examination, including MCCS test. Results. Based on MCCS test results, differences between twins, also males and females were statistically non-significant. We found statistically significant difference in comparison of age groups: ≤40 years vs. ≥ 40 years (t=4,615; p=0.000; p<0,001). Conclusions: Colour contrast sensitivity is important visual function related with age. Differences between twins were statistically non-significant.