EC OPHTHALMOLOGY
Short Communication

Development of a Novel Stereoacuity Test Device Using a High-Resolution 3D Monitor

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Abstract

Purpose: To develop stereoacuity test using a high-resolution 3D monitor and examined the effects of the monitor on the measured stereoacuity.

Methods: We conducted stereoacuity test using a high-resolution 3D monitor. This 3D monitor can show parallax of 27 s (crossed) at the minimum at measurement distance 40 cm, and circularly polarized glasses were used for binocular separation. Titmus stereo test (TST) and TNO stereotest (TNO) were performed for comparison.

Results: The high-resolution 3D monitor, TST, and TNO average stereoacuity values were 35.0 ± 18.4, 50.0 ± 10.4, and 91.3 ± 53.0s, respectively. The stereoacuity value of the 3D monitor was significantly lower than that of the TST and TNO tests ($p < 0.02$, $p < 0.0002$, respectively). The stereoacuity value of the TST test was significantly lower than that of the TNO test ($p = 0.002$).

Conclusion: We consider stereoacuity test using 3D monitor which can show various images is effective.

Keywords: *Stereoacuity; Stereoacuity Test; 3D Monitor; Binocular Function*

Introduction

Stereoacuity testing, such as the Titmus stereo test and TNO stereotest, is very useful for estimating visual function in children and can readily and quickly detect perspective and amblyopia. Although these devices allow clinicians to easily estimate stereoacuity, the targets and parallax that can be shown are limited because the devices use printed materials. In contrast, with the recent development of the imaging techniques, various stereoaruity test devices with the monitor have been developed [1-6]. It's reported that they can show the moving parallax and a lot of kinds of targets not by printed matters by monitors and they could estimate the stereoacuity which the previous stereoacuity test (for example TST, TNO) device couldn't. But there were some problems in the stereoacuity test device with the monitor before. It's the minimum parallax which we can show. The minimum parallax which we can show with 3D monitor, depends on the distance between 1 pixel. For example, to present a parallax of 60 s at a 40-cm test distance, 207 pixel per inch (ppi) is required. To our knowledge, no studies have evaluated near stereoacuity testing using a high-resolution 3D monitor that is able to display a parallax of less than 60 s. In this study, we developed stereoacuity test using a high-resolution 3D monitor and examined the effects of the monitor on the measured stereoacuity.

Materials and Methods

This study conformed to the tenets of the Declaration of Helsinki and was approved by the Kitasato University Human Sciences Ethics Committee. The methods were carried out in accordance with approved guidelines. Potential subjects gave written consent after being given detailed information about the study and their role as a participant. Informed consent was obtained from all subjects or their protector after an explanation of the nature and possible consequences of the study. We investigated 24 healthy volunteers with a mean age of 5.4 ± 2.4 years. All subjects had unremarkable ophthalmic examinations, except for minor refractive errors in several subjects. The subjects had at least -0.08 (logMAR value) of distant and near vision in each best corrected eye. We newly developed stereoacuity test device using high-resolution 3D monitor. The 3D monitor was 4.8 inches, and the resolution was 1920 × 1080 (459 ppi). Subjects were placed in a state of binocular separation using circularly polarized glasses. Measurements appearance is shown in figure 1. Parallax was presented as crossed parallax in units of 27 s at measurement distance 40 cm. Images of cookies served as the stereo visual target (Figure 2). TST and TNO testing were performed for comparison. The parallax of TST was 800, 400, 200, 140, 100, 80, 60, 50, and 40 s (circles), and the parallax of TNO was 480, 240, 120, 60, 30, and 15 s (plates V−VII). Data were statistically analyzed using the Bonferroni test, and $p < 0.05$ was considered significant.

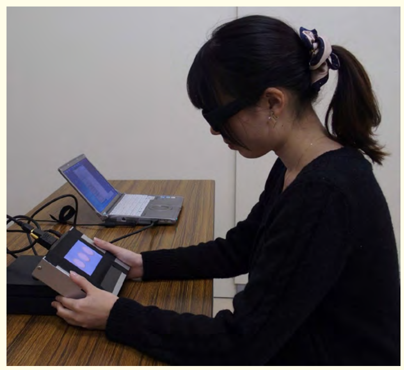

Figure 1: *High-resolution 3D monitor which we used for a stereoacuity test, and PC for visual target control. Subject is in a state of dichoptic viewing using polarized (circle) glasses.*

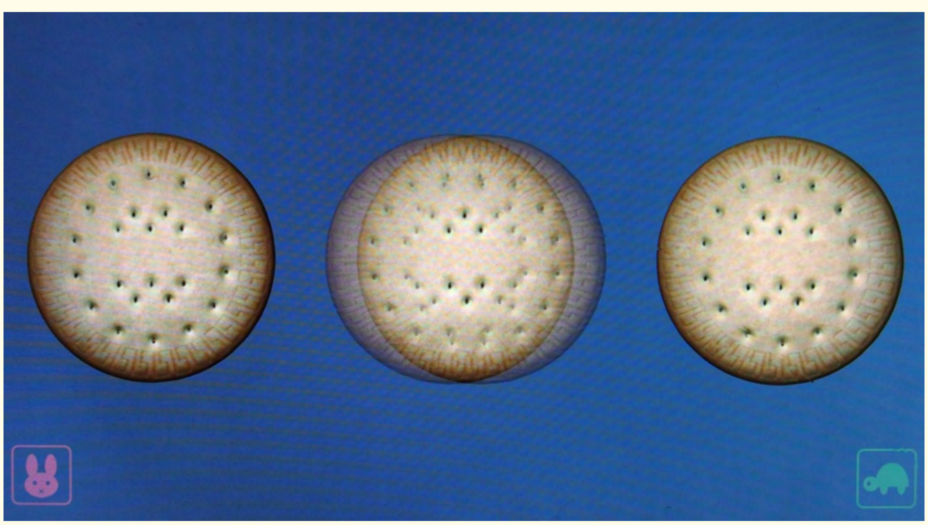

Figure 2: *Visual target of high-resolution 3D monitor. Visual target in the center is in 3D. The lower turtle and rabbit images are used for confirming binocular separation.*

Results

The high-resolution 3D monitor, TST, and TNO average stereoacuity values were 35.0 ± 18.4, 50.0 ± 10.4, and 91.3 ± 53.0s, respectively (Figure 3). The stereoacuity value of the 3D monitor was significantly lower than that of the TST and TNO tests ($p < 0.02$, $p < 0.0002$, respectively). The stereoacuity value of the TST test was significantly lower than that of the TNO test ($p = 0.002$).

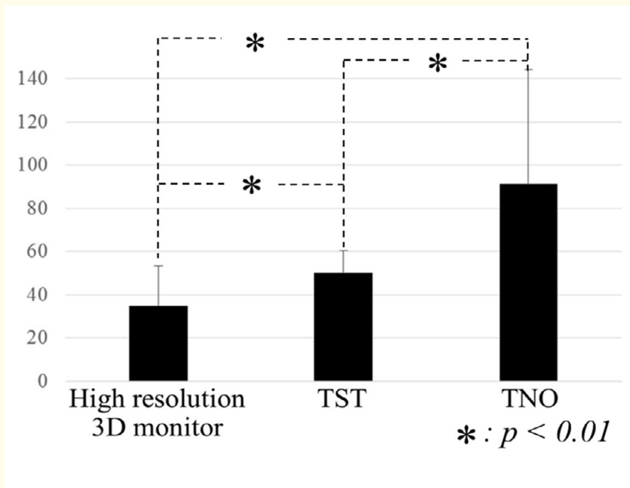

Figure 3: *Each average stereoacuity values.*

Discussion

We were able to show parallaxes that could not be displayed using older techniques and ultimately, the stereoacuity could be estimated. Additionally, stereoacuity is often difficult to estimate in children; if the child is uninterested in the target, the procedure cannot be conducted. Thus, the monitor that is able to interest children and that is able to present various images is required. In the present study, we used a picture that the child would recognize and exhibit interest in as the stereo target.

We found that the individual stereoacuity test device influenced the results. This appears to reflect differences in the dichoptic viewing method and the quality of the visual target. Stereo viewing is difficult to perform using the TNO test because the test dissociates subjects from the surrounding visual environment by requiring them to use red-green glasses with a random dot stereogram [7]. Conversely, TST is performed under dichoptic viewing by using linearly polarized glasses. However, linearly polarized glasses are easily affected by tilts in head posture and glasses; this allows the target of one eye to be viewed by both eyes (crosstalk), making stereo viewing difficult. By contrast, circularly polarized glasses are less affected by these limitations. Stereo viewing is easier owing to the lessened crosstalk, and large differences are maintained in the target.

We believe that testing devices that include a monitor will prove highly versatile and supersede printed material. In the present study, use of a high-resolution 3D monitor enabled us to perform a near stereoacuity test. We expect that the highly versatile 3D monitor will be used as a near stereoacuity test device to estimate the actual stereoacuity of patients in the future.

Conclusion

We newly developed stereoacuity test device using high-resolution 3D monitor. Stereoacuity test using 3D monitor which can show various images is effective.

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