

Validation of objective methods to measure fusional vergence ranges

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Abstract

Purpose : Fusional vergence ranges are typically measured subjectively using Risley prisms or a prism bar. In this study, new methods to measure fusional vergence ranges at near objectively were validated against the two conventional tests used in clinics.

Methods : A total of 46 typical adults (23.3 ± 3.0 years) participated in the study. Participants' BO (base out) and BI (base in) near fusional vergence ranges were measured objectively in an haploscopic set-up and recording eye movements with an Eyelink 1000 Plus (SR Research) at 500Hz. Firstly, stimulus disparity changed smoothly at 1PD/s up to 45PD for both divergence (BI) and convergence (BO), mimicking a Risley prism. Secondly, disparity was changed in steps of 2PD every 2 seconds mimicking a prism bar. Break and recovery points were determined offline using a custom Matlab code for the analysis of eye movements. Fusional vergence ranges were also measured with the conventional tests using a Risley prism and a prism bar, and the results were compared.

Results : When stimulus disparity changed smoothly, narrower BI ranges were obtained with the objective method (mean \pm SD break of 13.7 ± 4.7 PD and 10.6 ± 5.1 PD recovery) than with the Risley prism (break of 17.5 ± 3.8 PD and 12.8 ± 4.2 PD recovery) with a mean \pm SD difference between methods of -3.8 ± 3.5 PD (break) and -2.2 ± 4.7 PD (recovery). BO ranges were wider with the objective method (35.4 ± 10.9 PD break and 24.4 ± 10.7 PD recovery) than with the Risley prism (25.8 ± 7.5 PD break and 14.6 ± 5.8 PD recovery) with a mean difference of 9.2 ± 10.7 PD for the break, and 9.6 ± 10.1 PD for the recovery. When disparity changed in steps, fusional ranges measured with the objective method (15.7 ± 5.1 PD BI break, 12.8 ± 4.7 PD BI recovery, 36.3 ± 11.4 PD BO break, 23.9 ± 10.6 PD BO recovery) were not significantly different than with the prism bar (14.5 ± 3.8 PD BI break,

10.7±3.4PD BI recovery, 34.0±7.8PD BO break, 23.0 ±5.7PD BO recovery). Mean differences between these two methods were 1.2±5.2PD (BI break), 2.1±4.7PD (BI recovery), 2.3±13.0PD (BO break), and 0.9±11.3PD (BO recovery).

Conclusions : This study showed the possibility to measure fusional vergence ranges objectively. The agreement between the objective method with smooth-changed disparity and the conventional test using the Risley prism was considerably poorer than between the two methods where disparity changed in steps. However, a wide variability across subjects was still found, especially for the BO fusional ranges.

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