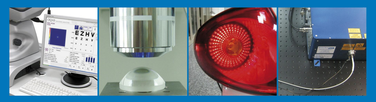
Centre for Sensors, Instruments and Systems Development
UNIVERSITAT POLITECNICA DE CATALUNYA
Shaping light to your needs



CONTACT ME:
cristina.rovira@upc.edu

VALIDATION OF OBJECTIVE METHODS TO MEASURE FUSIONAL VERGENCE RANGES

Cristina ROVIRA-GAY [1], Clara MESTRE [2], Marc ARGILES [1], Jaume PUJOL [1]

[1] Centre for Sensors, Instruments and Systems Development (CD6), Universitat Politècnica de Catalunya, Barcelona, Spain

[2] School of Optometry, Indiana University, Bloomington, USA

Poster Number:
F0525

PURPOSE

The measurement of fusional vergence amplitude is fundamental in a conventional optometric exam and is commonly done in clinics using **rotatory Risley prisms** (smooth vergence test) or **prism bars** (step vergence test). Although they are widely used in clinical practice, both methods have limitations: subjectivity[1], not interchangeable measurements[2], high variability of results[3].

In order to solve these limitations, two new methods to **measure fusional vergence amplitudes at near objectively were validated against the two conventional methods used in clinics**

MATERIAL AND METHODS

Subjects: 49 young adults between 19 and 29 years old (23.22 ± 3.06 years) wearing their habitual correction (either spectacle or contact lenses).

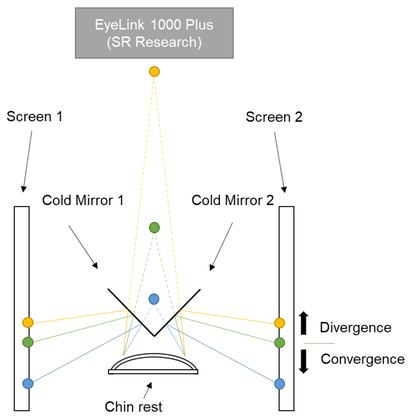
Procedure: Amplitude of Base In (BI) and Base Out (BO) (break and recovery points) were evaluated at 40 cm with:

- two **subjective** tests: step vergence test (prism bar) and smooth vergence test (Risley)
- two **objective** tests: step objective test, which mimicked a prism bar, and smooth objective test, which mimicked rotatory Risley prisms

In the two smooth vergence tests, vergence demand changed at 1 PD/s. In the two step vergence tests, vergence demand changed every 2 seconds.

Instrument: For the objective tests, an haploscope system was used. Eye movements were recorded with an EyeLink 1000 Plus (SR Research) and the fixation targets presented on each screen were controlled with custom software coded in Matlab R2020b.

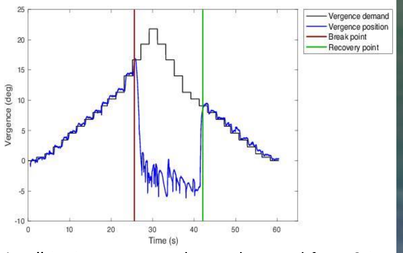
Haploscope system



Data Analysis: Objective determination of break and recovery points:

- Blinks removal and data smoothing.
- Iterative fitting procedure of the vergence position over time adding 0.10 seconds of data in each iteration.
- The vergence demand at the time when the coefficient of determination of the fit starts to decrease corresponds to the break point.
- Same procedure to determine the recovery point.

Example of a Step BO recording



In all tests, vergence demand ranged from 0 to 40 Prism Diopters (PD) for both BI and BO. A break point of 40 PD was assigned to participants who did not exhibit loss of motor fusion during the objective tests or who did not report diplopia during the subjective tests, and no recovery value was recorded. These participants were excluded from the BO recovery analysis.

CONCLUSIONS

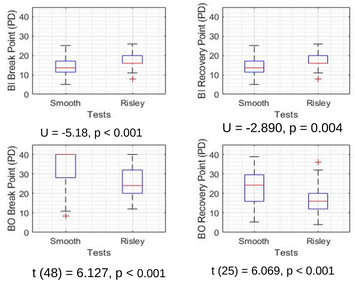
- Fusional vergence amplitudes were measured objectively. However, the subjective and objective methods cannot be used interchangeably due to the wide variability of results.
- The step objective and subjective tests showed better agreement than the smooth objective and subjective tests.
- More research is needed to translate eye-tracking technology into the clinic to assess fusional vergence amplitudes accurately and objectively in a user-friendly way without the need for complex setups.

REFERENCES

1. Scheiman M, Wick B. Case Analysis and Classification. In: Clinical Management of Binocular Vision: Heterophoric, Accommodative, and Eye Movement Disorders. 5th ed. Lippincott Williams & Wilkins; 2020. p. 47–84
2. Antona B, Barrio A, Barra F, Gonzalez E, Sanchez I. Repeatability and agreement in the measurement of horizontal fusional vergences. Ophthalmic and Physiological Optics. 2008. 28(5):475–91.
3. Lança CC, Rowe FJ. Measurement of fusional vergence: a systematic review. Strabismus. 2019. 27(2):88–113.

RESULTS

OBJECTIVE VS SUBJECTIVE SMOOTH VERGENCE TESTS



U = -5.18, p < 0.001

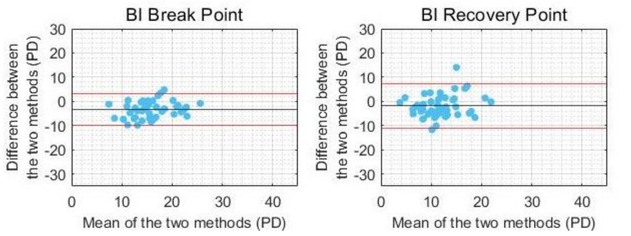
U = -2.890, p = 0.004

t (48) = 6.127, p < 0.001

t (25) = 6.069, p < 0.001

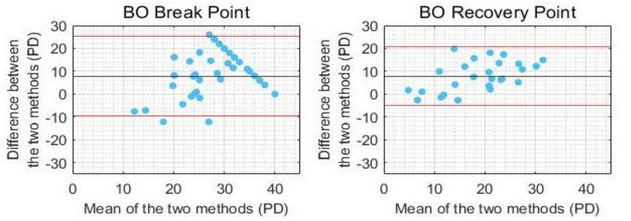
Bonferroni correction for multiple comparisons was applied (significance level set at p≤0.008)

Fusional ranges measured with the smooth objective test were **significantly** different than with the smooth subjective test.



- Mean of the differences ± SD: -3.45 ± 3.23 PD
- 95% limits of agreement: 3.06 PD, -9.97 PD

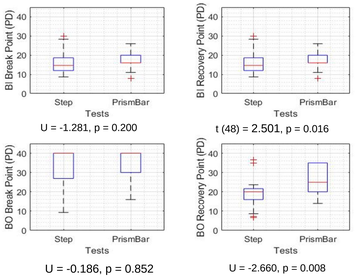
- Mean of the differences ± SD: -1.86 ± 4.70 PD
- 95% limits of agreement: 7.36 PD, -11.08 PD



- Mean of the differences ± SD: -7.76 ± 8.86 PD
- 95% limits of agreement: 25.13 PD, -9.61 PD

- Mean of the differences ± SD: 7.88 ± 6.62 PD
- 95% limits of agreement: 20.87 PD, -5.10 PD

OBJECTIVE VS SUBJECTIVE STEP VERGENCE TESTS



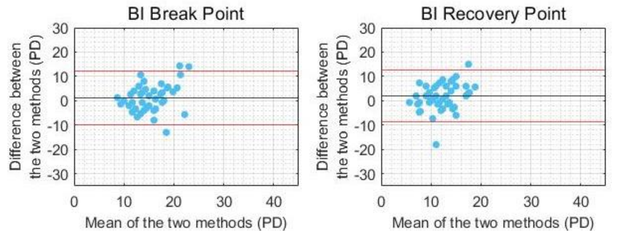
U = -1.281, p = 0.200

t (48) = 2.501, p = 0.016

U = -0.186, p = 0.852

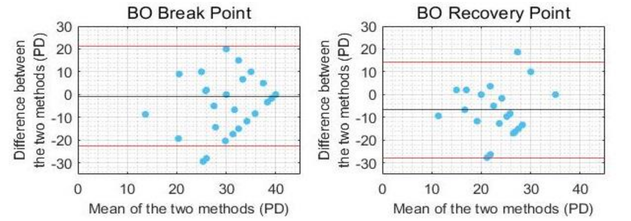
U = -2.660, p = 0.008

BI break, BI recovery, and BO break points measured with the two step vergence tests were **not significantly** different.
The differences between methods for the BO recovery points were at the limit of **significance**.



- Mean of the differences ± SD: 1.16 ± 5.55 PD
- 95% limits of agreement: 12.05 PD, -9.73 PD

- Mean of the differences ± SD: 1.95 ± 5.46 PD
- 95% limits of agreement: 12.65 PD, -8.75 PD



- Mean of the differences ± SD: -0.67± 11.21 PD
- 95% limits of agreement: 21.29 PD, -22.65 PD

- Mean of the differences ± SD: -6.78 ± 10.64 PD
- 95% limits of agreement: 14.08 PD, -27.65 PD

ACKNOWLEDGMENT: This project has been funded by Spanish Ministry of Economy and Competitiveness Grant PID2020-112527RB-I00 funded by MCIN/AEI/ 10.13039/501100011033; European Union, Generalitat de Catalunya by Predoctoral grant FI-DGR (CR).

COMMERCIAL RELATIONSHIPS DISCLOSURE: C. Rovira-Gay, C. Mestre, M. Argiles, J. Pujol: No Commercial Relationship (Code N).

Generalitat de Catalunya

TECNIO

www.cd6.upc.edu
+34 93 739 8901