Intra- and inter-rater reliability of ocular phoria tests

Vanessa Cristina G. Paula[1] , **Tiago D. A. Tsunoda[1]** , **Paulo Fernandes Pires[1]** , **Rodrigo Antonio C. Andraus[2]**, **Odivan B. B. Alves[1]**, **Giani A. Oliveira[1]**, **Barbara A. Teixeira[1]**, **Guilherme Luis S. Luchesi[1]**, **Felipe M. Bento[1]**, **Denis Carlos dos Santos[2]**, **Joao Paulo Freitas[2]**, **Sara A. Ito[1]**, **Fabrício J. Jassi[2]**.

[1] State University of Northern Paraná (UENP), Jacarezinho (PR), Brazil
[2] Northern Paraná University (UNOPAR), Londrina, PR, Brazil

Abstract

Background: Ocular fusion is responsible for maintaining adequate binocular alignment in relation to the distance from the fixation point to project the image onto the retina of both eyes and obtain a single fused image. Ocular phorias occur when there is a misalignment visualized when breaking binocularity, and are classified according to the direction of the deviation in the literature lacks information on the tests used to evaluate ocular phoria. **Objective:** This study has as objective to verify the intra- and inter-rater reliability of the ocular phoria test. **Methods:** Study cross-sectional observational type case-control. They were recruited voluntarily, 123 volunteers from both sexes from 18 to 49 years old. It was the coveruncover test was applied for evaluation qualitative alignment of the axes visuals. The test was accomplished by 3 reviewers distinct in 2 days. The linear weighted Cohen's Kappa was used to determine reliability and agreement inter-evaluators he was calculated between three pairs of therapists. **Results:** The reliability of the right ocular phoria test at 40cm showed agreement acceptable in all the tests, already on the left at 40cm the agreement no he was acceptable inter-evaluators in the first evaluation and intra- evaluators, and was acceptable in the second assessment inter-rater reliability. The intra- and inter-rater reliability of the ocular phoria test at 20 cm did not he was acceptable. **Conclusion:** The ocular phoria test in this moment, due to the low quality of evidence, cannot be recommended for evaluation of ocular phoria.

Keywords: Eye movement disorders; eye tracking; reliability of the data.

Corresponding author: Vanessa Cristina Godoi de Paula.

Email: vanessa.paula@uenp.edu.br

BACKGROUND

The visual receptor, the eye, acts as both an endo and exteroceptor, and is one of the receptors sensory involved in the activity motor musculoskeletal, relating the positioning of the cervical spine and movements of the eyes and head through integration of afferent information from the vestibular, visual and proprioceptive systems. This integration generates answers musculoskeletal postural suitable or adaptive compensatory triggered by the activation of the muscles in the cervical region in order to maintain the performing activities that require eye movement[1]. The neural commands needed to produce the response at the correct time are organized and sent to the appropriate brain centers in order to perform the desired action, or that is, the sensory information received is processed and transmitted to the effector mechanism, to then to be determined to the strategies suitable of response motor[2].

In this context, the visual system contributes to maintaining the natural balance within the limits of the support base, informing how to maintain the alignment of the head and trunk. Changes in this mechanism and the ability to keep the head in position neutral they can trigger postures inadequate, generating overload to the column and possible repercussions such as pain[3].

One of the disturbances more common node system oculomotor in monocular vision are the disturbances in phorias eyepieces and generate repercussions direct node system musculoskeletal and postural maintenance, presenting frequent symptoms associated with fatigue eyepiece, asthenopia, pain of head, drowsiness, difficulty of concentration in the reading, line skipping and intermittent diplopia, all of which are influenced by the general state of health, anxiety and prolonged close work, which sometimes interfere with the ability of to read, learn and of carry out works of close[4-6].

Ocular fusion is responsible for maintaining proper binocular alignment in relation to the distance from the point of fixation to project the image onto the retina of both eyes and obtain a single fused image, to the phorias eyepieces occur when exists one misalignment viewed to the break up the binocularity, and is classified according to the direction of the deviation[7-10]. Of all mode, node environment clinical, to assess ocular phoria the test is used coveruncover, which determines the ocular alignment with the fusional aspect eliminated, that is, with the musculature ocular at rest[11] however, there is no information in recent literature on the reliability of that test.

Like this, the present proposal and original and he has the purpose of assistant you clinical and researchers node diagnosis and identification of changes node receiver eyepiece proposing information coveruncover test reproducibility already used in the clinical and research environment, with relevance in the repercussions musculoskeletal, adaptations postural, possible pictures of pain, and others symptoms associates, what they can to generate the far away term postures   vicious and pictures of pain chronic, enabling, this form, the search put strategies of treatment and prevention. Finally, the hypothesis of this study is that the ocular phoria test is reliable for evaluating changes in the ocular receptor.

METHODS

The study design is a cross-sectional observational study approved by the ethics in research CAAE 57521821.2.0000.8123, under protocol no. 5,501,335. Volunteers of both sexes aged 18 to 49 were recruited in a voluntary[12,13] and forwarded the Clinic of Physiotherapy from the Center of Sciences from the Health from the University State of North of Paraná (UENP), where they were informed on the protocol of evaluation. Volunteers who presented (1) neurological symptoms were excluded from the study and/or psychiatric illnesses (2) use of medication that alters sensory perception and (3) tropia eyepiece. All you volunteers signed the Term of Consent Free and Informed, conducted in accordance with Resolution 466/2012 of the National Health Council (CNS) approved by the Human Research Ethics Committee.

The research followed the recommendations of the Guidelines for Reporting Reliability and Agreement Studies (GRRAS)[14], driven node outpatient clinic clinical of physiotherapy from the University State of North of Paraná in the city of Jacarezinho (PR), Brazil, between the months of June and August 2022. The procedures were carried out in a private office, in order to avoid any type of exhibition or possible constraints of the participants. All you procedures were conducted by three posturology expert evaluators, trained and calibrated to assessment of the tests visuals with experience average of 3 years. You volunteers were recruited through advertisements on social media. The size from the

sample he was accomplished considering the I point by[9], what pointed out a prevalence of 8% of convergence insufficiency in the general population. Considering an acceptable inter-rater Kappa value equal to or above 0.3, a power of 80% and alpha=0.05, we can consider an ideal sample of 113 individuals, in our 123 individuals participated in the study.

Protocol of intervention

Eligible volunteers, after signing the TCLE (annex 1), were subjected to the coveruncover test for qualitative assessment of the alignment of the visual axes and presence of tropia. The test was performed by 3 different evaluators at 2 times, with the one week interval between the 1st and 2nd moment, was accomplished one prize draw to order of the evaluators, all you evaluators they were blinded and no had access to the assessments between periods and assessments between them. This form of assessment was used to analyze the intra- and inter-rater reliability of the test.

Instruments and techniques of collect of data
Converuncover

For evaluation of the phoria eyepiece he was accomplished the test coveruncover for determine qualitatively the degree of alignment of the visual axes. With the volunteer standing he was requested what the same fixed the target object real – one pen placed 40cm away at eye level, and then the volunteer's right eye was occluded with an occluder black and then the occlusion was removed three times in a row, observing whether any movement occurred. After this observation, he was accomplished the same procedure to evaluate the eye left. Any eye movement assessed indicated the presence of a phoria and any movement of the eye did not evaluated indicated a tropia. From this point on, the ocular phoria was identified and classified in orthophoria when there was no eye movement, exophoria when the movement occurs inward, endophoria when the movement occurs outward, hyperphoria when the movement occurs downward and hypophoria when the movement occurs upward. The test was then repeated, with a distance of 20 cm. The same tests were performed repetitions and interpretations aforementioned in the test the 40 cm of distance[11].

Analysis of the data

You data of the 3 evaluators they were used to analysis. The Kappa of Cohen linear weighting was used to determine intra- and inter-rater reliability. The agreement inter-evaluators he was calculated between three pairs of therapists. To the rates of agreement inter and intra-rater they were analyzed, calculating the proportion of agreement, exact agreement and agreement expected by chance[14,15]. Intervals of trust [95%] they were calculated for you values. One coefficient Kappa of 1.0 indicates agreement total in addition of chance. Values above 0.80 are considered excellent, values between 0.60-0.80 substantial, 0.40-0.60 moderate, 0.40-0.20 reasonable and values <0.20 they are bad[16]. The analysis of data used the Statistical Package for the Social Sciences version 22. (IBM SPSS Statistics, Armonk, NY, USA).

RESULTS

123 volunteers were analyzed, predominantly male (50.4%) with age average of 28 ± 7 years. Table 1 shows acceptable agreement for categorical variables in the first and second second assessment regarding the inter-rater reliability of the ocular vergence test.

Table 1 shows the results regarding the inter-rater reliability of the test. right and left ocular phoria at 40cm. Acceptable agreement was detected for the categorical variables in the first and in the second assessment on the right, and unacceptable on the left.

Table 1. Analysis inter-evaluators of test of phoria eyepiece right and left to 40cm

	Pair AV1 vs AV2	Pair AV1 vs AV3	Pair AV2 vs AV3
First Kappa Right Assessment (95% CI)	1.0	1.00	1.00
Second Kappa Right Assessment (95% CI)	1.00	0.66 (0.00 to 1.00)	1.00
First Assessment Kappa Left (95% CI)	1.00	-0.14 (-0.38 to 0.00)	1.00
Second Assessment Kappa Left (95% CI)	1.00	0.66 (0.00 to 1.00)	1.00

Note: AV1 = evaluator 1; AV2 = evaluator 2; AV3 = evaluator 3.

Table 2 shows the results regarding the inter-rater reliability of the test. right ocular phoria at 20cm. It was detected that the unacceptable agreement for the variables categorical in the first and in the second evaluation in both tests

Table 2. Analysis inter-evaluators of test of phoria eyepiece right and left the 20cm

	Pair AV1 vs AV2	Pair AV1 vs AV3	Pair AV2 vs AV3
First Kappa Right Assessment (95% CI)	-0.008 (-0.20 the 0.00)	-0.01 (-0.04 the 0.00)	0.01 (-0.44 the 0.08)
Second Kappa Right Assessment (95% CI)	1.00	0.17 (0.00 the 0.49)	1.00
First Left Kappa Evaluation (95% CI)	-0.01 (-0.02 the 0.00)	-0.03 (-0.073 the 0.00)	-0.01 (-0.05 the 0.00)
Second Assessment Kappa Left (95% CI)	1.00	0.17 (0.00 the 0.49)	1.00

Note: AV1 = evaluator 1; AV2 = evaluator 2; AV3 = evaluator 3.

Table 3 shows the results regarding the intra-rater reliability of the test. of right ocular phoria at 40cm. Acceptable agreement was detected for the variables categorical on the right and unacceptable on the left.

Table 3. Analysis intra-rater of test of phoria eyepiece right and left to 40 cm

	AV1	AV2	AV 3
Kappa Right	1.00	1.00	0.38 (0.00 the 0.74)
kappa left	-0.008 (-0.20 the 1.00)	1.00	0.34 (0.00 the 0.65)

Note: AV1 = evaluator 1; AV2 = evaluator 2; AV3 = evaluator 3.

Table 4 shows the results regarding the intra-rater reliability of the test . phoria eyepiece right the 20cm. It was detected what the agreement no acceptable to to the variables categorical.

Table 4. Analysis intra-rater test of phoria eyepiece right the 20 cm

	AV1	AV2	AV3
Kappa	-0. 008 (-0.20 to 0.00)	1.00	0.32 (0.09 the 0.52)

Note: AV1 = evaluator 1; AV2 = evaluator 2; AV3 = evaluator 3.

Table 5 shows the results regarding the intra-rater reliability of the test. of left ocular phoria at 20cm. It was detected that the agreement was not acceptable for the variables categorical.

Table 5. Analysis intra-rater of test of phoria eyepiece left the 20 cm

	AV1	AV2	AV3
Kappa	-0.01 (-0.24 the 0.00)	1.00	0.32 (0.10 the 0.55)

Note: AV1 = evaluator 1; AV2 = evaluator 2; AV3 = evaluator 3.

DISCUSSION

The main findings of the present study refer to the inter- and intra-rater reliability of the ocular phoria test, where at this time, due to the low quality of the evidence, it is not possible to be recommended for the evaluation of phoria eyepiece. In this sense we can observe what the reliability inter-evaluators showed up reliable for the phoria of the right eye at a distance of 40cm, both in the first and second second assessment, suggesting that the start of the second part of the test battery (after rest) proved to be adequate. Furthermore, the intra-rater evaluation of this same test also showed reliable. However, in the evaluation of the phoria of the left eye at 40 cm, there was reliability just in the second assessment, suggesting perhaps, one possible learning of evaluated/evaluator regarding the tests applied.

In the ocular phoria test at 20cm, the assessment was not reliable in both eyes, both inter-evaluators in the first and in the second assessment, as intra-rater, demonstrating that perhaps some adaptive mechanism of the ocular receptors confuses the assessment of nearby through the test of ocular phoria. Studies show different forms of assessment to test the phoria eyepiece, being some of them the coveruncover test, alternating cover test and maddox rod test, with different instruments, and increment with prism bars that are used to measure diopters prismatic (DP) deviation. Coveruncover is the most practiced technique and the various forms of performance and subjectivity of the examiner can lead to inconsistency and errors in the results. Coveruncover is a test influenced by the experience, positioning of the evaluator and the participant, ambient lighting and, therefore, needs to be controlled for clinical decision[11,17].

There is a study that verified the agreement between two different methods of assessing ocular phoria by experienced examiners and beginners. Coveruncover was used with prism bar (to quantify the deviation in PD) and eye tracking (which records movements eyepieces saccadic), being what the researcher no it found differences significant differences between the means of both methods and between the examiners and observed

high limits of agreement, suggesting agreement between you tests[18]. Another study with young adult volunteers used the Maddox rod to assess the reliability of the measurement of ocular phorias, but the author could not conclude agreement with the use of this instrument (weak correlation coefficients and dispersion of results), but suggested that there may be operational improvement when applied to children[17].

Other limitations of coveruncover are also pointed out, such as non-objectivity and execution aspects such as occlusion time, which directly influence phorias measures. Furthermore, the smallest movement that can be detected with the naked eye is 2 SD, precisely the value to decision clinic of significance, remembering the difficulty of observation of eye evaluated, what depend from the position of evaluator and of rated[18,19]. This research did not use the prism bar to quantify the deviation in DP. as method quantitative from the change eyepiece, being used the test just of form qualitative, since it was sufficient to delimit the presence or absence of the phoria sign and its classification.

Therefore, given the literature presented for the evaluation of ocular phoria through the coveruncover, the large methodological variance makes it difficult to standardize the test and, therefore, Therefore, new studies are suggested with a greater number of evaluators, different averages of experience of evaluators, evaluations on specific days for each test and for each eye (right and left) as well as the increment with the prism bar for greater precision and standardization of the test.

CONCLUSION

In this study we can demonstrate that the coveruncover test due to low quality of evidence, it cannot be recommended for the evaluation of ocular phoria, since our findings do not allow inferences to be made regarding the applicability of the test, and it is necessary more research on the thematic. For futures studies, exists the need of one bigger rigor us protocols of assessment, and implications about of number of repetitions, like this as from the analysis of different averages of experience time of the evaluators, different materials used and time of rest to revaluation after rest. THE recruitment of a greater number of participants and number of assessments and assessors also if he does necessary. As the quality methodological should pay attention mainly due to the blinding of the evaluators, and the isolation of the tests, with the test being ocular phoria performed at another time so that the inference of the presented result is truly representative.

Author Contributions: V.C.G.P. and F.J.J. designed and approved the study and project. V.C.G.P., P.F.P., O.B.B.A., G.A.O., T.T.D.A., B.A.T., R.A.C.A., G.L.S.L., F.M.B., D.C.S., J.P.F., S.A.I. collected the data and, together with F.J.J., analyzed and interpreted them. T.T.D.A. was responsible for the statistical analysis, while V.C.G.P. and F.J.J. prepared and revised the manuscript. All authors approved the final version.

Conflict of interest: We declare that there are no conflicts of interest.

REFERENCES

1.   Figueiredo VFR. Analysis from the Function oculomotor and movements cervical in the convergence visual, dissertation, Master's degree in Sciences and Technologies in Health, University of Brasilia, Brasilia.2020.

2.   Erickson GB 2007 Sports Vision: Vision Care for the Enhancement of Sports. St Louis, Missouri: Butterworth Heinemann. Elsevier.

3.   Jang J.U. et al . Effectiveness of Vision Therapy in School Children with Symptomatic Convergence Insufficiency. J Ophthalmic Vis Res. 2019;12(2):187–92.

4.   Warrior VJJ . Clinical optometry. Santo University Thomas. 2014.

5.   Gupta THE et al Convergence insufficiency in patients visiting eye OPD with headache. Rev Sci. 2011;10(3):135-6, 2008.6Cunha, 2013).

6.   Cunha T et al. Convergence insufficiency and visual attention: exploratory study in students of higher education. Health Technol. 2013;(9):5-10.

7.   From NGK, Fields EC . Binocular vision and eyepiece motility: theory and management of strabismus. New York: Mosby. 2002; 6th ed.

8.   Scheiman MM. Optometric management of learning-related vision problems. New York: Mosby.2005.

9.   Dornbos B, Kokotas V, Kitchener G. Insufficiency of Convergence. International Review of Ophthalmic Optics. 2019.

10.   Trentin SR, Lobianc MK, Matilde SE . Forias: methods of assessment objectives and subjective. Magazine Scientific Multidisciplinary - ISSN 2675-6218. 2023;4(4), e443019.

11.   Rocha F. Manual of standards and routines from the optometry. Brasilia: Advice Brazilian of Optics and Optometry. 2023;68 p.

12.   Gonçalves VP et al. Oculomotor assessment in adults: a study of the effect of age and of visual changes. Audiology-Communication Research. 2016;v. 21.

13.   World Health Organization (WHO). World report on vision [Internet]. Geneva: World Health Organization. 2019.

14.   Kottner J and al . Guidelines for reporting reliability and agreement studies (GRRAS) were proposed J. Clin. Epidemiol. 2011;64 96–106.

15.   Sim J, Wright CC. The kappa statistic in reliability studies: use, interpretation, and sample size requirements Phys. Ther. 2015;85 257–68.

16.   Bland JM, Altman DG. Statistical methods for assessing agreement between two methods of clinical measurements. Lancet. 1986;1:307–10.

17.   Pointer, JS. An enhancement to the Maddox Wing test for the reliable measurement of horizontal heterophoria. Ophthalmic Physiol Opt. 2005.

18.   Hrynchak PK, Herriot C, Irving EL. Comparison of the reliability of the alternative coverage at near in non-strabismus between experienced and novice examiners. Ophthalmic Physiol Opt. 2010;30(3):304–9.

19.   Master C et al . An automated and objective cover test to measure heterophoria. Mailello G, editor. PLoS One. 2018.