

Comparison of Distance and Near Heterophoria by Two Clinical Methods

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ABSTRACT

Introduction: In the evaluation of binocular function, the heterophoria is an essential measure. Historically, the relationship of the near phoric measure to the far phoria has been a critical finding in the diagnosis of convergence and divergence anomalies. There are a number of ways that the phorias can be measured. It is noted in the literature that different types of phoria measures are statistically similar while other articles report various methods of measures can be quite different.

Methods: Each subject was evaluated for binocularity and visual acuity. The Von Graefe and modified Thorington (Howell Card) techniques were performed in a sample of young adult optometry students. Accommodative response was measured clinically following heterophoria testing by Nott retinoscopy. These results were then compared.

Results: The Von Graefe technique data was more variable and significantly more exophoric than the Howell Card findings both at distance and near.

Conclusions: These findings suggest that you cannot consider the Von Graefe and Howell Card as interchangeable tools to measure a heterophoria. The Von Graefe phoria will, using published criteria,

support the diagnoses of convergence insufficiency and of convergence excess more often than the Howell Card.

Keywords: accommodation, heterophoria, Howell Card, Von Graefe

Introduction

The *Dictionary of Visual Science and Related Clinical Terms*, defines heterophoria as “the tendency of the lines of sight (visual axes) to deviate from the relative positions necessary to maintain single binocular vision for a given distance of fixation, this tendency being identified by the occurrence of an actual deviation in the absence of an adequate stimulus to fusion, and occurring in variously designated forms according to the relative direction or orientation of the deviation.”¹

There are a number of methods used to determine heterophorias. Traditional techniques include the use of the alternate cover test with a neutralizing prism bar, the Maddox Rod, the Thorington and Modified Thorington, the Von Graefe, and the utilization of the synoptophore.²⁻¹⁰ The Von Graefe (VG) technique is an in-phoropter measurement method favored by many clinicians as it can be performed immediately after refraction with the tentative spectacle prescription in place. The Howell Card (available at oeopf.org) (HC) (Figure 1) is an alternative technique usually performed in free space, for both distance and near lateral heterophoria measurements. It is a relatively new modification of the Prentice Card and utilizes the Thorington technique to measure heterophoria.¹¹ Both the VG and HC techniques use vertical prism to dissociate the eyes.¹¹⁻¹⁴

There is no data on the validity of phoria measurements since the actual physical locations of the visual axes are not determined.² Research

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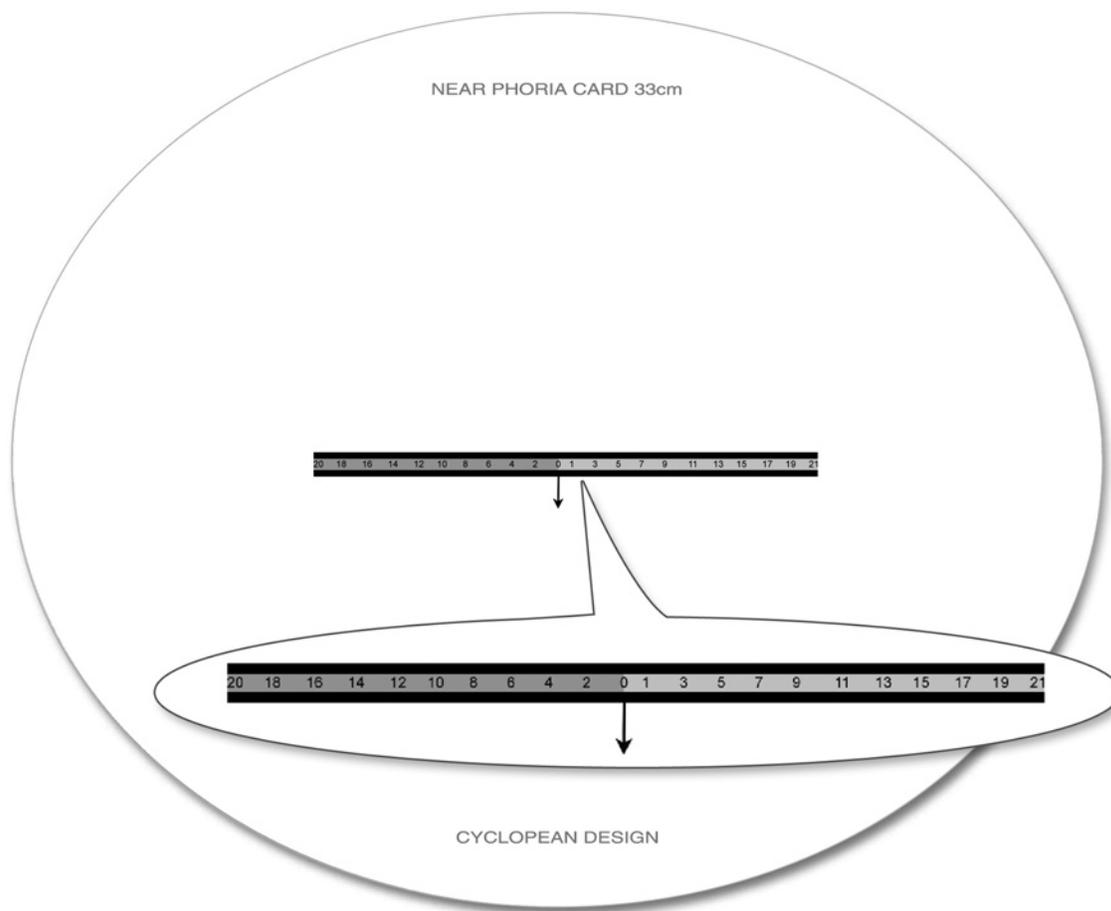


Figure 1: Near Howell Phoria Card 33cm.

looking at the reliability and repeatability of phoria testing has been conducted and comparisons between different techniques have been studied.²⁻¹⁰ Schroeder et al, published a comprehensive review article on the reliability of dissociated phoria measurements, as well as a comparison of different methods.² In a clinical research note, Rainey et al., compared three different cover test techniques and found that each method was reliable and resulted in clinically similar heterophoria findings.³ They later concluded in an original article looking at the inter-examiner repeatability of seven phoria tests, that the modified Thorington test was the most repeatable of those studied.¹⁵ Other research has shown the VG technique to give poor repeatability.¹⁶

Studies comparing different measurement techniques tend to be older.⁶⁻¹⁰ In 1947, Scobey and Green compared the results of three different techniques at distance and five different techniques at near. They concluded that at distance “all three tests yielded about the same average heterophoria and about the same spread around the averages” but that at near “on the basis of the means and standard deviation alone, the five tests cannot be regarded as

equivalent”.⁷ Several researchers have found the VG technique to measure phorias as more “exo” than other methods.^{8-10,16} Little data has been published describing or using the HC. Junghans et al. used the HC in their examination protocol to establish referral rates when screening Australian children.¹⁷ In a study of interexaminer repeatability, Wong et al. found quite similar near phoria means for the HC (using a flashed presentation) and for the VG heterophoria.¹¹ It is important to point out that their VG technique was performed in free space and not behind a phoropter.

The heterophoria measure has come under criticism as being highly variable and not well correlated with symptoms. Gall and Wick examined patients with normal heterophoria measurements (at distance and near) to discern which tests might identify symptomatic from asymptomatic patients. Their findings seemed to suggest that “the vergence system can be problematic despite normal distance phoria and AC/A ratio.”¹⁸ Notwithstanding these possible inconsistencies, heterophoria measurement is usually viewed as essential to the case analysis and management of non-strabismic binocular

dysfunction.¹⁹ Duane's classification, originally used for strabismus, describes binocular anomalies that are partially based on heterophoria measures at distance and near. Duane's classification includes convergence insufficiency, convergence excess, divergence insufficiency and finally, divergence excess.²⁰⁻²²

A study of the frequency of convergence insufficiency (CI) by the Convergence Insufficiency and Reading Study (CIRS) group used, as one criteria of convergence insufficiency, at least 4^Δ more exophoria at near than at distance.²³ The alternate cover test with prism neutralization was used to determine the initial eligibility of the patient for inclusion in this study. Once accepted into the study, Von Graefe heterophorias were employed to determine actual CI associated measurements.

The Optometric Clinical Practice Guidelines, regarding the Care of the Patient with Accommodative and Vergence Dysfunction, published by the American Optometric Association, citing a standard textbook by Scheiman and Wick²⁴, states that a patient with Convergence Excess (CE) has a near deviation at least 3 prism diopters more esophoric than the distance deviation. This document advocates the alternate cover test with prism neutralization as the preferred test for ocular alignment determination (heterophoria). However, several methods (including the use of Risley prisms in a phoropter or in free space, the Maddox Rod, and stereoscopic devices) are mentioned as acceptable alternative measurement techniques.²²

Phoric measurements are consistently considered relevant in the diagnosis of binocular vision anomalies. However, if different phoria measurements do not give clinically similar results then the choice of measurement technique may result in different sensitivities and specificities when diagnosing binocular vision anomalies. Two tests (VG & HC) represent the most common techniques used to measure phorias at the Southern College of Optometry. Are these two measures equal and essentially interchangeable? This study compares the results of the VG and HC on the same subjects, under similar clinical conditions.

Materials and Methods

One hundred and four subjects from Southern College of Optometry's first year class participated in this study. Informed consent was obtained in accordance with institutional review and protocol. All participating students wore their habitual correction and were pre-presbyopes. Each subject's dominant eye

was determined using the sighting "hole in the hand" technique. All subjects had corrected visual acuity of 20/20 in the dominant eye. A distance and near cover test was performed on each subject in free space to rule out strabismus.

Two clinical methods, the VG and HC, at distance and near were evaluated. Nott Retinoscopy was performed immediately after each heterophoria was measured. This was to ensure that a similar accommodative response was present when either phoria methods was performed.²⁵⁻²⁷ Accepted standard technique was used to take the VG measurement although the measurement distances were altered.¹² A 3 meter test distance was chosen for the VG measurements since the distance HC is calibrated at 3 meters. The VG distance phoria was measured at 3 meters with the subject's habitual distance Rx and distance interpupillary distance dialed into the phoropter. Subjects were allowed to wear their habitual contact lenses for the testing in which case plano lenses were placed in the phoropter. A single letter, one line above the best visual acuity was projected on the distance wall chart. Risley prisms were placed in the phoropter with 12^Δ Base In, OD (measuring) and 6^Δ Base Up, OS (disassociating). The subjects were instructed to look at the lower target, keep it clear and state when there was vertical alignment of the two targets. The near VG was measured at 33cm in a similar manner, as described above, with the subjects near interpupillary distance dialed into the phoropter. Although the standard distance for VG near phorias is 40cm, we measured near VG phorias at 33 cm as the HC is calibrated at 33cm. The endpoint was again the initial vertical alignment of the two targets.

Immediately after measuring the phoria, Nott dynamic retinoscopy was performed.

To perform in-phoropter Nott retinoscopy, the examiner observes the dominant eye reflex through the MEM card attached to a near point rod (33 cm) while moving back from the subject until a neutral reflex was seen. The distance from the phoropter to the retinoscope was noted and recorded. If the subject manifested a "lead" instead of a "lag", "lead" was recorded.

The HC measurement battery was generally performed at a later date. All HC measurements were taken in free space (without a phoropter) and were performed at both 3 meters and 33 cm. Accepted clinical procedures for HC measurements were employed.^{11,14} As before, subjects were wearing

either their habitual spectacle prescription or habitual contact lenses. To start the test, 6^ΔBD was placed over the subjects right eye. Upon seeing double, each subject was asked to make the numbers on the bottom image as clear as possible and report to what side the top arrow was pointing on the lower target (blue side [exo], yellow side [eso], or in the middle [ortho]). The subjects were then asked to what number, or between which numbers, the upper arrow was pointing. Immediately following the HC measurements, Nott retinoscopy was performed as previously described but with the patient in free space instead of behind the phoropter.

Results

A two-tailed “t” test was used to establish statistical significance between the means of two similar measures. Pearson’s Correlation was employed to quantify the correlation between similar findings. The mean phoria at distance with the VG was 1.75^Δ exophoria with a range of from 9 esophoria to 10 exophoria and a mode of 1 exophoria (N=26) (Table 1).

The mean phoria at distance with the HC was 0.11^Δ exophoria with a range of from 3 esophoria to 3 exophoria and a mode of orthophoria [N=56] {Figure 2}. The distance phorias were significantly different between the two methods at <.001 (Table 1). The two measures were correlated at .471.

The mean phoria at near with the VG was 6.33^Δ exophoria with a range of from 10 esophoria to 19 exophoria and a mode of 9 exophoria (N=14). The mean phoria at near with the HC was 2.09^Δ exophoria with a range of from 6 esophoria to 12 exophoria and a mode of 2 exophoria (N=18). {Figure 3} The near phorias were significantly different between the two methods at <.001. The two measures were correlated at .584. The 95% confidence interval for both near and far were considerably larger for the VG than for the HC.

When the differences between distance and near VG and HC findings were compared (Table 2), these differences are also found to be significant. The mean distance phoria difference of the HC was 1.64^Δ less exo than the VG. The 95% confidence limits of the differences between the two measures are from 1.18^Δ to 2.10^Δ and is significantly different between the two measures at <.001. The near phoria reveals a similar pattern. The VG phoria finding at near is 4.24^Δ more exo than is the HC with 95% confidence limits from 3.33^Δ to 5.15^Δ. These differences are again

significantly different between the two measures from one another at <.001.

A comparison of the frequency distributions of the VG and the HC measures (Figures 2 & 3) show a definite platykurtic skew to the VG plots when compared to the HC plots, both at distance and near. The frequency distribution for phorias obtained by the VG technique was considerably wider both at distance and near than that obtained with the HC technique. The HC findings were more closely distributed and also clustered closer to ortho.

At the 3 meter distance, 8 of the subjects determined to be exophoric by the VG method were found to be esophoric by the HC. Only 2 subjects were found esophoric by the VG technique and exophoric by the HC. The other 94 subjects were found either exophoric or esophoric by both techniques at 3 meters. At the 33 cm distance, 8 of the subjects determined to be exophoric by the VG method were found to be esophoric by the HC. No subjects were found esophoric by the VG technique and exophoric by the HC. The other 96 subjects were found either exophoric or esophoric by both techniques at 33 cms.

Nott Retinoscopy was performed immediately after the phoria measures were obtained. (Table 1) None of the subjects measured a lead of accommodation however 1 measured no lag in the phoropter while 5 measured no lag out of the phoropter. The in-phoropter findings (demand 33 cm) showed a significantly different mean lag of accommodation from the out-of-phoropter findings (46.85 cm to 43.90 cm; respectively: p=.001). The 95% confidence limits for both Nott retinoscopies can be seen in Table 1. The correlations between the two findings at each distance are also significantly different (p=.001: Table 2). The 95% confidence limits for the mean difference of the two retinoscopies were 1.24 to 4.66 cm. When the mean lag is converted into diopters, it is found that the difference in the accommodative lag between the two measures was 0.14D (Table 1). This difference, although statistically significant, is not considered clinically significant.

We separated the sample into three phoric groups. The first group was a category suggestive of CI (4^Δ more exophoria at near than the distance phoria), the second group was suggestive of CE (3^Δ more esophoria at near than the distance phoria) and the third, were those who exhibited a normal “relative” phoric posture. When considering only these relative

Table 1. Comparison of Means – Distance and Near Phorias by VonGrafe and Howell Card and Nott Retinoscopy in and out of Phoropter. (Phoria measurements are in Prism Diopters.)

	Distance Phoria (exo)	Standard Deviation	Standard Error Mean	Cor.	Sig	95% Conf. Interval
VonGrafe	1.75	2.65	.26			-3.44 to 6.94
Howell	0.11	0.99	.10	.471	<.001	-1.83 to 2.05
Near Phoria (exo)						
VonGrafe	6.33	5.74	.56			-4.92 to 17.58
Howell	2.09	3.11	.31	.584	<.001	-4.01 to 8.19
Nott Retinoscopy (33 cm demand distance)						
Neutrality in cm from the subject						
In Phor	46.85 cm	7.35	.73			32.44 to 61.26
Out Phor	43.90 cm	6.67	.66	.241	.015	30.83 to 56.97
In Phoropter mean lag of accommodation: 33 cm=demand (3.00D); 46.84 cm =response (2.14D) was: 0.86D						
Out of Phoropter mean lag of accommodation: 33 cm=demand (3.00D); 43.90 cm=response (2.28D) was: 0.72D						

Table 2. Paired Samples Test – Distance and Near Phorias by VonGrafe and Howell Card and Nott Retinoscopy in and out of Phoropter. (Phorias measurements are in Prism Diopters.)

	Mean Diff	Std Dev	Std Error	95% Confidence Lower	Upper	t	Sign
Distance Phoria	1.64	2.35	.23	1.18	2.10	7.12	<.001
Near Phoria	4.24	4.66	.46	3.33	5.15	9.27	<.001
Nott Retinoscopy	2.95cm	8.66	.86	1.24	4.66	3.43	.001

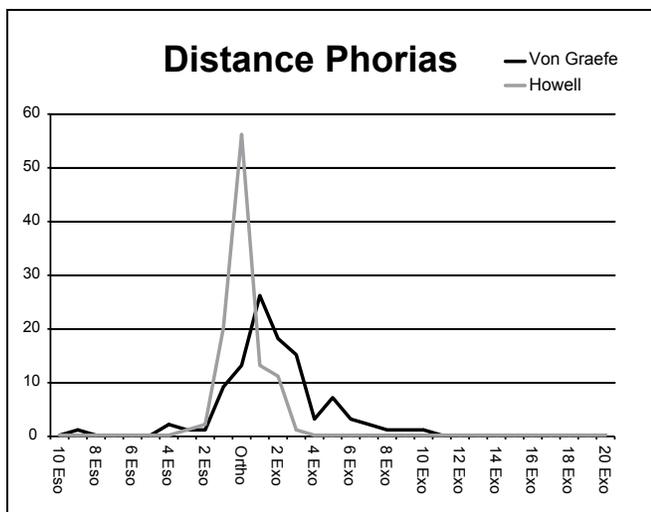


Figure 2: Phorias measurements are in Prism Diopters.

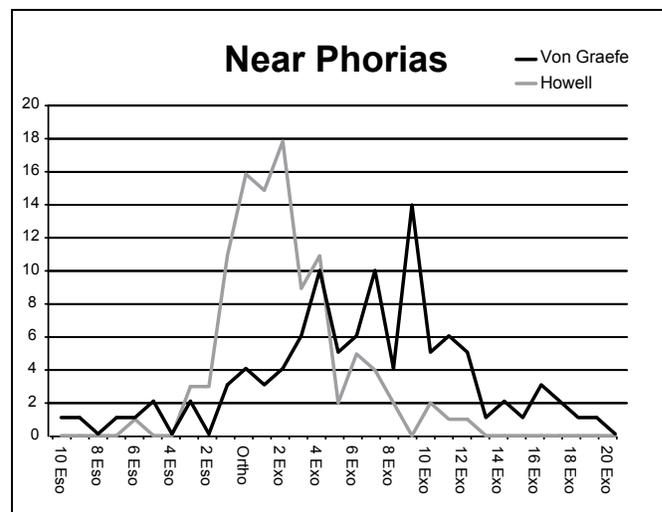


Figure 3: Phorias measurements are in Prism Diopters.

phoria postures, as measured by the VG method, CI was supported in 67 subjects while CI was supported in only 26 subjects using the HC phoria measurements.

In a similar fashion, when CE was considered, the VG supported a diagnosis of CE in 7 subjects while the HC identified only 3.

Discussion

A patient's heterophoria measurements are influential in the diagnosis and ultimately the patient's binocular vision treatment plan. Our findings indicate a higher percentage of patients would be classified with binocular vision anomalies should a clinician measure phorias using the VG technique than would be classified using the HC technique. For example, CI, as a common binocular vision deficit, is often loosely described as a condition manifesting a "significantly" greater exophoria at near than at distance. Although not considered pathognomonic for the condition, (other factors including symptoms, vergences [BO reserves], and near point of convergence are also considered) the heterophoric values are often closely scrutinized.^{22,23,28} One of the Convergence Insufficiency Treatment Trial (CITT) subject inclusion criteria requires a potential study subject's near phoria to be at least 4^Δ more exophoric than their distance phoria. Per study protocol, researchers used the alternate cover test and hand-held neutralizing prisms at near (40 cm) and distance (6 m) to make their phoric determinations. If the phoria relationship did not fit the CI criterion, these findings would eliminate subjects from the study.²⁸ Had the CITT researchers used either VG phorias or HC phorias, as is generally performed in our clinical setting instead of Cover Test phorias, a different distance-to-near phoria relationship might have been required for CI classification purposes.

This study then does not imply that one measurement technique is more accurate or even more useful than the other, only that wide differences in a measured phoria occur, dependent on the technique used. Both the VG and HC may ultimately be quite useful but, in reality, may be measuring different parameters. There could be multiple reasons for the differences between the VG and the HC findings. Maddox proposed four elements for convergence (tonic, accommodative, proximal, fusional).²⁹ We cannot advance a rational explanation for the discrepancy we found between the VG and HC measurements based on Maddox's classification system. However, an obvious difference is that the VG was measured behind the phoropter while the HC was presented in free-space. Support for this explanation is found in the previous study by Wong et al.¹¹ They found similar near phoria findings for the HC and the VG when performing both procedures in free space although slightly different near testing distances were used.

It is generally accepted that visual information travels from the retina to the cortex along at least two parallel (magnocellular and parvocellular) and somewhat independent pathways.³⁰ Arguably, the in-phoropter VG phorias, by cutting off much of the peripheral retinal, where M cell input is dominant, causes the visual information to be dominated by the parvocellular pathway. The free-space HC with a relative increase in peripheral cues and peripheral awareness compared to the VG method, may be more a function of the M pathway.³⁰ If this is the main reason for our measurement differences (in-phoropter vs. free-space), we could conjecture that the alternate cover test described in the CITT study (in free space) would agree better with the HC than the VG.

At any rate we suggest that the VG phorias and the HC phorias are quite different tests and require independent normative values. A patient may fit the phoria diagnostic criteria for a particular binocular anomaly with one technique and not with another. Additional research is needed in this area, especially concerning their relevance to clinical care and its correlation to patient symptomatology. It is not possible to state from this data, which, if either of these two phoria measures predicts symptoms. It is important that a study be conducted where each phoria is compared to symptoms to ascertain which phoric measure is most appropriate for diagnosing these binocular dysfunctions.

Conclusions

There are statistically significant different measures between the VG and HC. The VG test gives a broader range and more exophoric measurements than the HC both at distance (3 m) and at near (33 cm) on the same patient.

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