

# LITERATURE REVIEW

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## Current Eye & Vision Science Literature

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The articles to be reviewed for this issue all deal with dynamic retinoscopy testing procedures, and all were published in 2009.

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**Antona B, Sanchez I, Barrio A, Barra F, Gonzalez E. Intra-examiner repeatability and agreement in accommodative response measurements. *Ophthalmic and Physiological Optics* 2009;29:606-614.**

This study from Spain had the aims of finding the intra-examiner repeatability of four methods of determining accommodative response and of finding the level of agreement between the results of those four methods. The four methods were: Nott retinoscopy, monocular estimate method (MEM) retinoscopy, binocular cross cylinder (BCC) test, and use of an open view autorefractor.

Serving as subjects were 61 young adults (age range, 18-32 years; mean age, 19.7 years). Subjects had normal visual acuity, no accommodation or vergence anomalies, no ocular pathology, no history of refractive surgery, no medication or disease that could affect accommodation or vergence, and limited ocular symptoms.

There were four examiners, one for each test procedure. Each subject was tested two separate

times, which were separated by at least 24 hours and no more than ten days. Each examiner was masked to the results obtained by the other examiners. Subjects wore lenses from their subjective refractions during Nott retinoscopy, MEM, and near autorefractometry. Target illumination was similar for all four tests. For Nott retinoscopy, MEM, and near autorefractometry, the target consisted of letters at a 1.0 decimal acuity level. Nott retinoscopy and BCC were performed with a phoropter. The test distance for all procedures was 40 cm.

Room and stand lights were kept on during the BCC test. The test was started at the subject's subjective refraction and plus or minus was added until horizontal and vertical grid lines appeared equally clear. The autorefractor used for accommodative response measurements was a Shin-Nippon SRW-5000, which is also known as a Grand Seiko WV-500. It is an open view infrared autorefractor in which the subject can view a nearpoint test card placed at any distance.

A coefficient of repeatability (COR) for each test was calculated by multiplying the standard deviation of the differences between first and second test findings by 1.96. Similarly, a coefficient of agreement (COA) between each pair of tests was calculated by multiplying the standard deviation of differences between tests by 1.96. When the distribution of differences in a given comparison did not show a normal distribution, the values for COR and COA were determined using the 95th percentile of the differences in the given comparison. A low COR would indicate better repeatability for a given test. Good agreement between tests would be indicated a low difference between their means and a low COA.

The differences between the first and second measurements with each tests were: 0.10 D with Nott retinoscopy, 0.23 D with MEM, 0.05 D with BCC, and 0.12 D with near autorefractometry. The COR values were 0.66 D for Nott retinoscopy, 0.98 D for MEM, 0.75 D for BCC, and 1.00 D for near

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Goss DA. Current eye & vision science literature. *Optom Vis Dev* 2010;41(2):93-97.

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autorefractometry. The authors thus concluded that of the four tests, Nott retinoscopy and BCC showed the best repeatability.

The mean lags of accommodation were 0.83 D (SD=0.34) with Nott retinoscopy, 0.63 D (SD=0.50) with MEM, and 0.95 D (SD=0.40) with near autorefractometry. The mean lens power on BCC was +0.10 D (SD=0.38). It may be noted that the mean for the BCC differed the most from the others. The difference between BCC and the other procedures was probably accentuated by the fact that the BCC was not started with plus adds as is the typical technique. The mean on Nott retinoscopy showed 0.20 D more lag than MEM. The mean on Nott retinoscopy was closest to the mean on near autorefractometry. The COA for MEM and Nott was 0.64 D. The COA values for all of the other comparisons were between 0.92 and 1.00 D.

One of the concerns in comparing the results with two clinical tests is whether the difference between the two tests is about the same throughout the full range of measurements or whether the difference changes as the magnitude of the test finding varies. So, for example, we could ask what the difference is between Nott and MEM at high lags, mid-range lags, and low lags. Statistically this can be assessed by using what is often called a Bland and Altman analysis.<sup>1,2</sup> In such an analysis, the differences between two tests is correlated with, or plotted on a scatterplot with, the mean of the two tests. In this study, the authors concluded that: "None of the plots revealed a tendency for the difference between methods to increase as the dioptic value increased." (p. 611)

Another conclusion reached by the authors was that: "Despite better agreement between MEM and Nott, agreement among the remaining methods was poor such that their interchangeable use in clinical practice is not recommended." (p. 606)

### **Correction of Myopia Evaluation Trial 2 Study Group for the Pediatric Eye Disease Investigator Group. Accommodative lag by autorefraction and two dynamic retinoscopy methods. *Optometry and Vision Science* 2009;86:233-243.**

The authors stated that their purpose in conducting this study was to see how well Nott retinoscopy and MEM retinoscopy did in identifying children with lags of accommodation of 1.00 D or more as originally identified with an open view autorefractor. Subjects

in the study were 168 children, ages 8 to 12 years. Subjects had 0.50 to 3.00 D of myopia (spherical equivalent) in each eye, no more than 1.50 D of astigmatism, normal visual acuity, and no strabismus. Seventy percent of the subjects had an esophoria of more than 1 prism diopter at 33 cm as determined by prism neutralized alternate cover test.

The autorefractor used in the study was a Grand Seiko WR-5100K. The autorefractor accommodation measurements were taken as done in the group's ongoing studies. Nott retinoscopy and MEM were performed with methods similar to standard clinical procedure. Fixation targets were at 33 cm for all three tests.

Testing conditions were considerably different on near autorefractometry compared to the dynamic retinoscopy tests:

1. Moderate room illumination was used for Nott and MEM, but room lights were off for near autorefractometry.
2. Nott and MEM were performed under binocular conditions, but the left eye was occluded for near autorefractometry.
3. The spherocylindrical subjective refraction lenses were worn during Nott and MEM, but the spherical equivalent was worn during near autorefractometry.
4. The fixation target for Nott and MEM was the grade 6 Welch Allyn dynamic retinoscopy card (about 20/80 equivalent), while for near autorefractometry, a 20/100 self-illuminated row of letters was used.
5. On Nott and MEM testing, the subjects read the words aloud or they read the letters aloud if they didn't know the words. On near autorefractometry, the subjects were instructed to look at the middle letter and keep it clear.

Mean lags of accommodation for a 33 cm target were 0.74 D (SD=0.41) with Nott retinoscopy, 0.86 D (SD=0.48) with MEM retinoscopy, and 1.26 D (SD=0.61) with near autorefractometry. The mean lag of accommodation with MEM retinoscopy was thus 0.12 D greater than the mean lag with Nott retinoscopy. MEM and Nott findings were within 0.50 D of each other 72% of the time. A Bland and Altman plot of differences of MEM and Nott for each subject with the means of each subject's MEM and Nott findings showed that larger differences between the two methods were found when the lag was high.

The authors also reported a sensitivity of dynamic retinoscopy (what percentage of subjects with a lag of 1.00 D or more on near autorefractometry also had a lag of 1.00 D or more on dynamic retinoscopy) and a specificity of dynamic retinoscopy (what percentage of subjects with a lag of less than 1.00 D on near autorefractometry also had a lag of less than 1.00 D on dynamic retinoscopy). For Nott retinoscopy, the sensitivity was 30% and the specificity was 81%. For MEM retinoscopy, the sensitivity was 57% and the specificity was 63%.

The authors' primary conclusion was that MEM and Nott retinoscopy did not yield sufficient sensitivity and specificity to detect 1.00 D or greater lag of accommodation as determined by near autorefractometry. However, such findings could be explained by the methodological differences between the dynamic retinoscopy and near autorefractometry procedures used in the study. There were differences in illumination, letter size, cognitive demand, and astigmatism correction, all of which can affect accommodative response.<sup>3</sup> And there can be substantial differences between lag of accommodation under monocular conditions and lag under binocular conditions.<sup>3,4</sup>

**Tarczy-Hornoch K. Modified bell retinoscopy: measuring accommodative lag in children. *Optometry and Vision Science* 2009;86:1337-1345.**

The author of this paper is located in the Division of Ophthalmology of the Children's Hospital Los Angeles and the Department of Ophthalmology at the University of Southern California. In this paper, the author described a modified bell retinoscopy procedure designed to quantify lag of accommodation. Also presented in the paper were data on repeatability of the modified bell retinoscopy procedure and comparisons to MEM and Nott retinoscopy.

Data were collected from three study populations: a screening population of 5 to 23 month old children (n=172), a clinic population with ages ranging from 15 months to 16 years (n=30), and a group of children with Down syndrome, median age 45 months (n=11).

The target for modified bell retinoscopy was "an internally illuminated cube with high-contrast black-and-white cartoon images". (p. 1338) When with motion was observed on the modified bell retinoscopy procedure, the target was moved toward the subject until neutral or against motion was observed, then

pulled away from the subject until with motion was first seen again. The distance of the target from the subject at that point was used to calculate a dioptric value for accommodative stimulus. A dioptric accommodative response was determined by the distance of the retinoscope from the patient. This was done with the retinoscope at distances of 33, 50, and 67 cm from the subject. Using these three points, a regression line was calculated for an accommodative response / accommodative stimulus function. The regression equation was then used to estimate what lag of accommodation would have been expected at an accommodative stimulus of 2.50 D.

Nott retinoscopy was performed in the usual manner with the target held at 40 cm. The target for Nott retinoscopy was the same as that for modified bell retinoscopy. MEM was performed with a 40 cm test distance. The targets for MEM were stickers with spatial frequencies similar to the Nott and modified bell target and letters and numbers for older children. Illumination levels were higher for MEM retinoscopy than for the Nott and modified bell procedures.

Pearson correlation coefficients showed statistically significant correlations between each of the methods: modified bell and Nott,  $r=0.84$ ; modified bell and MEM,  $r=0.82$ ; Nott and MEM,  $r=0.80$ .

The average lag on modified bell retinoscopy was 0.32 D less than the average lag on Nott retinoscopy. A Bland and Altman analysis showed that the difference between modified bell and Nott did not change significantly with the magnitude of the lag.

The differences of MEM from the other two tests did vary with the magnitude of the lag. For lags of about 1.00 D, the MEM lag averaged 0.31 D more than Nott and 0.78 D more than modified bell. For lags of about 2.00 D, the MEM lag averaged 1.14 D more than Nott and 1.59 D more than modified bell.

A coefficient of repeatability for modified bell retinoscopy was calculated by multiplying the standard deviation of the intermeasurement differences by 1.96. Repeatability was better for lower lags of accommodation than for higher lags. The within-visit coefficients of repeatability were 0.33 D for lags of less than half a diopter and 0.69 D for lags of a half diopter or greater.

The author concluded that estimates of the lag of accommodation with modified bell retinoscopy "correlate with traditional dynamic retinoscopy measures over a wide range of lags and show comparable repeatability" and that modified bell

**Table 1:** Means (standard deviations in parentheses) and coefficients of agreement (COA) for MEM and Nott dynamic retinoscopy lags of accommodation in various studies. Test distance was 40 cm except where noted.

Study	Subjects; ages	MEM	Nott	COA
Locke and Somers <sup>5</sup>	n=10; 24-30 yrs	Examiner A, 0.50 D (0.16) Examiner B, 0.50 D (0.18)	Examiner A, 0.56 D (0.19) Examiner B, 0.63 D (0.08)	0.22
Cacho et al. <sup>6</sup>	n=50; 15-35 yrs	0.74 D (0.72)	0.42 D (0.41)	0.71
Garcia and Cacho <sup>7</sup>	n=34; 18-24 yrs	OD, 0.32 D (0.52) OS, 0.38 D (0.45)	OD, 0.20 D (0.33) OS, 0.17 D (0.29)	0.53
Goss et al. <sup>8</sup>	n=50; 20-35 yrs	Examiner 1, 0.93 D (0.40) Examiner 2, 0.85 D (0.37)	Examiner 1, 0.87 D (0.20) Examiner 2, 0.90 D (0.20)	0.55
Antona et al. <sup>9</sup>	n=61; 18-32 yrs	0.63 D (0.50)	0.83 D (0.34)	0.64
PEDIG <sup>10</sup> (33 cm)	n=168; 8-12 yrs	0.86 D (0.48)	0.74 D (0.41)	

**Table 2:** Coefficients of repeatability from various studies. Repeatability was assessed by comparing measurements of two examiners (interexaminer) in some studies and by comparing repeated measurements by one examiner (intraexaminer) in another study.

Study	Subjects; ages	Inter- or intra-examiner	MEM	Nott
Locke and Somers <sup>5</sup>	N=10; 24-30 yrs	interexaminer	0.16 D	0.37 D
Goss et al. <sup>8</sup>	N=50; 20-35 yrs	interexaminer	0.31 D	0.17 D
Antona et al. <sup>9</sup>	N=61; 18-32 yrs	intraexaminer	0.98 D	0.66 D

retinoscopy “may be a useful addition to the repertoire of clinical tools available for assessing accommodation in young children.” (p. 1337)

### Overall Trends and Comparison to Previous Studies

Several previous studies have compared findings with MEM retinoscopy and Nott retinoscopy. The results of those studies and the 2009 studies reviewed here are summarized in Table 1. There doesn't seem to be an obvious trend toward the means for one of the two procedures being consistently higher than the other. But the standard deviation for MEM is higher than that for Nott in most of the studies, indicating more variability in MEM than in Nott. In the studies reporting a Bland and Altman type analysis, three studies<sup>8,10,11</sup> found the MEM to have higher measurements of lag than Nott in high lag cases, and small differences between MEM and Nott for normal lag cases. One study<sup>9</sup> did not find a tendency for the difference between MEM and Nott to increase as the magnitude of the lag increased. The coefficients of agreement reported in various studies or calculated from the data reported in the studies

are given in Table 1. This coefficient of agreement represents the range within which differences between two measurements would be expected to be found 95% of the time. In most of the studies, the coefficient of agreement ranged between about 0.5 and 0.7 D. Because of the relation of difference between tests and magnitude of lag, differences greater than the coefficient of agreement could be found more often for high lag cases and lesser differences for mid-range lags.

Some studies reported repeatability data for MEM and Nott. Results can be given as a coefficient of repeatability, based on multiplying the standard deviation of differences between first and second tests by 1.96. This represents the range within which repeated measurements would be expected to agree 95% of the time. A lower coefficient would thus indicate better repeatability. Coefficients of repeatability reported in various studies or calculated from data reported in a study are given in Table 2. The results are variable with two studies showing better repeatability on Nott retinoscopy than on MEM and one showing the opposite. Repeatability was much better in the interexaminer studies, perhaps because

the measurements for a given subject were taken on the same day, whereas in the intraexaminer study, the two measurements on a given subject were taken on different days. Repeatability is a desirable characteristic for a test, but because it does not indicate how closely the results of a given test are to the “true” value, it is only one characteristic used to evaluate a test. The diagnostic “accuracy” or usefulness of a test depends on more than its repeatability.

The results of studies which have compared MEM and Nott retinoscopy to non-retinoscopic procedures for measuring accommodation have varied widely. One previous study found a very high correlation between MEM measurements of accommodation and the findings with subjective optometer instrumentation.<sup>12</sup> Two previous studies found close agreement between near autorefractometry and Nott retinoscopy,<sup>13,14</sup> while another found a trend toward lower lags with near autorefractometry than with MEM and Nott.<sup>8</sup> In contrast, one of the 2009 studies reviewed here reported higher lags with near autorefractometry than with MEM and Nott.<sup>10</sup>

Differences between studies comparing dynamic retinoscopy to non-retinoscopic measurements of accommodation might be explained by differences in procedures and instrumentation.

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