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Calculation of Nott dynamic retinoscopy

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1. Introduction

The accommodation that the eye uses to focus at a certain distance does not correspond exactly with the value of the accommodative stimulus. Such accommodation matches the diopter value of what is called the accommodative response.

The Nott method is used in the optometric examination to measure the accommodative response at 40 cm by dynamic retinoscopy.

The test is performed with the eye compensated by its neutralizing lens (P_{NL}), obtained from binocular subjective examination. In the literature one can find a measurement procedure in which an accommodative test is situated at a distance of 40 cm, starting from that distance, the optometrist without moving the test, shifts the retinoscope until he finds the point of neutralization. The value of the lead or lag of accommodation is usually obtained by subtracting at 2.50D the inverse of the distance to the point of neutralization (in meters). The value of 2.50D is considered accommodative stimulus at 40 cm. The normal value of the accommodative response, considered for the test at 40 cm, is +0.50 or +0.25 D with a standard deviation of ± 0.25 D.

2. Experimental method

The mathematical calculation described in the literature to obtain the value of the difference between the stimulus and accommodative response is not exact, especially when the observer wears neutralizing lens because these lens produce an intermediate image at which the eye must accommodate. It is necessary to note that the accommodative stimulus does not correspond exactly with the value of 2.50D in ametropic subject. This value depends on the refraction (R) (and hence of the P_{NL}) and the distance that the test (x) is situated.

$$A = R - X \quad (1)$$

In Fig. 1 we can see that although the test (T) is located at 40 cm from the neutralizing lens, the eye is accommodating at the intermediate image position (T'). Therefore, the Nott value should be calculated as the difference between the equivalent dioptric distance of T' ($A_{T'}$) and the equivalent dioptric distance when the retinoscope is in the neutral position (A_{PN}).

$$\text{Nott} = A_{T'} - A_{PN} \quad (2)$$

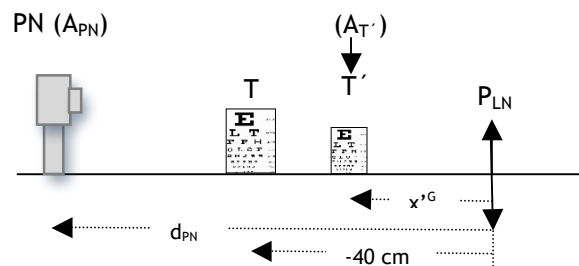


Figure 1 The experimental procedure used in the Nott method.

In order to evaluate the significance of the error for not taking into account the intermediate image, we calculated the Nott value by Eq. (2), and the value that would be obtained by performing the estimate optometric calculation described in the literature (Nott_{aprox}).

3. Results and discussion

Values obtained for the Nott method by the two forms of calculation are in Table 1. These values are obtained for different distances from the neutral point for both emmetropic and hyperopic and also myopic eyes. The negative sign indicates a lead of accommodation and positive values correspond to a lag.

d_{PN} (cm)	Nott _{aprox.} (D)	P_{NL}										
		0	-2	-4	-6	-8	-10	+2	+4	+6	+8	+10
30	-0,83	-0,77	-0,90	-1,01	-1,12	-1,22	-1,31	-0,64	-0,49	-0,33	-0,16	0,03
35	-0,36	-0,33	-0,46	-0,57	-0,68	-0,78	-0,87	-0,20	-0,05	0,11	0,28	0,47
40	0,00	0,00	-0,12	-0,24	-0,35	-0,44	-0,54	0,13	0,28	0,44	0,61	0,80
45	0,28	0,26	0,14	0,02	-0,08	-0,18	-0,28	0,40	0,54	0,70	0,87	1,06
50	0,50	0,47	0,35	0,23	0,13	0,03	-0,07	0,61	0,75	0,91	1,08	1,27
55	0,68	0,64	0,52	0,40	0,30	0,20	0,11	0,78	0,92	1,08	1,26	1,45
60	0,83	0,79	0,66	0,55	0,44	0,34	0,25	0,92	1,07	1,23	1,40	1,59
65	0,96	0,91	0,79	0,67	0,57	0,47	0,37	1,05	1,19	1,35	1,52	1,71
70	1,07	1,02	0,89	0,78	0,67	0,57	0,48	1,15	1,30	1,46	1,63	1,82

Table 1 Nott values for different values of P_{NL} . The first column is the distance to the point of neutralization (d_{PN}), the second column is the Nott_{aprox}, and the others columns are the Nott values for different values of P_{NL} .

As can be seen, the Nott values obtained by the two calculation methods described are different. For example, if we look at the line where the distance from the neutral point is 50 cm, the approximate Nott value is +0.50D, ie in this case corresponds to the normal value. However in ametropics, refractions above from -4D in myopic and above +4D in hyperopic, the value would be outside the norm (given that the standard deviation is $\pm 0.25D$).

In the case of myopia, for distances of neutral point greater than 40 cm, ie when there is lag of accommodation, measurement is overestimated with the approximate optometric method for all values considered. The errors are between 0.25 and 0.50D to P_{NL} values between -3 and -7D, to P_{NL} values lower than -2D the errors are lower than 0.25D, and for P_{NL} values above -8D, error range are between 0.50 and 1D. The higher value of the neutralizing lens, the greater error in the calculation. Whereas with increasing distance from the neutral point to the same value of P_{NL} , errors vary a bit.

In hyperopia, for distances of neutral point greater than 40 cm, the measurement is underestimates with the approximate optometric method for all values considered. Generally speaking, the higher the P_{NL} value, the greater mistakes will be in the calculation. For the same value of P_{NL} , with increasing distance from the neutral point, the errors decrease. For P_{NL} values between +4 and +6D the most of the errors are 0.25 and 0.50D. For P_{NL} values lower than +4D the most of the errors are less than 0.25D, and to values of P_{NL} above +6D errors ranging from about 0.50 to just over 1D. For distances less than 40 cm, the values obtained with the approximate calculation is greater than that obtained by considering the position

of the intermediate image.

4. Conclusions

We can conclude that in order to optimize the value of Nott method it would be wise to reconsider the calculation method in most of the studied refractions. Generally speaking, in the case of myopic refraction greater than or equal to -4D, and in the case of hyperopic refraction greater than or equal to +4D, (distances of neutral point equal or greater than 40 cm), calculation, taking into account the intermediate image, would be required by Eq. (2). For neutral point distances less than 40 cm, in myopia above of -5D and for all hyperopia, it is especially recommended performing a more accurate calculation taking into account the intermediate image by Eq. (2).

References

- [1] R. B. Rabbetts, *Clinical Visual Optics* (Butterworth-Heinemann, 2000).
- [2] M. Scheiman and B. Wick, *Tratamiento clínico de la Visión Binocular* (J.B. Lippincott Company-Ciagami, S.L., Madrid, 1996).
- [3] R. B. Morgan, "The analysis of clinical data", in *Optometric Weekly* (1964), August 13, pp. 27-34.