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Normative data in ENG and VNG

F. Wuyts and R. Boniver

Normative data from different papers and reports		
Test items	**Normative limits (μ ± 2s)**	**Reference, number of cases**
Spontaneous nystagmus	α 4°/s	1,2
	α 5°/s	3,4
	α 6°/s	5,6
	α 7°/s	7,8,9
	α 6 beats/10 s	3
Ocular motor testing		
Saccades		
Peak velocity for 20° saccade:	210°/s	4,10
lower limit	252°/s	11, *N* = 20
	283°/s	12, *N* = 38
Latency for 20° saccade	104-365 ms	13, *N* = 34 (IR method)
	128-255 ms	12, *N* = 38
Smooth pursuit gain at 0.3 Hz	>0.80	1,14,15
Optokinetic nystagmus asymmetry	<13%	12, *N* = 38
	<16%	1, *N* = 43

Normative data from different papers and reports		
Test items (μ ± 2s)	**Normative limits number of cases**	**Reference,**
Positional testing	<6°/s	5
Rotatory chair testing		
Sinusoidal harmonic acceleration Test		
Gain		
0.05 Hz, 60°/s	0.20-0.80	16, *N* = 20
0.05 Hz, 60°/s	0.13-0.77	17, *N* = 10
0.05 Hz, 50°/s	0.24-0.85	12, *N* = 38
0.05 Hz, 60°/s	0.38-0.98	18, *N* = 167
Phase		
0.05 Hz, 60°/s	6-14°	16, *N* = 20
0.05 Hz, 60°/s	2-20°	17, *N* = 10
0.05 Hz, 50°/s	-1-18°	12, *N* = 38
0.05 Hz, 50°/s	-1.9-24°	19, *N* = 50
0.05 Hz, 60°/s	0.8-20.2	18, *N* = 167
Directional preponderance		
0.05 Hz, 60°/s	≤15%	18, *N* = 208
0.05 Hz, 50°/s	≤24%	12, *N* = 38
Velocity step 90°/s		
Gain	0.33-0.72	20, *N* = 20
Time constant	11-26 s	20, *N* = 20
Directional preponderance	≤22%	20, *N* = 20
Velocity step 100°/s		
Gain	0.27-0.99	1, *N* = 43
Time constant	5-19.4 s	1, *N* = 43

Very important remarks

- Changing light conditions dramatically alter the calibration factors.
- It is crucial to perform calibrations repeatedly throughout the entire ENG.
- The clinician should never rely blindly on the computer output without inspecting the traces and the calculation results.
- Patients referred for ENG should not take tranquillisers, sedatives or alcohol for 48h before testing.
- Continuous visualisation of the patient and monitoring of the eye recordings are essential for test accuracy as well as for patient comfort and safety.
- Patient alertness has a major effect on the VOR. Ensure optimal alertness of the patient throughout the ENG examination.
- A clinically significant spontaneous nystagmus should appear consistently throughout the ENG test.

Normative data from different papers and reports		
Test items	**Normative limits (μ ± 2s)**	**Reference, number of cases**
Caloric testing		
Labyrinth asymmetry (%)	≤25%	5, *N* = 114
	≤19.8%	3, *N* = 30
	≤19%	12, *N* = 38
	≤15%	21, *N* = 47
	≤22%	1,2, *N* = 43
	≤20%	8, *N* = 58
	≤20%	22, *N* = 49
	≤25%	18, *N* = 167
General labyrinth asymmetry limit	≤22%	Meta-analysis
Directional preponderance (%)	≤23%	5, *N* = 114
	≤22.7%	3, *N* = 30
	≤16%	12, *N* = 38
	≤18%	21, *N* = 47
	≤28%	1,2, *N* = 43
	≤26 %	8, *N* = 58
	≤27%	22, *N* = 49
	≤31.8%	8, *N* = 167
General directional preponderance limit	≤26 %	Meta-analysis

Main parameters of interest of the standard vestibular test protocol	
Protocol item	**Parameters of interest**
Ocular motor screening battery	
Spontaneous nystagmus detection	Nystagmus direction, SCV
Gaze-evoked test (centre, 30° left/right, 15° up/down)	Nystagmus at different positions
Saccades	Velocity, latency, accuracy, binocular asymmetry
Optokinetic nystagmus	Gain, left-right asymmetry
Smooth pursuit	Gain, left-right asymmetry, morphology
Position tests	
Positioning testing	Nystagmus direction, latency, fatigability
Positional testing	Nystagmus SCV, fixation suppression
Vestibular tests	
Rotatory chair test	Gain, phase, time constant, asymmetry
Caloric test	Maximum SCV, labyrinth asymmetry, nystagmus asymmetry, total responsiveness

- Failure in the ocular motor pathways usually leads to consistently abnormal patterns. The patient can therefore either perform the test or not perform the test at all. Decreased alertness interferes with repeatability.
- During rotational testing, let the patient perform mental tasks, such as counting backwards in steps of 3.
- Do not talk continuously to the patient because that provides orientation clues that influence the VOR.
- If the gain is too low, measures of asymmetry or phase are inaccurate, and should be interpreted with caution.

Caloric test

- Maintain alertness throughout the caloric test.
- Calibrate prior to each irrigation since, in particular, the effect of the stimulus changes the impedance of the electrodes (due to sweating etc). Calibration is therefore required before each irrigation.
- Caloric responses should be consistent. If one out of four irrigations does not concur with the others, it should be repeated.

Conclusion

- Every laboratory is strongly advised to establish its own normative data.
- Meta-analysis indicates an upper normal limit for labyrinth asymmetry of 22% and for directional labyrinth preponderance of 26%.
- A dedicated and well-trained technician is crucial for the reliability of vestibular tests.

References

1. Baloh RW, Honrubia V. *Clinical Neurophysiology of the Vestibular System*. 2nd ed. FA Davis Company, Philadelphia, 1990.
2. Sills AW, Baloh RW, Honrubia V. Caloric testing 2. Results in normal subjects. *Ann Otol Rhinol Laryngol Suppl. 1977*;86:7-23.
3. Proctor L, Glackin R, Shimizu H, Smith C, Lietman P. Reference values for serial vestibular testing. *Ann Otol Rhinol Laryngol.* 1986;95:83-90.
4. Shepard NT, Telian SA. *Practical Management of the Balance Disorder Patient*. 1st ed. Singular Publishing Group, San Diego, London; 1996.
5. Barber HO, Stockwell CW. *Manual of Electronystagmography*. 2nd ed. Mosby, St Louis; 1980.
6. Mulch G, Lewitzki W. Spontaneous and positional nystagmus in healthy persons demonstrated only by electronystagmography: physiological spontaneous nystagmus or "functional scar"? *Arch Otorhinolaryngol.* 1977;215:135-145.
7. [No authors listed]. Evaluation of tests for vestibular function. Committee on Hearing, Bioacoustics, and Biomechanics. Commission on

Behavioral and Social Sciences and Education. National Research Council. *Aviat Space Environ Med.* 1992;3(2 suppl):A1-34.
8. Coats AC. Directional preponderance and spontaneous nystagmus as observed in the electronystagmographic examination. *Ann Otol Rhinol Laryngol.* 1966;75:1135-1159.
9. Fischer AJ, Huygen PL, Folgering HT, Verhagen WI, Theunissen EJ. Vestibular hyperreactivity and hyperventilation after whiplash injury. *J Neurol Sci.* 1995; 132:35-43.
10. Baloh RW, Konrad HR, Sills AW, Honrubia V. The saccade velocity test. *Neurology.* 1975;25:1071-1076.
11. Henriksson NG, Pyykko I, Schalen L, Wennmo C. Velocity patterns of rapid eye movements. *Acta Otolaryngol.* 1980;89:504-512.
12. Van Der Stappen A, Wuyts FL, Van De Heyning PH. Computerised electronystagmography: normative data revisited. *Acta Otolaryngol.* 2000;120:724-730.
13. Abel LA, Troost BT, Dell'Osso LF. The effects of age on normal saccadic characteristics and their variability. *Vision Res.* 1983;23:33-37.
14. Jacobson GP, Newman CW, Kartush JM. *Handbook of Balance Function Testing*. 1st ed. Singular, San Diego; 1997.
15. Leigh RJ, Zee DS. *The Neurology of Eye Movements*. 2nd ed. Davis, Philadelphia; 1991.
16. Baloh RW, Sakala SM, Yee RD, Langhofer L, Honrubia V. Quantitative vestibular testing. *Otolaryngol Head Neck Surg.* 1984;92:145-150.
17. Hess K, Baloh RW, Honrubia V, Yee RD. Rotational testing in patients with bilateral peripheral vestibular disease. *Laryngoscope.* 1985;95:85-88.
18. Peterka RJ, Black FO, Schoenhoff MB. Age-related changes in human vestibulo-ocular reflexes: sinusoidal rotation and caloric tests. *J Vestib Res.* 1990 -1991;1:49-59.
19. Wall C 3rd, Black FO, Hunt AE. Effects of age, sex and stimulus parameters upon vestibulo-ocular responses to sinusoidal rotation. *Acta Otolaryngol.* 1984;98:270-278.
20. Theunissen EJ, Huygen PL, Folgering HT. Vestibular hyperreactivity and hyperventilation. *Clin Otolaryngol Allied Sci*. 1986;11:161-169.
21. Jongkees LBW, Philipszoon AJ. Electronystagmography. *Acta Otolaryngol Suppl*. 1964;189:suppl 189:1
22. Boniver R, Demanez JP,Lennes G. Epreuves rotatoires et caloriques chez le sujet normal. Etude statistique des mesures obtenues. In: *Proceedings of the Neurootological and Equilibriometric Society.* Vol 1. Medicine und Pharmacie, Frankfurt a.m.; 1975:195-220.
23. Wuyts FL, Furman JM, Van de Heyning P. Instrumentation and principles of vestibular testing. In: Luxon L, ed. *Textbook of Audiological Medicine*. Martin Dunitz, London; 2003:717-734.

Prof. Floris Wuyts
Head of the Antwerp University Research Centre for Equilibrium and Aerospace
Department of ENT
Antwerp University Hospital
University of Antwerp
Wilrijkstraat 10
2650 Edegem, Belgium
E-mail: floris.wuyts@ua.ac.be