

FUNCTIONAL ACUITY CONTRAST TEST F.A.C.T.[®]

APPENDIX



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FUNCTIONAL ACUITY CONTRAST TEST INSTRUCTIONS FOR USE

INTRODUCTION

The new Functional Acuity Contrast Test (F.A.C.T.[®]) is an improvement on the original Contrast Sensitivity Test developed by Arthur P. Ginsburg, Ph.D., in 1983. The F.A.C.T.[®] also developed by Arthur P. Ginsburg, Ph.D., a pioneer of contrast sensitivity technology, offers a more sensitive and comprehensive measure of functional vision than does standard Snellen acuity.

Normal Snellen acuity only tests the ability to identify progressively smaller, high contrast letters. Although this may be adequate for quantifying refractive errors, it often fails to detect early vision loss due to a wide variety of eye disease and visual pathway disorders such as cataracts, glaucoma, macular and retinal dysfunction, optic nerve disease, toxic chemicals, etc.

Real-world vision is not always high contrast black and white. Rather, it consists of objects having a wide range of sizes viewed under a variety of visually degrading conditions, such as fog, nighttime, bright sun, etc. Many visual disorders will show more significant vision loss under these conditions.

The F.A.C.T. more effectively evaluates your patient's vision over a range of size and contrast, which closely simulates their normal environment.

PRODUCT DESCRIPTION

Specification of the test slides are as follows:

1. The progression of the high quality sine-wave grating size changes in steps equal to one octave (i.e., a factor of two) between rows A, B, C and D and half octave between rows D and E. The corresponding spatial frequencies are 1.5, 3, 6, 12 and 18 (cpd).
2. The contrast step between each grating patch is 0.15 log units. This means that there is a 50% loss or a 100% gain in contrast for any two contrast step increase or decrease, respectively. The contrast range exceeds the normal population range of contrast sensitivity.¹⁴
3. The gratings are tapered into an average gray background to eliminate ghost images (aliasing) and keep the mean retinal illumination constant.¹
4. The grating patch size, 1.7 degrees, exceeds the size of the macula (1 to 1.5 degrees).
5. The gratings are tilted +15°, 0° and -15° to keep them within the orientation bandwidth of visual channels.

Normative Values

On average, a healthy visual system is expected to have contrast sensitivity within the normal range shown by the dotted region on the recording form. This should be considered an average performance level. Normative limits, which include 90% of the normal population, can be used to help minimize the potential for false positives.

This normative range is useful for comparing the shape of a contrast sensitivity curve outside the normative limit.

If the curve is below the normal range for either eye at one or more rows, then the patient should be suspect.^{15,16}

APPLICATIONS

F.A.C.T. is designed to help identify vision loss from a variety of disorders, many of which are not detected by high or low contrast Snellen Acuity tests.

Many conditions hinder the ability to recognize low contrast objects, while having limited impact on the ability to identify high contrast items. Visual pathway dysfunction can cause visual loss that is quite different from the visual loss caused by refractive error. Visual pathway dysfunction can reduce the ability to see large objects while sparing the ability to see small objects.^{4,5} The visual pathway contains several kinds of contrast sensitive neurons, some responding only to objects of larger size, some to intermediate size and some only to smaller sized objects.

Contrast sensitivity tests address this weakness of Snellen high contrast acuity by varying two parameters: grating size and contrast level. Unlike letters, the visibility of gratings can generalize to the visibility of other objects including letters. The following gives more specific information on its use in many of these conditions.

Contact Lenses

Contrast Sensitivity is useful for helping to ensure proper contact lens fit as well as determining when replacement is necessary. For example, uncorrected residual astigmatism from a soft contact lens can result in decreased contrast sensitivity generally at the higher spatial frequencies when compared to hard lenses. Significant contact lens deposits can result in decreased contrast sensitivity at the middle and higher spatial frequencies when compared to contrast sensitivity obtained when the contact lenses are new.^{11,16}

Refractive Disorders

Generally, refractive disorders manifest themselves as a decline in contrast sensitivity first at the smaller grating sizes or higher spatial frequencies for mild refractive disorders. As the degree of refractive disorder increases, contrast sensitivity declines at the middle and then larger grating sizes (middle to lower spatial frequencies).

Refractive Surgery

Refractive surgery can generally result in contrast sensitivity curves similar to refractive error if surgery results in undercorrection.^{17,18}

Cataracts

Early cataracts generally cause contrast sensitivity losses similar to refractive disorders at higher spatial frequencies, rows D and E. Later cataract can reduce contrast sensitivity evenly or unevenly over the lower and middle as well as the higher spatial frequencies (fig. 6).^{19,20}

The addition of a glare source will exacerbate the results for patients with cataracts, producing a lower contrast sensitivity at some or all grating sizes.^{21, 22}

Glaucoma

Although glaucoma can reduce contrast sensitivity for all grating sizes, a number of studies have shown reduced contrast sensitivity mostly at the middle spatial frequencies, especially for row C (fig. 7).²³⁻²⁵

Macular Degeneration

Macular degeneration patients as a group appear to exhibit greater contrast sensitivity loss for all grating sizes with increased degeneration.²⁶

Diabetic Retinopathy

In diabetic patients, contrast sensitivity loss may occur for all grating sizes.²⁷

Optic Neuropathies

A variety of optic neuropathies including afferent pupillary defect, optic neuritis, multiple sclerosis, etc. will effect contrast sensitivity losses over some or all grating sizes. Multiple sclerosis can sometimes effect only the middle sizes.²⁸

Amblyopia

Vision loss due to amblyopia can be identified when tests from the amblyopic eye are compared to its fellow eye (as described in the Recording and Evaluation of Test Results section of

this manual). Typically, the amblyopic eye has lower contrast sensitivity for all grating sizes than the fellow eye. This has been shown with both anisometropic and strabismic amblyopia, however anisometropic amblyopes appear to have greater losses (fig. 8).^{29,30}

Pituitary Adenoma

Pituitary adenoma has been shown to cause contrast sensitivity loss at the middle grating sizes, row C.³¹

Drugs

Certain drugs such as alcohol and Ibuprofen can cause losses in contrast sensitivity.^{32,33}

Toxic Chemicals

Exposure to organic solvents of micro electronic workers has been shown to reduce contrast sensitivity for the middle size gratings.³⁴

FUNCTIONAL VISION

Normal Variation and Seeing Everyday Objects

Individuals with normal contrast sensitivity, that is without any detectable vision problem or eye disease, can have significant differences in grating contrast sensitivity within the normal range over different grating sizes that can effect their visual capability. Differences in seeing letters, aircraft silhouettes, faces and head-up displays have been related to grating contrast sensitivity.^{8,35}

Motor Vehicle Operators

Older drivers, having reduced normal grating contrast sensitivity as compared to younger drivers, have been shown to require to be 24% closer than younger drivers to correctly discriminate road signs even though both groups had better than 20/20 Snellen acuity.³⁶

Older drivers have been shown to have significantly higher crash rates correlated to lower grating contrast sensitivity.^{7,9}

Aircraft Pilots

Pilots have been shown to have significantly longer detection ranges for detecting targets in a flight simulator and field trials that related to individual differences in grating contrast sensitivity.^{6,8}

The Canadian Air Force used individual grating contrast sensitivity for pilot selection.³⁷

ADVANCED TOPICS

Examination Procedure

Methods 1 and 2 below are similar and are used primarily in research. Researchers generally tend to use repeated measures to minimize possible effects of test errors (increase test reliability) and allow statistical analysis. The clinician may want to adopt one of these methods.

Method 1

1. The patient is shown the test rows in a random sequence and tested three times. For example, row sequence C, A, E, D, B, E, C, A, B, D, A, C, E, D, B. Each response is recorded.
2. A final contrast sensitivity score is determined by the lowest contrast patch having at least two of three correct responses.
3. Record the responses on the recording forms.

Method 2

1. The rows are tested in a random sequence two or more times. Each correct response is recorded.
2. Convert each correct patch number into contrast sensitivity from Table 1 and determine the mean score for each row. Standard deviations or other statistics may also be determined.
3. Record mean score for each row on the attached recording form described in Method 1.
4. As with previous methods, scores for each row are connected and compared to the normative curves.

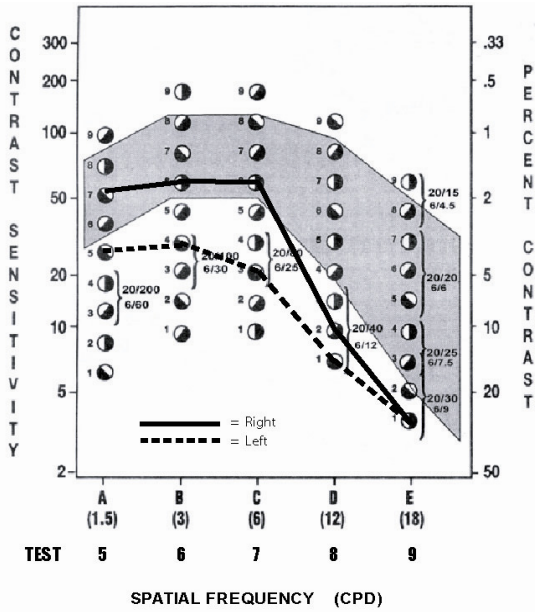


FIGURE 6
Early and Advanced Cataracts

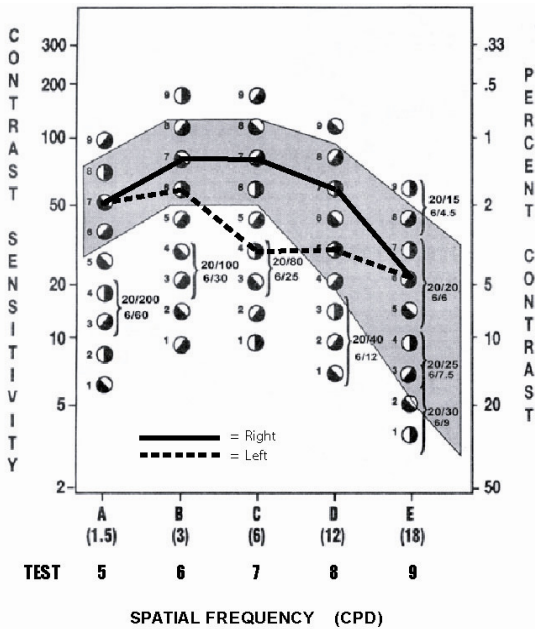


FIGURE 7
Early Glaucoma
Left Eye

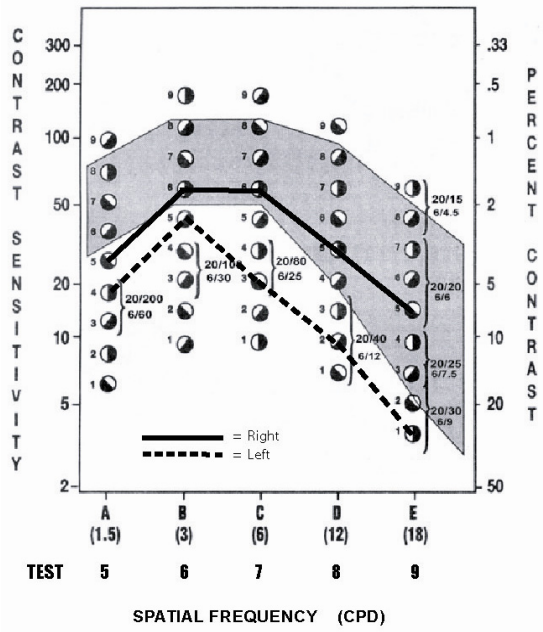


FIGURE 8
Amblyopia

F.A.C.T. CONTRAST SENSITIVITY VALUES

R O W	CYCLES PER DEGREE	COLUMN								
		1	2	3	4	5	6	7	8	9
A	(1.5)	7	9	13	18	25	36	50	71	100
B	(3)	10	15	20	29	40	57	80	114	160
C	(6)	12	16	23	33	45	64	90	128	180
D	(12)	8	11	15	22	30	43	60	85	120
E	(18)	4	6	8	12	17	23	33	46	65

The numbers (ABOVE) are the contrast values for each patch on the F.A.C.T. test slides. To find the contrast value, identify the patch by row and column. For example: the Contrast Value for Patch B, 4 is 29.

REFERENCES

1. Ginsburg, A.P. (December 28, 1982) "Spatial Frequency and Contrast Test Chart." U.S. Patent No. 4365873.
2. Ginsburg, A.P. (1984) "A New Contrast Sensitivity: Vision Test Chart," *Am. J. Opt. Physiol. Opt.*, 61(6), 403.
3. Ginsburg, A.P. (1987) "Clinical Findings From a New Contrast Sensitivity Test Chart," Fiorentini, A., Guyton, D.L. and Siegel, I.M. eds., *Advances in Diagnostic Visual Optics*, Berlin Heidelberg: Springer-Verlag, 132.
4. Ginsburg, A.P. (1981) "Spatial Filtering and Vision: Implications for Normal and Abnormal Vision," Proenza, L., Enoch, J. and Jambolsky, A., eds., *Clinical Applications of Visual Psychophysics*, New York: The Cambridge University Press, 70.
5. Nadler, M.P., Miller, D. and Nadler, D.J. (1990) "*Glare and Contrast Sensitivity For Clinicians*," NY: Springer-Verlag.
6. Ginsburg, A.P., Evans, D., Sekuler, R. and Harp, S.A. (1982) "Contrast Sensitivity Predicts Performance in Aircraft Simulators," *Am. J. Opt. Physiol. Opt.*, 59(1), 105.
7. Evans, D. and Ginsburg, A.P. (1985) "Contrast Sensitivity Predicts Age-related Differences in Highway Signs Discriminability," *Human Factors*, 27(12), 637.
8. Ginsburg, A.P. (1986) "Spatial Filtering and Visual Form Perception," Boff, K., ed, *In Handbook of Perception and Human Performance*, Vol. II., ed, New York: John Wiley & Sons.
9. Decina, L.E., Staplin, L., Spiegel, A. and Knoebel, K.V. (1991) "Contrast Sensitivity and Driver Vision Screening: An Accident Analysis." *35th Ann. Pro. Assoc. Adv. Automotive Medicine*, October 7-9, Toronto, Canada.

10. Stager, P. and Hameluck, D. (June 1986) "Contrast Sensitivity and Visual Detection In Search and Rescue." Prepared for the Defense and Civil Institute of Environmental Medicine, Toronto, Canada.
11. Kluka, D.A. and Love, P.A. "The Effects of Daily-Wear Contact Lenses Upon Contrast Sensitivity in Selected Professional and Collegiate Female Tennis PLayer," UBA at Birmingham.
12. "Emergent Techniques for Assessment of Visual Performance"(1985) Committee on Vision, Commission on Behavioral and Social Sciences and Education, National Research Council, Washington, D.C: National Academy Press.
13. "Recommended Standard Procedures for the Clinical Measurement and Specification of Visual Acuity" (1980) National Academy of Sciences-National Research Council. Report of Working Group 39. *Advances in Ophthalmology*, 41, 103.
14. Ginsburg, A.P., Evans, D., Cannon, M. and Mulvanny, P. (1984) "Large Sample Norms for Contrast Sensitivity." *Am. J. Opt. Physiol. Opt.*, 61(2), 80.
15. Marmor, M.F. and Gawande, A. (1988) "Effect of Visual Blur on Contrast Sensitivity" *Ophthalmology*, 95, 139.
16. Ginsburg, A.P. (January 1987) "The Evaluation of Contact Lenses and Refractive Surgery Using Contrast Sensitivity," *Contact Lenses: The CLAO Guide to Basic Science and Clinical Science Update 2*, Dabezies, O.H. (ed)
17. Ginsburg, A.P., Waring, G., Steinberg, E., Williams, P., Justin, N., Reinging Dietz, J., Roska-Duggan, V., Blauvelt, K. and Bourn, L. (1990) "Contrast Sensitivity Under Photopic Conditions in the Prospective Evaluation of Radial Keratotomy (PERK) Study," *J. Refractive Corneal Surgery*, 6(2), 82.
18. Krasnov, M.M, Avetisov, S.E., Makashove, N.V., Mamikonian, V.R. (1988) "The Effect of Radial Keratotomy on Contrast Sensitivity" *Am. J. Ophthalmology*, 105, 651.

19. Hess, R. and Woo, G. (1978) "Vision Through Cataracts," *Invest. Ophthalm. Vis. Sci.*, 17, 438.
20. Ginsburg, A.P. and Tedesco, J. (1986) "Evaluation of Functional Vision of Cataract and YAG Posterior Capsulotomy Patients Using the Vistech Contrast Sensitivity Chart," *Invest. Ophthalm. Vis. Sci.*, 27(3), (Suppl.), 107.
21. Sjostrand, J., Abrahamson, M. and Hard, A.L. (1987) "Glare Disability as a Cause of Deterioration of Vision in Cataract Patients." *Acta Ophthalmol.*, 65, 103.
22. Ginsburg, A.P., Osher, R.P., Blauvelt, K. and Blosser, E. (1987) "The Assessment of Contrast and Glare Sensitivity in Patients Having Cataract," *Invest. Ophthalm. Vis. Sci.*, 28(3), (Suppl.), 397.
23. Ross, J.E., Bron, A.J., Reeves, D.L. and Emmerson, P.G., (1985) "Detection of Optic Nerve Damage in Ocular Hypertension," *Br. J. Ophthalmol.*, 69, 897.
24. Blanchard, D.L. (1988) "Contrast Sensitivity: A Useful Tool in Glaucoma," *Glaucoma*, 10, 151.
25. Faye, E., Ginsburg, A.P. and Sponsel, R. "Case Reports: Reversibility of Contrast Sensitivity Changes in Treated Open-Angle Glaucoma," Submitted For Publication.
26. Loshin, D.S. and White, J. (1984) "Contrast Sensitivity: The Visual Rehabilitation of the Patient with Macular Degeneration," *Arch. Ophthalmol.*, 102, 1303.
27. Trick, G.L., Burde, R.N., Gordon, M.O., Santiago, J.V. and Kilo, C. (1988) "The Relationship Between Hue Discrimination and Contrast Sensitivity Deficits in Patients with Diabetes Mellitus," *Ophthalmol.*, 95(5), 693.
28. Regan, D., Raymond, J., Ginsburg, A.P. and Murray, T. (1981) "Contrast Sensitivity, Visual Acuity and the Discrimination of Snellen Letters in Multiple Sclerosis," *Brain*, 104, 333.

29. Bosse, J.C. and Lederer, P.J. (1987) "Contrast Sensitivity Used for Detection of Shallow Amblyopia," *J. Opt. Vis. Development*, Vol. XVIII, December, 10.
30. Lequire, L.E., Rogers, G.L. and Bremer, D.L. (1987) "Functional Amblyopia is a Single Continuum of Visual Impairment on Contrast Sensitivity Functions," *Binoc. Vis.*, 2(4), 199.
31. Kurzer, A.R. (1986) "Contrast Sensitivity Signals Pituitary Adenoma," *Rev. of Opt.*, 123(4), 119.
32. Ginsburg, A.P., Evans, D., McNinch, L., Blauvelt, K. and Siegel, H. (1985) "The Effect of Alcohol on Contrast Sensitivity," Presented at the Annual Meeting of the Human Factors Society.
33. Ridder, W.H. and Tomlinson, A. (1992) "Effect of Ibuprofen on Contrast Sensitivity," *Opt. and Vis. Sci.*, 69(8), 652.
34. Frenette, B., Mergler, D. and Bowler, R. (1991) "Contrast Sensitivity Loss in a Group of Former Microelectronics Workers with Normal Visual Acuity," *Opt. and Sci.*, 68(7), 556.
35. Oswley, C. and Sloane, M.E. (1987) "Contrast Sensitivity Acuity, and the Perception of "Real-World" Targets" *Brit. J. Ophth.*, 71, 791.
36. Shinar, D. and Gilead, E., "Contrast Sensitivity as a Predictor of Complex Target Detection," Presented at Human Factors Society meeting, Oct. 22, 1987, New York.

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