Norma Graham

Department of Psychology
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Born August 8, 1944, St. Louis, Missouri

Education and Professional Experience

Centennial Professor Emerita of Psychology, Columbia University, 2023-present.
Centennial Professor of Psychology, Columbia University, 2013-2022
William B. Ransford Professor of Psychology, Columbia University, 2009-2012.
Professor, Department of Psychology, Columbia University, 1982-2009.
Assistant & Associate Professor, Department of Psychology, Columbia University, 1972-1982.
Post-Doctoral Fellow, Visual Neuroscience, The Rockefeller University, 1970-1972
Ph.D. Psychology, The University of Pennsylvania, 1970.
B.S. Mathematics, Stanford University, 1966.

Honors & Awards

Nakayama Medal for Excellence in Vision Science. From the Vision Sciences Society 2022.
National Academy of Sciences. Elected 1998.
American Academy of Arts and Sciences. Elected 1993.
Society of Experimental Psychologists. Elected 1983.
American Association for the Advancement of Sciences. Fellow 2016.
Optical Society of America. Fellow 1996.
American Psychological Association. Fellow1992.

Current Research

Our research attempts to uncover and describe the hidden stages of visual processing, the many stages now known to intervene between the light entering the eye and the human's conscious perception. The neural substrate of these stages is known to be in the back part of the brain, but little is known about how they work. In our work we derive predictions from theories (embodied in mathematical models) about how these hidden stages might work. We compare these predictions to data from behavioral studies (some done by us) and neurophysiological studies (usually done by others). For many years now, we have been interested in the effects of a preceding visual scene on the perception of a current scene. We discovered a previously-unknown effect and suggested it may reveal the existence of a *visual contrast comparison* process. We have been studying the properties of this contrast-comparison process and its interactions with an older-known process, a *visual contrast normalization* process that produces Weber-law-like behavior. Lately we have begun attempting to characterize the dynamics of both visual processes using results from behavioral studies.

Teaching

Recent courses:

Computational Models of Vision (undergraduate: *Psych W3270)*
Special Topics in Vision (graduate and undergraduate: *Psych G4235*)

Some University Service Activities

Department Computer Committee Chair, 2001-2019
Chair, Psychology Department, Fall 2006, July 2007-June 2010
Director of Undergraduate Studies, Psychology Dept. early 2000's, Jan 2011-2012, 2016
Task Force for Diversity in the Sciences and Engineering at Columbia, Chair, 2004-June 2007
Advisory search committee for the College Dean, Spring 2012

Some Professional Activities

Visual Sciences Society Board of Directors 2013-2017, Treasurer 2015-2016
American Academy of Arts and Science Ad Hoc Cognitive Science committee 2015-2018
Refereeing and editing for journals including recently: *Vision Research*, *Journal of Vision*, *Journal of the Optical Society of America*, and *Proceedings of the National Academy of Sciences*

PUBLICATIONS

Book

Graham, N. (1989) *Visual Pattern Analyzers*. New York: Oxford University Press. 646 pages. Paperback edition (2001).

Articles and Chapters

Norman, M. F. and Graham, N. (1968) A central limit theorem for families of stochastic processes indexed by a small average step size parameter, and some applications to learning models. *Psychometrika*, **33**, 441-449.

Ratliff, F., Knight, B. W. and Graham, N. (1969) On tuning and amplification by lateral inhibition. *Proceedings of National Academy of Sciences*, **62**, 733-740.

Graham, N. and Nachmias, J. (1971) Detection of grating patterns containing two spatial frequencies: A test of single-channel and multiple-channels models. *Vision Research*, **11**, 251-259.

McCauley, C. R. and Graham, N. (1971) Influence of values in risky decision making: A formalization. *Representative Research in Social Psychology*, **2**(2), 3-11.

Graham, N. (1972) Spatial-frequency channels in the human visual system: Effects of luminance and pattern drift rate. *Vision Research*, **12**, 53-68.

Gordon, J. and Graham, N. (1973) Early light and dark adaptation in frog on-off retinal ganglion cells. *Vision Research,* **13**, 647-659.

Graham, N., Ratliff, F. and Hartline, H. K. (1973) Facilitation of inhibition in the compound lateral eye of Limulus. *Proceedings of National Academy of Sciences*, **70**, 894-898.

Graham, N. and Ratliff, F. (1974) Quantitative theories of the integrative action of the retina. In *Contemporary Developments in Mathematical Psychology,* R. C. Atkinson, D.H. Krantz, R. D. Luce, and P. Suppes, eds. pp. 306-371. San Francisco, W. H. Freeman Co.

Graham, N. and Rogowitz, B. E. (1976) Spatial-pooling properties deduced from the detectability of FM and Quasi-AM gratings: A reanalysis. *Vision Research*, **16**, 1021-1026.

Graham, N. (1977) Visual detection of aperiodic spatial stimuli by probability summation among narrowband channels. *Vision Research*, **17**, 637-652.

Graham, N. (1977) Spatial frequencies. In *International Encyclopedia of Neurology, Psychiatry, Psychoanalysis, and Psychology*, B.Wolman, ed. Van Nostrand Reinhold.

Graham, N., Robson, J. G., and Nachmias, J. (1978) Grating summation in fovea and periphery. *Vision Research*, **18**, 816-825.
Graham, N. (1979) Does the brain perform a Fourier analysis of the visual scene? *Trends in Neurosciences,* August, 1979, pp 207-208.
Graham, N. (1980) Spatial frequency channels in human vision: Detecting edges without edge detectors. In *Visual Coding and Adaptability*, C. Harris, ed. pp. 215-262. Hillsdale, New Jersey: Lawrence Erlbaum Assocs.
Davis, E. T. and Graham, N. (1981) Spatial frequency uncertainty effects in the detection of sinusoidal gratings. *Vision Research*, **21**, 705-712.
Graham, N. (1981) Psychophysics of spatial-frequency channels. In *Perceptual Organization,* M. Kubovy and J. Pomerantz, eds. pp. 1-26. Hillsdale, New Jersey, Lawrence Erlbaum Assocs.
Graham, N. (1981) The visual system does a crude Fourier analysis of patterns. In S. Grossberg, ed.*Mathematical Psychology and Psychophysiology, SIAM-AMS Proceedings,* Volume 13, pp. 1-16. Providence, Rhode Island, American Mathematical Society.
Robson, J. G. and Graham, N. (1981) Probability summation and regional variations in sensitivity across the visual field. *Vision Research*, **21**, 409-418.
Hirsch, J., Hylton, R and Graham, N. (1982) Simultaneous recognition of two spatial-frequency components. *Vision Research,* **22**, 365-375.
Davis, E T., Kramer, P., and Graham, N. (1983) Uncertainty about spatial frequency, spatial position, or contrast of visual patterns. *Perception and Psychophysics,* **33**, 20-28.
Yager, D., Kramer, P., Shaw, M., and Graham, N. (1984) Detection and identification of spatial frequency. *Vision Research*, **24**, **9**, 1021-1035
Graham, N. (1985) Detection and identification of near-threshold visual patterns. *J. Optical Society of America A*, **2**, 1468-1482.
Graham, N., Kramer, P. and Haber, N. (1985) Attending to the spatial frequency and spatial position of near-threshold visual patterns. In Posner, M.I. and Marin, O.S.M. (eds.) *Mechanisms of Attention: Attention and Performance XI* pp. 269-283. Hillsdale, N.J.; Erlbaum.
Kramer, P., Graham, N. and Yager, D. (1985) Simultaneous measurement of uncertainty and summation effects: Data and theory. *Journal of Optical Society of America A*, **2**, 1533-1542
Graham, N. and Robson, J.G. (1987) Summation of very close spatial frequencies. *Vision Research.* **27**, 1997-2007.
Graham, N., Kramer, P. and Yager, D. (1987) Signal-detection models for multidimensional stimuli: Probability distributions and combination rules. *J. Mathematical Psychology*, **31**, 366-409.
Graham, N. (1989) Low-level visual processes and texture segregation. *Physica Scripta*, **39**, 147-152.
Graham, N., Bartoshuk, L., Bregman, A., Hochberg, J., Rosenfeld, A., and Studdert-Kennedy, M. (1989) Sensory and Perceptual Processes. In *Leading Edges in Social and Behavioral Science,* edited by R. D. Luce, N. J. Smelser, and D. R. Gerstein. New York: Russell Sage Foundation.
Sutter, A., Beck, J. and Graham, N. (1989) Contrast and spatial variables in texture segregation: Testing a simple spatial-frequency channels model. *Perception and Psychophysics,* **46**, 312-332.
Beck, J., Graham, N., and Sutter, A. (1991) Lightness Differences and the Perceived Segregation of Regions and Populations. *Perception and Psychophysics,* 257-269.
Graham, N. (1991) Complex Channels, Early Local Nonlinearities, and Normalization in Texture Segregation. In *Computational Models of Visual Processing,* edited by M. L. Landy and J. A. Movshon, Cambridge, MA: MIT Press
Graham, N., Beck, J. and Sutter, A. (1992) Nonlinear processes in spatial-frequency channel models of perceived texture segregation: Effects of sign and amount of contrast. *Vision Research,* **32**, 719-743
Graham, N. and Hood, D. (1992) Quantal noise and decision rules in dynamic models of light adaptation. *Vision Research,* **32**, 779-787
Graham, N. and Hood, D. (1992) Modeling the dynamics of light adaptation: The merging of two traditions. *Vision Research,* **32**, 1373-1393

Graham, N., Sutter, A., Venkatesan, C., and Humaran, M. (1992) Nonlinear processes in perceived region segregation: Orientation selectivity of complex channels. *Opthalmic and Physiological Optics,* **12**, 142-146.
Graham, N. (1992) Breaking the visual stimulus into parts. *Current Directions in Psychological Science*, **1**, 55-61.
Graham, N., Sutter, A., Venkatesan, C. (1993) Spatial-frequency- and orientation-selectivity of simple and complex channels in region segregation. *Vision Research* , **33**, 14, 1893-1911.
Graham, N. (1994) Nonlinearities in texture segregation. *Higher-order Processing in the Visual System* Proceedings from The Ciba Foundation Symposium No. 184, Oct. 1993, London, England.
Sutter, A. and Graham, N (1995) Investigating simple and complex mechanisms in texture segregation using the speed-accuracy tradeoff method. *Vision Research.*, **35**, 20, 2825-2843.
Wiegand, T.E., Hood, D.C., and Graham, N. (1995). Testing a computational model of light-adaptation dynamics. *Vision Research.*, **35**, 21, 3037-3051.
Graham, N. and Sutter, A. (1996) Effect of spatial scale and background luminance on the spatial and intensive nonlinearities in texture segregation. *Vision Research*, **36**, 10, 1371-1390.
Hood, D.C., Graham, N., Wiegand, T.E, and Chase, V. M. (1997). Probed-sinewave paradigm: A test of models of light-adaptation dynamics. *Vision Research,* **37**, 9, 1177-1191.
Graham, N., and Sutter, A. (1998) Spatial summation in simple (Fourier) and complex (non-Fourier) channels in texture segregation. *Vision Research*, **38**, 231-257.
Hood, D.C. and Graham, N.G. (1998) Threshold fluctuations on temporally modulated backgrounds: A possible physiological explanation based upon a recent computational model. *Visual Neuroscience*, **15**, 957-967.
Graham, N., Rico, M., Offen, S. and Scott, W. (1999) Texture segregation shows only a very small lower-hemifield advantage. *Vision Research,* **39,** 1171-1175.
Wolfson, S. and Graham, N. (2000) Exploring the dynamics of light adaptation: The effects varying the flickering background's duration in the probed-sinewave paradigm. *Vision Research,* **40**, 2277-2289.
Graham, N. and Sutter, A. (2000) Normalization: Contrast-gain control in simple (Fourier) and complex (non-Fourier) pathways of pattern vision. *Vision Research,* **40**, 2737-2761.
Wolfson, S. and Graham, N. (2001) Comparing increment and decrement probes in the probed-sinewave paradigm. *Vision Research,* **41**, 1119-1131.
Graham, N. and Wolfson, S. (2001) A note about preferred orientations at the first and second stages of complex (second-order) texture channels. *Journal of the Optical Society of America A*, **18**, 2273-2281.
Wolfson, S. and Graham, N, (2001) The processing in the probed-sinewave paradigm is likely retinal. *Visual Neuroscience,* **18**, 1003-1010.
Landy, M,. and Graham, N, (2003) Visual Perception of Texture. In *The Visual Neurosciences*, Vol. 2, pp. 1106-1118. Eds. L. M. Chalupa and J.S. Werner, MIT press.
Graham, N and Wolfson S. (2004) Is there opponent-orientation coding in the second-order channels of pattern vision? *Vision Research*, 3145-3175
Wolfson, S. and Graham, N. (2005) Element-arrangement textures in multiple objective tasks. *Spatial Vision,* 19, 209-226
Hood, D.C., Ghadiali, Q., Zhang J.C., Graham, N., Wolfson, S., and Zhang, X (2006) Contrast-response functions for multifocal visual evoked potentials (mfVEP): A test of a model relating V1 activity to mfVEP activity. *Journal of Vision,* **6**, 580-593.
Wolfson, S. S. & Graham, N. (2006). Forty-four years of studying light adaptation using the probed-sinewave paradigm. *Journal of Vision*, **6**, 1026-1046.
Graham, N. and Wolfson, S. (2007). Exploring contrast-controlled adaptation processes in human vision (with help from Buffy the Vampire Slayer). In *Computational Vision in Neural and Machine System,* eds Michael Jenkins & Laurence Harris, Cambridge University Press. pp. 9-47.

Wolfson, S. and Graham, N. (2007). An unusual kind of contrast adaptation: shifting a contrast-comparison level. *Journal of Vision*, **8**, 1-7.
Wolfson, S and Graham, N (2009) Two contrast adaptation processes: contrast normalization and shifting, rectifying, contrast comparison. *Journal of Vision*. 9(4): 30, 1-23.
Graham, N. (2011). Beyond multiple pattern analyzers modeled as linear filters (as classical V1 simple cells): Useful additions of the last 25 years. *Vision Research*. doi:10.1016/j.visres.2011.02.007
Graham, N. and Wolfson S (2013) Two visual contrast processes in human vision: One new, One Old. In C. Chubb, B. Dosher, Z. Lu, and R. Schiffrin (Eds.), *Vision, Memory, and Attention*, American Psychological Association.
Graham,N. and Wolfson, S (2018). Is the straddle effect in contrast perception limited to 2nd-order spatial vision? *Journal of Vision*.18(5):15, 1-43, https://doi.org/10.1167/18.5.15
Wolfson, S. and Graham, N. (2019). Spatial characteristics of a contrast-comparison process. In *Pioneer Visual Neuroscience: A Festschrift for Naomi Weisstein.* Ed. James Brown. Routledge/Taylor&Francis, London and New York, pp 104-117.
Graham, N. V., & Wolfson, S. S. (2023). Varying test-pattern duration to explore the dynamics of contrast-comparison and contrast-normalization processes. *Journal of Vision*, *0*(0):08441, 1–22, https://doi.org/10.1167/jov.0.0.08441.