

Risto Miikkulainen, James A. Bednar, Yoonsuck  
Choe, and Joseph Sirosh

# Computational Maps in the Visual Cortex

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## References

- Abbott, L. F., and Marder, E. (1995). Activity-dependent regulation of neuronal conductances. In Arbib, M. A., editor, *The Handbook of Brain Theory and Neural Networks*, 63–65. Cambridge, MA: MIT Press. First edition.
- Abeles, M. (1982). *Local Cortical Circuits: An Electrophysiological Study*, vol. 6 of *Studies of Brain Function*. Berlin: Springer.
- Abeles, M. (1991). *Corticonics: Neuronal Circuits of the Cerebral Cortex*. Cambridge, UK: Cambridge University Press.
- Abeles, M., Bergman, H., Gat, I., Meilijson, I., Seidemann, E., Tishby, N., and Vaadia, E. (1995). Cortical activity flips among quasi-stationary states. *Proceedings of the National Academy of Sciences, USA*, 92:8616–8620.
- Abeles, M., Bergman, H., Margalit, E., and Vaadia, E. (1993). Spatiotemporal firing patterns in the frontal cortex of behaving monkeys. *Journal of Neurophysiology*, 70:1629–1638.
- Abramov, I., Gordon, J., Hendrickson, A., Hainline, L., Dobson, V., and LaBossiere, E. (1982). The retina of the newborn human infant. *Science*, 217:265–267.
- Acerra, F., Burnod, Y., and de Schonen, S. (2002). Modelling aspects of face processing in early infancy. *Developmental Science*, 5:98–117.
- Achermann, B. (1995). Full-faces database. Copyright 1995, University of Bern, all rights reserved. <http://iamwww.unibe.ch/fkiwww/Personen/achermann.html>.
- Adorján, P., Levitt, J. B., Lund, J. S., and Obermayer, K. (1999). A model for the intracortical origin of orientation preference and tuning in macaque striate cortex. *Visual Neuroscience*, 16:303–318.
- Adrian, E. D. (1926). The impulses produced by sensory nerve endings. *The Journal of Physiology*, 61:49–72.
- Agüera y Arcas, B., and Fairhall, A. L. (2003). What causes a neuron to spike?. *Neural Computation*, 15:1789–1807.
- Ahmed, R., Anderson, J. C., Martin, K. A. C., and Charmaine, N. J. (1997). Map of the synapses onto layer 4 basket cells of the primary visual cortex of the cat. *Journal of Computational Neuroscience*, 380:230–242.
- Albrecht, D. G., Farrar, S. B., and Hamilton, D. B. (1984). Spatial contrast adaptation characteristics of neurones recorded in the cat's visual cortex. *The Journal of Physiology*, 347:713–739.
- Albus, K., and Wolf, W. (1984). Early postnatal development of neuronal function in the kitten's visual cortex: A laminar analysis. *The Journal of Physiology*, 348:153–185.

- Alexander, D. M., Bourke, P. D., Sheridan, P., Konstandatos, O., and Wright, J. J. (2004). Intrinsic connections in tree shrew V1 imply a global to local mapping. *Vision Research*, 44:857–876.
- Aloumonos, J., Weiss, I., and Bandyopadhyay, A. (1988). Active vision. *International Journal of Computer Vision*, 1:333–356.
- Alvarez, P., and Squire, L. R. (1994). Memory consolidation and the medial temporal lobe: A simple network model. *Proceedings of the National Academy of Sciences, USA*, 91:7041–7045.
- Amari, S. (1980). Topographic organization of nerve fields. *Bulletin of Mathematical Biology*, 42:339–364.
- Amit, D. J. (1994). The Hebbian paradigm reintegrated: Local reverberations as internal representations. *Behavioral and Brain Sciences*, 18:617–626.
- Anderson, J. A., and Rosenfeld, E., editors (1988). *Neurocomputing: Foundations of Research*. Cambridge, MA: MIT Press.
- Andrade, M. A., Muro, E. M., and Morán, F. (2001). Simulation of plasticity in the adult visual cortex. *Biological Cybernetics*, 84:445–451.
- Angelucci, A., Levitt, J. B., and Lund, J. S. (2002). Anatomical origins of the classical receptive field and modulatory surround field of single neurons in macaque visual cortical area V1. *Progress in Brain Research*, 136:373–388.
- Arbib, M. A., Érdi, P., and Szentágothai, J. (1997). *Neural Organization: Structure, Function, and Dynamics*. Cambridge, MA: MIT Press.
- Arbib, M. A., and Grethe, J. S., editors (2001). *Computing the Brain: A Guide to Neuroinformatics*. San Diego, CA: Academic Press.
- Ascoli, G. A., Krichmar, J. L., Nasuto, S. J., and Senft, S. L. (2001). Generation, description and storage of dendritic morphology data. *Philosophical Transactions: Biological Sciences*, 356:1131–1145.
- Atick, J. J. (1992). Could information theory provide an ecological theory of sensory processing? *Network: Computation in Neural Systems*, 3:213–251.
- Atick, J. J., and Redlich, A. N. (1990). Towards a theory of early visual processing. *Neural Computation*, 2:308–320.
- Azouz, R., and Gray, C. M. (2000). Dynamic spike threshold reveals a mechanism for synaptic coincidence detection in cortical neurons in vivo. *Proceedings of the National Academy of Sciences, USA*, 97:8110–8115.
- Bach y Rita, P. (1972). *Brain Mechanisms in Sensory Substitution*. San Diego, CA: Academic Press.
- Bach y Rita, P. (2004). Tactile sensory substitution studies. *Annals of the New York Academy of Sciences*, 1013:83–91.
- Bailey, D., Feldman, J. A., Narayanan, S., and Lakoff, G. (1997). Modeling embodied lexical development. In Shafto, M. G., and Langley, P., editors, *Proceedings of the 19th Annual Conference of the Cognitive Science Society*, 19–24. Hillsdale, NJ: Erlbaum.
- Bair, W., Zohary, E., and Newsome, W. T. (2001). Correlated firing in macaque visual area MT: Time scales and relationship to behavior. *The Journal of Neuroscience*, 21:1676–1697.
- Bajcsy, R. (1988). Active perception. *Proceedings of the IEEE*, 78:996–1005.
- Baldi, P. (1998). Probabilistic models of neuronal spike trains. In Giles, C. L., and Gori, M., editors, *Adaptive Processing of Sequences and Data Structures: International Summer School on Neural Networks, “E. R. Caianiello” — Tutorial Lectures*, Lecture Notes in Artificial Intelligence 1387, 198–228. Berlin: Springer.

- Baldi, P., and Meir, R. (1990). Computing with arrays of coupled oscillators: An application to preattentive texture discrimination. *Neural Computation*, 2:458–471.
- Ballard, D. H. (1991). Animate vision. *Artificial Intelligence*, 48:57–86.
- Ballard, D. H., Hayhoe, M. M., Pook, P. K., and Rao, R. P. N. (1997). Deictic codes for the embodiment of cognition. *Behavioral and Brain Sciences*, 20:723–767.
- Banks, M. S., and Salapatek, P. (1981). Infant pattern vision: A new approach based on the contrast sensitivity function. *Journal of Experimental Child Psychology*, 31:1–45.
- Barker, A. T., Jalinous, R., and Freeston, I. L. (1985). Non-invasive magnetic stimulation of human motor cortex. *Lancet*, 1:1106–1107.
- Barlow, H. B. (1972). Single units and sensation: A neuron doctrine for perceptual psychology?. *Perception*, 1:371–394.
- Barlow, H. B. (1985). The twelfth Bartlett memorial lecture: The role of single neurons in the psychology of perception. *The Quarterly Journal of Experimental Psychology*, 37A:121–145.
- Barlow, H. B. (1989). Unsupervised learning. *Neural Computation*, 1:295–311.
- Barlow, H. B. (1990). A theory about the functional role and synaptic mechanism of visual after-effects. In Blakemore, C., editor, *Vision: Coding and Efficiency*, 363–375. Cambridge, UK: Cambridge University Press.
- Barlow, H. B. (1994). What is the computational goal of the neocortex? In Koch, C., and Davis, J. L., editors, *Large Scale Neuronal Theories of the Brain*, 1–22. Cambridge, MA: MIT Press.
- Barlow, H. B., and Földiák, P. (1989). Adaptation and decorrelation in the cortex. In Durbin, R., Miall, C., and Mitchison, G., editors, *The Computing Neuron*, 54–72. Reading, MA: Addison-Wesley.
- Barnard, K., Cardei, V., and Funt, B. (2002). A comparison of computational color constancy algorithms—part I: Methodology and experiments with synthesized data. *IEEE Transactions on Image Processing*, 11:972–984.
- Barrow, H. G., and Bray, A. J. (1992). An adaptive neural model of early visual processing. In Aleksander, I., and Taylor, J. G., editors, *Artificial Neural Networks, 2: Proceedings of the 1992 International Conference on Artificial Neural Networks*, 881–884. Amsterdam: North-Holland.
- Bartlett, M. S., Movellan, J. R., and Sejnowski, T. J. (2002). Face recognition by independent component analysis. *IEEE Transactions on Neural Networks*, 13:1450–1464.
- Bartlett, M. S., and Sejnowski, T. J. (1997). Viewpoint invariant face recognition using independent component analysis and attractor networks. In Mozer, M. C., Jordan, M. I., and Petsche, T., editors, *Advances in Neural Information Processing Systems 9*, 817–823. Cambridge, MA: MIT Press.
- Bartlett, M. S., and Sejnowski, T. J. (1998). Learning viewpoint-invariant face representations from visual experience in an attractor network. *Network: Computation in Neural Systems*, 9:399–417.
- Bartlett, P. L., and Maass, W. (2003). Vapnik–Chervonenkis dimension of neural nets. In Arbib, M. A., editor, *The Handbook of Brain Theory and Neural Networks*, 1188–1192. Cambridge, MA: MIT Press. Second edition.
- Bartrip, J., Morton, J., and de Schonen, S. (2001). Responses to mother’s face in 3-week to 5-month-old infants. *British Journal of Developmental Psychology*, 19:219–232.
- Bartsch, A. P., and van Hemmen, J. L. (2001). Combined Hebbian development of geniculocortical and lateral connectivity in a model of primary visual cortex. *Biological Cybernetics*, 84:41–55.

- Basole, A., White, L. E., and Fitzpatrick, D. (2003). Mapping multiple features in the population response of visual cortex. *Nature*, 424:986–990.
- Bauer, H.-U., Brockmann, D., and Geisel, T. (1997). Analysis of ocular dominance pattern formation in a high-dimensional self-organizing-map model. *Network: Computation in Neural Systems*, 8:17–33.
- Bauer, H.-U., and Villman, T. (1997). Growing a hypercubical output space in a self-organizing feature map. *IEEE Transactions on Neural Networks*, 218–226.
- Bauman, L. A., and Bonds, A. B. (1991). Inhibitory refinement of spatial frequency selectivity in single cells of the cat striate cortex. *Vision Research*, 31:933–944.
- Beaudot, W. H. A. (2002). Role of onset synchrony in contour integration. *Vision Research*, 42:1–9.
- Bechtel, W., and Abrahamsen, A. (2002). *Connectionism and the Mind: Parallel Processing, Dynamics, and Evolution in Networks*. Oxford, UK: Blackwell. Second edition.
- Becker, S. (1992). An information-theoretic unsupervised learning algorithm for neural networks. Doctoral dissertation, Department of Computer Science, University of Toronto, Toronto, Canada.
- Bednar, J. A. (1997). Tilt aftereffects in a self-organizing model of the primary visual cortex. Master’s thesis, Department of Computer Sciences, The University of Texas at Austin, Austin, TX. Technical Report AI-TR-97-259.
- Bednar, J. A. (2000). Internally generated activity, non-episodic memory, and emotional salience in sleep. *Behavioral and Brain Sciences*, 23:908–909. Commentary on the *Sleep and Dreaming* issue.
- Bednar, J. A. (2002). Learning to see: Genetic and environmental influences on visual development. Doctoral dissertation, Department of Computer Sciences, The University of Texas at Austin, Austin, TX. Technical Report AI-TR-02-294.
- Bednar, J. A., Kelkar, A., and Miikkulainen, R. (2004). Scaling self-organizing maps to model large cortical networks. *Neuroinformatics*, 2:275–302.
- Bednar, J. A., and Miikkulainen, R. (1998). Pattern-generator-driven development in self-organizing models. In Bower, J. M., editor, *Computational Neuroscience: Trends in Research, 1998*, 317–323. New York: Plenum Press.
- Bednar, J. A., and Miikkulainen, R. (2000a). Self-organization of innate face preferences: Could genetics be expressed through learning? In *Proceedings of the 17th National Conference on Artificial Intelligence and the 12th Annual Conference on Innovative Applications of Artificial Intelligence*, 117–122. Menlo Park, CA: AAAI Press.
- Bednar, J. A., and Miikkulainen, R. (2000b). Tilt aftereffects in a self-organizing model of the primary visual cortex. *Neural Computation*, 12:1721–1740.
- Bednar, J. A., and Miikkulainen, R. (2003a). Learning innate face preferences. *Neural Computation*, 15:1525–1557.
- Bednar, J. A., and Miikkulainen, R. (2003b). Self-organization of spatiotemporal receptive fields and laterally connected direction and orientation maps. *Neurocomputing*, 52–54:473–480.
- Bednar, J. A., and Miikkulainen, R. (2005). Constructing visual function through prenatal and postnatal learning. In Mareschal, D., Johnson, M. H., Sirois, S., Spratling, M., Thomas, M. S. C., and Westermann, G., editors, *Neuroconstructivism, Vol. 2: Perspectives and Prospects*. Oxford, UK: Oxford University Press. In press.
- Beer, R. D. (2000). Dynamical approaches to cognitive science. *Trends in Cognitive Sciences*, 4:91–99.
- Bell, A. J., and Sejnowski, T. J. (1997). The “independent components” of natural scenes are edge filters. *Vision Research*, 37:3327.

- Ben-Hur, A., Horn, D., Siegelmann, H. T., and Vapnik, V. (2001). Support vector clustering. *Journal of Machine Learning Research*, 2:125–137.
- Ben-Shahar, O., and Zucker, S. W. (2004). Geometrical computations explain projection patterns of long-range horizontal connections in visual cortex. *Neural Computation*, 16:445–476.
- Ben-Yishai, R., Bar-Or, R. L., and Sompolinsky, H. (1995). Theory of orientation tuning in visual cortex. *Proceedings of the National Academy of Sciences, USA*, 92:3844–3848.
- Berkley, M. A., Debruyn, B., and Orban, G. (1993). Illusory, motion, and luminance-defined contours interact in the human visual system. *Vision Research*, 34:209–216.
- Berns, G. S., Dayan, P., and Sejnowski, T. J. (1993). A correlational model for the development of disparity selectivity in visual cortex that depends on prenatal and postnatal phases. *Proceedings of the National Academy of Sciences, USA*, 90:8277–81.
- Beyer, H.-G., and Schwefel, H.-P. (2002). Evolution strategies: A comprehensive introduction. *Natural Computing*, 1:3–52.
- Bienenstock, E. L., Cooper, L. N., and Munro, P. W. (1982). Theory for the development of neuron selectivity: Orientation specificity and binocular interaction in visual cortex. *The Journal of Neuroscience*, 2:32–48.
- Binzegger, T., Douglas, R. J., and Martin, K. A. C. (2004). A quantitative map of the circuit of cat primary visual cortex. *The Journal of Neuroscience*, 24:8441–8453.
- Bishop, C. M., Svensén, M., and Williams, C. K. I. (1998). GTM: The generative topographic mapping. *Neural Computation*, 10:215–234.
- Bisley, J. W., and Goldberg, M. E. (2003). The role of the parietal cortex in the neural processing of saccadic eye movements. *Advances in Neurology*, 93:141–157.
- Blackmore, J., and Miikkulainen, R. (1995). Visualizing high-dimensional structure with the incremental grid growing neural network. In Prieditis, A., and Russell, S., editors, *Machine Learning: Proceedings of the 12th Annual Conference*, 55–63. San Francisco: Kaufmann.
- Blais, B. S., Cooper, L. N., and Shouval, H. Z. (2000). Formation of direction selectivity in natural scene environments. *Neural Computation*, 12:1057–1066.
- Blake, A., and Yuille, A. L., editors (1992). *Active Vision*. Cambridge, MA: MIT Press.
- Blakemore, C., and Carpenter, R. H. S. (1971). Lateral thinking about lateral inhibition. *Nature*, 234:418–419.
- Blakemore, C., Carpenter, R. H. S., and Georgeson, M. A. (1970). Lateral inhibition between orientation detectors in the human visual system. *Nature*, 228:37–39.
- Blakemore, C., and Cooper, G. F. (1970). Development of the brain depends on the visual environment. *Nature*, 228:477–478.
- Blakemore, C., and van Sluyters, R. C. (1975). Innate and environmental factors in the development of the kitten's visual cortex. *The Journal of Physiology*, 248:663–716.
- Blasdel, G. G. (1992a). Differential imaging of ocular dominance columns and orientation selectivity in monkey striate cortex. *The Journal of Neuroscience*, 12:3115–3138.
- Blasdel, G. G. (1992b). Orientation selectivity, preference, and continuity in monkey striate cortex. *The Journal of Neuroscience*, 12:3139–3161.
- Blasdel, G. G., Obermayer, K., and Kiorpes, L. (1995). Organization of ocular dominance and orientation columns in the striate cortex of neonatal macaque monkeys. *Visual Neuroscience*, 12:589–603.
- Blasdel, G. G., and Salama, G. (1986). Voltage-sensitive dyes reveal a modular organization in monkey striate cortex. *Nature*, 321:579–585.

- Bohte, S. M., and Mozer, M. C. (2005). Reducing spike train variability: A computational theory of spike-timing dependent plasticity. In *Advances in Neural Information Processing Systems 17*. Cambridge, MA: MIT Press. In press.
- Bolhuis, J. J. (1999). Early learning and the development of filial preferences in the chick. *Behavioural Brain Research*, 98:245–252.
- Bolhuis, J. J., and Honey, R. C. (1998). Imprinting, learning and development: From behaviour to brain and back. *Trends in Neurosciences*, 21:306–311.
- Bolz, J., and Gilbert, C. D. (1986). Generation of end-inhibition in the visual cortex via interlaminar connections. *Nature*, 320:362–364.
- Bonds, A. B. (1979). Development of orientation tuning in the visual cortex of kittens. In Freeman, R. D., editor, *Developmental Neurobiology of Vision*, 31–41. New York: Plenum Press.
- Bosking, W. H., Zhang, Y., Schofield, B. R., and Fitzpatrick, D. (1997). Orientation selectivity and the arrangement of horizontal connections in tree shrew striate cortex. *The Journal of Neuroscience*, 17:2112–2127.
- Bourgeois, J. P., Jastreboff, P. J., and Rakic, P. (1989). Synaptogenesis in visual cortex of normal and preterm monkeys: Evidence for intrinsic regulation of synaptic overproduction. *Proceedings of the National Academy of Sciences, USA*, 86:4297–4301.
- Bower, J. M., and Beeman, D. (1998). *The Book of GENESIS: Exploring Realistic Neural Models with the GEneral NEural SIMulation System*. Santa Clara, CA: Telos. Second edition.
- Braastad, B. O., and Heggelund, P. (1985). Development of spatial receptive-field organization and orientation selectivity in kitten striate cortex. *Journal of Neurophysiology*, 53:1158–1178.
- Brainard, D. H. (2004). Color constancy. In Chalupa, L. M., and Werner, J. S., editors, *The Visual Neurosciences*, 948–961. Cambridge, MA: MIT Press.
- Bray, A. J., and Barrow, H. G. (1996). Simple cell adaptation in visual cortex: A computational model of processing in the early visual pathway. Technical Report CSR 331, School of Cognitive and Computing Sciences, University of Sussex, Brighton, UK.
- Britten, K. H., Shalden, M. N., Newsome, W. T., and Movshon, J. A. (1992). The analysis of visual motion: A comparison of neuronal and psychophysical performance. *The Journal of Neuroscience*, 12:4745–4765.
- Bronson, G. W. (1974). The postnatal growth of visual capacity. *Child Development*, 45:873–890.
- Brooks, R. A., Breazeal (Ferrell), C., Irie, R., Kemp, C. C., Marjanović, M., Scassellati, B., and Williamson, M. M. (1998). Alternative essences of intelligence. In *Proceedings of the 15th National Conference on Artificial Intelligence and the 10th Annual Conference on Innovative Applications of Artificial Intelligence*, 961–976. Menlo Park, CA: AAAI Press.
- Bruns, A., Eckhorn, R., Jokeit, H., and Ebner, A. (2000). Amplitude envelope correlation detects coupling among incoherent brain signals. *Neuroreport*, 11:1509–1514.
- Buonomano, D. V., and Merzenich, M. M. (1998). Cortical plasticity: From synapses to maps. *Annual Review of Neuroscience*, 21:149–186.
- Burger, D., and Goodman, J. R. (1997). Billion-transistor architectures. *IEEE Computer*, 30:46–48.
- Burger, T., and Lang, E. W. (1999). An incremental Hebbian learning model of the primary visual cortex with lateral plasticity and real input patterns. *Zeitschrift für Naturforschung C — A Journal of Biosciences*, 54:128–140.



- Burger, T., and Lang, E. W. (2001). Self-organization of local cortical circuits and cortical orientation maps: A nonlinear Hebbian model of the visual cortex with adaptive lateral couplings. *Zeitschrift für Naturforschung C—A Journal of Biosciences*, 56:464–478.
- Burkhalter, A., and Bernardo, K. L. (1989). Organization of corticocortical connections in human visual cortex. *Proceedings of the National Academy of Sciences, USA*, 86:1071–1075.
- Burkhalter, A., Bernardo, K. L., and Charles, V. (1993). Development of local circuits in human visual cortex. *The Journal of Neuroscience*, 13:1916–1931.
- Burton, A. M., Bruce, V., and Hancock, P. J. B. (1999). From pixels to people: A model of familiar face recognition. *Cognitive Science*, 23:1–31.
- Bushnell, I. W. R. (1998). The origins of face perception. In Simion, F., and Butterworth, G., editors, *The Development of Sensory, Motor and Cognitive Capacities in Early Infancy: From Perception to Cognition*, 69–86. East Sussex, UK: Psychology Press.
- Bushnell, I. W. R. (2001). Mother's face recognition in newborn infants: Learning and memory. *Infant and Child Development*, 10:67–74.
- Bushnell, I. W. R., Sai, F., and Mullin, J. T. (1989). Neonatal recognition of the mother's face. *British Journal of Developmental Psychology*, 7:3–15.
- Butts, D. A., Feller, M. B., Shatz, C. J., and Rokhsar, D. S. (1999). Retinal waves are governed by collective network properties. *The Journal of Neuroscience*, 19:3580–3593.
- Buzsáki, G., and Draguhn, A. (2004). Neuronal oscillations in cortical networks. *Science*, 304:1926–1929.
- Cai, D., DeAngelis, G. C., and Freeman, R. D. (1997). Spatiotemporal receptive field organization in the lateral geniculate nucleus of cats and kittens. *Journal of Neurophysiology*, 78:1045–1061.
- Calford, M. B., Schmid, L. M., and Rosa, M. G. P. (1999). Monocular focal retinal lesions induce short-term topographic plasticity in adult visual cortex. *Proceedings: Biological Sciences*, 266:499–507.
- Calford, M. B., Wang, C., Taglianetti, V., Waleszczyk, W. J., Burke, W., and Dreher, B. (2000). Plasticity in adult cat visual cortex (area 17) following circumscribed monocular lesions of all retinal layers. *The Journal of Physiology*, 524:587–602.
- Calford, M. B., Wright, L. L., Metha, A. B., and Taglianetti, V. (2003). Topographic plasticity in primary visual cortex is mediated by local corticocortical connections. *The Journal of Neuroscience*, 23:6434–6442.
- Callaway, C. W., Lydic, R., Baghdoyan, H. A., and Hobson, J. A. (1987). Pontogeniculooccipital waves: Spontaneous visual system activity during rapid eye movement sleep. *Cellular and Molecular Neurobiology*, 7:105–149.
- Callaway, E. M., and Katz, L. C. (1990). Emergence and refinement of clustered horizontal connections in cat striate cortex. *The Journal of Neuroscience*, 10:1134–1153.
- Callaway, E. M., and Katz, L. C. (1991). Effects of binocular deprivation on the development of clustered horizontal connections in cat striate cortex. *Proceedings of the National Academy of Sciences, USA*, 88:745–749.
- Callaway, E. M., and Wiser, A. K. (1996). Contributions of individual layer 2–5 spiny neurons to local circuits in macaque primary visual cortex. *Visual Neuroscience*, 13:907–922.
- Calvert, G. A. (2001). Crossmodal processing in the human brain: Insights from functional neuroimaging studies. *Cerebral Cortex*, 11:1110–1123.
- Calvert, J. E., and Harris, J. P. (1988). Spatial frequency and duration effects on the tilt illusion and orientation acuity. *Vision Research*, 28:1051–1059.
- Campbell, F. W., and Maffei, L. (1971). The tilt aftereffect: A fresh look. *Vision Research*, 11:833–840.

- Campbell, S. R., Wang, D., and Jayaprakash, C. (1999). Synchrony and desynchrony in integrate-and-fire oscillators. *Neural Computation*, 11:1595–1619.
- Campos, M. M., and Carpenter, G. A. (2000). Building adaptive basis functions with a continuous self-organizing map. *Neural Processing Letters*, 11:59–78.
- Carney, T. (1982). Directional specificity in tilt aftereffect induced with moving contours: A reexamination. *Vision Research*, 22:1273–1275.
- Carpenter, G. A. (2001). Neural network models of learning and memory: Leading questions and an emerging framework. *Trends in Cognitive Sciences*, 5:114–118.
- Carpenter, R. H. S., and Blakemore, C. (1973). Interactions between orientations in human vision. *Experimental Brain Research*, 18:287–303.
- Casagrande, V. A., and Norton, T. T. (1989). Lateral geniculate nucleus: A review of its physiology and function. In Leventhal, A. G., editor, *The Neural Basis of Visual Function*, vol. 4 of *Vision and Visual Dysfunction*, 41–84. Boca Raton, FL: CRC Press.
- Catania, K. C., Lyon, D. C., Mock, O. B., and Kaas, J. H. (1999). Cortical organization in shrews: Evidence from five species. *The Journal of Comparative Neurology*, 410:55–72.
- Catsicas, M., and Mobbs, P. (1995). Waves are swell. *Current Biology*, 5:977–979.
- Celebrini, S., and Newsome, W. T. (1994). Neuronal and psychophysical sensitivity to motion signals in extrastriate MST of the macaque monkey. *The Journal of Neuroscience*, 14:4109–4124.
- Chakravarthy, S. V., and Ghosh, J. (1996). A complex-valued associative memory for storing patterns as oscillatory states. *Biological Cybernetics*, 75:229–238.
- Chance, F. S., Nelson, S. B., and Abbott, L. F. (1999). Complex cells as cortically amplified simple cells. *Nature Neuroscience*, 2:277–282.
- Chang, L.-C., and Chang, F.-J. (2002). An efficient parallel algorithm for LISSOM neural network. *Parallel Computing*, 28:1611–1633.
- Chapman, B. (2000). Necessity for afferent activity to maintain eye-specific segregation in ferret lateral geniculate nucleus. *Science*, 287:2479–2482.
- Chapman, B., and Bonhoeffer, T. (1998). Overrepresentation of horizontal and vertical orientation preferences in developing ferret area 17. *Proceedings of the National Academy of Sciences, USA*, 95:2609–2614.
- Chapman, B., Gödecke, I., and Bonhoeffer, T. (1999). Development of orientation preference in the mammalian visual cortex. *Journal of Neurobiology*, 41:18–24.
- Chapman, B., and Stryker, M. P. (1993). Development of orientation selectivity in ferret primary visual cortex and effects of deprivation. *The Journal of Neuroscience*, 13:5251–5262.
- Chapman, B., Stryker, M. P., and Bonhoeffer, T. (1996). Development of orientation preference maps in ferret primary visual cortex. *The Journal of Neuroscience*, 16:6443–6453.
- Chauvin, Y., and Rumelhart, D. E., editors (1995). *Backpropagation: Theory, Architectures, and Applications*. Hillsdale, NJ: Erlbaum.
- Chino, Y. M., Kaas, J. H., Smith, E. L., Langston, A. L., and Cheng, H. (1992). Rapid reorganization of cortical maps in adult cats following restricted deafferentation in retina. *Vision Research*, 32:789–796.
- Chino, Y. M., Smith, E. L., Kaas, J. H., and Cheng, H. (1995). Receptive-field properties of deafferentated visual cortical neurons after topographic map reorganization in adult cats. *The Journal of Neuroscience*, 15:2417–2433.
- Chklovskii, D. B., Mel, B. W., and Svoboda, K. (2004). Cortical rewiring and information storage. *Nature*, 431:782–788.
- Chklovskii, D. B., Schikorski, T., and Stevens, C. F. (2002). Wiring optimization in cortical circuits. *Neuron*, 34:341–347.

- Cho, S.-B. (1997). Self-organizing map with dynamical node splitting: Application to handwritten digit recognition. *Neural Computation*, 9:1345–1355.
- Choe, Y. (1995). Laterally interconnected self-organizing feature map in handwritten digit recognition. Master's thesis, Department of Computer Sciences, The University of Texas at Austin, Austin, TX. Technical Report AI95-236.
- Choe, Y. (2001). Perceptual grouping in a self-organizing map of spiking neurons. Doctoral dissertation, Department of Computer Sciences, The University of Texas at Austin, Austin, TX. Technical Report AI01-292.
- Choe, Y. (2002). Second order isomorphism: A reinterpretation and its implications in brain and cognitive sciences. In Gray, W. D., and Schunn, C. D., editors, *Proceedings of the 24th Annual Conference of the Cognitive Science Society*, 190–195. Hillsdale, NJ: Erlbaum.
- Choe, Y. (2003a). Analogical cascade: A theory on the role of the thalamo-cortical loop in brain function. *Neurocomputing*, 52–54:713–719.
- Choe, Y. (2003b). Processing of analogy in the thalamocortical circuit. In *Proceedings of the International Joint Conference on Neural Networks*, 1480–1485. Piscataway, NJ: IEEE.
- Choe, Y. (2004). The role of temporal parameters in a thalamocortical model of analogy. *IEEE Transactions on Neural Networks*, 15:1071–1082.
- Choe, Y., and Bhamidipati, S. K. (2004). Autonomous acquisition of the meaning of sensory states through sensory-invariance driven action. In Ijspeert, A. J., Murata, M., and Wakamiya, N., editors, *Biologically Inspired Approaches to Advanced Information Technology*, Lecture Notes in Computer Science 3141, 176–188. Berlin: Springer.
- Choe, Y., and Miikkulainen, R. (1997). Self-organization and segmentation with laterally connected spiking neurons. In *Proceedings of the 15th International Joint Conference on Artificial Intelligence*, 1120–1125. San Francisco: Kaufmann.
- Choe, Y., and Miikkulainen, R. (1998). Self-organization and segmentation in a laterally connected orientation map of spiking neurons. *Neurocomputing*, 21:139–157.
- Choe, Y., and Miikkulainen, R. (2000). A self-organizing neural network for contour integration through synchronized firing. In *Proceedings of the 17th National Conference on Artificial Intelligence and the 12th Annual Conference on Innovative Applications of Artificial Intelligence*, 123–128. Menlo Park, CA: AAAI Press.
- Choe, Y., and Miikkulainen, R. (2004). Contour integration and segmentation in a self-organizing map of spiking neurons. *Biological Cybernetics*, 90:75–88.
- Choe, Y., Miikkulainen, R., and Cormack, L. K. (2000). Effects of presynaptic and postsynaptic resource redistribution in Hebbian weight adaptation. *Neurocomputing*, 32–33:77–82.
- Chouvet, G., Blois, R., Debilly, G., and Jouvet, M. (1983). La structure d'occurrence des mouvements oculaires rapides du sommeil paradoxal est similaire chez les jumeaux homozygotes [The structure of the occurrence of rapid eye movements in paradoxical sleep is similar in homozygotic twins]. *Comptes Rendus des Seances de l'Academie des Sciences – Serie III, Sciences de la Vie*, 296:1063–1068.
- Churchland, P. S., Ramachandran, V. S., and Sejnowski, T. J. (1994). A critique of pure vision. In Koch, C., and Davis, J. L., editors, *Large Scale Neuronal Theories of the Brain*, 23–60. Cambridge, MA: MIT Press.
- Churchland, P. S., and Sejnowski, T. J. (1992). *The Computational Brain*. Cambridge, MA: MIT Press.
- Clark, A. (1999). An embodied cognitive science. *Trends in Cognitive Sciences*, 3:345–351.
- Clifford, C. W., and Ibbotson, M. R. (2002). Fundamental mechanisms of visual motion detection: Models, cells and functions. *Progress in Neurobiology*, 68:409–437.

- Cohen, L. B. (1998). An information-processing approach to infant perception and cognition. In Simion, F., and Butterworth, G., editors, *The Development of Sensory, Motor and Cognitive Capacities in Early Infancy: From Perception to Cognition*, 277–300. East Sussex, UK: Psychology Press.
- Cohen, L. B., and Cashon, C. H. (2003). Infant perception and cognition. In Easterbrooks, M. A., Lerner, R. M., and Mistry, J., editors, *Handbook of Psychology, Vol. VI: Developmental Psychology*, 65–89. Hoboken, NJ: Wiley.
- Cohen, P. R., and Beal, C. R. (2000). Natural semantics for a mobile robot. Technical Report 00-59, Department of Computer Science, University of Massachusetts, Amherst, MA.
- Coltheart, M. (1971). Visual feature-analyzers and aftereffects of tilt and curvature. *Psychological Review*, 78:114–121.
- Constantine-Paton, M., Cline, H. T., and Debski, E. (1990). Patterned activity, synaptic convergence, and the NMDA receptor in developing visual pathways. *Annual Review of Neuroscience*, 13:129–154.
- Constantine-Paton, M., and Law, M. I. (1978). Eye-specific termination bands in tecta of three-eyed frogs. *Science*, 202:639–641.
- Conway, B. R. (2003). Colour vision: A clue to hue in V2. *Current Biology*, 13:308–310.
- Cooper, L. N., Intrator, N., Blais, B. S., and Shouval, H. Z. (2004). *Theory of Cortical Plasticity*. Singapore: World Scientific.
- Coppola, D. M., White, L. E., Fitzpatrick, D., and Purves, D. (1998). Unequal representation of cardinal and oblique contours in ferret visual cortex. *Proceedings of the National Academy of Sciences, USA*, 95:2621–2623.
- Cormack, L. K., and Riddle, R. B. (1996). Binocular correlation detection with oriented dynamic random-line stereograms. *Vision Research*, 36:2303–2310.
- Cottrell, M., de Bodt, E., and Verleysen, M. (2001). A statistical tool to assess the reliability of self-organizing maps. In Allinson, N. M., Yin, H., Allinson, L. J., and Slack, J., editors, *Advances in Self-Organizing Maps*, 7–14. Berlin: Springer.
- Cover, T. M., and Thomas, J. (1991). *Elements of Information Theory*. Hoboken, NJ: Wiley.
- Crabtree, J. W., Collingridge, G. L., and Isaac, J. T. R. (1998). A new intrathalamic pathway linking modality-related nuclei in the dorsal thalamus. *Nature Neuroscience*, 1:389–394.
- Crabtree, J. W., and Isaac, J. T. R. (2002). Intrathalamic pathways allowing modality-related and cross-modality switching in the dorsal thalamus. *The Journal of Neuroscience*, 22:8754–8761.
- Crair, M. C. (1999). Neuronal activity during development: Permissive or instructive? *Current Opinion in Neurobiology*, 9:88–93.
- Crair, M. C., Gillespie, D. C., and Stryker, M. P. (1998). The role of visual experience in the development of columns in cat visual cortex. *Science*, 279:566–570.
- Crair, M. C., Horton, J. C., Antonini, A., and Stryker, M. P. (2001). Emergence of ocular dominance columns in cat visual cortex by 2 weeks of age. *The Journal of Comparative Neurology*, 430:235–249.
- Crair, M. C., and Malenka, R. C. (1995). A critical period for long-term potentiation at thalamocortical synapses. *Nature*, 375:325–328.
- Crick, F. (1984). Function of the thalamic reticular complex: The searchlight hypothesis. *Proceedings of the National Academy of Sciences, USA*, 81:4586–4950.
- Crowley, J. C., and Katz, L. C. (1999). Development of ocular dominance columns in the absence of retinal input. *Nature Neuroscience*, 2:1125–1130.
- Crowley, J. C., and Katz, L. C. (2000). Early development of ocular dominance columns. *Science*, 290:1321–1324.

- Çürüklü, B., and Lansner, A. (2003). Quantitative assessment of the local and long-range horizontal connections within the striate cortex. In *Proceedings of the Second International Conference on Computational Intelligence, Robotics, and Autonomous Systems*. Piscataway, NJ: IEEE.
- Dailey, M. N., and Cottrell, G. W. (1999). Organization of face and object recognition in modular neural network models. *Neural Networks*, 12:1053–1074.
- Dalva, M. B., and Katz, L. C. (1994). Rearrangements of synaptic connections in visual cortex revealed by laser photostimulation. *Science*, 265:255–258.
- Darian-Smith, C., and Gilbert, C. D. (1995). Topographic reorganization in the striate cortex of the adult cat and monkey is cortically mediated. *The Journal of Neuroscience*, 15:1631–1647.
- Das, A., and Gilbert, C. D. (1997). Distortions of visuotopic map match orientation singularities in primary visual cortex. *Nature*, 387:594–598.
- Datta, S. (1997). Cellular basis of pontine ponto-geniculo-occipital wave generation and modulation. *Cellular and Molecular Neurobiology*, 17:341–365.
- Daugman, J. G. (1980). Two-dimensional spectral analysis of cortical receptive field profiles. *Vision Research*, 20:847–856.
- Daw, N. (1995). *Visual Development*. New York: Plenum Press.
- Dayan, P. (1993). Arbitrary elastic topologies and ocular dominance. *Neural Computation*, 5:392–401.
- Dayan, P., and Abbott, L. F. (2001). *Theoretical Neuroscience: Computational and Mathematical Modeling of Neural Systems*. Cambridge, MA: MIT Press.
- Dayan, P., Hinton, G. E., Neal, R. M., and Zemel, R. S. (1995). The Helmholtz machine. *Neural Computation*, 7:889–904.
- de Gelder, B., and Rouw, R. (2000). Configural face processes in acquired and developmental prosopagnosia: Evidence for two separate face systems. *Neuroreport*, 11:3145–3150.
- de Gelder, B., and Rouw, R. (2001). Beyond localisation: A dynamical dual route account of face recognition. *Acta Psychologica*, 107:183–207.
- de Haan, M. (2001). The neuropsychology of face processing during infancy and childhood. In Nelson, C. A., and Luciana, M., editors, *Handbook of Developmental Cognitive Neuroscience*, 381–398. Cambridge, MA: MIT Press.
- de Sa, V. R. (1994). Unsupervised classification learning from cross-modal environmental structure. Doctoral dissertation, Department of Computer Science, University of Rochester, Rochester, NY.
- de Sa, V. R., and Ballard, D. H. (1997). Perceptual learning from cross-modal feedback. In Goldstone, R. L., Schyns, P. G., and Medin, D. L., editors, *Perceptual Learning*, vol. 36 of *Psychology of Learning and Motivation*, 309–351. San Diego, CA: Academic Press.
- de Schonen, S., Mancini, J., and Liegeois, F. (1998). About functional cortical specialization: The development of face recognition. In Simion, F., and Butterworth, G., editors, *The Development of Sensory, Motor and Cognitive Capacities in Early Infancy: From Perception to Cognition*, 103–120. East Sussex, UK: Psychology Press.
- De Schutter, E., and Bower, J. M. (1994a). An active membrane model of the cerebellar Purkinje cell. I. *Journal of Neurophysiology*, 71:375–400.
- De Schutter, E., and Bower, J. M. (1994b). An active membrane model of the cerebellar Purkinje cell. II. *Journal of Neurophysiology*, 71:401–419.
- De Valois, K. K., and Tootell, R. B. H. (1983). Spatial-frequency-specific inhibition in cat striate cortex cells. *The Journal of Physiology*, 336:359–376.

- DeAngelis, G. C., Ghose, G. M., Ohzawa, I., and Freeman, R. D. (1999). Functional micro-organization of primary visual cortex: Receptive field analysis of nearby neurons. *The Journal of Neuroscience*, 19:4046–4064.
- DeAngelis, G. C., Ohzawa, I., and Freeman, R. D. (1993). Spatiotemporal organization of simple-cell receptive fields in the cat's striate cortex. I. General characteristics and post-natal development. *Journal of Neurophysiology*, 69:1091–1117.
- DeAngelis, G. C., Ohzawa, I., and Freeman, R. D. (1995). Receptive-field dynamics in the central visual pathways. *Trends in Neurosciences*, 18:451–458.
- Desai, N. S., Rutherford, L. C., and Turrigiano, G. G. (1999). Plasticity in the intrinsic excitability of cortical pyramidal neurons. *Nature Neuroscience*, 2:515–520.
- Diamond, S. (1974). Four hundred years of instinct controversy. *Behavior Genetics*, 4:237–252.
- Doi, E., Inui, T., Lee, T.-W., Wachtler, T., and Sejnowski, T. J. (2003). Spatio-chromatic receptive field properties derived from information-theoretic analyses of cone mosaic responses to natural scenes. *Neural Computation*, 15:397–417.
- Dong, D. W. (1995). Associative decorrelation dynamics: A theory of self-organization and optimization in feedback networks. In Tesauro, G., Touretzky, D. S., and Leen, T. K., editors, *Advances in Neural Information Processing Systems 7*, 925–932. Cambridge, MA: MIT Press.
- Dong, D. W. (1996). Associative decorrelation dynamics in visual cortex. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Dong, D. W., and Hopfield, J. J. (1992). Dynamic properties of neural networks with adapting synapses. *Network*, 3:267–283.
- Douglas, R. J., Koch, C., Mahowald, M., Martin, K. A. C., and Suarez, H. H. (1995). Recurrent excitation in neocortical circuits. *Science*, 269:981–985.
- Douglas, R. J., and Martin, K. A. C. (2004). Neuronal circuits of the neocortex. *Annual Review of Neuroscience*, 27:419–451.
- Doya, K., Sclerston, A. I., and Rowat, P. F. (1995). A Hodgkin-Huxley type neuron model that learns slow non-spike oscillation. In Tesauro, G., Touretzky, D. S., and Leen, T. K., editors, *Advances in Neural Information Processing Systems 7*, 566–573. Cambridge, MA: MIT Press.
- Dragoi, V., Sharma, J., Miller, E. K., and Sur, M. (2002). Dynamics of neuronal sensitivity in visual cortex and local feature discrimination. *Nature Neuroscience*, 5:883–891.
- Dragoi, V., Sharma, J., and Sur, M. (2000). Adaptation-induced plasticity of orientation tuning in adult visual cortex. *Neuron*, 28:287–298.
- Durbin, R., and Mitchison, G. (1990). A dimension reduction framework for understanding cortical maps. *Nature*, 343:644–647.
- Easterbrook, M. A., Kisilevsky, B. S., Hains, S. M. J., and Muir, D. W. (1999). Faceness or complexity: Evidence from newborn visual tracking of facelike stimuli. *Infant Behavior and Development*, 22:17–35.
- Eckhorn, R. (1999). Neural mechanisms of scene segmentation: Recordings from the visual cortex suggest basic circuits for linking field models. *IEEE Transactions on Neural Networks*, 10:464–479.
- Eckhorn, R., Bauer, R., Jordan, W., Kruse, M., Munk, W., and Reitboeck, H. J. (1988). Coherent oscillations: A mechanism of feature linking in the visual cortex? *Biological Cybernetics*, 60:121–130.

- Eckhorn, R., Gail, A. M., Bruns, A., Gabriel, A., Al-Shaikhli, B., and Saam, M. (2004). Different types of signal coupling in the visual cortex related to neural mechanisms of associative processing and perception. *IEEE Transactions on Neural Networks*, 15:1039–1052.
- Eckhorn, R., Reitboeck, H. J., Arndt, M., and Dicke, P. (1990). Feature linking via synchronization among distributed assemblies: Simulations of results from cat visual cortex. *Neural Computation*, 2:293–307.
- Edelman, S. (1996). Why have lateral connections in the visual cortex?. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Eeckman, F. H., and Freeman, W. J. (1990). Correlations between unit firing and EEG in the rat olfactory system. *Brain Research*, 528:238–244.
- Egan, J. P. (1975). *Signal Detection Theory and ROC Analysis*. San Diego, CA: Academic Press.
- Eglen, S. J. (1997). Modeling the development of the retinogeniculate pathway. Doctoral dissertation, School of Cognitive and Computing Sciences, University of Sussex, Brighton, UK. Technical Report CSRP 467.
- Ehrenstein, W. (1941). Über Abwandlungen der L. Hermannschen Helligkeitserscheinung. *Zeitschrift für Psychologie*, 150:83–91. Modifications of Brightness Phenomenon of L. Hermann; translated by A. Hogg. In Petry, S., and Meyer, G. E., editors (1987). *The Perception of Illusory Contours*, 35–39. Berlin: Springer.
- Einhäuser, W., Kayser, C., König, P., and Kording, K. P. (2002). Learning the invariance properties of complex cells from their responses to natural stimuli. *European Journal of Neuroscience*, 15:475–486.
- Elder, J. H., and Goldberg, R. M. (2002). Ecological statistics for the Gestalt laws of perceptual organization of contours. *Journal of Vision*, 2:324–353.
- Elliott, T., Howarth, C. I., and Shadbolt, N. R. (1996). Axonal processes and neural plasticity. I: Ocular dominance columns. *Cerebral Cortex*, 6:781–788.
- Elliott, T., and Shadbolt, N. R. (1999). A neurotrophic model of the development of the retinogeniculocortical pathway induced by spontaneous retinal waves. *The Journal of Neuroscience*, 19:7951–7970.
- Elliott, T., and Shadbolt, N. R. (2002). Multiplicative synaptic normalization and a nonlinear Hebb rule underlie a neurotrophic model of competitive synaptic plasticity. *Neural Computation*, 14:1311–1322.
- Elliott, T., and Shadbolt, N. R. (2003). Developmental robotics: Manifesto and application. *Philosophical Transactions: Mathematical, Physical and Engineering Sciences*, 361:2187–2206.
- Elman, J. L., Bates, E. A., Johnson, M. H., Karmiloff-Smith, A., Parisi, D., and Plunkett, K. (1996). *Rethinking Innateness: A Connectionist Perspective on Development*. Cambridge, MA: MIT Press.
- Elston, G. N., and Rosa, M. G. P. (1998). Morphological variation of layer III pyramidal neurons in the occipitotemporal pathway of the macaque monkey visual cortex. *Cerebral Cortex*, 8:278–294.
- Emery, D. L., Royo, N. C., Fischer, I., Saatman, K. E., and McIntosh, T. K. (2003). Plasticity following injury to the adult central nervous system: Is recapitulation of a developmental state worth promoting?. *Journal of Neurotrauma*, 20:1271–1292.
- Engel, A. K., König, P., Kreiter, A. K., and Singer, W. (1991a). Interhemispheric synchronization of oscillatory neuronal responses in cat visual cortex. *Science*, 252:1177–1179.

- Engel, A. K., Kreiter, A. K., König, P., and Singer, W. (1991b). Synchronization of oscillatory neuronal responses between striate and extrastriate visual cortical areas of the cat. *Proceedings of the National Academy of Sciences, USA*, 88:6048–6052.
- Ernst, U., Pawelzik, K., Sahar-Pikielny, C., and Tsodyks, M. (2001). Intracortical origin of visual maps. *Nature Neuroscience*, 4:431–436.
- Erwin, E., and Miller, K. D. (1998). Correlation-based development of ocularly matched orientation and ocular dominance maps: Determination of required input activities. *The Journal of Neuroscience*, 18:9870–9895.
- Erwin, E., Obermayer, K., and Schulten, K. J. (1992a). Self-organizing maps: Ordering, convergence properties and energy functions. *Biological Cybernetics*, 67:47–55.
- Erwin, E., Obermayer, K., and Schulten, K. J. (1992b). Self-organizing maps: Stationary states, metastability and convergence rate. *Biological Cybernetics*, 67:35–45.
- Erwin, E., Obermayer, K., and Schulten, K. J. (1995). Models of orientation and ocular dominance columns in the visual cortex: A critical comparison. *Neural Computation*, 7:425–468.
- Eurich, C. W., Pawelzik, K., Ernst, U., Cowan, J. D., and Milton, J. G. (1999). Dynamics of self-organized delay adaptation. *Physical Review Letters*, 82:1594–1597.
- Eurich, C. W., Pawelzik, K., Ernst, U., Thiel, A., Cowan, J. D., and Milton, J. G. (2000). Delay adaptation in the nervous system. *Neurocomputing*, 32–33:741–748.
- Eysel, U. T., and Schweigart, G. (1999). Increased receptive field size in the surround of chronic lesions in the adult cat visual cortex. *Cerebral Cortex*, 9:101–109.
- Fahle, M. (1993). Figure-ground discrimination from temporal information. *Proceedings: Biological Sciences*, 254:199–203.
- Fahle, M., Edelman, S., and Poggio, T. (1995). Fast perceptual learning in hyperacuity. *Vision Research*, 35:3003–3013.
- Farah, M. J., Wilson, K. D., Drain, M., and Tanaka, J. N. (1998). What is “special” about face perception?. *Psychological Review*, 105:482–498.
- Farkas, I., and Miikkulainen, R. (1999). Modeling the self-organization of directional selectivity in the primary visual cortex. In *Proceedings of the Ninth International Conference on Artificial Neural Networks*, 251–256. Berlin: Springer.
- Felleman, D. J., and Van Essen, D. C. (1991). Distributed hierarchical processing in primate cerebral cortex. *Cerebral Cortex*, 1:1–47.
- Fellenz, W. A., and Taylor, J. G. (2002). Establishing retinotopy by lateral-inhibition type homogeneous neural fields. *Neurocomputing*, 48:313–322.
- Feller, M. B. (1999). Spontaneous correlated activity in developing neural circuits. *Neuron*, 22:653–656.
- Feller, M. B., Butts, D. A., Aaron, H. L., Rokhsar, D. S., and Shatz, C. J. (1997). Dynamic processes shape spatiotemporal properties of retinal waves. *Neuron*, 19:293–306.
- Feller, M. B., Wellis, D. P., Stellwagen, D., Werblin, F. S., and Shatz, C. J. (1996). Requirement for cholinergic synaptic transmission in the propagation of spontaneous retinal waves. *Science*, 272:1182–1187.
- Ferrari, F., Manzotti, R., Nalin, A., Benatti, A., Cavallo, R., Torricelli, A., and Cavazzutti, G. (1986). Visual orientation to the human face in the premature and fullterm newborn. *The Italian Journal of Neurological Sciences*, 5:53–60.
- Ferster, D. (1994). Linearity of synaptic interactions in the assembly of receptive fields in cat visual cortex. *Current Opinion in Neurobiology*, 4:563–568.
- Ferster, D., and Lindström, S. (1985). Synaptic excitation of neurons in area 17 of the cat by intracortical axon collaterals of cortico-geniculate cells. *The Journal of Physiology*, 367:233–252.



- Field, D. J. (1994). What is the goal of sensory coding? *Neural Computation*, 6:559–601.
- Field, D. J., Hayes, A., and Hess, R. F. (1993). Contour integration by the human visual system: Evidence for a local association field. *Vision Research*, 33:173–193.
- Field, T. M., Cohen, D., Garcia, R., and Greenberg, R. (1984). Mother–stranger face discrimination by the newborn. *Infant Behavior and Development*, 7:19–25.
- Findlay, J. M. (1998). Active vision: Visual activity in everyday life. *Current Biology*, 8:R640–R642.
- Findlay, J. M., and Gilchrist, I. D. (2003). *Active Vision: The Psychology of Looking and Seeing*. Oxford, UK: Oxford University Press.
- Finkel, L. H., and Edelman, G. M. (1989). Integration of distributed cortical systems by reentry: A computer simulation of interactive functionally segregated visual areas. *The Journal of Neuroscience*, 9:3188–3208.
- Fisher, S. A., Fisher, T. M., and Carew, T. J. (1997). Multiple overlapping processes underlying short-term synaptic enhancement. *Trends in Neurosciences*, 20:170–177.
- Fisken, R. A., Garey, L. J., and Powell, T. P. S. (1975). The intrinsic, association and commissural connections of area 17 of the visual cortex. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 272:487–536.
- FitzHugh, R. (1961). Impulses and physiological states in models of nerve membrane. *Biophysics Journal*, 1:445–466.
- Fitzpatrick, D., Schofield, B. R., and Strote, J. (1994). Spatial organization and connections of iso-orientation domains in the tree shrew striate cortex. In *Society for Neuroscience Abstracts*, vol. 20, 837. Washington, DC: Society for Neuroscience.
- Fogel, D. B. (1999). *Evolutionary Computation: Toward a New Philosophy of Machine Intelligence*. Piscataway, NJ: IEEE. Second edition.
- Földiák, P. (1990). Forming sparse representations by local anti-Hebbian learning. *Biological Cybernetics*, 64:165–170.
- Földiák, P. (1991a). Learning invariance from transformation sequences. *Neural Computation*, 3:194–200.
- Földiák, P. (1991b). Models of sensory coding. Doctoral dissertation, Churchill College, University of Cambridge, Cambridge, UK. Department of Engineering Technical Report CUED/F-INFENG/TR 91.
- Freeman, E., Driver, J., Sagi, D., and Zhaoping, L. (2003). Top-down modulation of lateral interactions in early vision: Does attention affect integration of the whole or just perception of the parts?. *Current Biology*, 13:985–989.
- Freeman, W. J., and Burke, B. C. (2003). A neurobiological theory of meaning in perception. Part IV: Multicortical patterns of amplitude modulation in gamma EEG. *International Journal of Bifurcation and Chaos*, 13:2857–2866.
- Friedrich, R. W., and Laurent, G. (2001). Dynamic optimization of odor representations by slow temporal patterning of mitral cell activity. *Science*, 291:889–894.
- Fritzke, B. (1994). Growing cell structures—a self-organizing network for unsupervised and supervised learning. *Neural Networks*, 7:1441–1460.
- Fritzke, B. (1995). Growing grid: A self-organizing network with constant neighborhood range and adaptation strength. *Neural Processing Letters*, 2:9–13.
- Fu, Y. X., Djupsund, K., Gao, H., Hayden, B., Shen, K., and Dan, Y. (2002). Temporal specificity in the cortical plasticity of visual space representation. *Science*, 296:1999–2003.
- Fuhs, M. C., Redish, A. D., and Touretzky, D. S. (1998). A visually driven hippocampal place cell model. In Bower, J. M., editor, *Computational Neuroscience: Trends in Research*, 379–384. New York: Plenum Press.

- Fukushima, K., and Miyake, S. (1982). Neocognitron: A self-organizing neural network model for a mechanism of visual pattern recognition. In Amari, S., and Arbib, M. A., editors, *Competition and Cooperation in Neural Nets*, Lecture Notes in Biomathematics 45, 267–285. Berlin: Springer.
- Gabbiani, F., and Koch, C. (1998). Principles of spike train analysis. In Koch, C., and Segev, I., editors, *Methods in Neuronal Modeling: From Ions to Networks*, 313–360. Cambridge, MA: MIT Press. Second edition.
- Gandhi, S. P., Heeger, D. J., and Boynton, G. M. (1999). Spatial attention affects brain activity in human primary visual cortex. *Proceedings of the National Academy of Sciences, USA*, 96:3314–3319.
- Gardner, D. (2004). Neurodatabase.org: Networking the microelectrode. *Nature Neuroscience*, 7:486–487.
- Garris, M. D. (1992). Design and collection of a handwriting sample image database. *Social Science Computer Review*, 10:196–214.
- Gauthier, I., and Logothetis, N. K. (2000). Is face recognition not so unique, after all? *Cognitive Neuropsychology*, 17:125–142.
- Gauthier, I., and Nelson, C. A. (2001). The development of face expertise. *Current Opinion in Neurobiology*, 11:219–224.
- Geisler, W. S., and Albrecht, D. G. (1995). Bayesian analysis of identification performance in the primary visual cortex: Nonlinear mechanisms and stimulus certainty. *Vision Research*, 35:2723–2730.
- Geisler, W. S., and Albrecht, D. G. (1997). Visual cortex neurons in monkeys and cats: Detection, discrimination, and identification. *Visual Neuroscience*, 14:897–919.
- Geisler, W. S., Perry, J. S., Super, B. J., and Gallogly, D. P. (2001). Edge co-occurrence in natural images predicts contour grouping performance. *Vision Research*, 41:711–724.
- Geisler, W. S., and Super, B. J. (2000). Perceptual organization of two-dimensional patterns. *Psychological Review*, 107:677–708.
- Geisler, W. S., Thornton, T., Gallogly, D. P., and Perry, J. S. (2000). Image structure models of texture and contour visibility. In *Search and Target Acquisition (Recherche et acquisition d'objectifs)*, RTO Meeting Proceedings 45, 15/1–15/8. Hull, Québec: Canada Communication Group.
- Gelbtuch, M. H., Calvert, J. E., Harris, J. P., and Phillipson, O. T. (1986). Modification of visual orientation illusions by drugs which influence dopamine and GABA neurones: Differential effects on simultaneous and successive illusions. *Psychopharmacology*, 90:379–383.
- Geman, S., Bienenstock, E. L., and Doursat, R. (1992). Neural networks and the bias/variance dilemma. *Neural Computation*, 4:1–58.
- George, M. S., Wassermann, E. M., Williams, W. A., Steppell, J., Pascual-Leone, A., Basser, P., Hallett, M., and Post, R. M. (1996). Changes in mood and hormone levels after rapid-rate transcranial magnetic stimulation (rTMS) of the prefrontal cortex. *The Journal of Neuropsychiatry and Clinical Neurosciences*, 8:172–180.
- Gerstner, W. (1998a). Hebbian learning of pulse timing in the barn owl auditory system. In Maass, W., and Bishop, C. M., editors, *Pulsed Neural Networks*, 353–377. Cambridge, MA: MIT Press.
- Gerstner, W. (1998b). Spiking neurons. In Maass, W., and Bishop, C. M., editors, *Pulsed Neural Networks*, 3–54. Cambridge, MA: MIT Press.
- Gerstner, W., and Kistler, W. M. (2002). *Spiking Neuron Models: Single Neurons, Populations, Plasticity*. Cambridge, UK: Cambridge University Press.

- Gerstner, W., and van Hemmen, J. L. (1992). Associative memory in a network of spiking neurons. *Network*, 3:139–164.
- Ghahramani, Z., and Hinton, G. E. (1998). Hierarchical non-linear factor analysis and topographic maps. In Jordan, M. I., Kearns, M. J., and Solla, S. A., editors, *Advances in Neural Information Processing Systems 10*, 486–492. Cambridge, MA: MIT Press.
- Ghose, G. M., and Ts'o, D. Y. (1997). Form processing modules in primate area V4. *Journal of Neurophysiology*, 77:2191–2196.
- Gibson, J. J. (1950). *The Perception of the Visual World*. Boston: Houghton Mifflin.
- Gibson, J. J. (1979). *The Ecological Approach to Visual Perception*. Boston: Houghton Mifflin.
- Gibson, J. J., and Radner, M. (1937). Adaptation, after-effect and contrast in the perception of tilted lines. *Journal of Experimental Psychology*, 20:453–467.
- Giese, M. A. (1998). *Dynamic Neural Field Theory for Motion Perception*. Berlin: Springer.
- Gilbert, C. D. (1992). Horizontal integration and cortical dynamics. *Neuron*, 9:1–13.
- Gilbert, C. D. (1994). Circuitry, architecture and functional dynamics of visual cortex. In Bock, G. R., and Goode, J. A., editors, *Higher-Order Processing in the Visual System*, Ciba Foundation Symposium 184, 35–62. Hoboken, NJ: Wiley.
- Gilbert, C. D. (1998). Adult cortical dynamics. *Physiological Reviews*, 78:467–485.
- Gilbert, C. D., Das, A., Ito, M., Kapadia, M. K., and Westheimer, G. (1996). Spatial integration and cortical dynamics. *Proceedings of the National Academy of Sciences, USA*, 93:615–622.
- Gilbert, C. D., Hirsch, J. A., and Wiesel, T. N. (1990). Lateral interactions in visual cortex. In *The Brain*, vol. LV of *Cold Spring Harbor Symposia on Quantitative Biology*, 663–677. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Gilbert, C. D., and Wiesel, T. N. (1979). Morphology and intracortical projections of functionally identified neurons in cat visual cortex. *Nature*, 280:120–125.
- Gilbert, C. D., and Wiesel, T. N. (1983). Clustered intrinsic connections in cat visual cortex. *The Journal of Neuroscience*, 3:1116–1133.
- Gilbert, C. D., and Wiesel, T. N. (1989). Columnar specificity of intrinsic horizontal and corticocortical connections in cat visual cortex. *The Journal of Neuroscience*, 9:2432–2442.
- Gilbert, C. D., and Wiesel, T. N. (1990). The influence of contextual stimuli on the orientation selectivity of cells in primary visual cortex of the cat. *Vision Research*, 30:1689–1701.
- Gilbert, C. D., and Wiesel, T. N. (1992). Receptive field dynamics in adult primary visual cortex. *Nature*, 356:150–152.
- Glover, M., Hamilton, A., and Smith, L. S. (2002). Analogue VLSI leaky integrate-and-fire neurons and their use in a sound analysis system. *Analog Integrated Circuits and Signal Processing*, 30:91–100.
- Goddard, N. H., Hucka, M., Howell, F., Cornelis, H., Shankar, K., and Beeman, D. (2001). Towards NeuroML: Model description methods for collaborative modelling in neuroscience. *Philosophical Transactions: Biological Sciences*, 356:1209–1228.
- Gödecke, I., and Bonhoeffer, T. (1996). Development of identical orientation maps for two eyes without common visual experience. *Nature*, 379:251–254.
- Gödecke, I., Kim, D. S., Bonhoeffer, T., and Singer, W. (1997). Development of orientation preference maps in area 18 of kitten visual cortex. *European Journal of Neuroscience*, 9:1754–1762.
- Goldberg, D. E. (1989). *Genetic Algorithms in Search, Optimization and Machine Learning*. Reading, MA: Addison-Wesley.

- Goldman-Rakic, P. S. (1980). Morphological consequences of prenatal injury to the primate brain. In McConnell, P. S., Boer, G. J., Romijn, H. J., van de Poll, N. E., and Corner, M. A., editors, *Adaptive Capabilities of the Nervous System: Proceedings of the 11th International Summer School of Brain Research*, vol. 53 of *Progress in Brain Research*, 3–19. Amsterdam: Elsevier.
- Goldstone, R. L. (2003). Learning to perceive while perceiving to learn. In Kimchi, R., Behrmann, M., and Olson, C., editors, *Perceptual Organization in Vision: Behavioral and Neural Perspectives*, 233–278. Hillsdale, NJ: Erlbaum.
- Gomez, F., and Miikkulainen, R. (1997). Incremental evolution of complex general behavior. *Adaptive Behavior*, 5:317–342.
- Goodale, M. A., and Milner, A. D. (1992). Separate visual pathways for perception and action. *Trends in Neurosciences*, 15:20–25.
- Goodall, S., Reggia, J. A., Chen, Y., Ruppin, E., and Whitney, C. (1997). A computational model of acute focal cortical lesions. *Stroke*, 28:101–109.
- Goodhill, G. J. (1993). Topography and ocular dominance: A model exploring positive correlations. *Biological Cybernetics*, 69:109–118.
- Goodhill, G. J., and Cimponeriu, A. (2000). Analysis of the elastic net model applied to the formation of ocular dominance and orientation columns. *Network: Computation in Neural Systems*, 11:153–168.
- Goodhill, G. J., and Löwel, S. (1995). Theory meets experiment: Correlated neural activity helps determine ocular dominance column periodicity. *Trends in Neurosciences*, 18:437–439.
- Goodhill, G. J., and Willshaw, D. J. (1990). Application of the elastic net algorithm to the formation of ocular dominance stripes. *Network: Computation in Neural Systems*, 1:41–59.
- Goodhill, G. J., and Willshaw, D. J. (1994). Elastic net model of ocular dominance: Overall stripe pattern and monocular deprivation. *Neural Computation*, 6:615–621.
- Göppert, J., and Rosenstiel, W. (1997). The continuous interpolating self-organizing map. *Neural Processing Letters*, 5:185–192.
- Gorchetchnikov, A. (2000). Introduction of threshold self-adjustment improves the convergence in feature-detective neural nets. *Neurocomputing*, 32–33:385–390.
- Goren, C. C., Sarty, M., and Wu, P. Y. (1975). Visual following and pattern discrimination of face-like stimuli by newborn infants. *Pediatrics*, 56:544–549.
- Gould, E., Reeves, A. J., Graziano, M. S. A., and Gross, C. G. (1999). Neurogenesis in the neocortex of adult primates. *Science*, 286:548–552.
- Gove, A., Grossberg, S., and Mingolla, E. (1993). Brightness perception, illusory contours and corticogeniculate feedback. In *World Congress on Neural Networks*, vol. I, 25–28. Hillside, NJ: Erlbaum.
- Govindan, V. K., and Shivaprasad, A. P. (1990). Character recognition — a review. *Pattern Recognition*, 23:671–683.
- Graham, D. B., and Allinson, N. M. (1998). Automatic face representation and classification. In Nixon, M. S., and Carter, J. N., editors, *Proceedings of the Ninth British Machine Vision Conference*, 64–73. Malvern, UK: BMVA Press.
- Grajski, K. A., and Merzenich, M. M. (1990). Hebb-type dynamics is sufficient to account for the inverse magnification rule in cortical somatotopy. *Neural Computation*, 2:71–84.
- Gray, C. M. (1999). The temporal correlation hypothesis of visual feature integration: Still alive and well. *Neuron*, 24:31–47.

- Gray, C. M., Konig, P., Engel, A. K., and Singer, W. (1989). Oscillatory responses in cat visual cortex exhibit inter-columnar synchronization which reflects global stimulus properties. *Nature*, 338:334–337.
- Gray, C. M., and McCormick, D. A. (1996). Chattering cells: Superficial pyramidal neurons contributing to the generation of synchronous oscillations in the visual cortex. *Science*, 274:109–113.
- Gray, C. M., and Singer, W. (1987). Stimulus-specific neuronal oscillations in the cat visual cortex: A cortical functional unit. In *Society for Neuroscience Abstracts*, vol. 13, 404.3. Washington, DC: Society for Neuroscience.
- Gray, M. S., Lawrence, D. T., Golomb, B. A., and Sejnowski, T. J. (1995). A perceptron reveals the face of sex. *Neural Computation*, 7:1160–1164.
- Greenlee, M. W., and Magnussen, S. (1987). Saturation of the tilt aftereffect. *Vision Research*, 27:1041–1043.
- Grieve, K. L., and Sillito, A. M. (1995). Non-length-tuned cells in layer II/III and IV of the visual cortex: The effect of blockade of layer VI on responses to stimuli of different lengths. *Experimental Brain Research*, 104:12–20.
- Grinvald, A., Lieke, E. E., Frostig, R. D., and Hildesheim, R. (1994). Cortical point-spread function and long-range lateral interactions revealed by real-time optical imaging of macaque monkey primary visual cortex. *The Journal of Neuroscience*, 14:2545–2568.
- Gross, C. G., Rocha-Miranda, C. E., and Bender, D. B. (1972). Visual properties of neurons in inferotemporal cortex of the macaque. *Journal of Neurophysiology*, 35:96–111.
- Grossberg, S. (1976). On the development of feature detectors in the visual cortex with applications to learning and reaction-diffusion systems. *Biological Cybernetics*, 21:145–159.
- Grossberg, S. (1999). How does the cerebral cortex work? Learning, attention, and grouping by the laminar circuits of visual cortex. *Spatial Vision*, 12:125–254.
- Grossberg, S., and Mingolla, E. (1985). Neural dynamics of form perception: Boundary completion, illusory figures, and neon color spreading. *Psychological Review*, 92:173–211.
- Grossberg, S., Mingolla, E., and Ross, W. D. (1997). Visual brain and visual perception: How does the cortex do perceptual grouping?. *Trends in Neurosciences*, 20:106–111.
- Grossberg, S., and Olson, S. J. (1994). Rules for the cortical map of ocular dominance and orientation columns. *Neural Networks*, 7:883–894.
- Grossberg, S., and Seitz, A. (2003). Laminar development of receptive fields, maps and columns in visual cortex: The coordinating role of the subplate. *Cerebral Cortex*, 13:852–863.
- Grossberg, S., and Williamson, J. R. (2001). A neural model of how horizontal and inter-laminar connections of visual cortex develop into adult circuits that carry out perceptual grouping and learning. *Cerebral Cortex*, 11:37–58.
- Grubb, M. S., Rossi, F. M., Changeux, J.-P., and Thompson, I. (2003). Abnormal functional organization in the dorsal lateral geniculate nucleus of mice lacking the  $\beta 2$  subunit of the nicotinic acetylcholine receptor. *Neuron*, 40:1161–1172.
- Gustafsson, B., and Wigström, H. (1988). Physiological mechanisms underlying long-term potentiation. *Trends in Neurosciences*, 11:156–162.
- Hadjikhani, N., and Roland, P. E. (1998). Cross-modal transfer of information between the tactile and the visual representations in the human brain: A positron emission tomographic study. *The Journal of Neuroscience*, 18:1072–1084.
- Haessly, A., Sirosh, J., and Miikkulainen, R. (1995). A model of visually guided plasticity of the auditory spatial map in the barn owl. In *Proceedings of the 17th Annual Conference of the Cognitive Science Society*, 154–158. Hillsdale, NJ: Erlbaum.

- Haith, G. L. (1998). Modeling activity-dependent development in the retinogeniculate projection. Doctoral dissertation, Department of Psychology, Stanford University, Palo Alto, CA.
- Halgren, E., Dale, A. M., Sereno, M. I., Tootell, R. B. H., Marinkovic, K., and Rosen, B. R. (1999). Location of human face-selective cortex with respect to retinotopic areas. *Human Brain Mapping*, 7:29–37.
- Hallett, M. (2000). Transcranial magnetic stimulation and the human brain. *Nature*, 406:147–150.
- Han, S. K., Kim, W. S., and Kook, H. (1998). Temporal segmentation of the stochastic oscillator neural network. *Physical Review E*, 58:2325–2334.
- Hanson, S. J., Matsuka, T., and Haxby, J. V. (2004). Combinatorial codes in ventral temporal lobe for object recognition: Haxby (2001) revisited: Is there a “face” area? *Neuroimage*, 23:156–166.
- Harnad, S., Pace-Schott, E., Blagrove, M., and Solms, M., editors (2003). *Sleep and Dreaming: Scientific Advances and Reconsiderations*. Cambridge, UK: Cambridge University Press.
- Harris, L., and Jenkin, M., editors (1998). *Vision and Action*. Cambridge, UK: Cambridge University Press.
- Hasselmo, M. E., Bodelón, C., and Wyble, B. P. (2002). A proposed function for hippocampal theta rhythm: Separate phases of encoding and retrieval enhance reversal of prior learning. *Neural Computation*, 14:793–817.
- Hasselmo, M. E., Rolls, E. T., and Baylis, G. C. (1989). The role of expression and identity in the face-selective responses of neurons in the temporal visual cortex of the monkey. *Behavioural Brain Research*, 32:203–218.
- Hastie, T., and Stuetzle, W. (1989). Principal curves. *Journal of the American Statistical Association*, 84:502–516.
- Hata, Y., Tsumoto, T., Sato, H., Hagihara, K., and Tamura, H. (1993). Development of local horizontal interactions in cat visual cortex studied by cross-correlation analysis. *Journal of Neurophysiology*, 69:40–56.
- Haussler, D. (1988). Quantifying inductive bias: AI learning algorithms and Valiant’s learning framework. *Artificial Intelligence*, 36:177–221.
- Haxby, J. V., Gobbini, M. I., Furey, M. L., Ishai, A., Schouten, J. L., and Pietrini, P. (2001). Distributed and overlapping representations of faces and objects in ventral temporal cortex. *Science*, 293:2425–2430.
- Haxby, J. V., Horowitz, B., Ungerleider, L. G., Maisog, J. M., Pietrini, P., and Grady, C. L. (1994). The functional organization of human extrastriate cortex: A PET-rCBF study of selective attention to faces and locations. *The Journal of Neuroscience*, 14:6336–6353.
- Hayes, W. P., and Meyer, R. L. (1988a). Optic synapse number but not density is constrained during regeneration onto surgically halved tectum in goldfish: HRP-EM evidence that optic fibers compete for fixed numbers of postsynaptic sites on the tectum. *Journal of Computational Neurology*, 274:539–559.
- Hayes, W. P., and Meyer, R. L. (1988b). Retinotopically inappropriate synapses of subnormal density formed by misdirected optic fibers in goldfish tectum. *Developmental Brain Research*, 38:304–312.
- Haykin, S. (1994). *Neural Networks: A Comprehensive Foundation*. New York: Macmillan.
- Hebb, D. O. (1949). *The Organization of Behavior: A Neuropsychological Theory*. Hoboken, NJ: Wiley.

- Hecht-Nielsen, R. (1989). Theory of the backpropagation neural network. In *Proceedings of the International Joint Conference on Neural Networks*, vol. I, 593–605. Piscataway, NJ: IEEE.
- Hecht-Nielsen, R. (2002). A theory of thalamocortex. In Hecht-Nielsen, R., and McKenna, T., editors, *Computational Models for Neuroscience: Human Cortical Information Processing*, 85–124. Berlin: Springer.
- Heeger, D. J., Boynton, G. M., Demb, J. B., Seidemann, E., and Newsome, W. T. (1999). Motion opponency in visual cortex. *The Journal of Neuroscience*, 19:7162–7174.
- Hempel, C. M., Hartman, K. H., Wang, X.-J., Turrigiano, G. G., and Nelson, S. B. (2000). Multiple forms of short-term plasticity at excitatory synapses in rat medial prefrontal cortex. *Journal of Neurophysiology*, 83:3031–3041.
- Henry, G. H. (1989). Afferent inputs, receptive field properties and morphological cell types in different laminae of the striate cortex. In Leventhal, A. G., editor, *The Neural Basis of Visual Function*, vol. 4 of *Vision and Visual Dysfunction*, 223–245. Boca Raton, FL: CRC Press.
- Hensch, T. K., Fagiolini, M., Mataga, N., Stryker, M. P., Baekkeskov, S., and Kash, S. F. (1998). Local GABA circuit control of experience-dependent plasticity in developing visual cortex. *Science*, 282:1604–1608.
- Hensch, T. K., and Stryker, M. P. (2004). Columnar architecture sculpted by GABA circuits in developing cat visual cortex. *Science*, 303:1678–1681.
- Hershenson, M., Kessen, W., and Munsinger, H. (1967). Pattern perception in the human newborn: A close look at some positive and negative results. In Wathen-Dunn, W., editor, *Models for the Perception of Speech and Visual Form: Proceedings of a Symposium*, 282–290. Cambridge, MA: MIT Press.
- Hess, R. F., and Dakin, S. C. (1997). Absence of contour linking in peripheral vision. *Nature*, 390:602–604.
- Hess, R. F., Hayes, A., and Field, D. J. (2004). Contour integration and cortical processing. *Journal of Physiology - Paris*, 97:105–119.
- Hines, M. L., and Carnevale, N. T. (1997). The NEURON simulation environment. *Neural Computation*, 9:1179–1209.
- Hirsch, H. V. B. (1985). The role of visual experience in the development of cat striate cortex. *Cellular and Molecular Neurobiology*, 5:103–121.
- Hirsch, H. V. B., and Spinelli, D. (1970). Visual experience modifies distribution of horizontally and vertically oriented receptive fields in cats. *Science*, 168:869–871.
- Hirsch, J. A., Alonso, J. M., Reid, R. C., and Martinez, L. M. (1998a). Synaptic integration in striate cortical simple cells. *The Journal of Neuroscience*, 18:9517–9528.
- Hirsch, J. A., Gallagher, C. A., Alonso, J. M., and Martinez, L. M. (1998b). Ascending projections of simple and complex cells in layer 6 of the cat striate cortex. *The Journal of Neuroscience*, 18:8086–8094.
- Hirsch, J. A., and Gilbert, C. D. (1991). Synaptic physiology of horizontal connections in the cat's visual cortex. *The Journal of Neuroscience*, 11:1800–1809.
- Hochreiter, S., and Schmidhuber, J. (1999). Source separation as a by-product of regularization. In Kearns, M. S., Solla, S. A., and Cohn, D. A., editors, *Advances in Neural Information Processing Systems 11*, 459–465. Cambridge, MA: MIT Press.
- Hodgkin, A. L., and Huxley, A. F. (1952). A quantitative description of membrane current and its application to conduction and excitation in nerve. *The Journal of Physiology*, 117:500–544.
- Hoffman, D. D. (1998). *Visual Intelligence: How We Create What We See*. New York: Norton.

- Holland, J. H. (1975). *Adaptation in Natural and Artificial Systems: An Introductory Analysis with Applications to Biology, Control and Artificial Intelligence*. Ann Arbor, MI: University of Michigan Press.
- Hopkins, R. O., Myers, C. E., Shohamy, D., Grossman, S., and Gluck, M. (2003). Impaired probabilistic category learning in hypoxic subjects with hippocampal damage. *Neuropsychologia*, 41:1919–1928.
- Hoppensteadt, F. C., and Izhikevich, E. M. (1997). *Weakly Connected Neural Networks*. Berlin: Springer.
- Horn, D., Levy, N., and Ruppin, E. (1998). Memory maintenance via neuronal regulation. *Neural Computation*, 10:1–18.
- Horn, D., and Opher, I. (1998). Collective excitation phenomena and their applications. In Maass, W., and Bishop, C. M., editors, *Pulsed Neural Networks*, 297–320. Cambridge, MA: MIT Press.
- Horn, D., and Usher, M. (1989). Neural networks with dynamical thresholds. *Physical Review A*, 40:1036–1044.
- Horn, D., and Usher, M. (1992). Oscillatory model of short term memory. In Moody, J. E., Hanson, S. J., and Lippmann, R. P., editors, *Advances in Neural Information Processing Systems*, 4, 125–132. San Francisco: Kaufmann.
- Horn, G. (1985). *Memory, Imprinting, and the Brain: An Inquiry Into Mechanisms*. Oxford, UK: Clarendon Press.
- Horne, J. A. (1988). *Why We Sleep: The Functions of Sleep in Humans and Other Mammals*. Oxford, UK: Oxford University Press.
- Horton, J. C., and Hocking, D. R. (1996). An adult-like pattern of ocular dominance columns in striate cortex of newborn monkeys prior to visual experience. *The Journal of Neuroscience*, 16:1791–1807.
- Howard, I. P., and Templeton, W. B. (1966). *Human Spatial Orientation*. Hoboken, NJ: Wiley.
- Hubel, D. H., and Wiesel, T. N. (1959). Receptive fields of single neurons in the cat's striate cortex. *The Journal of Physiology*, 148:574–591.
- Hubel, D. H., and Wiesel, T. N. (1962). Receptive fields, binocular interaction and functional architecture in the cat's visual cortex. *The Journal of Physiology*, 160:106–154.
- Hubel, D. H., and Wiesel, T. N. (1965). Receptive fields and functional architecture in two nonstriate visual areas (18 and 19) of the cat. *Journal of Neurophysiology*, 28:229–289.
- Hubel, D. H., and Wiesel, T. N. (1967). Cortical and callosal connections concerned with the vertical meridian of visual fields of the cat. *Journal of Neurophysiology*, 30:1561–1573.
- Hubel, D. H., and Wiesel, T. N. (1968). Receptive fields and functional architecture of monkey striate cortex. *The Journal of Physiology*, 195:215–243.
- Hubel, D. H., and Wiesel, T. N. (1974). Sequence regularity and geometry of orientation columns in the monkey striate cortex. *The Journal of Comparative Neurology*, 158:267–294.
- Hubel, D. H., Wiesel, T. N., and LeVay, S. (1977). Plasticity of ocular dominance columns in monkey striate cortex. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 278:377–409.
- Hubener, M., Shoham, D., Grinvald, A., and Bonhoeffer, T. (1997). Spatial relationships among three columnar systems in cat area 17. *The Journal of Neuroscience*, 17:9270–9284.
- Hugh, G. S., Laubach, M., Nicolelis, M. A. L., and Henriquez, C. S. (2002). A simulator for the analysis of neuronal ensemble activity: Application to reaching tasks. *Neurocomputing*, 44–46:847–854.



- Hugues, E., Guilleux, F., and Rochel, O. (2002). Contour detection by synchronization of integrate-and-fire neurons. In Bühlhoff, H. H., Lee, S.-W., Poggio, T., and Wallraven, C., editors, *Biologically Motivated Computer Vision: Second International Workshop*, Lecture Notes in Computer Science 2525, 60–69. Berlin: Springer.
- Humphrey, A. L., Saul, A. B., and Feidler, J. C. (1998). Strobe rearing prevents the convergence of inputs with different response timings onto area 17 simple cells. *Journal of Neurophysiology*, 80:3005–3020.
- Hurri, J., and Hyvarinen, A. (2003). Temporal and spatiotemporal coherence in simple-cell responses: A generative model of natural image sequences. *Network: Computation in Neural Systems*, 14:527–551.
- Hyvärinen, A., and Hoyer, P. O. (2001). A two-layer sparse coding model learns simple and complex cell receptive fields and topography from natural images. *Vision Research*, 41:2413–2423.
- Ilmoniemi, R. J., Virtanen, J., Ruohonen, J., Karhu, J., Aronen, H. J., Näätänen, R., and Katila, T. (1997). Neuronal responses to magnetic stimulation reveal cortical reactivity and connectivity. *Neuroreport*, 8:3537–3540.
- Issa, N. P., Trachtenberg, J. T., Chapman, B., Zahs, K. R., and Stryker, M. P. (1999). The critical period for ocular dominance plasticity in the ferret's visual cortex. *The Journal of Neuroscience*, 19:6965–6978.
- Issa, N. P., Trepel, C., and Stryker, M. P. (2001). Spatial frequency maps in cat visual cortex. *The Journal of Neuroscience*, 20:8504–8514.
- Izhikevich, E. M. (2001). Resonate-and-fire neurons. *Neural Networks*, 14:883–894.
- Izhikevich, E. M. (2003). Simple model of spiking neurons. *IEEE Transactions on Neural Networks*, 14:1569–1572.
- Jani, N. G., and Levine, D. S. (2000). A neural network theory of proportional analogy-making. *Neural Networks*, 13:149–183.
- Jefferys, J. G. R., Traub, R. D., and Whittington, M. A. (1996). Neuronal networks for induced '40 Hz' rhythms. *Trends in Neurosciences*, 19:202–208.
- Jensen, K., and Mody, I. (2001). L-type  $\text{Ca}^{2+}$  channel-mediated short-term plasticity of GABAergic synapses. *Nature Neuroscience*, 4:975–976.
- Jockusch, S. (1990). A neural network which adapts its structure to a given set of patterns. In Eckmiller, R., Hartmann, G., and Hauske, G., editors, *Parallel Processing in Neural Systems and Computers*, 169–172. Amsterdam: North-Holland.
- Johnson, M. H., Dziurawiec, S., Ellis, H., and Morton, J. (1991). Newborns' preferential tracking of face-like stimuli and its subsequent decline. *Cognition*, 40:1–19.
- Johnson, M. H., and Mareschal, D. (2001). Cognitive and perceptual development during infancy. *Current Opinion in Neurobiology*, 11:213–218.
- Johnson, M. H., and Morton, J. (1991). *Biology and Cognitive Development: The Case of Face Recognition*. Oxford, UK: Blackwell.
- Joliot, M., Ribary, U., and Llinás, R. (1994). Human oscillatory brain activity near 40 Hz coexists with cognitive temporal binding. *Proceedings of the National Academy of Sciences, USA*, 91:11748–11751.
- Jolliffe, I. T. (1986). *Principal Component Analysis*. Berlin: Springer.
- Jones, J. P., and Palmer, L. A. (1987). The two-dimensional spatial structure of simple receptive fields in cat striate cortex. *Journal of Neurophysiology*, 58:1187–1211.
- Jouvet, M. (1980). Paradoxical sleep and the nature-nurture controversy. In McConnell, P. S., Boer, G. J., Romijn, H. J., van de Poll, N. E., and Corner, M. A., editors, *Adaptive Capabilities of the Nervous System: Proceedings of the 11th International Summer School of Brain Research*, vol. 53 of *Progress in Brain Research*, 331–346. Amsterdam: Elsevier.

- Jouvet, M. (1998). Paradoxical sleep as a programming system. *Journal of Sleep Research*, 7:1–5.
- Jouvet, M. (1999). *The Paradox of Sleep: The Story of Dreaming*. Cambridge, MA: MIT Press.
- Kaas, J. H. (1991). Plasticity of sensory and motor maps in adult animals. *Annual Review of Neuroscience*, 14:137–167.
- Kaas, J. H. (2000). Why is brain size so important: Design problems and solutions as neocortex gets bigger or smaller. *Brain and Mind*, 1:7–23.
- Kaas, J. H. (2001a). The mutability of sensory representations after injury in adult mammals. In Shaw, C. A., and McEachern, J. C., editors, *Toward a Theory of Neuroplasticity*, 323–334. East Sussex, UK: Psychology Press.
- Kaas, J. H. (2001b). Reorganization of sensory and motor systems in adult mammals after injury. In Kaas, J. H., editor, *The Mutable Brain: Dynamic and Plastic Features of the Developing and Mature Brain*, 165–242. Chur, Switzerland: Harwood.
- Kaas, J. H., Krubitzer, L. A., Chino, Y. M., Langston, A. L., Polley, E. H., and Blair, N. (1990). Reorganization of retinotopic cortical maps in adult mammals after lesions of the retina. *Science*, 248:229–231.
- Kalarickal, G. J., and Marshall, J. A. (2002). Rearrangement of receptive field topography after intracortical and peripheral stimulation: The role of plasticity in inhibitory pathways. *Network: Computation in Neural Systems*, 13:1–40.
- Kambhatla, N., and Leen, T. K. (1997). Dimension reduction by local principal component analysis. *Neural Computation*, 9:1493–1516.
- Kammen, D. M., Holmes, P. J., and Koch, C. (1989). Origin of oscillations in visual cortex: Feedback versus local coupling. In Cotterill, R. M. J., editor, *Models of Brain Functions*, 273–284. Cambridge, UK: Cambridge University Press.
- Kandel, E. R., Schwartz, J. H., and Jessell, T. M. (1991). *Principles of Neural Science*. Amsterdam: Elsevier. Third edition.
- Kandel, E. R., Schwartz, J. H., and Jessell, T. M. (2000). *Principles of Neural Science*. New York: McGraw-Hill. Fourth edition.
- Kanerva, P. (1998). Dual role of analogy in the design of a cognitive computer. In Holyoak, K., Gentner, D., and Kokinov, B., editors, *Advances in Analogy Research: Integration of Theory and Data from the Cognitive, Computational, and Neural Sciences*, 164–170. Sofia, Bulgaria: NBU Press.
- Kanizsa, G. (1955). Margini quasi-Percettivi in Campi con Stimolazione Omogenea. *Rivista di Psicologia*, 49:7–30. Quasiperceptual Margins in Homogeneously Stimulated Fields; translated by W. Gerbino. In Petry, S., and Meyer, G. E., editors (1987). *The Perception of Illusory Contours*, 40–49. Berlin: Springer.
- Kanizsa, G. (1976). Subjective contours. *Scientific American*, 234:48–52.
- Kanwisher, N. (2000). Domain specificity in face perception. *Nature Neuroscience*, 3:759–763.
- Kanwisher, N., McDermott, J., and Chun, M. M. (1997). The fusiform face area: A module in human extrastriate cortex specialized for face perception. *The Journal of Neuroscience*, 17:4302–4311.
- Kapadia, M. K., Gilbert, C. D., and Westheimer, G. (1994). A quantitative measure for short-term cortical plasticity in human vision. *The Journal of Neuroscience*, 14:451–457.
- Kapadia, M. K., Ito, M., Gilbert, C. D., and Westheimer, G. (1995). Improvement in visual sensitivity by changes in local context: Parallel studies in human observers and in V1 of alert monkeys. *Neuron*, 15:843–856.

- Karni, A., and Bertini, G. (1997). Learning perceptual skills: Behavioral probes into adult cortical plasticity. *Current Opinion in Neurobiology*, 7:530–535.
- Kasamatsu, T., Kitano, M., Sutter, E. E., and Norcia, A. M. (1998). Lack of lateral inhibitory interactions in visual cortex of monocularly deprived cats. *Vision Research*, 38:1–12.
- Kaski, S., Kangas, J., and Kohonen, T. (1998). Bibliography of self-organizing map (SOM) papers: 1981–1997. *Neural Computing Surveys*, 1:102–350.
- Katz, L. C., and Callaway, E. M. (1992). Development of local circuits in mammalian visual cortex. *Annual Review of Neuroscience*, 15:31–56.
- Katz, L. C., and Shatz, C. J. (1996). Synaptic activity and the construction of cortical circuits. *Science*, 274:1133–1138.
- Keeler, J., and Rumelhart, D. E. (1992). A self-organizing integrated segmentation and recognition neural network. In Moody, J. E., Hanson, S. J., and Lippmann, R. P., editors, *Advances in Neural Information Processing Systems 4*, 496–504. San Francisco: Kaufmann.
- Keesing, R., Stork, D. G., and Shatz, C. J. (1992). Retinogeniculate development: The role of competition and correlated retinal activity. In Moody, J. E., Hanson, S. J., and Lippmann, R. P., editors, *Advances in Neural Information Processing Systems 4*, 91–97. San Francisco: Kaufmann.
- Kellman, P. J., Yin, C., and Shapley, T. F. (1998). A common mechanism for illusory and occluded object completion. *Journal of Experimental Psychology: Human Perception and Performance*, 24:859–869.
- Kim, D. (2004). A spiking neuron model for synchronous flashing of fireflies. *Biosystems*, 76:7–20.
- Kim, D. S., and Bonhoeffer, T. (1994). Reverse occlusion leads to a precise restoration of orientation preference maps in visual cortex. *Nature*, 370:370–372.
- Kiorpes, L., and Kiper, D. C. (1996). Development of contrast sensitivity across the visual field in macaque monkeys (*Macaca nemestrina*). *Vision Research*, 36:239–247.
- Kirillov, A. B., and Woodward, D. J. (1993). Synchronization of spiking neurons: Transmission delays, noise and NMDA receptors. In *World Congress on Neural Networks*, 594–597. Hillsdale, New Jersey: Erlbaum.
- Kisvárdy, Z. F., and Eysel, U. T. (1992). Cellular organization of reciprocal patchy networks in layer III of cat visual cortex (area 17). *Neuroscience*, 46:275–286.
- Kisvárdy, Z. F., Kim, D. S., Eysel, U. T., and Bonhoeffer, T. (1994). Relationship between lateral inhibitory connections and the topography of the orientation map in the cat visual cortex. *European Journal of Neuroscience*, 6:1619–1632.
- Kleiner, K. A. (1987). Amplitude and phase spectra as indices of infants' pattern preferences. *Infant Behavior and Development*, 10:49–59.
- Kleiner, K. A. (1993). Specific vs. non-specific face-recognition device. In de Boysson-Bardies, B., editor, *Developmental Neurocognition: Speech and Face Processing in the First Year of Life*, 103–108. Dordrecht, The Netherlands: Kluwer.
- Knoblauch, A., and Palm, G. (2003). Synchronization of neuronal assemblies in reciprocally connected cortical areas. *Theory in Biosciences*, 122:37–54.
- Knudsen, E. I., and Knudsen, P. F. (1985). Vision calibrates sound localization in developing barn owls. *The Journal of Neuroscience*, 9:3306–3313.
- Ko, J., and Byun, H. (2003). N-division output coding method applied to face recognition. *Pattern Recognition Letters*, 24:3115–3123.
- Köhler, W., and Wallach, H. (1944). Figural after-effects: An investigation of visual processes. *Proceedings of the American Philosophical Society*, 88:269–357.

- Kohn, A., and Movshon, J. A. (2003). Neuronal adaptation to visual motion in area MT of the macaque. *Neuron*, 39:681–691.
- Kohonen, T. (1982a). Analysis of a simple self-organizing process. *Biological Cybernetics*, 44:135–140.
- Kohonen, T. (1982b). Self-organized formation of topologically correct feature maps. *Biological Cybernetics*, 43:59–69.
- Kohonen, T. (1989). *Self-Organization and Associative Memory*. Berlin: Springer. Third edition.
- Kohonen, T. (1990). The self-organizing map. *Proceedings of the IEEE*, 78:1464–1480.
- Kohonen, T. (1993). Physiological interpretation of the self-organizing map algorithm. *Neural Networks*, 6:895–905.
- Kohonen, T. (2001). *Self-Organizing Maps*. Berlin: Springer. Third edition.
- Kohonen, T., Kaski, S., Lagus, K., Salojärvi, J., Honkela, J., Paatero, V., and Saarela, A. (2000). Self-organization of a massive document collection. *IEEE Transactions on Neural Networks*, 11:574–585.
- Kolen, J. F., and Pollack, J. B. (1990). Scenes from exclusive-or: Back propagation is sensitive to initial conditions. In *Proceedings of the 12th Annual Conference of the Cognitive Science Society*, 868–875. Hillsdale, NJ: Erlbaum.
- Kosslyn, S. M., and Sussman, A. L. (1995). Roles of imagery in perception: Or, there is no such thing as immaculate perception. In Gazzaniga, M. S., editor, *The Cognitive Neurosciences*, 1035–1041. Cambridge, MA: MIT Press.
- Kötter, R. (2004). Online retrieval, processing, and visualization of primate connectivity data from the CoCoMac database. *Neuroinformatics*, 2:127–144.
- Koulakov, A. A., and Chklovskii, D. B. (2001). Orientation preference patterns in mammalian visual cortex: A wire length minimization approach. *Neuron*, 29:519–527.
- Kovacs, I., and Julesz, B. (1993). A closed curve is much more than an incomplete one: Effect of closure in figure-ground segmentation. *Proceedings of the National Academy of Sciences, USA*, 90:7495–7497.
- Koza, J. R. (1992). *Genetic Programming: On the Programming of Computers by Means of Natural Selection*. Cambridge, MA: MIT Press.
- Kozma, R., Alvarado, M., Rogers, L., Lau, B., and Freeman, W. J. (2001). Emergence of un-correlated common-mode oscillations in the sensory cortex. *Neurocomputing*, 38–40:747–755.
- Krüger, N., and Wörgötter, F. (2002). Multi modal estimation of collinearity and parallelism in natural image sequences. *Network: Computation in Neural Systems*, 13:553–576.
- Kuhlmann, L., Burkitt, A. N., Paolini, A., and Clark, G. M. (2002). Summation of spatiotemporal input patterns in leaky integrate-and-fire neurons: Application to neurons in the cochlear nucleus receiving converging auditory nerve fiber input. *Journal of Computational Neuroscience*, 12:55–73.
- LaBerge, D. (1995). *Attentional Processing: The Brain's Art of Mindfulness*. Cambridge, MA: Harvard University Press.
- LaBerge, D., and Buchsbaum, M. S. (1990). Positron emission tomographic measurements of pulvinar activity during an attention task. *The Journal of Neuroscience*, 10:613–619.
- Lamme, V. A., Super, H., and Spekreijse, H. (1998). Feedforward, horizontal, and feedback processing in the visual cortex. *Current Opinion in Neurobiology*, 8:529–535.
- Lancaster, J. L., Narayana, S., Wenzel, D., Luckemeyer, J., Roby, J., and Fox, P. (2004). Evaluation of an image-guided, robotically positioned transcranial magnetic stimulation system. *Human Brain Mapping*, 22:329–340.

- Lander, E. S., et al. (2001). Initial sequencing and analysis of the human genome. *Nature*, 409:860–921.
- Landisman, C. E., and Ts'o, D. Y. (2002a). Color processing in macaque striate cortex: Electrophysiological properties. *Journal of Neurophysiology*, 87:3138–3151.
- Landisman, C. E., and Ts'o, D. Y. (2002b). Color processing in macaque striate cortex: Relationships to ocular dominance, cytochrome oxidase, and orientation. *Journal of Neurophysiology*, 87:3126–3137.
- Landy, M. S., Maloney, L. T., and Pavel, M., editors (1995). *Exploratory Vision: The Active Eye*. Berlin: Springer.
- Langley, P., Choi, D., and Shapiro, D. (2004). A cognitive architecture for physical agents. Technical report, Institute for the Study of Learning and Expertise, Palo Alto, CA.
- Lapicque, M. L. (1907). Recherches quantitatives sur l'excitation électrique des nerfs traitée comme une polarisation [Quantitative studies on electric excitation of nerves treated as polarization]. *Journal de Physiologie et Pathologie General*, 9:620–635.
- Lawrence, S., Giles, C. L., Tsoi, A. C., and Back, A. D. (1997). Face recognition: A convolutional neural network approach. *IEEE Transactions on Neural Networks*, 8:98–113.
- LeCun, Y., Jackel, L. D., Bottou, L., Cortes, C., Denker, J. S., Drucker, H., Guyon, I., Muller, U. A., Sackinger, E., Simard, P., and Vapnik, V. (1995). Learning algorithms for classification: A comparison on handwritten digit recognition. In Oh, J. H., Kwon, C., and Cho, S., editors, *Neural Networks: The Statistical Mechanics Perspective. Proceedings of the CTP-PBSRI Joint Workshop on Theoretical Physics*, 261–276. Singapore: World Scientific.
- Lee, C. W., Eglén, S. J., and Wong, R. O. L. (2002a). Segregation of ON and OFF retinogeniculate connectivity directed by patterned spontaneous activity. *Journal of Neurophysiology*, 88:2311–2321.
- Lee, K., and Lee, Y. (2000a). A framework of two-stage combination of multiple recognizers for handwritten numerals. In Mizoguchi, R., and Slaney, J., editors, *Topics in Artificial Intelligence: 6th Pacific Rim International Conference on Artificial Intelligence*, Lecture Notes in Artificial Intelligence 1886, 617–626. Berlin: Springer.
- Lee, S.-H., and Blake, R. (1999). Visual form created solely from temporal structure. *Science*, 284:1165–1168.
- Lee, S.-H., and Blake, R. (2001). Neural synergy in visual grouping: When good continuation meets common fate. *Vision Research*, 41:2057–2064.
- Lee, S.-I., and Lee, S.-Y. (2000b). Top-down attention control at feature space for robust pattern recognition. In Lee, S.-W., Bülthoff, H. H., and Poggio, T., editors, *Biologically Motivated Computer Vision: First IEEE International Workshop*, Lecture Notes in Computer Science 1811, 129–138. Berlin: Springer.
- Lee, S.-W. (1996). Off-line recognition of totally unconstrained handwritten numerals using multilayer cluster neural network. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 18:648–652.
- Lee, T. S., and Nguyen, M. (2001). Dynamics of subjective contour formation in early visual cortex. *Proceedings of the National Academy of Sciences, USA*, 98:1907–1911.
- Lee, T.-W., Wachtler, T., and Sejnowski, T. J. (2002b). Color opponency is an efficient representation of spectral properties in natural scenes. *Vision Research*, 42:2095–2103.
- Lennie, P. (2003). The cost of cortical computation. *Current Biology*, 13:493–497.
- Leonards, U., and Singer, W. (1998). Two segmentation mechanisms with differential sensitivity for colour and luminance contrast. *Vision Research*, 38:101–109.
- Leonards, U., Singer, W., and Fahle, M. (1996). The influence of temporal phase difference on texture segmentation. *Vision Research*, 36:2689–2697.

- Leopold, D. A., O'Toole, A. J., Vetter, T., and Blanz, V. (2001). Prototype-referenced shape encoding revealed by high-level aftereffects. *Nature Neuroscience*, 4:89–94.
- Leow, W. K. (1994). VISOR: Learning visual schemas in neural networks for object recognition and scene analysis. Doctoral dissertation, Department of Computer Sciences, The University of Texas at Austin, Austin, TX. Technical Report AI94-219.
- Leow, W. K., and Miikkulainen, R. (1997). Visual schemas in neural networks for object recognition and scene analysis. *Connection Science*, 9:161–200.
- Leshner, G. W., and Mingolla, E. (1995). Illusory contour formation. In Arbib, M. A., editor, *The Handbook of Brain Theory and Neural Networks*, 481–483. Cambridge, MA: MIT Press. First edition.
- Levine, D. S., and Grossberg, S. (1976). Visual illusions in neural networks: Line neutralization, tilt after effect, and angle expansion. *Journal of Theoretical Biology*, 61:477–504.
- Levy, I., Hasson, U., Avidan, G., Hendler, T., and Malach, R. (2001). Center-periphery organization of human object areas. *Nature Neuroscience*, 4:533–539.
- Lewis, J. W., and Van Essen, D. C. (2000). Corticocortical connections of visual, sensorimotor, and multimodal processing areas in the parietal lobe of the macaque monkey. *The Journal of Comparative Neurology*, 428:112–137.
- Li, P., Farkas, I., and MacWhinney, B. (2004). Early lexical development in a self-organizing neural network. *Neural Networks*, 17:1345–1362.
- Li, Z. (1998). A neural model of contour integration in the primary visual cortex. *Neural Computation*, 10:903–940.
- Li, Z. (1999). Visual segmentation by contextual influences via inter-cortical interactions in the primary visual cortex. *Network: Computation in Neural Systems*, 10:187–212.
- Linsker, R. (1986a). From basic network principles to neural architecture: Emergence of orientation columns. *Proceedings of the National Academy of Sciences, USA*, 83:8779–8783.
- Linsker, R. (1986b). From basic network principles to neural architecture: Emergence of orientation-selective cells. *Proceedings of the National Academy of Sciences, USA*, 83:8390–8394.
- Linsker, R. (1986c). From basic network principles to neural architecture: Emergence of spatial-opponent cells. *Proceedings of the National Academy of Sciences, USA*, 83:7508–7512.
- Lippe, W. R. (1994). Rhythmic spontaneous activity in the developing avian auditory system. *The Journal of Neuroscience*, 14:1486–1495.
- Lisman, J. (1998). What makes the brain's ticker tock. *Nature*, 394:132–133.
- Liu, X., and Wang, D. (1999). Range image segmentation using an oscillatory network. *IEEE Transactions of Neural Networks*, 10:564–573.
- Livingstone, M. S., and Hubel, D. H. (1984a). Anatomy and physiology of a color system in the primate visual cortex. *The Journal of Neuroscience*, 4:309–356.
- Livingstone, M. S., and Hubel, D. H. (1984b). Specificity of intrinsic connections in primate primary visual cortex. *The Journal of Neuroscience*, 4:2830–2835.
- Löwel, S. (1994). Ocular dominance column development: Strabismus changes the spacing of adjacent columns in cat visual cortex. *The Journal of Neuroscience*, 14:7451–7468.
- Löwel, S., Bischof, H. J., Leutenecker, B., and Singer, W. (1988). Topographic relations between ocular dominance and orientation columns in the cat striate cortex. *Experimental Brain Research*, 71:33–46.
- Löwel, S., and Singer, W. (1992). Selection of intrinsic horizontal connections in the visual cortex by correlated neuronal activity. *Science*, 255:209–212.

- Luhmann, H. J., Martínez Millán, L., and Singer, W. (1986). Development of horizontal intrinsic connections in cat striate cortex. *Experimental Brain Research*, 63:443–448.
- Lund, J. S., Yoshioka, T., and Levitt, J. B. (1993). Comparison of intrinsic connectivity in different areas of macaque monkey cerebral cortex. *Cerebral Cortex*, 3:148–162.
- Lytton, W. W. (2002). *From Computer to Brain: Foundations of Computational Neuroscience*. Berlin: Springer.
- Lytton, W. W., and Sejnowski, T. J. (1991). Simulations of cortical pyramidal neurons synchronized by inhibitory interneurons. *Journal of Neurophysiology*, 66:1059–1079.
- Maass, W. (1997). Networks of spiking neurons: The third generation of neural network models. *Neural Networks*, 10:1659–1671.
- Maass, W. (1998). Computing with spiking neurons. In Maass, W., and Bishop, C. M., editors, *Pulsed Neural Networks*, 55–85. Cambridge, MA: MIT Press.
- Maffei, L., and Galli-Resta, L. (1990). Correlation in the discharges of neighboring rat retinal ganglion cells during prenatal life. *Proceedings of the National Academy of Sciences, USA*, 87:2861–2864.
- Magnussen, S., and Johnsen, T. (1986). Temporal aspects of spatial adaptation: A study of the tilt aftereffect. *Vision Research*, 26:661–672.
- Magnussen, S., and Kurtenbach, W. (1980). Adapting to two orientations: Disinhibition in a visual aftereffect. *Science*, 207:908–909.
- Mainen, Z. F., and Sejnowski, T. J. (1998). Modeling active dendritic processes in pyramidal neurons. In Koch, C., and Segev, I., editors, *Methods in Neuronal Modeling: From Ions to Networks*, 170–209. Cambridge, MA: MIT Press. Second edition.
- Mäkelä, P., Näsänen, R., Rovamo, J., and Melmoth, D. (2001). Identification of facial images in peripheral vision. *Vision Research*, 41:599–610.
- Malach, R., Amir, Y., Harel, M., and Grinvald, A. (1993). Relationship between intrinsic connections and functional architecture revealed by optical imaging and in vivo targeted biocytin injections in the primate striate cortex. *Proceedings of the National Academy of Sciences, USA*, 90:10469–10473.
- Maldonado, P. E., Gödecke, I., Gray, C. M., and Bonhoeffer, T. (1997). Selectivity in pinwheel centers in cat striate cortex. *Science*, 276:1551–1555.
- Maquet, P., and Phillips, S. C. (1998). Functional brain imaging of human sleep. *Journal of Sleep Research*, 7:42–47.
- Marcus, G. F. (2003). *The Algebraic Mind: Integrating Connectionism and Cognitive Science*. Cambridge, MA: MIT Press.
- Marder, E., and Calabrese, R. L. (1996). Principles of rhythmic motor pattern generation. *Physiological Reviews*, 76:687–717.
- Mareschal, D., Johnson, M. H., Sirois, S., Spratling, M., Thomas, M. S. C., and Westermann, G., editors (2005a). *Neuroconstructivism, Vol. 1: How the Brain Constructs Cognition*. Oxford, UK: Oxford University Press. In press.
- Mareschal, D., Johnson, M. H., Sirois, S., Spratling, M., Thomas, M. S. C., and Westermann, G., editors (2005b). *Neuroconstructivism, Vol. 2: Perspectives and Prospects*. Oxford, UK: Oxford University Press. In press.
- Markman, A. B., and Dietrich, E. (2000). Extending the classical view of representation. *Trends in Cognitive Sciences*, 4:470–475.
- Markram, H., Lübke, J., Frotscher, M., and Sakmann, B. (1997). Regulation of synaptic efficacy by coincidence of postsynaptic APs and EPSPs. *Science*, 275:213–215.
- Marks, G. A., Shaffery, J. P., Oksenberg, A., Speciale, S. G., and Roffwarg, H. P. (1995). A functional role for REM sleep in brain maturation. *Behavioural Brain Research*, 69:1–11.

- Marr, D. (1982). *Vision*. New York: Freeman.
- Marsalek, P., Koch, C., and Maunsell, J. H. R. (1997). On the relationship between sublinear input and spike output jitter in individual neurons. *Proceedings of the National Academy of Sciences, USA*, 94:735–740.
- Marshall, J. A. (1990). Self-organizing neural networks for perception of visual motion. *Neural Networks*, 3:45–74.
- Marshall, J. A., and Alley, R. (1996). A self-organizing neural network that learns to detect and represent visual depth from occlusion events. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Martin, G. L., Rashid, M., Chapman, D., and Pittman, J. A. (1993). Learning to see where and what: Training a net to make saccades and recognize handwritten characters. In Giles, C. L., Hanson, S. J., and Cowan, J. D., editors, *Advances in Neural Information Processing Systems 5*, 441–447. San Francisco: Kaufmann.
- Martinez-Conde, S., Macknik, S. L., and Hubel, D. H. (2000). Microsaccadic eye movements and firing of single cells in the striate cortex of macaque monkeys. *Nature Neuroscience*, 3:251–258.
- Masini, R., Antonietti, A., and Moja, E. A. (1990). An increase in strength of tilt aftereffect associated with tryptophan depletion. *Perceptual and Motor Skills*, 70:531–539.
- Mastrorarde, D. N., Humphrey, A. L., and Saul, A. B. (1991). Lagged Y cells in the cat lateral geniculate nucleus. *Visual Neuroscience*, 7:191–200.
- Maurer, D., and Barrera, M. (1981). Infants' perception of natural and distorted arrangements of a schematic face. *Child Development*, 52:196–202.
- Mayer, N., Herrmann, J. M., and Geisel, T. (2001). Signatures of natural image statistics in cortical simple cell receptive fields. *Neurocomputing*, 38:279–284.
- Mazziotta, J., Toga, A., Evans, A., Fox, P., Lancaster, J. L., Zilles, K., Woods, R., Paus, T., Simpson, G., Pike, B., Holmes, C., Collins, L., Thompson, P., MacDonald, D., Iacoboni, M., Schormann, T., Amunts, K., Palomero-Gallagher, N., Geyer, S., Parsons, L., Narr, K., Kabani, N., Le Goualher, G., Feidler, J. C., Smith, K., Boomsma, D., Hulshoff Pol, H., Cannon, T., Kawashima, R., and Mazoyer, B. (2001). A four-dimensional probabilistic atlas of the human brain. *Journal of the American Medical Informatics Association*, 8:401–430.
- McCasland, J. S., Bernardo, K. L., Probst, K. L., and Woolsey, T. A. (1992). Cortical local circuit axons do not mature after early deafferentation. *Proceedings of the National Academy of Sciences, USA*, 89:1832–1836.
- McClelland, J. L., and Rogers, T. T. (2003). The parallel distributed processing approach to semantic cognition. *Nature Reviews Neuroscience*, 4:1–14.
- McCormick, B. H., Choe, Y., Koh, W., Abbott, L. C., Keyser, J., Melek, Z., Doddapaneni, P., and Mayerich, D. M. (2004a). Construction of anatomically correct models of mouse brain networks. *Neurocomputing*, 58–60:379–386.
- McCormick, B. H., Mayerich, D. M., Abbott, L. C., Gutierrez-Osuna, R., Keyser, J., Choe, Y., Koh, W., and Busse, B. L. (2004b). Whole mouse brain mapped at submicron resolution using knife-edge scanning microscope. In *Society for Neuroscience Abstracts*, Program No. 1033.4. Washington, DC: Society for Neuroscience.
- McDonald, C. T., and Burkhalter, A. (1993). Organization of long-range inhibitory connections within rat visual cortex. *The Journal of Neuroscience*, 13:768–781.
- McGraw, P. V., Walsh, V., and Barrett, B. T. (2004). Motion-sensitive neurones in V5/MT modulate perceived spatial position. *Current Biology*, 14:1090–1093.



- McGuire, B. A., Gilbert, C. D., Rivlin, P. K., and Wiesel, T. N. (1991). Targets of horizontal connections in macaque primary visual cortex. *The Journal of Comparative Neurology*, 305:370–392.
- McGurk, H., and MacDonald, J. (1976). Hearing lips and seeing voices. *Nature*, 264:746–748.
- McIlhagga, W. H., and Mullen, K. T. (1996). Contour integration with colour and luminance contrast. *Vision Research*, 36:1265–1279.
- McLaughlin, T., Torborg, C. L., Feller, M. B., and O’Leary, D. D. (2003). Retinotopic map refinement requires spontaneous retinal waves during a brief critical period of development. *Neuron*, 40:1147–1160.
- Meister, M., Wong, R. O. L., Baylor, D. A., and Shatz, C. J. (1991). Synchronous bursts of action-potentials in the ganglion cells of the developing mammalian retina. *Science*, 252:939–943.
- Meltzoff, A. N., and Moore, A. K. (1993). Why faces are special to infants — On connecting the attraction of faces and infants’ ability for imitation and cross-modal processing. In de Boysson-Bardies, B., editor, *Developmental Neurocognition: Speech and Face Processing in the First Year of Life*, 211–226. Dordrecht, The Netherlands: Kluwer.
- Menon, V. (1990). Dynamic aspects of signaling in distributed neural systems. Doctoral dissertation, Department of Computer Sciences, The University of Texas at Austin, Austin, TX. Technical Report TR-90-36.
- Menon, V. (1991). Population oscillations in neuronal groups. *International Journal of Neural Systems*, 2:237–262.
- Meredith, M. A., and Stein, B. E. (1986). Visual, auditory, and somatosensory convergence on cells in superior colliculus results in multisensory integration. *Journal of Neurophysiology*, 56:640–662.
- Merigan, W. H., and Maunsell, J. H. R. (1993). How parallel are the primate visual pathways?. *Annual Review of Neuroscience*, 16:369–402.
- Merzenich, M. M., Nelson, R. J., Stryker, M. P., Cynader, M. S., Schoppmann, A., and Zook, J. M. (1984). Somatosensory cortical map changes following digit amputation in adult monkeys. *The Journal of Comparative Neurology*, 224:591–605.
- Merzenich, M. M., Recanzone, G. H., Jenkins, W. M., and Grajski, K. A. (1990). Adaptive mechanisms in cortical networks underlying cortical contributions to learning and nondeclarative memory. In *The Brain*, vol. LV of *Cold Spring Harbor Symposia on Quantitative Biology*, 873–887. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Meunier, C., and Segev, I. (2002). Playing the devil’s advocate: Is the Hodgkin–Huxley model useful? *Trends in Neurosciences*, 25:558–563.
- Meyerson, R. G., and Palmer, S. E. (2004). Change blindness in synchrony grouping. *Journal of Vision*, 4:496a.
- Miikkulainen, R. (1991). Self-organizing process based on lateral inhibition and synaptic resource redistribution. In Kohonen, T., Mäkisara, K., Simula, O., and Kangas, J., editors, *Proceedings of the 1991 International Conference on Artificial Neural Networks*, 415–420. Amsterdam: North-Holland.
- Miikkulainen, R. (1992). Trace feature map: A model of episodic associative memory. *Biological Cybernetics*, 66:273–282.
- Miikkulainen, R. (1993). *Subsymbolic Natural Language Processing: An Integrated Model of Scripts, Lexicon, and Memory*. Cambridge, MA: MIT Press.
- Miikkulainen, R., Bednar, J. A., Choe, Y., and Sirosh, J. (1997). Self-organization, plasticity, and low-level visual phenomena in a laterally connected map model of the primary visual cortex. In Goldstone, R. L., Schyns, P. G., and Medin, D. L., editors, *Perceptual*

- Learning*, vol. 36 of *Psychology of Learning and Motivation*, 257–308. San Diego, CA: Academic Press.
- Miller, G. A. (1956). The magical number seven, plus or minus two: Some limits on our capacity of processing information. *Psychological Review*, 63:81–97.
- Miller, K. D. (1994). A model for the development of simple cell receptive fields and the ordered arrangement of orientation columns through activity-dependent competition between ON- and OFF-center inputs. *The Journal of Neuroscience*, 14:409–441.
- Miller, K. D., Erwin, E., and Kayser, A. (1999). Is the development of orientation selectivity instructed by activity?. *Journal of Neurobiology*, 41:44–57.
- Miller, K. D., Keller, J. B., and Stryker, M. P. (1989). Ocular dominance column development: Analysis and simulation. *Science*, 245:605–615.
- Miller, K. D., and MacKay, D. J. C. (1994). The role of constraints in Hebbian learning. *Neural Computation*, 6:100–126.
- Milner, A. D., and Goodale, M. A. (1993). Visual pathways to perception and action. *Progress in Brain Research*, 95:317–337.
- Mirollo, R. E., and Strogatz, S. H. (1990). Synchronization of pulse-coupled biological oscillators. *SIAM Journal of Applied Mathematics*, 50:1645–1662.
- Mirsky, J. S., Nadkarni, P. M., Healy, M. D., Miller, P. L., and Shepherd, G. M. (1998). Database tools for integrating and searching membrane property data correlated with neuronal morphology. *Journal of Neuroscience Methods*, 82:105–121.
- Mitchell, D. E., and Muir, D. W. (1976). Does the tilt aftereffect occur in the oblique meridian?. *Vision Research*, 16:609–613.
- Mitchell, M. (1996). *An Introduction to Genetic Algorithms*. Cambridge, MA: MIT Press.
- Miyashita, M., Kim, D. S., and Tanaka, S. (1997). Cortical direction selectivity without directional experience. *Neuroreport*, 8:1187–1191.
- Miyashita, M., and Tanaka, S. (1992). A mathematical model for the self-organization of orientation columns in visual cortex. *Neuroreport*, 3:69–72.
- Miyashita-Lin, E. M., Hevner, R., Wassarman, K. M., Martinez, S., and Rubenstein, J. L. (1999). Early neocortical regionalization in the absence of thalamic innervation. *Science*, 285:906–909.
- Molnár, Z., Higashi, S., and López-Bendito, G. (2003). Choreography of early thalamocortical development. *Cerebral Cortex*, 13:661–669.
- Mondloch, C. J., Lewis, T. L., Budreau, D. R., Maurer, D., Dannemiller, J. L., Stephens, B. R., and Kleiner-Gathercoal, K. A. (1999). Face perception during early infancy. *Psychological Science*, 10:419–422.
- Moody, J., and Darken, C. (1990). Fast learning in networks of locally-tuned processing units. *Neural Computation*, 1:281–294.
- Moorcroft, W. H. (1995). [The function of sleep] Comments on the symposium and an attempt at synthesis. *Behavioural Brain Research*, 69:207–210.
- Mori, S., Kaufmann, W. E., Davatzikos, C., Stieltjes, B., Amodei, L., Fredericksen, K., Pearlson, G. D., Melhem, E. R., Solaiyappan, M., Raymond, G. V., Moser, H. W., and van Zijl, P. C. M. (2002). Imaging cortical association tracts in the human brain using diffusion-tensor-based axonal tracking. *Magnetic Resonance in Medicine*, 215–223.
- Morris, J. S., Ohman, A., and Dolan, R. J. (1999). A subcortical pathway to the right amygdala mediating “unseen” fear. *Proceedings of the National Academy of Sciences, USA*, 96:1680–1685.
- Moscovitch, M., and Nadel, L. (1998). Consolidation and the hippocampal complex revisited: In defense of the multiple-trace model. *Current Opinion in Neurobiology*, 8:297–300.

- Movshon, J. A., and van Sluyters, R. C. (1981). Visual neural development. *Annual Review of Psychology*, 32:477–522.
- Muir, D. W., and Over, R. (1970). Tilt aftereffects in central and peripheral vision. *Journal of Experimental Psychology*, 85:165–170.
- Müller, T., Stetter, M., Hubener, M., Sengpiel, F., Bonhoeffer, T., Gödecke, I., Chapman, B., Löwel, S., and Obermayer, K. (2000). An analysis of orientation and ocular dominance patterns in the visual cortex of cats and ferrets. *Neural Computation*, 12:2573–2595.
- Mundel, T., Dimitrov, A., and Cowan, J. D. (1997). Visual cortex circuitry and orientation tuning. In Mozer, M. C., Jordan, M. I., and Petsche, T., editors, *Advances in Neural Information Processing Systems 9*, 887–893. Cambridge, MA: MIT Press.
- Murray, M., Sharma, S., and Edwards, M. A. (1982). Target regulation of synaptic number in the compressed retinotectal projection of goldfish. *Journal of Computational Neurology*, 209:374–385.
- Murray, S. O., Schrater, P. R., and Kersten, D. (2004). Perceptual grouping and the interactions between visual cortical areas. *Neural Networks*, 17:695–705.
- Myhr, K. L., Lukasiewicz, P. D., and Wong, R. O. L. (2001). Mechanisms underlying developmental changes in the firing patterns of ON and OFF retinal ganglion cells during refinement of their central projections. *The Journal of Neuroscience*, 21:8664–8671.
- Nachson, I. (1995). On the modularity of face recognition: The riddle of domain specificity. *Journal of Clinical and Experimental Neuropsychology*, 17:256–275.
- Nadel, L., and Moscovitch, M. (1997). Memory consolidation, retrograde amnesia and the hippocampal complex. *Current Opinion in Neurobiology*, 7:217–227.
- Nagumo, J. S., Arimoto, S., and Yoshizawa, S. (1962). An active pulse transmission line simulating a nerve axon. *Proceedings of the IRE*, 50:2061–2070.
- Nakayama, K., and Shimojo, S. (1992). Experiencing and perceiving visual surfaces. *Science*, 257:1357–1363.
- Nass, M. M., and Cooper, L. N. (1975). A theory for the development of feature detecting cells in visual cortex. *Biological Cybernetics*, 19:1–18.
- National Park Service (1995). Image database. [www.freestockphotos.com/NPS](http://www.freestockphotos.com/NPS).
- Nelson, J. I. (1995). Visual scene perception: Neurophysiology. In Arbib, M. A., editor, *The Handbook of Brain Theory and Neural Networks*, 1024–1028. Cambridge, MA: MIT Press. First edition.
- Niebur, E., and Wörgötter, F. (1993). Orientation columns from first principles classical visual receptive field. *Biological Cybernetics*, 70:1–13.
- Nischwitz, A., and Glünder, H. (1995). Local lateral inhibition: A key to spike synchronization? *Biological Cybernetics*, 73:389–400.
- Nolfi, S., and Parisi, D. (1994). Desired answers do not correspond to good teaching inputs in ecological neural networks. *Neural Processing Letters*, 1:1–4.
- Nowak, L. G., and Bullier, J. (1997). The timing of information transfer in the visual system. In Rockland, K. S., Kaas, J. H., and Peters, A., editors, *Extrastriate Cortex in Primates*, vol. 12 of *Cerebral Cortex*, 205–241. New York: Plenum Press.
- Nudo, R. J., Wise, B. M., Fuentas, F., and Milliken, G. W. (1996). Neural substrates for the effects of rehabilitative training on motor recovery after ischemic infarct. *Science*, 272:1791–1794.
- Nugent, A. K., Keswani, R. N., Woods, R. L., and Peli, E. (2003). Contour integration in peripheral vision reduces gradually with eccentricity. *Vision Research*, 43:2427–2437.
- Obermayer, K., and Blasdel, G. G. (1993). Geometry of orientation and ocular dominance columns in the monkey striate cortex. *The Journal of Neuroscience*, 13:4114–4129.

- Obermayer, K., Blasdel, G. G., and Schulten, K. J. (1992). Statistical–mechanical analysis of self-organization and pattern formation during the development of visual maps. *Physical Review A*, 45:7568–7589.
- Obermayer, K., Ritter, H., and Schulten, K. J. (1990a). Large-scale simulation of a self-organizing neural network: Formation of a somatotopic map. In Eckmiller, R., Hartmann, G., and Hauske, G., editors, *Parallel Processing in Neural Systems and Computers*, 71–74. Amsterdam: North-Holland.
- Obermayer, K., Ritter, H., and Schulten, K. J. (1990b). Large-scale simulations of self-organizing neural networks on parallel computers: Application to biological modelling. *Parallel Computing*, 14:381–404.
- Obermayer, K., Ritter, H., and Schulten, K. J. (1990c). A neural network model for the formation of topographic maps in the CNS: Development of receptive fields. In *International Joint Conference on Neural Networks* (San Diego, CA), vol. II, 423–429. Piscataway, NJ: IEEE.
- Obermayer, K., Ritter, H., and Schulten, K. J. (1990d). A principle for the formation of the spatial structure of cortical feature maps. *Proceedings of the National Academy of Sciences, USA*, 87:8345–8349.
- Obermayer, K., Sejnowski, T. J., and Blasdel, G. G. (1995). Neural pattern formation via a competitive Hebbian mechanism. *Behavioural Brain Research*, 66:161–167.
- O’Donovan, M. J. (1999). The origin of spontaneous activity in developing networks of the vertebrate nervous system. *Current Opinion in Neurobiology*, 9:94–104.
- Oja, E. (1982). A simplified neuron model as a principal component analyzer. *Journal of Mathematical Biology*, 15:267–273.
- Oja, E. (1989). Neural networks, principal components, and subspaces. *International Journal of Neural Systems*, 1:61–68.
- Oja, E., and Kaski, S., editors (1999). *Kohonen Maps*. Amsterdam: Elsevier.
- Oja, M., Kaski, S., and Kohonen, T. (2003). Bibliography of self-organizing map (SOM) papers: 1998-2001 addendum. *Neural Computing Surveys*, 3:1–156.
- O’Keefe, J., and Burgess, N. (1996). Geometric determinants of the place fields of hippocampal neurones. *Nature*, 381:425–428.
- O’Keefe, J., and Reece, M. (1993). Phase relationship between hippocampal place units and the hippocampal theta rhythm. *Hippocampus*, 3:317–330.
- Oksenberg, A., Shaffery, J. P., Marks, G. A., Speciale, S. G., Mihailoff, G., and Roffwarg, H. P. (1996). Rapid eye movement sleep deprivation in kittens amplifies LGN cell-size disparity induced by monocular deprivation. *Developmental Brain Research*, 97:51–61.
- Olshausen, B. A. (2003). Principles of image representation in visual cortex. In Chalupa, L. M., and Werner, J. S., editors, *The Visual Neurosciences*, 1603–1615. Cambridge, MA: MIT Press.
- Olshausen, B. A., Anderson, C. H., and Van Essen, D. C. (1995). A multiscale dynamic routing circuit for forming size- and position-invariant object representations. *Journal of Computational Neuroscience*, 2:45–62.
- Olshausen, B. A., Anderson, C. H., and Van Essen, D. C. (1996). A neurobiological model of visual attention and invariant pattern recognition based on dynamic routing of information. *The Journal of Neuroscience*, 13:4700–4719.
- Olshausen, B. A., and Field, D. J. (1997). Sparse coding with an overcomplete basis set: A strategy employed by V1?. *Vision Research*, 37:3311–3325.
- Olson, S. J., and Grossberg, S. (1998). A neural network model for the development of simple and complex cell receptive fields within cortical maps of orientation and ocular dominance. *Neural Networks*, 11:189–208.

- Oram, M. W., Wiener, M. C., Lestienne, R., and Richmond, B. J. (1999). Stochastic nature of precisely timed spike patterns in visual system neuronal responses. *Journal of Neurophysiology*, 81:3021–3033.
- O'Regan, J. K., and Noë, A. (2001). A sensorimotor account of vision and visual consciousness. *Behavioral and Brain Sciences*, 24:939–973.
- O'Reilly, R. C., and Munakata, Y. (2000). *Computational Explorations in Cognitive Neuroscience: Understanding the Mind by Simulating the Brain*. Cambridge, MA: MIT Press.
- Osan, R., and Ermentrout, B. (2002). Development of joint ocular dominance and orientation selectivity maps in a correlation-based neural network model. *Neurocomputing*, 44–46:561–566.
- O'Toole, A. J., Millward, R. B., and Anderson, J. A. (1988). A physical system approach to recognition memory for spatially transformed faces. *Neural Networks*, 1:179–199.
- O'Toole, B. I. (1979). Exposure-time and spatial-frequency effects in the tilt illusion. *Perception*, 8:557–564.
- Pallas, S. L., and Finlay, B. L. (1991). Compensation for population-size mismatches in the hamster retinotectal system: Alterations in the organization of retinal projections. *Visual Neuroscience*, 6:271–281.
- Palmer, S. E. (1999). *Vision Science: Photons to Phenomenology*. Cambridge, MA: MIT Press.
- Panchev, C., and Wermter, S. (2001). Hebbian spike-timing dependent self-organization in pulsed neural networks. In Rattay, F., editor, *World Congress on Neuroinformatics: Part II, Proceedings*, 378–385. Vienna: ARGESIM/ASIM-Verlag.
- Paradiso, M. A., Shimojo, S., and Nakayama, K. (1989). Subjective contours, tilt aftereffects, and visual cortical organization. *Vision Research*, 29:1205–1213.
- Parker, A. J., and Newsome, W. T. (1998). Sense and the single neuron: Probing the physiology of perception. *Annual Review of Neuroscience*, 21:227–277.
- Parker, D. B. (1982). Learning-logic. Invention Report S81-64, File 1, Office of Technology Licensing, Stanford University, Palo Alto, CA.
- Parks, T. E. (1980). Letter to the editor. *Perception*, 9:723.
- Pascalis, O., de Schonen, S., Morton, J., Deruelle, C., and Fabre-Grenet, M. (1995). Mother's face recognition by neonates: A replication and an extension. *Infant Behavior and Development*, 18:79–85.
- Pearson, J. C., Finkel, L. H., and Edelman, G. M. (1987). Plasticity in the organization of adult cortical maps: A computer simulation based on neuronal group selection. *The Journal of Neuroscience*, 7:4209–4223.
- Pei, X., Vidyasagar, T. R., Volgushev, M., and Creutzfeldt, O. D. (1994). Receptive field analysis and orientation selectivity of postsynaptic potentials of simple cells in cat visual cortex. *The Journal of Neuroscience*, 14:7130–7140.
- Peinado, A., Yuste, R., and Katz, L. C. (1993). Extensive dye-coupling between rat neocortical neurons during the period of circuit formation. *Neuron*, 14:103–114.
- Penn, A. A., and Shatz, C. J. (1999). Brain waves and brain wiring: The role of endogenous and sensory-driven neural activity in development. *Pediatric Research*, 45:447–458.
- Perrett, D. I. (1992). Organization and functions of cells responsive to faces in the temporal cortex. *Philosophical Transactions: Biological Sciences*, 335:23–30.
- Peterhans, E., von der Heydt, R., and Baumgartner, G. (1986). Neuronal responses to illusory contour stimuli reveal stages of visual cortical processing. In Pettigrew, J. D., Sander-son, K. J., and Levick, W. R., editors, *Visual Neuroscience*, 343–351. Cambridge, UK: Cambridge University Press.

- Petrov, Y. (2002). Disparity capture by flanking stimuli: A measure for the cooperative mechanism of stereopsis. *Vision Research*, 42:809–813.
- Petry, S., and Meyer, G. E., editors (1987). *The Perception of Illusory Contours*. Berlin: Springer.
- Pettet, M. W., and Gilbert, C. D. (1992). Dynamic changes in receptive-field size in cat primary visual cortex. *Proceedings of the National Academy of Sciences, USA*, 89:8366–8370.
- Pettet, M. W., McKee, S. P., and Grzywacz, N. M. (1998). Constraints on long range interactions mediating contour detection. *Vision Research*, 38:865–879.
- Pfeifer, R., and Scheier, C. (1997). Sensory-motor coordination: The metaphor and beyond. *Robotics and Autonomous Systems*, 20:157–178.
- Pfeifer, R., and Scheier, C. (1998). Representation in natural and artificial agents: An embodied cognitive science perspective. *Zeitschrift für Naturforschung C — A Journal of Biosciences*, 53:480–503.
- Pfleger, B., and Bonds, A. B. (1995). Dynamic differentiation of GABA<sub>A</sub>-sensitive influences on orientation selectivity of complex cells in the cat striate cortex. *Experimental Brain Research*, 104:81–88.
- Philipona, D., O'Regan, J. K., and Nadal, J.-P. (2003). Is there something out there? Inferring space from sensorimotor dependencies. *Neural Computation*, 15:2029–2050.
- Phillips, P. J., Wechsler, H., Huang, J., and Rauss, P. (1998). The FERET database and evaluation procedure for face recognition algorithms. *Image and Vision Computing*, 16:295–306.
- Piepbrock, C., and Obermayer, K. (2002). Cortical orientation map development from natural images: The role of cortical response amplification in V1. In Backhaus, W., editor, *Neuronal Coding of Perceptual Systems: Proceedings of the International School of Biophysics*, 161–168. Singapore: World Scientific.
- Piepbrock, C., Ritter, H., and Obermayer, K. (1996). Cortical map development driven by spontaneous retinal activity waves. In von der Malsburg, C., von Seelen, W., Vorbrüggen, J. C., and Sendhoff, B., editors, *Proceedings of the Sixth International Conference on Artificial Neural Networks*, Lecture Notes in Computer Science 1112, 427–432. Berlin: Springer.
- Pinsk, M. A., Doniger, G. M., and Kastner, S. (2004). Push–pull mechanism of selective attention in human extrastriate cortex. *Journal of Neurophysiology*, 92:622–629.
- Polat, U., Mizobe, K., Pettet, M. W., Kasamatsu, T., and Norcia, A. M. (1998). Collinear stimuli regulate visual responses depending on cell's contrast threshold. *Nature*, 391:580–584.
- Polat, U., Norcia, A. M., and Sagi, D. (1996). The pattern and functional significance of long-range interactions in human visual cortex. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Pollen, D. A. (1999). On the neural correlates of visual perception. *Cerebral Cortex*, 9:4–19.
- Pompeiano, O., Pompeiano, M., and Corvaja, N. (1995). Effects of sleep deprivation on the postnatal development of visual-deprived cells in the cat's lateral geniculate nucleus. *Archives Italiennes de Biologie*, 134:121–140.
- Prazdny, K. (1983). Illusory contours are not caused by simultaneous brightness contrast. *Perception and Psychophysics*, 34:403–404.
- Previc, F. H. (1990). Functional specialization in the lower and upper visual fields in humans: Its ecological origins and neurophysiological implications. *Behavioral and Brain Sciences*, 13:519–575.

- Prince, D. A., and Huguenard, J. R. (1988). Functional properties of neocortical neurons. In Rakic, P., and Singer, W., editors, *Neurobiology of Neocortex*, 153–176. Hoboken, NJ: Wiley.
- Prodöhl, C., Würtz, R. P., and von der Malsburg, C. (2003). Learning the gestalt rule of collinearity from object motion. *Neural Computation*, 15:1865–1896.
- Prut, Y., Vaadia, E., Bergman, H., Haalman, I., Slovlin, H., and Abeles, M. (1998). Spatiotemporal structure of cortical activity: Properties and behavioral relevance. *Journal of Neurophysiology*, 79:2857–2874.
- Puce, A., Allison, T., Gore, J. C., and McCarthy, G. (1995). Face-sensitive regions in human extrastriate cortex studied by functional MRI. *Journal of Neurophysiology*, 74:1192–1199.
- Purves, D. (1988). *Body and Brain: A Trophic Theory of Neural Connections*. Cambridge, MA: Harvard University Press.
- Purves, D., and Lichtman, J. W. (1985). *Principles of Neural Development*. Sunderland, MA: Sinauer.
- Pylyshyn, Z. W. (2000). Situating vision in the world. *Trends in Cognitive Sciences*, 4:197–207.
- Qin, Y.-L., McNaughton, B. L., Skaggs, W. E., and Barnes, C. A. (1997). Memory reprocessing in corticocortical and hippocampocortical neuronal ensembles. *Philosophical Transactions: Biological Sciences*, 352:1525–1533.
- Raizada, R. D. S., and Grossberg, S. (2001). Context-sensitive binding by the laminar circuits of V1 and V2: A unified model of perceptual grouping, attention, and orientation contrast. *Visual Cognition*, 8:431–466.
- Rakic, P. (1988). Specification of cerebral cortical areas. *Science*, 241:170–176.
- Rall, W. (1962). Theory of physiological properties of dendrites. *Annals of the New York Academy of Sciences*, 96:1071–1092.
- Rall, W. (1977). Core conductor theory and cable properties of neurons. In Kandel, E. R., Brookhart, J. M., and Mountcastle, V. B., editors, *The Handbook of Physiology, Section 1: The Nervous System, Vol. 1: Cellular Biology of Neurons*, 39–97. Bethesda, MD: American Physiological Society.
- Rall, W., and Agmon-Snir, H. (1998). Cable theory for dendritic neurons. In Koch, C., and Segev, I., editors, *Methods in Neuronal Modeling: From Ions to Networks*, 27–92. Cambridge, MA: MIT Press. Second edition.
- Ramoá, A. S., Mower, A. F., Liao, D., and Jafri, S. I. (2001). Suppression of cortical NMDA receptor function prevents development of orientation selectivity in the primary visual cortex. *The Journal of Neuroscience*, 21:4299–4309.
- Rao, R. P. N., and Ballard, D. H. (1995). Natural basis functions and topographic memory for face recognition. In *Proceedings of the 14th International Joint Conference on Artificial Intelligence*, 10–17. San Francisco: Kaufmann.
- Rao, R. P. N., and Ballard, D. H. (1997). Efficient encoding of natural time varying images produces oriented space-time receptive fields. Technical Report 97.4, Department of Computer Science, University of Rochester, Rochester, New York.
- Rao, R. P. N., Olshausen, B. A., and Lewicki, M. S., editors (2002). *Probabilistic Models of the Brain: Perception and Neural Function*. Cambridge, MA: MIT Press.
- Rao, S. C., Toth, L. J., and Sur, M. (1997). Optically imaged maps of orientation preference in primary visual cortex of cats and ferrets. *The Journal of Comparative Neurology*, 387:358–370.
- Rechtschaffen, A. (1998). Current perspectives on the function of sleep. *Perspectives in Biology and Medicine*, 41:359–390.

- Rector, D. M., Poe, G. R., Redgrave, P., and Harper, R. M. (1997). A miniature CCD video camera for high-sensitivity light measurements in freely behaving animals. *Journal of Neuroscience Methods*, 78:85–91.
- Redies, C., Crook, J. M., and Creutzfeldt, O. D. (1986). Neuronal responses to borders with and without luminance gradients in cat visual cortex and dorsal lateral geniculate nucleus. *Experimental Brain Research*, 61:469–481.
- Regehr, W. G., Delaney, K. R., and Tank, D. W. (1994). The role of presynaptic calcium in short-term enhancement at the hippocampal mossy fiber synapse. *The Journal of Neuroscience*, 14:523–537.
- Regier, T. (1996). *The Human Semantic Potential: Spatial Language and Constrained Connectionism*. Cambridge, MA: MIT Press.
- Rehn, M., and Lansner, A. (2004). Sequence memory with dynamical synapses. *Neurocomputing*, 58–60:271–278.
- Reinagel, P., and Zador, A. M. (1999). Natural scene statistics at the center of gaze. *Network: Computation in Neural Systems*, 10:1–10.
- Reitboeck, H. J., Stoecker, M., and Hahn, C. (1993). Object separation in dynamic neural networks. In *Proceedings of the IEEE International Conference on Neural Networks* (San Francisco, CA), 638–641. Piscataway, NJ: IEEE.
- Rensink, R. A., and Enns, J. T. (1998). Early completion of occluded objects. *Vision Research*, 38:2489–2505.
- Repp, B. H., and Penel, A. (2002). Auditory dominance in temporal processing: New evidence from synchronization with simultaneous visual and auditory sequences. *Journal of Experimental Psychology: Human Perception and Performance*, 28:1085–1099.
- Revow, M., Williams, C. K. I., and Hinton, G. E. (1995). Using generative models for handwritten digit recognition. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 18:592–606.
- Rieke, F., Warland, D., de Ruyter van Steveninck, R., and Bialek, W. (1997). *Spikes: Exploring the Neural Code*. Cambridge, MA: MIT Press.
- Riesenhuber, M., Bauer, H.-U., Brockmann, D., and Geisel, T. (1998). Breaking rotational symmetry in a self-organizing map model for orientation map development. *Neural Computation*, 10:717–730.
- Ringach, D. L. (2004). Mapping receptive fields in primary visual cortex. *The Journal of Physiology*, 558:717–728.
- Rinzel, J., and Ermentrout, B. (1998). Analysis of neural excitability and oscillations. In Koch, C., and Segev, I., editors, *Methods in Neuronal Modeling: From Ions to Networks*, 251–291. Cambridge, MA: MIT Press. Second edition.
- Ritter, H. (1991). Asymptotic level density for a class of vector quantization processes. *IEEE Transactions on Neural Networks*, 2:173–175.
- Ritter, H., Martinetz, T., and Schulten, K. J. (1992). *Neural Computation and Self-Organizing Maps: An Introduction*. Reading, MA: Addison-Wesley.
- Ritter, H., Obermayer, K., Schulten, K. J., and Rubner, J. (1991). Self-organizing maps and adaptive filters. In *Models of Neural Networks*, 281–306. Berlin: Springer.
- Robert, A. (1999). Lamination and within-area integration in the neocortex. Doctoral dissertation, Department of Cognitive Science, University of California at San Diego, San Diego, CA.
- Rochester, N., Holland, J. H., Haibt, L. H., and Duda, W. L. (1956). Tests on a cell assembly theory of the action of the brain, using a large digital computer. *IRE Transactions on Information Theory*, 2:80–93. Reprinted in Anderson and Rosenfeld (1988), 68–79.



- Rockel, A. J., Hiorns, R. W., and Powell, T. P. S. (1980). The basic uniformity in structure of the neocortex. *Brain*, 103:221–244.
- Rockland, K. S. (1985). Anatomical organization of primary visual cortex (area 17) in the ferret. *The Journal of Comparative Neurology*, 241:225–236.
- Rockland, K. S., Lund, J. S., and Humphrey, A. L. (1982). Anatomical binding of intrinsic connections in striate cortex of tree shrews (*Tupaia glis*). *The Journal of Comparative Neurology*, 209:41–58.
- Rodieck, R. W. (1965). Quantitative analysis of cat retinal ganglion cell response to visual stimuli. *Vision Research*, 5:583–601.
- Rodman, H. R. (1994). Development of inferior temporal cortex in the monkey. *Cerebral Cortex*, 4:484–498.
- Rodman, H. R., Skelly, J. P., and Gross, C. G. (1991). Stimulus selectivity and state dependence of activity in inferior temporal cortex of infant monkeys. *Proceedings of the National Academy of Sciences, USA*, 88:7572–7575.
- Rodrigues, J. S., and Almeida, L. B. (1990). Improving the learning speed in topological maps of patterns. In *Proceedings of the International Neural Networks Conference*, 813–816. Dordrecht, The Netherlands: Kluwer.
- Roffwarg, H. P., Muzio, J. N., and Dement, W. C. (1966). Ontogenetic development of the human sleep-dream cycle. *Science*, 152:604–619.
- Rojer, A. S., and Schwartz, E. L. (1990). Cat and monkey cortical columnar patterns modeled by bandpass-filtered 2D white noise. *Biological Cybernetics*, 62:381–391.
- Rolls, E. T. (1990). The representation of information in the temporal lobe visual cortical areas of macaques. In Eckmiller, R., editor, *Advanced Neural Computers*, 69–78. Amsterdam: Elsevier.
- Rolls, E. T. (1992). Neurophysiological mechanisms underlying face processing within and beyond the temporal cortical visual areas. *Philosophical Transactions: Biological Sciences*, 335:11–21.
- Rolls, E. T. (2000). Functions of the primate temporal lobe cortical visual areas in invariant visual object and face recognition. *Neuron*, 27:205–218.
- Rolls, E. T., Baylis, G. C., Hasselmo, M. E., and Nalwa, V. (1989). The effect of learning on the face selective responses of neurons in the cortex in the superior temporal sulcus of the monkey. *Experimental Brain Research*, 76:153–164.
- Rolls, E. T., and Milward, T. (2000). A model of invariant object recognition in the visual system: Learning rules, activation functions, lateral inhibition, and information-based performance measures. *Neural Computation*, 12:2547–2572.
- Roque Da Silva Filho, A. C. (1992). Investigation of a generalized version of Amari's continuous model for neural networks. Doctoral dissertation, School of Cognitive and Computing Sciences, University of Sussex, Brighton, UK.
- Rosen, D. J., Rumelhart, D. E., and Knudsen, E. I. (1995). A connectionist model of the owl's sound localization system. In Tesauro, G., Touretzky, D. S., and Leen, T. K., editors, *Advances in Neural Information Processing Systems 7*, 606–613. Cambridge, MA: MIT Press.
- Ross, W. D., Grossberg, S., and Mingolla, E. (2000). Visual cortical mechanisms of perceptual grouping: Interacting layers, networks, columns, and maps. *Neural Networks*, 13:571–588.
- Rotenberg, V. S. (1992). Sleep and memory. I: The influence of different sleep stages on memory. *Neuroscience & Biobehavioral Reviews*, 16:497–502.
- Roweis, S. T., and Saul, L. K. (2000). Nonlinear dimensionality reduction by locally linear embedding. *Science*, 290:2323–2326.

- Rowley, H. A., Baluja, S., and Kanade, T. (1998). Neural network-based face detection. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 20:23–38.
- Rubin, N., Nakayama, K., and Shapley, R. (1996). Enhanced perception of illusory contours in the lower versus upper visual hemifields. *Science*, 271:651–653.
- Ruf, B., and Schmitt, M. (1998). Self-organization of spiking neurons using action potential timing. *IEEE Transactions on Neural Networks*, 9:575–578.
- Rumelhart, D. E., Hinton, G. E., and Williams, R. J. (1986). Learning internal representations by error propagation. In Rumelhart, D. E., and McClelland, J. L., editors, *Parallel Distributed Processing: Explorations in the Microstructure of Cognition, Vol. 1: Foundations*, 318–362. Cambridge, MA: MIT Press.
- Ruthazer, E. S., and Stryker, M. P. (1996). The role of activity in the development of long-range horizontal connections in area 17 of the ferret. *The Journal of Neuroscience*, 16:7253–7269.
- Sabatini, S. P. (1996). Recurrent inhibition and clustered connectivity as a basis for Gabor-like receptive fields in the visual cortex. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Sabatini, S. P., Solari, F., and Secchi, L. (2004). A continuum-field model of visual cortex stimulus-driven behaviour: Emergent oscillations and coherence fields. *Neurocomputing*, 57:411–433.
- Sackett, G. P. (1966). Monkeys reared in isolation with pictures as visual input: Evidence for an innate releasing mechanism. *Science*, 154:1468–1473.
- Sackett, G. P. (1970). Unlearned responses, differential rearing, experiences, and the development of social attachments by rhesus monkeys. In Rosenblum, L. A., editor, *Primate Behavior: Developments in Field and Laboratory Research*, vol. 1, 111–140. San Diego, CA: Academic Press.
- Saito, D. N., Okada, T., Morita, Y., Yonekura, Y., and Sadato, N. (2003). Tactile-visual cross-modal shape matching: A functional MRI study. *Cognitive Brain Research*, 17:14–25.
- Sajda, P., and Finkel, L. H. (1992). A neural network model of object segmentation and feature binding in visual cortex. In *International Joint Conference on Neural Networks*, 43–48. Piscataway, NJ: IEEE.
- Sakamoto, S. (2004). Synaptic weight normalization effects for topographic mapping formation. *Neural Networks*, 17:1109–1120.
- Salzman, C. D., Britten, K. H., and Newsome, W. T. (1990). Cortical microstimulation influences perceptual judgements of motion direction. *Nature*, 346:174–177, Erratum 346:589.
- Sanger, T. D. (1989). Optimal unsupervised learning in a single-layer linear feedforward neural network. *Neural Networks*, 2:459–473.
- Saudargiene, A., Porr, B., and Wörgötter, F. (2004). How the shape of pre-and postsynaptic signals can influence STDP: A biophysical model. *Neural Computation*, 16:595–625.
- Saul, A. B., and Humphrey, A. L. (1992). Evidence of input from lagged cells in the lateral geniculate nucleus to simple cells in cortical area 17 of the cat. *Journal of Neurophysiology*, 68:1190–1208.
- Sceniak, M. P., Hawken, M. J., and Shapley, R. (2001). Visual spatial characterization of macaque V1 neurons. *Journal of Neurophysiology*, 85:1873–1887.
- Schaffer, J. D., Whitley, D., and Eshelman, L. J. (1992). Combinations of genetic algorithms and neural networks: A survey of the state of the art. In Whitley, D., and Schaffer, J., edi-

- tors, *Proceedings of the International Workshop on Combinations of Genetic Algorithms and Neural Networks*, 1–37. Los Alamitos, CA: IEEE Computer Society Press.
- Schmid, L. M., Rosa, M. G. P., and Calford, M. B. (1995). Retinal detachment induces massive immediate reorganization in visual cortex. *Neuroreport*, 6:1349–1353.
- Schmidt, K. E., Kim, D. S., Singer, W., Bonhoeffer, T., and Löwel, S. (1997). Functional specificity of long-range intrinsic and interhemispheric connections in the visual cortex of strabismic cats. *The Journal of Neuroscience*, 17:5480–5492.
- Schrater, P. R., Knill, D. C., and Simoncelli, E. P. (2001). Perceiving visual expansion without optic flow. *Nature*, 410:816–819.
- Schumann, F. (1900). Beiträge zur Analyse der Gesichtswahrnehmungen. Erste Abhandlung: Einige Beobachtungen über die Zusammenfassung von Gesichtseindrücken zu Einheiten [Contributions to the analysis of visual perceptions. First paper: Some observations on the grouping of visual impressions into wholes]. *Zeitschrift für Psychologie und Physiologie der Sinnesorgane*, 23:1–32.
- Schwark, H. D., and Jones, E. G. (1989). The distribution of intrinsic cortical axons in area 3b of cat primary somatosensory cortex. *Experimental Brain Research*, 78:501–513.
- Schyns, P. G., Goldstone, R. L., and Thibaut, J.-P. (1998). The development of features in object concepts. *Behavioral and Brain Sciences*, 21:1–54.
- Sclar, G., and Freeman, R. D. (1982). Orientation selectivity in the cat's striate cortex is invariant with stimulus contrast. *Experimental Brain Research*, 46:457–461.
- Sejnowski, T. J. (1995). Neural networks: Sleep and memory. *Current Biology*, 5:832–834.
- Sejnowski, T. J., and Rosenberg, C. R. (1987). Parallel networks that learn to pronounce English text. *Complex Systems*, 1:145–168.
- Sengpiel, F., and Kind, P. C. (2002). The role of activity in development of the visual system. *Current Biology*, 12:R818–R826.
- Sengpiel, F., Stawinski, P., and Bonhoeffer, T. (1999). Influence of experience on orientation maps in cat visual cortex. *Nature Neuroscience*, 2:727–732.
- Senn, W., Segev, I., and Tsodyks, M. (1998). Reading neuronal synchrony with depressing synapses. *Neural Computation*, 10:815–819.
- Senseman, D. M. (1996). High-speed optical imaging of afferent flow through rat olfactory bulb slices: Voltage-sensitive dye signals reveal periglomerular cell activity. *The Journal of Neuroscience*, 16:313–324.
- Sergent, J. (1989). Structural processing of faces. In Young, A. W., and Ellis, H. D., editors, *Handbook of Research on Face Processing*, 57–91. Amsterdam: Elsevier.
- Seung, H. S., and Lee, D. D. (2000). The manifold ways of perception. *Science*, 290:2268–2269.
- Seung, H. S., Lee, D. D., Reis, B. Y., and Tank, D. W. (2000). The autapse: A simple illustration of short-term analog memory storage by tuned synaptic feedback. *Journal of Computational Neuroscience*, 9:171–185.
- Sharma, J., Angelucci, A., and Sur, M. (2000). Induction of visual orientation modules in auditory cortex. *Nature*, 404:841–847.
- Shastri, L. (2002). Episodic memory and cortico-hippocampal interactions. *Trends in Cognitive Sciences*, 6:162–168.
- Shatz, C. J. (1990). Impulse activity and the patterning of connections during CNS development. *Neuron*, 5:745–756.
- Shatz, C. J. (1992). The developing brain. *Scientific American*, 267:61–67.
- Shatz, C. J. (1996). Emergence of order in visual system development. *Proceedings of the National Academy of Sciences, USA*, 93:602–608.

- Shatz, C. J., and Stryker, M. P. (1978). Ocular dominance in layer IV of the cat's visual cortex and the effects of monocular deprivation. *The Journal of Physiology*, 281:267–283.
- Shepherd, G. M. (2003). *The Synaptic Organization of the Brain*. Oxford, UK: Oxford University Press. Fifth edition.
- Sherman, S. M., and Guillery, R. W. (2001). *Exploring the Thalamus*. San Diego, CA: Academic Press.
- Sheth, B. R., Sharma, J., Rao, S. C., and Sur, M. (1996). Orientation maps of subjective contours in visual cortex. *Science*, 274:2110–2115.
- Shimojo, S., Kamitani, Y., and Nishida, S. (2001). Afterimage of perceptually filled-in surface. *Science*, 293:1677–1680.
- Shipley, T. F., and Kellman, P. J. (1992). Strength of visual interpolation depends on the ratio of physically specified to total edge length. *Perception and Psychophysics*, 52:97–106.
- Shipp, S., Blanton, M., and Zeki, S. (1998). A visuo-somatomotor pathway through superior parietal cortex in the macaque monkey: Cortical connections of areas V6 and V6A. *European Journal of Neuroscience*, 10:3171–3193.
- Shiu, L.-P., and Pashler, H. (1992). Improvement in line orientation discrimination is retinally local but dependent on cognitive set. *Perception and Psychophysics*, 52:582–588.
- Shmuel, A., and Grinvald, A. (1996). Functional organization for direction of motion and its relationship to orientation maps in cat area 18. *The Journal of Neuroscience*, 16:6945–6964.
- Shouno, H., and Kurata, K. (2001). Formation of a direction map by projection learning using Kohonen's self-organization map. *Biological Cybernetics*, 85:241–246.
- Shouval, H. Z. (1995). Formation and organization of receptive fields, with an input environment composed of natural scenes. Doctoral dissertation, Department of Physics, Brown University, Providence, RI.
- Shouval, H. Z., Goldberg, D. H., Jones, J. P., Beckerman, M., and Cooper, L. N. (2000). Structured long-range connections can provide a scaffold for orientation maps. *The Journal of Neuroscience*, 20:1119–1128.
- Shouval, H. Z., Intrator, N., and Cooper, L. N. (1997). BCM network develops orientation selectivity and ocular dominance in natural scene environment. *Vision Research*, 37:3339–3342.
- Shouval, H. Z., Intrator, N., Law, C. C., and Cooper, L. N. (1996). Effect of binocular cortical misalignment on ocular dominance and orientation selectivity. *Neural Computation*, 8:1021–1040.
- Siegel, J. M. (1999). The evolution of REM sleep. In Lydic, R., and Baghdoyan, H. A., editors, *Handbook of Behavioral State Control: Cellular and Molecular Mechanisms*, 87–100. Boca Raton, FL: CRC Press.
- Sigman, M., Cecchi, G. A., Gilbert, C. D., and Magnasco, M. O. (2001). On a common circle: Natural scenes and gestalt rules. *Proceedings of the National Academy of Sciences, USA*, 98:1935–1940.
- Sillito, A. M. (1979). Inhibitory mechanisms influencing complex cell orientation selectivity and their modification at high resting discharge. *The Journal of Physiology*, 289:33–53.
- Sillito, A. M., Jones, H. E., Gerstein, G. L., and West, D. C. (1994). Feature-linked synchronization of thalamic relay cell firing induced by feedback from the visual cortex. *Nature*, 369:479–482.
- Simion, F., Cassia, V. M., Turati, C., and Valenza, E. (2001). The origins of face perception: Specific versus non-specific mechanisms. *Infant and Child Development*, 10:59–66.
- Simion, F., Valenza, E., and Umiltà, C. (1998a). Mechanisms underlying face preference at birth. In Simion, F., and Butterworth, G., editors, *The Development of Sensory, Motor*

- and *Cognitive Capacities in Early Infancy: From Perception to Cognition*, 87–102. East Sussex, UK: Psychology Press.
- Simion, F., Valenza, E., Umiltà, C., and Dalla Barba, B. (1998b). Preferential orienting to faces in newborns: A temporal-nasal asymmetry. *Journal of Experimental Psychology: Human Perception and Performance*, 24:1399–1405.
- Simoncelli, E. P., and Olshausen, B. A. (2001). Natural image statistics and neural representation. *Annual Review of Neuroscience*, 24:1193–1216.
- Sincich, L. C., and Blasdel, G. G. (2001). Oriented axon projections in primary visual cortex of the monkey. *The Journal of Neuroscience*, 21:4416–4426.
- Singer, W. (1993). Synchronization of cortical activity and its putative role in information processing and learning. *Annual Review of Physiology*, 55:349–374.
- Singer, W. (1999). Neuronal synchrony: A versatile code for the definition of relations?. *Neuron*, 24:49–65.
- Singer, W., and Gray, C. M. (1995). Visual feature integration and the temporal correlation hypothesis. *Annual Review of Neuroscience*, 18:555–586.
- Singer, W., Gray, C. M., Engel, A. K., König, P., Artola, A., and Bröcher, S. (1990). Formation of cortical cell assemblies. In *The Brain*, vol. LV of *Cold Spring Harbor Symposia on Quantitative Biology*, 939–952. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Sirosh, J. (1995). A self-organizing neural network model of the primary visual cortex. Doctoral dissertation, Department of Computer Sciences, The University of Texas at Austin, Austin, TX. Technical Report AI95-237.
- Sirosh, J., and Miikkulainen, R. (1993). How lateral interaction develops in a self-organizing feature map. In *Proceedings of the IEEE International Conference on Neural Networks* (San Francisco, CA), 1360–1365. Piscataway, NJ: IEEE.
- Sirosh, J., and Miikkulainen, R. (1994a). Cooperative self-organization of afferent and lateral connections in cortical maps. *Biological Cybernetics*, 71:66–78.
- Sirosh, J., and Miikkulainen, R. (1994b). Modeling cortical plasticity based on adapting lateral interaction. In Bower, J. M., editor, *The Neurobiology of Computation: The Proceedings of the Third Annual Computation and Neural Systems Conference*, 305–310. Dordrecht, The Netherlands: Kluwer.
- Sirosh, J., and Miikkulainen, R. (1996a). A neural network model of topographic reorganization following cortical lesions. In *Computational Medicine, Public Health and Biotechnology: Building a Man in the Machine. Proceedings of the First World Congress*, vol. 5 of *Mathematical Biology and Medicine*. Singapore: World Scientific.
- Sirosh, J., and Miikkulainen, R. (1996b). Self-organization and functional role of lateral connections and multisize receptive fields in the primary visual cortex. *Neural Processing Letters*, 3:39–48.
- Sirosh, J., and Miikkulainen, R. (1997). Topographic receptive fields and patterned lateral interaction in a self-organizing model of the primary visual cortex. *Neural Computation*, 9:577–594.
- Sirosh, J., Miikkulainen, R., and Bednar, J. A. (1996a). Self-organization of orientation maps, lateral connections, and dynamic receptive fields in the primary visual cortex. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Sirosh, J., Miikkulainen, R., and Choe, Y., editors (1996b). *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.

- Slater, A. (1993). Visual perceptual abilities at birth: Implications for face perception. In de Boysson-Bardies, B., editor, *Developmental Neurocognition: Speech and Face Processing in the First Year of Life*, 125–134. Dordrecht, The Netherlands: Kluwer.
- Slater, A., and Johnson, S. P. (1998). Visual sensory and perceptual abilities of the newborn: Beyond the blooming, buzzing confusion. In Simion, F., and Butterworth, G., editors, *The Development of Sensory, Motor and Cognitive Capacities in Early Infancy: From Perception to Cognition*, 121–142. East Sussex, UK: Psychology Press.
- Slater, A., and Kirby, R. (1998). Innate and learned perceptual abilities in the newborn infant. *Experimental Brain Research*, 123:90–94.
- Slater, A., Morison, V., and Somers, M. (1988). Orientation discrimination and cortical function in the human newborn. *Perception*, 17:597–602.
- Smith, A. T., and Over, R. (1977). Orientation masking and the tilt illusion with subjective contours. *Perception*, 6:441–447.
- Smith, C. (1996). Sleep states, memory processes and synaptic plasticity. *Behavioural Brain Research*, 78:49–56.
- Snippe, H. P. (1996). Parameter extraction from population codes: A critical assessment. *Neural Computation*, 8:511–529.
- Sober, S. J., Stark, J. M., Yamasaki, D. S., and Lytton, W. W. (1997). Receptive field changes after strokelike cortical ablation: A role for activation dynamics. *Journal of Neurophysiology*, 78:3438–3443.
- Sohn, J.-W., Zhang, B.-T., and Kaang, B.-K. (1999). Temporal pattern recognition using a spiking neural network with delays. In *Proceedings of the International Joint Conference on Neural Networks*, 2590–2593. Piscataway, NJ: IEEE.
- Somers, D. C., Toth, L. J., Todorov, E., Rao, S. C., Kim, D.-S., Nelson, S. B., Siapas, A. G., and Sur, M. (1996). Variable gain control in local cortical circuitry supports context-dependent modulation by long-range connections. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Song, S., Miller, K. D., and Abbott, L. F. (2000). Competitive Hebbian learning through spike-timing-dependent synaptic plasticity. *Nature Neuroscience*, 3:919–926.
- Sporns, O., Tononi, G., and Edelman, G. E. (1991). Modeling perceptual grouping and figure-ground segregation by means of active reentrant connections. *Proceedings of the National Academy of Sciences, USA*, 88:129–33.
- Stanley, K. O., and Miikkulainen, R. (2002). Evolving neural networks through augmenting topologies. *Evolutionary Computation*, 10:99–127.
- Stein, B. E., and Meredith, M. A. (1993). *The Merging of the Senses*. Cambridge, MA: MIT Press.
- Stein, B. E., Meredith, M. A., Huneycutt, W. S., and McDade, L. (1989). Behavioral indices of multisensory integration: Orientation to visual cues is affected by auditory stimuli. *The Journal of Cognitive Neuroscience*, 1:12–24.
- Stellwagen, D., and Shatz, C. J. (2002). An instructive role for retinal waves in the development of retinogeniculate connectivity. *Neuron*, 33:357–367.
- Stemmler, M., Usher, M., and Niebur, E. (1995). Lateral interactions in primary visual cortex: A model bridging physiology and psychophysics. *Science*, 269:1877–1880.
- Steriade, M., Paré, D., Bouhassira, D., Deschênes, M., and Oakson, G. (1989). Phasic activation of lateral geniculate and perigeniculate thalamic neurons during sleep with pontogeniculo-occipital waves. *The Journal of Neuroscience*, 9:2215–2229.

- Stetter, M., Müller, A., and Lang, E. W. (1994). Neural network model for the coordinated formation of orientation preference and orientation selectivity maps. *Physical Review E*, 50:4167–4181.
- Stettler, D. D., Das, A., Bennett, J., and Gilbert, C. D. (2002). Lateral connectivity and contextual interactions in macaque primary visual cortex. *Neuron*, 36:739–750.
- Stevens, B., Tanner, S., and Fields, R. D. (1998). Control of myelination by specific patterns of neural impulses. *The Journal of Neuroscience*, 18:9303–9311.
- Strasburger, H., and Rentschler, I. (1996). Contrast-dependent dissociation of visual recognition and detection fields. *European Journal of Neuroscience*, 8:1787–1791.
- Stringer, S. M., and Rolls, E. T. (2002). Invariant object recognition in the visual system with novel views of 3D objects. *Neural Computation*, 14:2585–2596.
- Suenaga, H., and Ishikawa, M. (2000). Self-organizing map with a variable-size competitive layer. In Lee, S.-Y., editor, *Proceedings of the Seventh International Conference on Neural Information Processing*, 727–731.
- Sulston, J. E., and Horvitz, H. R. (1977). Post-embryonic cell lineages of the nematode, *Caenorhabditis elegans*. *Developmental Biology*, 56:110–156.
- Sur, M., Angelucci, A., and Sharma, J. (1999). Rewiring cortex: The role of patterned activity in development and plasticity of neocortical circuits. *Journal of Neurobiology*, 41:33–43.
- Sur, M., Garraghty, P. E., and Roe, A. W. (1988). Experimentally induced visual projections in auditory thalamus and cortex. *Science*, 242:1437–1441.
- Sur, M., and Leamey, C. A. (2001). Development and plasticity of cortical areas and networks. *Nature Reviews Neuroscience*, 2:251–262.
- Sutherland, N. S. (1961). Figural after-effects and apparent size. *Quarterly Journal of Psychology*, 13:222–228.
- Sutor, B., and Luhmann, H. J. (1995). Development of excitatory and inhibitory postsynaptic potentials in the rat neocortex. *Perspectives on Developmental Neurobiology*, 2:409–419.
- Sutton, G. G., Reggia, J. A., Armentrout, S. L., and D’Autrechy, C. L. (1994). Cortical map reorganization as a competitive process. *Neural Computation*, 6:1–13.
- Swindale, N. V. (1980). A model for the formation of ocular dominance stripes. *Proceedings of the Royal Society of London. Series B, Biological Sciences*, 215:243–264.
- Swindale, N. V. (1992). A model for the coordinated development of columnar systems in primate striate cortex. *Biological Cybernetics*, 66:217–230.
- Swindale, N. V. (1996). The development of topography in the visual cortex: A review of models. *Network: Computation in Neural Systems*, 7:161–247.
- Switkes, E., Mayer, M. J., and Sloan, J. A. (1978). Spatial frequency analysis of the visual environment: Anisotropy and the carpentered environment hypothesis. *Vision Research*, 18:1393–1399.
- Tanaka, S. (1990). Theory of self-organization of cortical maps: Mathematical framework. *Neural Networks*, 3:625–640.
- Tarr, M. J., and Gauthier, I. (2000). FFA: A flexible fusiform area for subordinate-level visual processing automatized by expertise. *Nature Neuroscience*, 3:764–769.
- Tavazoie, S. F., and Reid, R. C. (2000). Diverse receptive fields in the lateral geniculate nucleus during thalamocortical development. *Nature Neuroscience*, 3:608–616.
- Taylor, J. G., and Alavi, F. N. (1996). A basis for long-range inhibition across cortex. In Sirosh, J., Mikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.

- Tenenbaum, J. B., de Silva, V., and Langford, J. C. (2000). A global geometric framework for nonlinear dimensionality reduction. *Science*, 290:2319–2323.
- Terman, D., and Wang, D. (1995). Global competition and local cooperation in a network of neural oscillators. *Physica D*, 81:148–176.
- Thomas, H. (1965). Visual-fixation responses of infants to stimuli of varying complexity. *Child Development*, 36:629–638.
- Thompson, E., and Varela, F. J. (2001). Radical embodiment: Neural dynamics and consciousness. *Trends in Cognitive Sciences*, 5:418–425.
- Thompson, I. (1997). Cortical development: A role for spontaneous activity? *Current Biology*, 7:R324–R326.
- Thomson, A. M., and Deuchars, J. (1994). Temporal and spatial properties of local circuits in neocortex. *Trends in Neurosciences*, 17:119–126.
- Tiño, P., and Nabney, I. (2002). Hierarchical GTM: Constructing localized non-linear projection manifolds in a principled way. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 24:639–659.
- Tolhurst, D. J., and Thompson, P. G. (1975). Orientation illusions and aftereffects: Inhibition between channels. *Vision Research*, 15:967–972.
- Tonkes, B., Blair, A. D., and Wiles, J. (2000). Evolving learnable languages. In Solla, S. A., Leen, T. K., and Muller, K.-R., editors, *Advances in Neural Information Processing Systems 12*, 66–72. Cambridge, MA: MIT Press.
- Touretzky, D. S. (2002). The rodent navigation circuit. In Sharp, P. E., editor, *The Neural Basis of Navigation: Evidence from Single Cell Recording*, 217–233. Dordrecht, The Netherlands: Kluwer.
- Tovée, M. J. (1998). Face processing: Getting by with a little help from its friends. *Current Biology*, 8:R317–R320.
- Trappenberg, T. P. (2002). *Fundamentals of Computational Neuroscience*. Oxford, UK: Oxford University Press.
- Treves, A. (1997). On the perceptual structure of face space. *Biosystems*, 40:189–196.
- Troyer, T. W., Krukowski, A. E., Priebe, N. J., and Miller, K. D. (1998). Contrast-invariant orientation tuning in cat visual cortex: Thalamocortical input tuning and correlation-based intracortical connectivity. *The Journal of Neuroscience*, 18:5908–5927.
- Tsien, J. Z. (2000). Linking Hebb's coincidence-detection to memory formation. *Current Opinion in Neurobiology*, 10:266–273.
- Ts'o, D. Y., Frostig, R. D., Lieke, E. E., and Grinvald, A. (1990). Functional organization of primate visual cortex revealed by high resolution optical imaging. *Science*, 249:417–420.
- Ts'o, D. Y., Roe, A. W., and Gilbert, C. D. (2001). A hierarchy of the functional organization for color, form and disparity in primate visual area V2. *Vision Research*, 41:1333–1349.
- Tsodyks, M., Pawelzik, K., and Markram, H. (1998). Neural networks with dynamic synapses. *Neural Computation*, 10:821–835.
- Turney, P. D. (1996). How to shift bias: Lessons from the Baldwin effect. *Evolutionary Computation*, 4:271–295.
- Turrigiano, G. G. (1999). Homeostatic plasticity in neuronal networks: The more things change, the more they stay the same. *Trends in Neurosciences*, 22:221–227.
- Turrigiano, G. G., Leslie, K. R., Desai, N. S., Rutherford, L. C., and Nelson, S. B. (1998). Activity-dependent scaling of quantal amplitude in neocortical neurons. *Nature*, 391:892–896.
- Tversky, T., Geisler, W. S., and Perry, J. S. (2004). Contour grouping: Closure effects are explained by good continuation and proximity. *Vision Research*, 44:2769–2777.



- Tversky, T., and Miikkulainen, R. (2002). Modeling directional selectivity using self-organized delay-adaptation maps. *Neurocomputing*, 44–46:679–684.
- Ullman, S. (1976). Filling-in the gaps: The shape of subjective contours and a model for their generation. *Biological Cybernetics*, 25:1–6.
- Usher, M., and Donnelly, N. (1998). Visual synchrony affects binding and segmentation in perception. *Nature*, 394:179–182.
- Usher, M., Stemmler, M., and Niebur, E. (1996). The role of lateral connections in visual cortex: Dynamics and information processing. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Utgoff, P., and Mitchell, T. (1982). Acquisition of appropriate bias for inductive concept learning. In *Proceedings of the Second National Conference on Artificial Intelligence*, 414–417. Menlo Park, CA: AAAI Press.
- Vaadia, E., Haalman, I., Abeles, M., Bergman, H., Prut, Y., Slovin, H., and Aertsen, A. (1995). Dynamics of neuronal interactions in monkey cortex in relation to behavioral events. *Nature*, 373:515–518.
- Vaitkevicius, H., Karalius, M., Meskauskas, A., Sinius, J., and Sokolov, E. (1983). A model for the monocular line orientation analyzer. *Biological Cybernetics*, 48:139–147.
- Valentin, D., Abdi, H., O’Toole, A. J., and Cottrell, G. W. (1994). Connectionist models of face processing: A survey. *Pattern Recognition*, 27:1209–1230.
- Valenza, E., Simion, F., Cassia, V. M., and Umiltà, C. (1996). Face preference at birth. *Journal of Experimental Psychology: Human Perception and Performance*, 22:892–903.
- Valiant, L. G. (1994). *Circuits of the Mind*. Oxford, UK: Oxford University Press.
- van der Zwan, R., and Wenderoth, P. (1994). Psychophysical evidence for area V2 involvement in the reduction of subjective contour tilt aftereffects by binocular rivalry. *Visual Neuroscience*, 11:823–830.
- van der Zwan, R., and Wenderoth, P. (1995). Mechanisms of purely subjective contour tilt aftereffects. *Vision Research*, 35:2547–2557.
- Van Essen, D. C. (2003). Organization of visual areas in macaque and human cerebral cortex. In Chalupa, L. M., and Werner, J. S., editors, *The Visual Neurosciences*, 507–521. Cambridge, MA: MIT Press.
- Van Essen, D. C. (2004). Surface-based approaches to spatial localization and registration in primate cerebral cortex. *Neuroimage*, 23(Suppl.):S97–S107.
- Van Essen, D. C., Anderson, C. H., and Felleman, D. J. (1992). Information processing in the primate visual system: An integrated systems perspective. *Science*, 255:419–423.
- Van Horn, J. D., Grafton, S. T., Rockmore, D., and Gazzaniga, M. S. (2004). Sharing neuroimaging studies of human cognition. *Nature Neuroscience*, 7:473–481.
- van Vreeswijk, C., and Abbott, L. F. (1994). When inhibition not excitation synchronizes neural firing. *Journal of Computational Neuroscience*, 1:313–321.
- VanRullen, R., Delorme, A., and Thorpe, S. J. (2001). Feed-forward contour integration in primary visual cortex based on asynchronous spike propagation. *Neurocomputing*, 38–40:1003–1009.
- Vapnik, V., and Chervonenkis, A. (1971). On the uniform convergence of relative frequencies of events to their probabilities. *Theory of Probability and its Applications*, 16:264–280.
- Venter, J. C., et al. (2001). The sequence of the human genome. *Science*, 291:1304–1351.
- Vidyasagar, T. R. (1990). Pattern adaptation in cat visual cortex is a co-operative phenomenon. *Neuroscience*, 36:175–179.

- Vidyasagar, T. R., and Mueller, A. (1994). Function of GABA inhibition in specifying spatial frequency and orientation selectivities in cat striate cortex. *Experimental Brain Research*, 98:31–38.
- Viola, P., and Jones, M. (2004). Robust real-time object detection. *International Journal of Computer Vision*, 57:137–154.
- von der Heydt, R., and Peterhans, E. (1989). Mechanisms of contour perception in monkey visual cortex. I. Lines of pattern discontinuity. *The Journal of Neuroscience*, 9:1731–1748.
- von der Malsburg, C. (1973). Self-organization of orientation-sensitive cells in the striate cortex. *Kybernetik*, 15:85–100. Reprinted in Anderson and Rosenfeld (1988), 212–227.
- von der Malsburg, C. (1981). The correlation theory of brain function. Internal Report 81-2, Department of Neurobiology, Max-Planck-Institute for Biophysical Chemistry, Göttingen, Germany.
- von der Malsburg, C. (1986a). Am I thinking assemblies? In Palm, G., and Aertsen, A., editors, *Brain Theory: Proceedings of the First Trieste Meeting on Brain Theory*, 161–176. Berlin: Springer.
- von der Malsburg, C. (1986b). A neural cocktail-party processor. *Biological Cybernetics*, 54:29–40.
- von der Malsburg, C. (1987). Synaptic plasticity as basis of brain organization. In Changeux, J.-P., and Konishi, M., editors, *The Neural and Molecular Bases of Learning*, 411–432. Hoboken, NJ: Wiley.
- von der Malsburg, C. (1999). The what and why of binding: The modeler's perspective. *Neuron*, 24:95–104.
- von der Malsburg, C. (2003). Dynamic link architecture. In Arbib, M. A., editor, *The Handbook of Brain Theory and Neural Networks*, 365–368. Cambridge, MA: MIT Press. Second edition.
- von der Malsburg, C., and Buhmann, J. (1992). Sensory segmentation with coupled neural oscillators. *Biological Cybernetics*, 67:233–242.
- von der Malsburg, C., and Singer, W. (1988). Principles of cortical network organization. In Rakic, P., and Singer, W., editors, *Neurobiology of Neocortex*, 69–99. Hoboken, NJ: Wiley.
- von der Malsburg, C., and Willshaw, D. J. (1977). How to label nerve cells so that they can interconnect in an ordered fashion. *Proceedings of the National Academy of Sciences, USA*, 74:5176–5178.
- von Melchner, L., Pallas, S. L., and Sur, M. (2000). Visual behaviour mediated by retinal projections directed to the auditory pathway. *Nature*, 404:871–876.
- Waleszczyk, W. J., Wang, C., Young, J. M., Burke, W., Calford, M. B., and Dreher, B. (2003). Laminar differences in plasticity in area 17 following retinal lesions in kittens or adult cats. *European Journal of Neuroscience*, 17:2351–2368.
- Wallace, M. T., McHaffie, J. G., and Stein, B. E. (1997). Visual response properties and visuotopic representation in the newborn monkey superior colliculus. *Journal of Neurophysiology*, 78:2732–2741.
- Wallis, G. M. (1994). Neural mechanisms underlying processing in the visual areas of the occipital and temporal lobes. Doctoral dissertation, Corpus Christi College, Oxford University, Oxford, UK.
- Wallis, G. M., and Rolls, E. T. (1997). Invariant face and object recognition in the visual system. *Progress in Neurobiology*, 51:167–194.
- Walsh, V., and Cowey, A. (2000). Transcranial magnetic stimulation and cognitive neuroscience. *Nature Reviews Neuroscience*, 1:73–79.

- Walton, G. E., Armstrong, E. S., and Bower, T. G. R. (1997). Faces as forms in the world of the newborn. *Infant Behavior and Development*, 20:537–543.
- Walton, G. E., and Bower, T. G. R. (1993). Newborns form “prototypes” in less than 1 minute. *Psychological Science*, 4:203–205.
- Wandell, B. A. (1995). *Foundations of Vision*. Sunderland, MA: Sinauer.
- Wang, D. (1995). Emergent synchrony in locally coupled neural oscillators. *IEEE Transactions on Neural Networks*, 6:941–948.
- Wang, D. (1996). Synchronous oscillations based on lateral connections. In Sirosh, J., Mikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Wang, D. (1999). Relaxation oscillators and networks. In Webster, J. G., editor, *Wiley Encyclopedia of Electrical and Electronics Engineering*, 396–405. Hoboken, NJ: Wiley.
- Wang, D. (2000). On connectedness: A solution based on oscillatory correlation. *Neural Computation*, 12:131–139.
- Wang, D., and Brown, G. J. (1999). Separation of speech from interfering sounds based on oscillatory correlation. *IEEE Transactions on Neural Networks*, 10:684–697.
- Wang, G., Tanaka, K., and Tanifuji, M. (1996). Optical imaging of functional organization in the monkey inferotemporal cortex. *Science*, 272:1665–1668.
- Wang, X.-J. (2001). Synaptic reverberation underlying mnemonic persistent activity. *Trends in Neurosciences*, 24:455–463.
- Ware, C., and Mitchell, D. E. (1974). The spatial selectivity of the tilt aftereffect. *Vision Research*, 14:735–737.
- Watt, R. J., and Phillips, W. A. (2000). The function of dynamic grouping in vision. *Trends in Cognitive Sciences*, 4:447–454.
- Weber, C. (2001). Self-organization of orientation maps, lateral connections, and dynamic receptive fields in the primary visual cortex. In *Proceedings of the International Conference on Artificial Neural Networks*, Lecture Notes in Computer Science 2130, 1147–1152. Berlin: Springer.
- Webster, M. A., and MacLin, O. H. (1999). Figural aftereffects in the perception of faces. *Psychonomic Bulletin and Review*, 6:647–653.
- Wehrhahn, C., and Westheimer, G. (1993). Temporal asynchrony interferes with vernier acuity. *Visual Neuroscience*, 10:13–19.
- Weiss, Y., Edelman, S., and Fahle, M. (1993). Models of perceptual learning in vernier hyperacuity. *Neural Computation*, 5:695–718.
- Weitzel, L., Kopecz, K., Spengler, C., Eckhorn, R., and Reitboeck, H. J. (1997). Contour segmentation with recurrent neural networks of pulse-coding neurons. In *Proceedings of the 7th International Conference on Computer Analysis of Images and Patterns*, 337–344. Berlin: Springer.
- Weliky, M., Bosking, W. H., and Fitzpatrick, D. (1996). A systematic map of direction preference in primary visual cortex. *Nature*, 379:725–728.
- Weliky, M., Kandler, K., Fitzpatrick, D., and Katz, L. C. (1995). Patterns of excitation and inhibition evoked by horizontal connections in visual cortex share a common relationship to orientation columns. *Neuron*, 15:541–552.
- Weliky, M., and Katz, L. C. (1997). Disruption of orientation tuning in visual cortex by artificially correlated neuronal activity. *Nature*, 386:680–685.
- Wenderoth, P., and Johnstone, S. (1988). The different mechanisms of the direct and indirect tilt illusions. *Vision Research*, 28:301–312.

- Weng, J., McClelland, J. L., Pentland, A., Sporns, O., Stockman, I., Sur, M., and Thelen, E. (2001). Autonomous mental development by robots and animals. *Science*, 291:599–600.
- Werbos, P. J. (1974). Beyond regression: New tools for prediction and analysis in the behavioral sciences. Doctoral dissertation, Department of Applied Mathematics, Harvard University, Cambridge, MA.
- Wersing, H., Steil, J. J., and Ritter, H. (2001). A competitive layer model for feature binding and segmentation. *Neural Computation*, 13:357–387.
- Westheimer, G. (1990). Simultaneous orientation contrast for lines in the human fovea. *Vision Research*, 30:1913–1921.
- White, E. L. (1989). *Cortical Circuits: Synaptic Organization of the Cerebral Cortex — Structure, Function, and Theory*. Basel, Switzerland: Birkhäuser.
- White, L. E., Bosking, W. H., Weliky, M., and Fitzpatrick, D. (1996). Direction selectivity and horizontal connections in layers 2/3 of ferret primary visual cortex (V1). In *Society for Neuroscience Abstracts*, vol. 22, 1610. Washington, DC: Society for Neuroscience.
- White, L. E., Bosking, W. H., Williams, S. M., and Fitzpatrick, D. (1999). Maps of central visual space in ferret V1 and V2 lack matching inputs from the two eyes. *The Journal of Neuroscience*, 19:7089–7099.
- White, L. E., Coppola, D. M., and Fitzpatrick, D. (2001). The contribution of sensory experience to the maturation of orientation selectivity in ferret visual cortex. *Nature*, 411:1049–1052.
- White, L. E., and Fitzpatrick, D. (2003). Dark-rearing prevents the development of direction selectivity in ferret visual cortex. In *Society for Neuroscience Abstracts*, Program No. 567.12. Washington, DC: Society for Neuroscience.
- Widrow, B., and Hoff, M. E. (1960). Adaptive switching circuits. In *1960 IRE WESCON Convention Record*, Part 4, 96–104. New York: IRE. Reprinted in Anderson and Rosenfeld (1988), 126–134.
- Wiesel, T. N. (1982). Postnatal development of the visual cortex and the influence of the environment. *Nature*, 299:583–591.
- Wilkinson, R. A., Garris, M. D., and Geist, J. (1993). Machine-assisted human classification of segmented characters for OCR testing and training. In D’Amato, D. P., editor, *Character Recognition Technologies, Proceedings of SPIE 1906*, 208–217. Bellingham, WA: SPIE.
- Willmore, B., and Tolhurst, D. J. (2001). Characterizing the sparseness of neural codes. *Network: Computation in Neural Systems*, 12:255–270.
- Willshaw, D. J., and von der Malsburg, C. (1976). How patterned neural connections can be set up by self-organization. *Proceedings of the Royal Society of London. Series B, Biological Sciences*, 194:431–445.
- Willshaw, D. J., and von der Malsburg, C. (1979). A marker induction mechanism for the establishment of ordered neural mappings: Its application to the retinotectal problem. *Philosophical Transactions of the Royal Society of London. Series B, Biological Sciences*, 287:203–243.
- Wilson, H. R., and Cowan, J. D. (1972). Excitatory and inhibitory interactions in localized populations of model neurons. *Biophysical Journal*, 12:1–24.
- Wilson, H. R., and Humanski, R. (1993). Spatial frequency adaptation and contrast gain control. *Vision Research*, 33:1133–1149.
- Wilson, M. A., and McNaughton, B. L. (1994). Reactivation of hippocampal ensemble memories during sleep. *Science*, 265:676–679.
- Wimbauer, S., Wenisch, O. G., Miller, K. D., and van Hemmen, J. L. (1997a). Development of spatiotemporal receptive fields of simple cells: I. Model formulation. *Biological Cybernetics*, 77:453–461.

- Wimbauer, S., Wenisch, O. G., van Hemmen, J. L., and Miller, K. D. (1997b). Development of spatiotemporal receptive fields of simple cells: II. Simulation and analysis. *Biological Cybernetics*, 77:463–477.
- Wiskott, L., and Sejnowski, T. J. (1998). Constrained optimization for neural map formation: A unifying framework for weight growth and normalization. *Neural Computation*, 10:671–716.
- Wiskott, L., and von der Malsburg, C. (1996). Face recognition by dynamic link matching. In Sirosh, J., Miikkulainen, R., and Choe, Y., editors, *Lateral Interactions in the Cortex: Structure and Function*. Austin, TX: The UTCS Neural Networks Research Group. Electronic book, ISBN 0-9647060-0-8, <http://nn.cs.utexas.edu/web-pubs/htmlbook96>.
- Wolfe, J., and Palmer, L. A. (1998). Temporal diversity in the lateral geniculate nucleus of cat. *Visual Neuroscience*, 15:653–675.
- Wolfe, J. M. (1984). Short test flashes produce large tilt aftereffects. *Vision Research*, 24:1959–1964.
- Wong, R. O. L. (1999). Retinal waves and visual system development. *Annual Review of Neuroscience*, 22:29–47.
- Wong, R. O. L., Meister, M., and Shatz, C. J. (1993). Transient period of correlated bursting activity during development of the mammalian retina. *Neuron*, 11:923–938.
- Wong, S. T., and Koslow, S. H. (2001). Human brain program research progress in bioinformatics/neuroinformatics. *Journal of the American Medical Informatics Association*, 8:103–104.
- Wu, S., Amari, S., and Nakahara, H. (2002). Population coding and decoding in a neural field: A computational study. *Neural Computation*, 14:999–1026.
- Wurtz, R. H., Yamasaki, D. S., Duffy, C. J., and Roy, J. P. (1990). Functional specialization for visual motion processing in primate cerebral cortex. In *The Brain*, vol. LV of *Cold Spring Harbor Symposia on Quantitative Biology*, 717–727. Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Xiao, Y., Wang, Y., and Felleman, D. J. (2003). A spatially organized representation of color in macaque cortical area V2. *Nature*, 421:535–539.
- Xu, L., and Oja, E. (1990). Adding top-down expectation into the learning procedure of self-organizing maps. In *International Joint Conference on Neural Networks* (Washington, DC), vol. II, 531–534. Hillsdale, NJ: Erlbaum.
- Yaeger, L. S., Webb, B. J., and Lyon, R. F. (1998). Combining neural networks and context-driven search for online, printed handwriting recognition in the NEWTON. *AI Magazine*, 19:73–89.
- Yang, M.-H., Kriegman, D., and Ahuja, N. (2002). Detecting faces in images: A survey. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 24:34–58.
- Yao, X. (1999). Evolving artificial neural networks. *Proceedings of the IEEE*, 87:1423–1447.
- Yen, S.-C., and Finkel, L. H. (1997). Identification of salient contours in cluttered images. In *Proceedings of IEEE Computer Society Conference on Computer Vision and Pattern Recognition*, 273–279. Los Alamitos, CA: IEEE Computer Society Press.
- Yen, S.-C., and Finkel, L. H. (1998). Extraction of perceptually salient contours by striate cortical networks. *Vision Research*, 38:719–741.
- Yilmaz, A., and Shah, M. (2002). Automatic feature detection and pose recovery for faces. In *Proceedings of the Fifth Asian Conference on Computer Vision*, 284–289.
- Yu, Y., and Choe, Y. (2004). Angular disinhibition effect in a modified Poggendorff illusion. In Forbus, K. D., Gentner, D., and Regier, T., editors, *Proceedings of the 26th Annual Conference of the Cognitive Science Society*, 1500–1505. Hillsdale, NJ: Erlbaum.

- Yu, Y., Yamauchi, T., and Choe, Y. (2004). Explaining low-level brightness-contrast illusions using disinhibition. In *Biologically Inspired Approaches to Advanced Information Technology*, Lecture Notes in Computer Science 3141, 166–175. Berlin: Springer.
- Yuille, A. L., Kammen, D. M., and Cohen, D. S. (1989). Quadrature and the development of orientation selective cortical cells by Hebb rules. *Biological Cybernetics*, 61:183–194.
- Yuille, A. L., Kolodny, J. A., and Lee, C. W. (1996). Dimension reduction, generalized deformable models and the development of ocularity and orientation. *Neural Networks*, 9:309–319.
- Yuste, R., Nelson, D. A., Rubin, W. W., and Katz, L. C. (1995). Neuronal domains in developing neocortex: Mechanisms of coactivation. *Neuron*, 14:7–17.
- Zador, A. M., and Pearlmuter, B. A. (1996). VC dimension of an integrate-and-fire neuron model. *Neural Computation*, 8:611–624.
- Zemel, R. S., Dayan, P., and Pouget, A. (1998). Probabilistic interpretation of population codes. *Neural Computation*, 10:403–430.
- Zepeda, A., Sengpiel, F., Guagnelli, M. A., Vaca, L., and Arias, C. (2004). Functional reorganization of visual cortex maps after ischemic lesions is accompanied by changes in expression of cytoskeletal proteins and NMDA and GABA<sub>A</sub> receptor subunits. *The Journal of Neuroscience*, 24:1812–1821.
- Zhang, L. I., Tao, H. W., Holt, C. E., Harris, W. A., and Poo, M.-M. (1998). A critical window for cooperation and competition among developing retinotectal synapses. *Nature*, 395:37–44.
- Zhao, L., and Chubb, C. (2001). The size-tuning of the face-distortion after-effect. *Vision Research*, 41:2979–2994.
- Zhou, Y.-D., and Fuster, J. M. (2000). Visuo-tactile cross-modal associations in cortical somatosensory cells. *Proceedings of the National Academy of Sciences, USA*, 97:9777–9782.
- Ziemke, T. (1999). Rethinking grounding. In Riegler, A., Peschl, M., and von Stein, A., editors, *Understanding Representation in the Cognitive Sciences: Does Representation Need Reality?*, 177–199. Dordrecht, The Netherlands: Kluwer.
- Zucker, R. S. (1989). Short-term synaptic plasticity. *Annual Review of Neuroscience*, 12:13–31.
- Zucker, S. W. (1995). Perceptual grouping. In Arbib, M. A., editor, *The Handbook of Brain Theory and Neural Networks*, 725–727. Cambridge, MA: MIT Press. First edition.