

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

Computational Maps in the Visual Cortex

February 6, 2005

Springer

Berlin Heidelberg New York

Hong Kong London

Milan Paris Tokyo

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., Steppel, 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., Horwitz, 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 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.
- Mastrorade, 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.
- 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_A-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.
- Ramo, 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.
- Shiple, 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_A 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.