

Curriculum Vitae
Edward M. Hubbard

Assistant Professor
Educational Psychology
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Education

- 2004 Ph.D. Psychology and Cognitive Science
University of California, San Diego
Thesis Advisors: Professor V.S. Ramachandran
and Professor Geoffrey M. Boynton
- 2001 M.A. Experimental Psychology
University of California, San Diego
Thesis Advisor: Professor V. S. Ramachandran
- 1998 B.A. Cognitive Science
University of California, Berkeley

Professional Experience

- April 2014 – Present: Neuroscience Training Program Faculty Member, University of Wisconsin–Madison.
- August 2012 – Present: Assistant Professor, Educational Psychology and Waisman Center, University of Wisconsin–Madison
- February 2011 – July 2012: Postdoctoral Affiliate of Vanderbilt Kennedy Center for Research on Human Development, Vanderbilt University.
- October 2008 – July 2012: Post–doctoral fellow: Professor Bruce McCandliss, Department of Psychology and Human Development, Vanderbilt University.
- July 2007 – Present: Consultant: Learnimation Corporation, CEO Sarah Manning, New York, NY.
- November 2004 – September 2008: NUMBRA Post–doctoral fellow. Professor Stanislas Dehaene. INSERM (French equivalent of NIH) Unité 562 “Cognitive Neuroimaging Unit.”
- August 2000 – October 2004: Graduate Research Assistant, Professors V.S. Ramachandran and G.M. Boynton, University of California, San Diego, and Salk Institute for Biological Studies.
- August 1999 – August 2000: Graduate Research Assistant, Professor V. S. Ramachandran, Department of Psychology, University of California, San Diego.
- January 1999 – August 1999: Post–B.A. Research Assistant, Professor Joseph J. Campos, Department of Psychology, University of California, Berkeley.
- January 1998 – May 1999: Undergraduate and Post–B.A. Research Assistant, Professor Stephen E. Palmer, Department of Psychology, University of California, Berkeley.

Awards and Honors

- September 2014: Highly Commended Book Award Winner in the Psychiatry Category for *The Oxford Handbook of Synesthesia* (Simner, J. & **Hubbard, E.M.** Eds.). British Medical Association.
- January 2013 – January 2014: Madison Teaching and Learning Excellence (MTLE) Faculty Fellow (\$4500 to improve undergrad teaching).
- September 2004: Fyssen Foundation Post–Doctoral Scholarship (2 years, €44,000, Declined).
- May 2001 – May 2004: NIMH Pre–Doctoral Fellowship “The Neural Basis of Number-Color Synesthesia” 1 F31 MH63585 \$75,473.00
- June – July 2001: Fellow, Summer Institute in Cognitive Neuroscience, Dartmouth College, Hanover, NH.
- June 2000 – May 2001: Geckler Graduate Student Stipend (Competitive Award) \$10,722.23
- November 2000, 2002, 2003: Departmental Travel and Research Awards

Books

- Simner, J. & **Hubbard, E.M.** (Eds; 2013). *The Oxford Handbook of Synaesthesia*. Oxford, UK: Oxford University Press. ISBN 978–0199603329.

Peer–Reviewed Articles

- Matthews, P.G. & **Hubbard, E.M.** (in press, 2016). Making space for spatial proportions. *Journal of Learning Disabilities*.
- Hubbard, E.M.**, Matthews, P.G. & Samek, A. (2016). Using online compound interest tools to improve financial literacy. *Journal of Economic Education*, 47(2):106-120. DOI:10.1080/00220485.2016.1146097
- Matthews, P.M., Lewis, M.R. & **Hubbard, E.M.** (2016). Individual differences in nonsymbolic ratio processing predict symbolic math performance. *Psychological Science*, 27(2):191-202. doi:10.1177/0956797615617799
- Simner, J., Carmichael, D.A., **Hubbard, E.M.**, Morris, Z. & Lawrie, S.M. (2015). Higher rates of white matter hyperintensities compatible with the radiological profile of multiple sclerosis within self-referred synaesthete populations. *Neurocase*. 21(3):322-330. doi:10.1080/13554794.2014.892625
- Viarouge, A., **Hubbard, E.M.** & Dehaene, S. (2014). Which spatial reference frames are critical for the SNARC effect? *Quarterly Journal of Experimental Psychology*. 67(8):1484-1499. (doi:10.1080/17470218.2014.897358)
- Oberman, L., **Hubbard, E.M.** & McCleery, J.P. (2014). Associative learning alone is insufficient for the evolution and maintenance of the human mirror neuron system. *Behavioral and Brain Sciences*. 37(2): 212 – 213 (doi: 10.1017/S0140525X13002422).
- Viarouge, A., **Hubbard, E.M.** & McCandliss, B.D. (2014). The cognitive mechanisms of the SNARC effect: an individual differences approach. *PLOS One*. 9(4): e95756 (doi:10.1371/journal.pone.0095756).
- Oberman, L.M., McCleery, J.P., **Hubbard, E.M.**, Bernier, R., Wiersema, J.R. Raymaekers, R. & Pineda, J.A. (2013). Developmental changes in mu suppression to observed and executed actions in autism spectrum disorders. *Social Cognitive and Affective Neuroscience*. 8(3): 300–304 (doi:10.1093/scan/nsr097).
- Hubbard, E.M.**, Brang, D. and Ramachandran, V.S. (2011). The cross–activation theory at 10. *Journal of Neuropsychology*. 5(2):152–177 (doi:10.1111/j.1748–6653.2011.02014)
- Viarouge, A., **Hubbard, E. M.**, Dehaene, S. & Sackur, J. (2010). Number line compression and the illusory perception of random numbers. *Experimental Psychology*. 57(6): 446–454. (doi:10.1027/1618–3169/a000055)
- Brang, D., **Hubbard, E.M.**, Coulson, S., Huang, M. & Ramachandran, V.S. (2010). Magnetoencephalography reveals early activation of V4 in grapheme–color synesthesia. *Neuroimage*. 53(1):268–274. (doi:10.1016/j.neuroimage.2010.06.008).
- Williams, L.E., Ramachandran, V.S., **Hubbard, E.M.**, Braff, D.L. & Light, G.A. (2010). Superior size–weight illusion performance in patients with schizophrenia: Evidence for deficits in forward models and multisensory integration. *Schizophrenia Research*. 121(1–3):101–106. (doi:10.1016/j.schres.2009.10.021).
- Berteletti, I., **Hubbard, E.M.** & Zorzi, M. (2010). Implicit versus explicit interference effects in a number–color synesthete. *Cortex*. 46(2): 170–177 (doi:10.1016/j.cortex.2008.12.009)
- Hubbard, E.M.**, Ranzini, M., Piazza, M. & Dehaene, S. (2009). What information is critical to elicit interference in number–form synesthesia? *Cortex: Special Issue on sequence–form synaesthesia*. 45(10):1200–1216. (doi:10.1016/j.cortex.2009.06.011)

- Ranzini, M., Piazza, M., Dehaene, S. & **Hubbard, E.M.** (2009). Neural mechanisms of attentional shifts due to irrelevant spatial and numerical cues. *Neuropsychologia*, **47**(12): 2615–2624. (doi:10.1016/j.neuropsychologia.2009.05.011)
- Knops, A., Thirion, B., **Hubbard, E.M.**, Michel, V. & Dehaene, S. (2009). Recruitment of an area involved in eye movements during mental arithmetic. *Science*, **324**(5934):1583–1585. (doi:10.1126/science.1171599)
- Hubbard, E. M.**, Diester, I., Cantlon, J. F., Ansari, D. van Opstal, F. & Troiani, V. (2008). The evolution of numerical cognition: From number neurons to linguistic quantifiers. *Journal of Neuroscience*. **28**(46):11819–11824.
- Hubbard, E. M.** (2008). Synaesthesia: The sounds of moving patterns. *Current Biology*, **18**(15): R657–R659.
- Hubbard, E.M.** (2007). A real red letter day. *Nature Neuroscience*. **10**(6):671–672.
- Hubbard, E.M.** (2007). Neurophysiology of synesthesia. *Current Psychiatry Reports*. **9**(3): 193–199.
- Simner, J. & **Hubbard, E.M.** (2006). Variants of synaesthesia interact in cognitive tasks: Evidence for implicit associations and late connectivity in cross-talk theories. *Neuroscience*. **143**(3):805–814.
- Thirion, B., Duchesnay, E., **Hubbard, E.M.**, Dubois, J., Poline, J.–B., Lebihan, D. & Dehaene, S. (2006). Inverse retinotopy: Inferring the visual content of images from brain activation patterns. *Neuroimage*. **33**(4):1104–1116.
- Hubbard, E.M.**, Manohar, S. & Ramachandran, V.S. (2006). Contrast affects the strength of synesthetic colors. *Cortex: Special Issue on Synesthesia*, **42**(2): 184–194.
- Hubbard, E.M.** & Ramachandran, V.S. (2005). Neurocognitive mechanisms of synesthesia. *Neuron*, **48**(3): 509–520.
- Hubbard, E.M.**, Piazza, M., Pinel, P. & Dehaene, S. (2005b). Interactions between number and space in parietal cortex. *Nature Reviews Neuroscience*, **6**(6): 435–448.
- Hubbard, E.M.**, Arman, A.C., Ramachandran, V.S. & Boynton, G.M. (2005a). Individual differences among grapheme–color synesthetes: Brain–behavior correlations. *Neuron*, **45**(6): 975–985.
- Oberman, L.M., **Hubbard, E.M.**, McCleery, J.P., Altschuler, E.L., Ramachandran, V.S. & Pineda, J.A. (2005) EEG Evidence for Mirror Neuron dysfunction in autism. *Cognitive Brain Research*, **24**(2): 190–198.
- Hubbard, E.M.** & Ramachandran, V.S. (2004). The size–weight illusion, emulation, and the cerebellum. *Behavioral and Brain Sciences*, **27**(3): 407–408.
- Ramachandran, V.S. & **Hubbard, E.M.** (2003). The phenomenology of synaesthesia. *Journal of Consciousness Studies*, **10**(8): 49–57.
- Hubbard, E.M.** & Ramachandran, V.S. (2003). Refining the experimental lever: A reply to Shannon and Pribram. *Journal of Consciousness Studies*, **9**(3):77–84.
- Hubbard, E.M.** (2003). A discussion and review of Uttal (2001) *The New Phrenology*. *Cognitive Science Online*, **1**: 22–33. <http://cogsci-online.ucsd.edu/1/1-3.pdf>
- Ramachandran, V.S. & **Hubbard, E.M.** (2001b) Synaesthesia: A window into perception, thought and language. *Journal of Consciousness Studies*. **8**(12): 3–34.
- Ramachandran, V.S & **Hubbard, E.M.** (2001a). Psychophysical investigations into the neural basis of synesthesia. *Proceedings of the Royal Society, B*, **268**(1470): 979–983.
- Anderson, D. I., **Hubbard, E.M.**, Campos, J. J., Barbu–Roth, M. A., Witherington, D. & Hertenstein, M. (2000) Probabilistic epigenesis, experience, and psychological development in infancy. *Infancy*, **1**(2): 245–251.
- Campos, J. J., Anderson, D. I., Barbu–Roth, M.A, **Hubbard, E.M.**, Hertenstein, M. & Witherington, D. (2000) Travel Broadens the Mind. *Infancy*, **1**(2): 149–219.

Manuscripts submitted, under revision, and in preparation

- Toomarian, E. & **Hubbard, E.M.** (under review). The fractions SNARC revisited: Holistic and componential processing of fractions on the mental number line. *Quarterly Journal of Experimental Psychology*
- Binzak, J.V., Matthews, P.G. & **Hubbard, E.M.** (under revision). No calculation necessary: Accessing rational magnitudes through fraction notation.

Book Chapters

- Hubbard, E.M.** & Viarouge, A (in press, 2016). Basic numerical abilities and mathematical achievement: A cognitive neuroscience perspective. In P. Barraza, V. Figueroa & P. Lacerna. *Neuroscience and Education: New Ideas for old Challenges*.
- Lewis, M.R., Matthews, P.M. & **Hubbard, E.M.** (2015). Neurocognitive Architectures and the Nonsymbolic Foundations of Fractions Understanding. In D.B. Berch, D.C. Geary, and K.M. Koepke (Eds.) *Development of Mathematical Cognition-Neural Substrates and Genetic Influences*. (p. 141-160) Elsevier. ISBN: 978-0128018712.
- Hubbard, E.M.**, Brang, D. & Ramachandran, V.S. (2014). The cross-activation theory at ten. In M. José De Cordoba, D. Riccò & S. Day (eds.). *Synaesthesia: Theoretical, Artistic and Scientific Foundations*, Granada, Spain, July 2014, pp. 176-196. Print Edition, ISBN: 978-84-939054-6-0, eBook Edition, ISBN: 978-84-939054-9-1.
- Hubbard, E.M.** (2013). Synaesthesia and Functional Imaging. In J. Simner. & **E.M. Hubbard** (Eds). *The Oxford Handbook of Synaesthesia*. Oxford, UK: Oxford University Press. ISBN 9780199603329 (HB).
- Simner, J. & **Hubbard, E.M.** (2013). Synaesthesia in School-aged Children. In J. Simner. & **E.M. Hubbard** (Eds). *The Oxford Handbook of Synaesthesia*. Oxford, UK: Oxford University Press. ISBN 9780199603329 (HB).
- Hubbard, E.M.** (2013). Synesthesia [1000 word entry]. In H. Pashler (Ed.) *Encyclopedia of the Mind*. (p. 725–727) Thousand Oaks, CA. SAGE Reference.
- Hubbard, E.M.**, Brang, D. & Ramachandran, V.S. (2012) Diez años de la teoría de la interactivación" in M. José De Córdoba & Dina Riccò (Eds.) *Sinestesia: Los Fundamentos Teóricos, Artísticos y Científicos*. Granada: Ediciones Fundación Internacional Artecittà. ISBN–13: 978–84–939054–1–5.
- Hubbard, E.M.**, Piazza, M., Pinel, P. & Dehaene, S. (2009). Numerical and spatial intuitions: A role for posterior parietal cortex? In L. Tommasi, L. Nadel and M.A. Peterson (Eds.) *Cognitive Biology: Evolutionary and Developmental Perspectives on Mind, Brain and Behavior*. (pp. 221–246). Cambridge, MA: MIT Press
- Ramachandran, V.S. & **Hubbard, E.M.** (2006). Can the study of synesthesia help to explain the emergence of qualia, metaphor, language and abstract thought? In L. van Hemmen & T.J. Sejnowski (Eds.) *23 Problems in Systems Neuroscience*. (pp. 432–473) New York, NY: Oxford University Press
- Ramachandran, V.S. & **Hubbard, E.M.** (2005). The emergence of the human mind: Some clues from synesthesia. In L. Robertson & N. Sagiv (Eds.) *Synesthesia: A Cognitive Neuroscience Perspective*. (pp. 147–190) New York, NY: Oxford University Press.
- Ramachandran, V.S. & **Hubbard, E.M.** (2004). What can neuroscience teach us about human nature and the potential for change? *Aspen Foundation Symposium: The Internet and the University*. (pp. 15–33). Boulder, CO: Educause.
- Ramachandran, V.S., **Hubbard, E.M.** & Butcher, P.A. (2004). Synesthesia, cross-activation and the foundations of neuroepistemology. In G. Calvert, C. Spence & B. Stein (Eds.) *Handbook of Multisensory Processes*. (pp. 867–883). Cambridge, MA: MIT Press.

Diffusion of Scientific Knowledge

- Ramachandran, V.S. & **Hubbard, E.M.** (2006b). Hearing colors, tasting shapes. *Scientific American Special Issue: Secrets of the Senses*. 76–83 (October, 2006; updated from Ramachandran & Hubbard, 2003).
- Ramachandran, V.S. & **Hubbard, E.M.** (2006a). La synesthésie ou la confusion des sens [Synesthesia, or the confusion of the senses]. *Cerveau et Psycho*.72–77 (March, 2006; updated and translated from Ramachandran & Hubbard, 2003).
- Hubbard, E.M.** (2005) L'étrange monde du synesthète [The strange world of the synesthete]. *Médecine et Enfance*. 667–674 (December, 2005).
- Ramachandran, V.S. & **Hubbard, E.M.** (2005b) Hearing colors, tasting shapes. *Scientific American Mind*. 16–23 (October, 2005; updated from Ramachandran & Hubbard, 2003).
- Ramachandran, V.S. & **Hubbard, E.M.** (2005a). Hearing colors, tasting shapes. Reprinted in Axelrod, R.B., Cooper, C.R., Warriner, A.M. *Reading Critically, Writing Well: A Reader and Guide*, 7th edition, (436–452) New York: Bedford, St. Martin's Press.
- Ramachandran, V.S. & **Hubbard, E.M.** (2003). Hearing colors, tasting shapes. *Scientific American*.52–59 (May, 2003).

Conference Organizing Responsibilities

Organizing Board/Committee

Governing Board Member: Mathematical Cognition Learning Society: 2016 - Present

Secretary/Treasurer: Brain, Neurosciences, and Education SIG, American Education Research Association: 2014-2016.

Board: American Synesthesia Association: 2011–Present

Program Committee: American Synesthesia Association 2002 – Present.

Scientific Program Committee (2012, February): IV International Conference on Synaesthesia, Art and Science, Almeria, Spain

Organizing Committee: Mitchell, K., Corvin, A., Graf, I., **Hubbard, E.M.** and Polleux, F. (2011, April). Wiring the Brain: From genetic to neural networks. Dublin, Ireland.

Organizing Committee: de Cordoba, M.–J., Ricco, D., Day, S. and **Hubbard, E.M.** (2009, May). III International Congress on Synaesthesia, Art and Science, Granada, Spain.

Co–host with Randolph Blake (2010, October) 8th Annual Meeting of the American Synesthesia Association. Nashville, TN.

Organizing Committee: Mitchell, K., Corvin, A., Graf, I., **Hubbard, E.M.** and Polleux, F. (2009, May). Wiring the Brain: From genetic to neural networks. Limerick, Ireland.

Scientific Program Committee (2007, April): II International Conference on Art and Synesthesia, Granada Spain

Co–host with V.S. Ramachandran (2002, May). 2nd Annual Meeting of the American Synesthesia Association. San Diego, CA

Symposium Chair

Symposium co–chair: **Hubbard, E.M.** & Rosenberg–Lee, M. (2013, April): Contributions of Basic Cognitive Processes to School–Based Mathematics Learning: Uncovering the Neural Pathways. American Education Research Association, San Francisco, CA.

Nano–Symposium co–chair: Rosenberg–Lee, M. & **Hubbard, E.M.** (2012, October): Development of Numerical Cognition. Society for Neuroscience, New Orleans, LA.

Symposium Co–Chair: **Hubbard, E.M.** and Troiani, V. (2008, November). The evolution of numerical cognition: From number neurons to linguistic quantifiers. Society for Neuroscience, Washington, D.C.

Symposium Co–Chair: Sagiv, N. & **Hubbard, E.M.** (2002, April). The cognitive neuroscience of synesthesia. Ninth Annual meeting of the Cognitive Neuroscience Society. San Francisco, CA.

Invited Talks

Association for Psychological Science, Invited Symposium “Frontiers in Educational Neuroscience” (May 28, 2016). Understanding Fractions: A Case Study in Educational Neuroscience.

Temple Institute for Learning & Education Sciences (April 13, 2016). Understanding Fractions: A Case Study in Educational Neuroscience.

2015 Educational Neuroscience Conference, University of Nebraska-Lincoln (October 16, 2015). Understanding Fractions: A Case Study in Educational Neuroscience.

Amsterdam Brain and Cognition (ABC) Summer School on Multisensory Integration and Synesthesia (June 26, 2015). Developing and Decoding Synesthesia

Department of Educational Psychology, University of Nebraska-Lincoln (April 10, 2015). Linking Education and Neuroscience: The Foundations of a New Field.

Royal Netherlands Academy of Arts and Sciences (March 20, 2015). Decoding the Impact of Synesthesia on Perception, Learning and Memory.

Oberlin Synesthesia Symposium, Keynote Lecture, Oberlin College (March 13, 2015). Hearing Colors, Tasting Shapes: Synesthesia as a Window into Human Nature.

Communication Arts Colloquium Series, University of Wisconsin–Madison (May 8, 2014). Linking Education and Neuroscience: The Foundations of a New Field.

- Neuroscience and Public Policy Seminar Series, University of Wisconsin–Madison (April 12, 2014). Linking Education and Neuroscience: The Foundations of a New Field.
- Waisman Early Childhood Seminar Series, University of Wisconsin–Madison (April 8, 2014). Linking Education and Neuroscience: The Foundations of a New Field.
- Doctoral Research Program, University of Wisconsin–Madison (October 10, 2013). Linking Education and Neuroscience: The Foundations of a New Field.
- Cognitive and Systems Neuroscience Laboratory, Stanford University (April 29, 2013). On the Genesis of Exact Number Ideas: How Education Builds Brain Circuits for Exact Number.
- Department of Psychology, University of Wisconsin–Madison. (April 4, 2013). Integration of quantities, symbols and space in parietal cortex: Implications for education.
- DELTA Center, University of Iowa (April 6, 2012). Synaesthesia as a window into human nature.
- Waisman Center, University of Wisconsin–Madison (March 1, 2012). Integration of quantities, symbols and space in parietal cortex: Implications for education.
- Department of Psychology, Neuroscience and Behaviour, McMaster University (January 6, 2012). Integration of quantities, symbols and space in parietal cortex: Implications for education.
- Department of Psychology, Neuroscience and Behaviour, McMaster University (January 5, 2012). Synesthesia as a window into human nature.
- Department of Educational Psychology, University of Wisconsin–Madison (December 14, 2011). Integration of quantities, symbols and space in parietal cortex: Implications for education.
- Department of Psychology, Birkbeck College, London, England (November 28, 2011). On the Origins of Human–Specific Numerical Abilities.
- American Synesthesia Association, Keynote Lecture, U.C. San Diego (October 15, 2011). The cross–activation theory at ten: Substantial progress, future challenges.
- U.K. Synaesthesia Association, Keynote Lecture, University of East London (March 26, 2011). The cross–activation theory at ten: Substantial progress, future challenges.
- U.K. Synaesthesia Association, Public Lecture, University of East London (March 25, 2011). Synesthesia as a window into human nature.
- Department of Cognitive Science, Case Western Reserve University, Cleveland, OH (April 17, 2010). Number lines: From synesthesia to education and back.
- Department of Cognitive Science, Case Western Reserve University, Cleveland, OH (April 16, 2010). Synesthesia as cross–activation between brain maps: A window into human nature.
- Department of Psychology, Sussex University, Bristol, England (January 28, 2010). How the study of synesthesia sheds light on basic cognitive and perceptual processes.
- Department of Psychology, University College London, London, England (January 26, 2010). How the study of synesthesia sheds light on basic cognitive and perceptual processes.
- John B. Pierce laboratory, Yale University (November 3, 2009). How the study of synesthesia sheds light on basic cognitive and perceptual processes.
- Department of Cognitive Science, Case Western Reserve University, Cleveland, Ohio (May 11, 2009). Cognitive Neuroscience of Mathematical Intuitions. Workshop on “Mathematics as an Emergent Phenomenon”.
- Department of Psychology, University of Bern, Bern, Switzerland (September 18, 2008). Behavioral and neuroimaging investigations of synesthesia.
- Department of Psychology, University of Milan, Milan, Italy (June 12, 2008). Neural mechanisms underlying mappings between numbers and space.
- Center for Mind/Brain Sciences, University of Trento, Italy (June 11, 2008). Neural mechanisms of synesthesia.
- Center for Mind/Brain Sciences, University of Trento, Italy (June 9, 2008). Neural mechanisms underlying mappings between numbers and space.
- Laboratoire Psychologie de la Perception [Perceptual Psychology Laboratory], Paris, France (May 22, 2008). Neural mechanisms of synesthesia.
- Stanford Cognitive & Systems Neuroscience Lab, Stanford University School of Medicine (April 18, 2008). Neural mechanisms underlying mappings between numbers and space.
- Ecole des Hautes Etudes en Sciences Sociales [School for Advanced Studies in Social Sciences], Paris, France (January 29, 2008). Les bases cérébrales de la synesthésie [The cerebral basis of synesthesia]

- Department of Cognitive Science, Case Western Reserve University, Cleveland, Ohio (January 4, 2008). Neural mechanisms underlying mappings between numbers and space.
- Maastricht Brain Imaging Center, Maastricht, The Netherlands. (October 5, 2007). Neural mechanisms of synesthesia.
- Duke University, Center for Cognitive Neuroscience (May 9, 2007). Neural mechanisms subserving the mental number line.
- Brunel University, Department of Psychology (March 20, 2007). Neural mechanisms subserving the mental number line.
- University of Cambridge, Centre for Neuroscience in Education (February 27, 2007). Neural mechanisms subserving the mental number line.
- University College London, Numeracy and Literacy Series. (February 13, 2007). Neural mechanisms subserving the mental number line.
- European M1 Course in Neuroscience "Neocortex: Computation, Architecture and Development", Ecole Normale Supérieure, Lyon. (January 23, 2007) Anatomically Constrained Cross-Activation: A Grand Unified Theory of Synesthesia. Day long course on synesthesia.
- Hanover Medical School, 2nd International Conference on Synaesthesia (December 1–3, 2006). Individual differences among synaesthetes: Phenomenological, behavioral and neuroimaging measures.
- University College London, Institute of Cognitive Neuroscience (May 27, 2006). Neurocognitive Mechanisms of Synaesthesia. Part of a workshop on the Cognitive Neuroscience of Synaesthesia.
- Department of Psychology, University of Ghent, Belgium (February 6, 2006). Individual differences among grapheme–color synaesthetes: Psychophysical and neuroimaging investigations
- Department of Psychology, Louvain la Neuve, Belgium (November 22, 2005). Des différences individus entre synesthetes : Corrélations entre données comportementale et IRMf [Given in French]
- L'Institut des Sciences Cognitives, Lyon France (November 10, 2005). Individual differences among grapheme–color synaesthetes: Psychophysical and neuroimaging investigations
- University of Almeria, Spain (July 25, 2005). Perceptual and neuronal mechanisms of synesthesia. *First International Congress on Synesthesia and Art.*
- University College London, Department of Psychology (February 22, 2005). Individual differences among grapheme–color synaesthetes: Psychophysical and neuroimaging investigations.
- University of Texas, Houston Medical Center (September 7, 2004). Psychophysical and neuroimaging investigations of synesthesia.
- UCLA Brain Mapping Seminar (April 23, 2003). Different forms of synesthesia may arise from cross-activation at different stages of numerical processing.
- INSERM Unité 562 (March 10, 2003). "Higher" and "lower" forms of synaesthesia arise at different stages of numerical processing.

Recent Conference Presentations (since 2012)

- Matthews, P. G., Meng, R., Toomarian, E. Y. & **Hubbard, E.M.** (August, 2016). The Relational SNARC: Spatial Representation of Nonsymbolic Ratios? Paper to be included in Proceedings of the 38th Annual Conference of the Cognitive Science Society. Philadelphia, PA: Cognitive Science Society.
- Binzak, J. V. & **Hubbard, E.M.** (July, 2016). Symbolic encoding and magnitude processing during decimals & fractions comparisons. Paper presented at the 4th Annual Midwest Meeting on Mathematical Thinking, Madison, WI.
- Meng, R., Matthews, P. G., Toomarian, E. Y. & **Hubbard, E.M.** (July, 2016). The relational SNARC: Spatial representation of nonsymbolic ratios? Paper presented at the 4th Annual Midwest Meeting on Mathematical Thinking, Madison, WI.
- Toomarian, E. Y. & **Hubbard, E.M.** (July, 2016). Individual differences in spatial representations of fractions relate to formal math achievement. Paper presented at the 4th Annual Midwest Meeting on Mathematical Thinking, Madison, WI.
- Toomarian, E.Y. & **Hubbard, E.M.** (April 2016). Individual Differences in Spatial Representations of Fractions Relate to Formal Math Achievement. Poster presented at the 2016 Annual meeting of the Cognitive Neuroscience Society, New York, NY.
- Toomarian, E.Y., Lewis, M.R., Binzak, J.V. & **Hubbard, E.M.** (October, 2015). Grounding symbolic fractions in the ratio processing system: A developmental fMRI-A study. Society for Neuroscience Meeting. Chicago, IL.

- Gosavi, R. Meyering, E. Rose, N. **Hubbard, E.M.** & Postle, B.R. (October, 2015). Decoding grapheme-color synesthesia using multivariate pattern analysis. Society for Neuroscience Meeting. Chicago, IL.
- Gosavi, R. Meyering, E. Rose, N. Postle, B.R. & **Hubbard, E.M.** (October, 2015). Decoding Grapheme-Color Synesthesia. American Synesthesia Association, Coral Gables, FL.
- Hubbard, E.M.**, Murphy, A.D. & Rogers, T.T. (August, 2015). Beyond Magnitude: How Math Expertise Guides Number Representation. 3rd Annual Midwest Meeting on Mathematical Thinking. Minneapolis, MN.
- Toomarian, E.Y. & **Hubbard, E.M.** (August, 2015). Fractions on the Mental Number Line: How to Reverse the SNARC. 3rd Annual Midwest Meeting on Mathematical Thinking. Minneapolis, MN.
- Binzak, J.V. & **Hubbard, E.M.** (August, 2015). Accessing Rational Magnitudes Through Fractions Notation. 3rd Annual Midwest Meeting on Mathematical Thinking. Minneapolis, MN.
- Murphy, A.D., Rogers, T.T., **Hubbard, E.M.**, Brower, A. (August, 2015). Beyond Magnitude: How Math Expertise Guides Number Representation. Cognitive Science Society Annual Meeting, Pasadena, CA.
- Lewis, M. & **Hubbard, E.M.** (April, 2015). A Neurocognitive Model of Fractions Learning. Symposium "Fractions Learning: One Subject, Multiple Perspectives" (Chairs, P.G. Matthews & C.C. Williams) American Education Research Association (AERA), Chicago, IL.
- Toomarian, E.Y. & **Hubbard, E.M.** (April, 2015). Fractions on the Mental Number Line: How to Reverse the SNARC. American Education Research Association (AERA), Chicago, IL.
- Hubbard, E.M.** Day, D.T., Tran, C.T., Hathaway, J.C., George, G.C. and Siepmann, C. (April, 2015). The Multisensory (AV) Representation of Number. Cognitive Neuroscience Society Meeting, San Francisco, CA.
- Lewis, M.R., Toomarian, E.Y. & **Hubbard, E.M.** (April, 2015). Representation of symbolic fractions recruits circuits tuned to nonsymbolic ratio magnitude. Cognitive Neuroscience Society Meeting, San Francisco, CA.
- Toomarian, E.Y. & **Hubbard, E.M.** (April, 2015). The Impact on Stimulus-Induced Processing Strategies on Symbolic Fraction Representations. Cognitive Neuroscience Society Meeting, San Francisco, CA.
- Hubbard, E.M.**, Mattarella-Micke, A., Viarouge, A. & McCandliss, B.D. (November, 2014) On the Genesis of Exact Number Ideas: How Education Builds Brain Circuits for Exact Number. International Mind, Brain and Education Society (IMBES), Dallas, TX.
- Lewis, M.R., Matthews, P.G. & **Hubbard, E.M.** (July, 2014). The perceptual roots of fraction knowledge: A neurocognitive approach. 2nd Annual Midwest Meeting on Mathematical Thinking. Madison, WI.
- Hubbard, E.M.** (July, 2014). The Multisensory Representation of Number. 2nd Annual Midwest Meeting on Mathematical Thinking. Madison, WI.
- Toomarian, E.Y. & **Hubbard, E.M.** (July, 2014). Stimulus-Induced Processing Strategies Impact Symbolic Fraction Representations. 2nd Annual Midwest Meeting on Mathematical Thinking. Madison, WI.
- Ziols, R., Matthews, P.G., Lewis, M.R., Toomarian, E.Y. & **Hubbard, E.M.** (July, 2014). Refining fraction constructs: An exploratory study of preference and generalization. 2nd Annual Midwest Meeting on Mathematical Thinking. Madison, WI.
- Lewis, M., Matthews, P.G. & **Hubbard, E.M.** (July, 2014). The Neurocognitive Roots of Fraction Knowledge. Cognitive Science Society, Quebec City, QB, Canada.
- Hubbard, E.M.** (May, 2014). Neural mechanisms underlying the building of links between perceptual and symbolic representations of number. NICHD Math Cognition Conference, Washington, DC.
- Lewis, M., Matthews, P.G. & **Hubbard, E.M.** (May, 2014). The "Rational Brain System" and Fraction Learning. NICHD Math Cognition Conference, Washington, DC.
- Hubbard, E.M.** & McCandliss, B.D. (June, 2013). On the genesis of exact number ideas: How education builds brain circuits for exact number. Jean Piaget Society Meeting, Chicago, IL.
- Hubbard, E. M.**, Viarouge, A. & McCandliss, B.D. (April, 2013). Developmental changes in approximate number system (ANS) acuity drive the construction of neural systems for number symbols. American Education Research Association, San Francisco, CA.
- Hubbard, E. M.** & McCandliss, B.D. (2012, October). Progressive and regressive developmental changes in the IPS for number symbols. Society for Neuroscience, New Orleans, LA.

Teaching Experience

Instructor – UW–Madison

Mind, Brain and Education (created; undergrad survey): Spring 2013; Fall 2013; Spring 2014, Fall 2014; Fall 2015
 Graduate Seminar in Research in Educational Psychology I (grad seminar): Fall 2013; Fall 2014; Fall 2015
 Developmental Cognitive Neuroscience (grad seminar): Spring 2013; Spring 2014; Spring 2015; Spring 2016
 Exploring the Number Sense (undergrad seminar, with Percival Matthews): Fall 2012

Instructor – UC San Diego

General Psychology: Cognitive Foundations (lower division): Summer 2003; Summer 2004
 Psi Chi Seminar Series (lower division): Fall 2003 to Spring 2004 (three consecutive quarters).

Teaching Assistant – UC San Diego

Brain Damage and Mental Function (upper division): Fall 2000; Summer 2001; Summer 2002; Fall 2002
 Introduction to Neuropsychology (upper division): Summer 2001; Summer 2002
 Introduction to Cognitive Psychology (upper division): Winter 2002; Summer 2004
 General Psychology: Cognitive Foundations (lower division): Winter 2000; Spring 2004
 Introduction to Sensation and Perception (upper division): Summer 2000; Spring 2003
 The Logic of Perception (upper division): Fall 2001
 Introduction to Statistics (lower division): Winter 2001; Winter 2004

Reader – UC Berkeley

Cognitive Neuroscience (upper division): Fall 1998
 Introduction to Mind and Language (upper division): Spring 1999

Mentoring

Post-Doctoral Fellow

Mark R. Lewis (5/2013 – 10/2014) Director of Research and Planning, Normandale Community College
 Laura C. Gibson (2/2015 – 1/2016)

PhD Students

Elizabeth Y. Toomarian (9/2013 – Present)
 Radhika Gosavi (9/2014 – Present)
 Zachary Grulke (9/2014 – Present)
 John Binzak (9/2014 – Present)

PhD Rotation Students

Leigh Ann Leabo (Rehab. Psych. Masters Student; 1/2014 – 5/2014)
 Caitlin Murphy (Neurophysiology PhD Program, 10/2014 – 12/2014)
 Andrew Merluzzi (Neuroscience and Public Policy PhD Program, 11/2014 – 1/2015)

Thesis Committees

Elizabeth Y. Toomarian (Master's Thesis and Preliminary Examination, Chair)
 Radhika Gosavi (Master's Thesis Proposal, Chair)
 John Binzak (Master's Thesis Proposal, Chair)
 Matthew J. Hirshberg (Preliminary Examination)
 April D. Murphy (Preliminary Examination)

Undergraduate Research Assistants

Christina Tran (9/2012 – 5/2014)^{§ * †}
 Danielle Day (9/2012 – 5/2015)^{* †}
 Abigail Zellner (9/2012 – 5/2016)^{* †}
 Jennifer Hathaway (9/2013 – 5/2016)^{§ * †}
 Brittany Seidl (9/2013 – 5/2014)
 Xiao Yang (9/2013 – 5/2014)
 Aaron Meusch (9/2013 – Present)^{*}
 Dakota Pawlak (9/2013 – 5/2016)
 Taylor Shiff (9/2014 – 5/2015)[§]
 Grace George (9/2014 – Present)^{§ * †}
 Cooper Siepman (1/2014 – 5/2016)^{*}
 Austin Petermann (6/2014 – 5/2015)
 McKenna Splett (Summer, 2014)[†]
 Evan Smith (9/2014 – Present)^{*}
 Becky Liu (9/2014 – Present)^{* †}
 Rob Shaver (9/2014 – 5/2015)

Madeline Krahn (1/2015 – 5/2016)
 Ellie Port (1/2015 – 5/2016)
 Brody Fitzpatrick (1/2015 – 5/2106)^{*}
 Anjali Thakrar (9/2015 – 5/2016)
 Carolyn Heal (9/2015 – 5/2016)
 Cara Lee (9/2015 – 5/2016)
 Kymberly Sickle (9/2015 – 5/2016)
 Kimberly Crow (9/2015 – Present)[§]
 Maiyer Vang (9/2015 – 5/2016)[§]
 Nina Vakil (9/2015 – Present)[§]

§ = Undergraduate Research Scholar

* = Completed Bio 152 Project

† = Awarded Welton/Hilldale Fellowship

University Service

January 2014 – Present: UW-Madison Faculty Senate Representative/Alternate, Department of Educational Psychology.

August 2012 – Present: UW-Madison Education and Educational Services (EES) Certificate Program Steering Committee Member (Chuck Kalish, Chair; Hubbard, Acting Chair 9/2014-5/2016)

December 2012 – Present: UW-Madison Education and Neuroscience Initiative Committee Member (Cheryl Hanley–Maxwell, Chair)

August 2012 – January 2013: Faculty Affairs Committee, University of Wisconsin–Madison (Chuck Kalish, Chair).

August 2010 – October 2011: Conte Center Science Outreach Advisory Board, Vanderbilt University

August 2002 – June 2003: Admissions Representative, Department of Psychology, University of California, San Diego (elected by graduate students).

August 2001 – June 2002: Graduate Student Representative, Department of Psychology, University of California, San Diego (elected by graduate students).

August 2000 – July 2001: Colloquium Representative, Department of Psychology, University of California, San Diego (elected by graduate students).

Editorial Service

Editorial Board: *Cognition* (since January 2007), *Frontiers in Cognitive Science* (since April 2010)

Ad Hoc reviewer: *Nature*; *Nature Neuroscience*; *Proceedings of the National Academy of Sciences*; *Public Library of Science, Biology*; *Current Biology*; *Proceedings of the Royal Society of London*; *Journal of Neuroscience*; *Trends in Cognitive Sciences*; *Trends in Neurosciences*; *Psychological Science*; *Journal of Cognitive Neuroscience*; *Human Brain Mapping*; *Cognitive, Affective and Behavioral Neuroscience*; *Neuropsychologia*; *Brain*; *Cognitive Neuroscience*; *Journal of Neurophysiology*; *European Journal of Neuroscience*; *Journal of Experimental Psychology: General*; *Journal of Experimental Psychology: Learning, Memory and Cognition*; *Cognitive Psychology*; *Perception*; *Attention, Perception & Psychophysics*; *Quarterly Journal of Experimental Psychology*; *Vision Research*; *Journal of Vision*; *Consciousness and Cognition*; *Journal of Experimental Child Psychology*; *Developmental Psychology*; *Developmental Science*; *Developmental Cognitive Neuroscience*; *Frontiers in Human Neuroscience*; *Cortex*; *Journal of Neurological Sciences*; *Experimental Brain Research*; *Neurocase*; *Hormones and Behavior*; *Journal of Consciousness Studies*.

Book proposal reviewer for *Oxford University Press*

Grant Reviews

Ad hoc external grant reviewer for:

National Science Foundation (Science of Learning-Collaborative Networks)

National Science Foundation (CAREER Awards)

National Science Foundation (BCS – Perception, Action and Cognition)

NIH: Special Emphasis Panel (SEP) ZRG1 BBBP–T (52) to review grant applications in response to RFA–EY–13–001, Basic Behavioral Research on Multisensory Processing (R21) Member.

Canada NSERC Discovery Grants (Biological Systems and Functions)

European Science Foundation (Consciousness in Natural and Cultural Contexts)

Health Research Board, Ireland; Education and Research Fund at Trinity College

Israel Science Foundation

Agence Nationale de la Recherche (ANR), France

Swiss National Science Foundation

Netherlands Organisation for Scientific Research (NWO) Vidi Program (2014); Vici Program (2015)

Nuffeld Foundation

Leverhulme Trust

Research Grants

Awarded

September 1, 2016 – August 31, 2021 NIH R01 "Perceptual and Cognitive Mechanisms of Developing Fractions Knowledge: A Cross-Sequential Approach" PI: **Hubbard**, Co-PI: Matthews; Total costs: \$2,260,653;

September 1, 2014-August 31, 2017: NSF REAL "Using Nonsymbolic Ratios to Promote Fraction Knowledge: A Neurocognitive Approach" PI: Matthews, co-PI: **Hubbard**. Total costs: 499,998.

NSF Graduate Research Fellowship Program (GRFP) PI: Toomarian, Mentor: **Hubbard** (\$120,000.00)

Wisconsin Alumni Research Foundation (WARF) Fall Competition "Using fMRI to Probe Numerical Representations in the Brain" PI: **Hubbard** (\$30,474)

Wisconsin Alumni Research Foundation: "Educating the Mathematical Brain: The Role of Maturation and Education in the Development of Neural Links between Quantities and Symbols". PI: **Hubbard** (\$26,033.00)

Wisconsin Alumni Research Foundation: "CIViz: Development of Compound Interest Visualizations and Testing of Design Principles for Improving Financial Literacy" PI: Samak (Co-PIs, **Hubbard**, Matthews: \$48,154.00)

School of Human Ecology Matching Funds Samak (PI) Matching funds to purchase shared ASL D6000 Desk-mounted eye-tracker for financial literacy visualization tool project. (\$12,500.00)

Memberships

2014 – Present: International Mind, Brain and Education Society.

2012 – Present: American Education Research Association (Brain, Neuroscience and Education SIG).

2000 – Present: American Synesthesia Association, Founding Member.

2000 – Present: Society for Neuroscience

2000 – 2003: Vision Sciences Society

1998 – Present: Cognitive Neuroscience Society

References

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