# EDWARD W. LARGE

Department of Psychological Sciences and Department of Physics
University of Connecticut
Storrs, CT 06269-1020, U.S.A.
561.486.3515
edward.large@uconn.edu


## EDUCATION

| | | | |
|---|---|---|---|
| University of Pennsylvania | Postdoc | Neuroscience & Psychology | 1997-1998 |
| | Postdoc | Cognitive Science | 1995-1997 |
| The Ohio State University | Ph.D. | Computer and Information Science | 1994 |
| | M.S. | Computer and Information Science | 1991 |
| Cornell University | | Far East Asian Languages | 1987 |
| Southern Methodist University | B.S. | Mathematics | 1982 |
| & Colorado College | | Music Performance | |

## PROFESSIONAL POSITIONS

Professor, Psychological Sciences & Physics, *University of Connecticut,* 2013 –
President & Founder, *Oscilloscape,* 2016 –
President, Society for Music Perception and Cognition, 2014 – 2016
Editorial Board Member, *Music Mind & Language*, 2013 –
Associate Editor, *Frontiers in Auditory Cognitive Neuroscience*, 2010 –
Associate Editor, *Music Perception*, 2002 –
President & Founder, *Circular Logic, LLC,* 1998 – 2016
Visiting Research Chair, Department of Music, *McGill University,* 2006 – 2007
Professor, Complex Systems & Brain Sciences, *Florida Atlantic University,* 2012 – 2013
Associate Professor, Complex Systems & Brain Sciences, *Florida Atlantic University,* 2005 – 2011
Director, NIMH Training Program in Complex Systems & Brain Sciences, *FAU,* 2006 – 2008
Consulting Editor, *Music Perception*, 1999 – 2002
Assistant Professor, Complex Systems & Brain Sciences, *Florida Atlantic University,* 1999 – 2005
Research Fellow, Armstrong Laboratory, *US Air Force,* 1994 – 1995
Research Assistant & Teaching Assistant, *The Ohio State University,* 1989 – 1994
Research Assistant, *Toshiba Research and Design Center*, Kawasaki, Japan 1987 – 1988
Service Support Engineer, *Otis Elevator Company* North American Operations, 1983 – 1985

## AWARDS & HONORS

Sponsored Member, American Association for the Advancement of Science, 2015.
Elected Member, Acoustical Society of America, 2010.
Researcher of the Year, Florida Atlantic University, 2008.
Fulbright Visiting Research Chair, J. William Fulbright Foreign Scholarship Board, 2006.
CAREER Award, National Science Foundation, 2001.
Fred Brown Award, Ohio State University, 2000.
National Research Service Award, National Institutes of Health, 1997.
National Research Council Fellowship, National Research Council, 1994.
Presidential Fellowship, Ohio State University, 1993.
Cognitive Science Graduate Research Fellow, Ohio State University, 1992.
Japan Engineering Fellow, American Electronics Association, 1987.

## GRANTS & CONTRACTS

***Under Review***

NIMH, 2019-24, “Incorporating Neurochemistry in Individualized Models of Cortical Dynamics,” $2,875,894.

***Current***

UConn IBACS Seed, 2017-2018, “Characterization of neural & electrophysiological correlates of pitch perception,” $22,214.
UConn Tier 1, 2015-17, “Interdisciplinary Neuroscience Core for Optogenetic and Brain Computer Interface Treatments,” Co-PI (PI: Read), $290,692.

***Completed***

NSF, 2012-17, "Language Plasticity: Genes, Brain, Cognition and Computation," IGERT DGE-1144399, (Faculty Participant) $3.0M.
AFOSR, 2015-17, “Signal Processing and Pattern Formation in Networks,” SPS-151328, $134,782.
AFOSR, 2013-17, “Perception of Sounds in Noisy Environments,” FA8650-13-C-6383, $1,497,612.
AFOSR, 2012-16, “Signal Processing, Plasticity and Pattern Formation,” FA9550-12-10388, $787,774.
NSF, 2010-14 “Neurodynamics of Tonality,” BCS-1027761, $403,128.
FAU, 2011-13 ‘Dynamics of Human and Nonhuman Ape Social Interactions, $16,000.
AFRL, 2011-13 “Auditory Acuity in Ambient Environments,” FA8650-08D-6801, $147,837.
FAU, 2012-13 ‘Central Auditory System: Dynamics of Normal and Abnormal Perception, $6,000.
AFOSR, 2012-13 “Listener Performance Modeling,” FA8650-12-M-6262, $149,974.
AFOSR, 2010–11 “Auditory Pattern Recognition and Learning,” FA9550-10-C-0092, $99,788.
AFOSR, 2007–10 “A Model of Human Perception and Attention,” FA9550-07-C0095, $731,551.
AFOSR, 2006–07 “A Model of Human Attentional Allocation,” FA9550-07-C-0017, $91,902.
FSB, 2006–07 “Dynamics of Music,” Fulbright Scholar Grant, $25,000.
NIMH, 2006–08 “Training Program: Complex Systems and Brain Sciences” 5 T32 MH 19116, $77,666.
FAU, 2005 “Listening to Music while Recovering from Hip and Knee Surgery” PI: McCaffrey, $5,000.
NSF, 2001–07 “Dynamics of Audition: Rhythm, Music, and Attending” BCS-0094229, $421,628.
NSF, 1998–01 “A Dynamical Approach to Attending” SBR-9808446, $158,911.
NIDCD, 1998–99 “Dynamical Modeling of Auditory Neural Computation” 1 F32DC00347-01, $32,824.

## SELECTED PRESS COVERAGE & PUBLIC COMMENTARY

“Notes on the folds: Why music makes us shiver,” World Science Festival, NYC, Jun 2, 2018.
“Overcoming Bias About Music Takes Work,” UConn Today & Science Newsline, Apr 18, 2018.
“Feel the Beat,” EMBO Reports, Science & Society, Jan 26, 2017.
“This sea lion grooves to Earth, Wind & Fire,” The Washington Post, Aug 5, 2016.
“Neuroscience and music,” Thelonious Monk Institute of Jazz, Math Science Music, Apr 22, 2016.
“Hit me with your rhythm stick!” The Daily Mail, Nov 26, 2015.
“Why we love music,” The Greater Good, Jan 12, 2015.
“Bonobos, like humans, keep time to music,” Reuters, Feb 15, 2014.
“To tug hearts, music first must tickle the neurons,” New York Times, Apr 19, 2011.
“Study identifies key aspects of music that evoke emotions in brain,” Scienceagogo, Dec 27, 2010.

## PEER-REVIEWED ARTICLES AND BOOK CHAPTERS

### *In Preparation*

1. Kim, J. C., & **Large, E. W.** (in preparation). Hebbian plasticity in gradient frequency networks of neural oscillators.
2. Kim, J. C., & **Large, E. W.** (in preparation). Mode-locking dynamics in gradient frequency neural networks.
3. Kim, J. C., Lerud, K. L., & **Large, E. W.** (in preparation). Consonance, harmonicity and neural synchronization.
4. Harding, E., Sammler, M., Henry, M., **Large, E. W.** & Kotz, S. (in preparation). Cortical tracking of nested beat structure in music and speech.

### *Submitted, Under Review, and Under Revision*

5. Lerud, K. L., Kim, J. C., Almonte, F. V., Carney, L. H. & **Large, E. W.** (under revision). A canonical nonlinear cochlear model. *PNAS.*
6. Kim, J. C., & **Large, E. W.** (under revision). Establishing tonal stability: The role of melodic steps and leaps. *Music Perception.*

### *Published and In Press*

7. **Large, E. W.**, & Kim, J. C. (in press). Expectation. In J. Rentfrow & D. Levitin (Eds.), *Foundations of Music Psychology*. *Cambridge: MIT Press.*
8. Aydogan, G., Flaig, N., Ravi, S. N., **Large, E. W.,** McClure, S. M., Margulis, E. H. (2018). Overcoming bias: Cognitive control reduces susceptibility to framing effects in evaluating musical performance. *Scientific Reports,* 8:6229. doi: 10.1038/s41598-018-24528-3.
9. Kim, J. N., **Large, E. W.,** Gwon, Y., & Ashley, R. (2018). The online processing of implied harmony in the perception of tonal melodies: Effects of harmonic expectations. *Music Perception. 35 (5), 594-606.* doi: 10.1525/mp.2018.35.5.594.
10. Tal, I., **Large, E. W.**, Rabinovitch, E., Wei, Y., Schroeder, C. E., Poeppel, D., & Zion Golumbic, E. (2017). Neural Entrainment to the Beat: The "Missing Pulse" Phenomenon. *Journal of Neuroscience, 37 (26)*, 6331– 6341. doi: 10.1523/JNEUROSCI.2500-16.2017.
11. Farokhniaee, A., & **Large, E. W.** (2017). Mode-locking behavior of Izhikevich neurons under periodic external forcing. *Physical Review E*, *95 (6)*, 062414. doi: 10.1103/PhysRevE.95.062414.
12. **Large, E. W.** (2017). Music from the air to the brain and body. In R. Ashley & R. Timmers (Eds.), *Routledge Handbook of Music Cognition. pp. 3-11*, NewYork: Routledge.
13. Jantzen, M. G., **Large, E. W.**, & Magne, C. (2016). Overlap of neural systems for processing language and music. *Frontiers in Psychology, 14*. doi: 10.3389/fpsyg.2016.00876
14. Rouse, A. A., Cook, P. F., **Large, E. W.** & Reichmuth, C. (2016). Beat keeping in a sea lion as coupled oscillation: Implications for comparative understanding of human rhythm. *Frontiers in Neuroscience. 10 (159), 403.* doi: 10.3389/fnins.2016.00257
15. **Large, E. W.**, Kim, J. C., Flaig, N., Bharucha, J., & Krumhansl, C. L. (2016). A neurodynamic account of musical tonality. *Music Perception*. *33 (3),* 319-331. doi: 10.1525/mp.2016.33.3.319

16. Kim, J. C., & **Large, E. W.** (2015). Signal processing in forced gradient frequency neural oscillator networks. *Frontiers in Computational Neuroscience.* 9:152. doi: 10.3389/fncom.2015.00152
17. **Large, E. W.**, Herrera J. A. and Velasco M. J. (2015). Neural networks for beat perception in musical rhythm. *Frontiers in Systems Neuroscience*. *9 (159)*. doi: 10.3389/fnsys.2015.00159
18. **Large, E. W.** & Gray, P. (2015). Spontaneous tempo and entrainment in a bonobo (Pan paniscus). *Journal of Comparative Psychology, 129 (4),* 317-328. doi: 10.1037/com0000011.
19. Rankin, S. K., Fink, P. & **Large, E. W.** (2014). Fractal structure enables temporal prediction in music. *Journal of the Acoustical Society of America,* 136 (4). EL256. doi: 10.1121/1.4890198.
20. Lerud, K. L., Almonte, F. V., Kim, J. C. & **Large, E. W.** (2014). Mode-locked neural oscillation predicts human auditory brainstem responses to musical intervals. *Hearing Research*, *308,* 41-49. doi: 10.1016/j.heares.2013.09.010
21. Musacchia, G., **Large, E. W.** & Schroeder, C. E. (2014). Thalamocortical mechanisms for integrating musical tone and rhythm. *Hearing Research*, *308*, 50-59.
22. Flaig, N. K. & **Large, E.W.** (2014). Dynamic musical expression of core affect. *Frontiers in Psychology, 5*, 72.
23. **Large, E. W.** (2014). Rhythm Perception: Pulse and Meter. In: Jaeger D., Jung R. (Ed.) *Encyclopedia of Computational Neuroscience: SpringerReference* (www.springerreference.com). Springer-Verlag Berlin Heidelberg.
24. Flaig, N. K., **Large, E. W.** (2013). What is special about musical emotion? *Physics of Life Reviews*, *10 (3)*, 267-268.
25. Fujioka, T., Trainor, L. J., **Large, E. W.** & Ross, B. (2012). Internalized timing of isochronous sounds is represented in neuromagnetic beta oscillations. *The Journal of Neuroscience*, *32*, 1791-1802.
26. **Large, E. W.** & Almonte, F. (2012). Brainstem neurodynamics: Implications for the perception of tonality in music. *Annals of the New York Academy of Sciences*, *1252*, (*E)* 1-7.
27. Gordon, R. L., Magne, C. L., **Large, E. W.** (2011). EEG correlates of song prosody: A new look at the relationship between linguistic and musical rhythm. *Frontiers in Psychology 2, 352*.
28. Loehr, J. D., **Large, E. W**., & Palmer, C. (2011). Temporal coordination and adaptation to rate change in music performance. *Journal of Experimental Psychology: Human Perception and Performance*, *37 (4)*, 1292–1309.
29. Velasco, M. J. & **Large, E. W.** (2011). Pulse detection in syncopating rhythms using neural oscillators. *Proceedings of the 12th Annual Conference of the International Society for Music Information Retrieval*. (pp. 186-190).
30. **Large, E. W.** (2011). Musical tonality, neural resonance and Hebbian learning. In C. Agon, E. Amiot, M. Andreatta, G. Assayag, J. Bresson, J. Mandereau (Eds.), *Mathematics and Computation in Music* (pp. 115-125). Berlin: Springer-Verlag.
31. Chapin, H., Jantzen, K. J., Kelso, J. A. S., Steinberg, F. & **Large, E. W.** (2010). Dynamic emotional and neural responses to music depend on performance expression and listener experience. *PLoS ONE 5(12),* e13812.

32. Chapin, H., Zanto, T., Jantzen, K. J., Kelso, J. A. S., Steinberg, F. & **Large, E. W.** (2010). Neural responses to complex auditory rhythms: The role of attending. *Frontiers in Auditory Cognitive Neuroscience*, *1*, 224.
33. **Large, E. W.**, Almonte, F. & Velasco, M. (2010). A canonical model for gradient frequency neural networks. *Physica D, 239*, 905-911.
34. **Large, E. W.** (2010). Neurodynamics of Music. In M. Riess Jones, R. R. Fay & A. N. Popper (Eds.), *Springer Handbook of Auditory Research, Vol. 36: Music Perception* (pp. 201-231). New York: Springer.
35. **Large, E. W.** (2010). A dynamical systems approach to musical tonality. R. Huys and V. K. Jirsa (Eds.): *Nonlinear Dynamics in Human Behavior* (pp. 193–211). Berlin: Springer-Verlag.
36. Rankin, S. K., **Large, E. W.** & Fink, P. (2009). Fractal tempo fluctuation and pulse prediction. *Music Perception, 26 (5),* 401-413.
37. Fujioka, T., Trainor, L., **Large, E. W.** & Ross, B. (2009). Beta and gamma rhythms in human auditory cortex during musical beat processing. *Annals of the New York Academy of Sciences,* 1169, 89-92.
38. **Large, E. W.** & Snyder, J. S. (2009). Pulse and meter as neural resonance. *Annals of the New York Academy of Sciences, 1169*, 46-57.
39. **Large, E. W.** (2009). Book review: Music, Thought, and Feeling: Understanding the Psychology of Music, *Music Perception, 27 (2)*, 145-147.
40. **Large, E. W.** (2008). Resonating to Musical Rhythm: Theory and Experiment. In S. Grondin, (Ed.) *The Psychology of Time*. West Yorkshire: Emerald.
41. Hannon, E. E., Snyder, J. S., **Large, E. W.** & Christiansen (2006). Synchronization and continuation tapping to complex meters. *Music Perception, 24 (2), 135-146*.
42. Zanto, T. P., Snyder, J. S., **Large, E. W.** (2006). Neural correlates of rhythmic expectancy. *Advances in Cognitive Psychology, 2 (2–3)*, 221-231.
43. **Large, E. W.** (2006). A generic nonlinear model for auditory perception. In A. L. Nuttall¸ T. Ren, P. Gillespie, K. Grosh & E. de Boer (Eds.) *Auditory Mechanisms: Processes and Models*, pp. 516-517. Singapore: World Scientific.
44. Snyder, J. S., & **Large, E. W.** (2005). Gamma-band activity reflects the metric structure of rhythmic tone sequences. *Cognitive Brain Research*, *24* (*1*), 117-126.
45. Almonte, F., Jirsa, V. K., **Large, E. W.**, & Tuller, B. (2005). Integration and segregation in auditory streaming. *Physica D*, *212* (*1-2*), 137-159.
46. Zanto, T. P., **Large, E. W.**, Fuchs, A., & Kelso, J. A. S. (2005). Gamma-band responses to perturbed auditory sequences: Evidence for synchronization of perceptual processes. *Music Perception*, *22 (3)*, 531-547.
47. **Large, E. W.** & Tretakis, A. E. (2005). Tonality and Nonlinear Resonance. *The Neurosciences and Music II: From Perception to Performance: Annals of the New York Academy of Sciences, 1060, 53–56*.
48. Snyder, J. S., & **Large, E. W.** (2004). Tempo Dependence of Middle- and Long-Latency Auditory Responses: Power and Phase Modulation of the EEG at Multiple Time-Scales. *Clinical Neurophysiology*, *115*, 1885-1895.

49. **Large, E. W.** (2004). Nonlinear resonance: A musical universal? Commentary on “In time with the music: The concept of entrainment and its significance for ethnomusicology” (Clayton, Will, & Sager, 2004). *ESEM CounterPoint*, *1*, 1-81.
50. Zanto, T.P., **Large, E. W.**, Fuchs, A., & Kelso, J.A.S. (2004). Gamma band activity during perturbed auditory sequences: An EEG study. *Proceedings of the Eighth International Conference on Music Perception and Cognition*.
51. **Large, E. W.**, and Crawford, J.D. (2002). Auditory temporal computation: Interval selectivity based on post-inhibitory rebound. *Journal of Computational Neuroscience*, *13*, 125-142.
52. **Large, E. W.**, Fink, P., and Kelso, J. A. S. (2002). Tracking simple and complex sequences. *Psychological Research, 66*, 3-17.
53. **Large, E. W.**, and Palmer, C. (2002). Temporal responses to music performance: Perceiving structure in temporal fluctuation. *Cognitive Science, 26,* 1-37.
54. Snyder, J. S., & **Large, E. W.** (2002). Neurophysiological correlates of meter perception: Evoked and induced gamma-band (20-60 Hz) activity. *Proceedings of the Seventh International Conference on Music Perception and Cognition*. Adelaide, Australia: Causal Productions.
55. Nair, D., **Large, E. W.**, Steinberg, F. & Kelso, J. A. S. (2002). Expressive timing and perception of emotion in music: an fMRI study. *Proceedings of the Seventh International Conference on Music Perception and Cognition*. Adelaide, Australia: Causal Productions.
56. **Large, E. W.** (2001). Periodicity, pattern formation, and metric structure. *Journal of New Music Research, 22*, 173-185.
57. **Large, E. W.** (2000). On synchronizing movements with music. *Human Movement Science*, *19*, 527- 566.
58. **Large, E. W.** (2000). Rhythm categorization in context. *Proceedings of the International Conference on Music Perception and Cognition*.
59. **Large, E. W.**, and Jones, M. R. (1999). The dynamics of attending: How we track time varying events. *Psychological Review*, *106* (*1*), 119-159.
60. Bajcsy, R. and **Large, E. W.** (1999). When and where will AI meet robotics: Issues in representation. *Artificial Intelligence Magazine*, *20 (3)*, 57 - 65.
61. Goldenstein, S., **Large, E. W.**, and Metaxis, D. M. (1999). Nonlinear dynamical systems approach to behavior modeling. *The Visual Computer*, *15*, 349 -364.
62. **Large, E. W.**, Christensen, H. I., and Bajcsy, R. (1999). Scaling the dynamic approach to path planning and control: Competition among behavioral constraints. *International Journal of Robotics Research*, *18 (1)*, 37-58.
63. **Large, E. W.**, Palmer, C., & Pollack, J. B. (1999). Reduced memory representations for music. In N. Griffith and P. Todd (Eds.), *Musical Networks: Parallel Distributed Perception and Performance*, pp. 65 - 98. Cambridge, MA: MIT Press.
64. **Large, E. W.**, & Kolen, J. F. (1999). Resonance and the perception of musical meter. In N. Griffith and P. Todd (Eds.), *Musical Networks: Parallel Distributed Perception and Performance*, pp. 279 - 312. Cambridge, MA: MIT Press.
65. **Large, E. W.** (1998). Music and schema theory. *Music Perception*, *14* (*3*), 319 - 326.

66. **Large, E. W.** & Christensen, H. I. (1998). Dynamics for Robot Path Planning and Control. In H. Bunke (Ed.), *Modeling and Planning for Sensor-Based Intelligent Robot Systems,* 137-152. Berlin: World Scientific.
67. Venetianer, P., **Large, E. W.**, and Bajcsy, M. R. (1997). Methodology for evaluation of task performance in robotic systems: A case study in vision-based localization. *Machine Vision and Applications*, *9 (5-6)*, 304-320.
68. **Large, E. W.**, Christensen, H. I., and Bajcsy, R. (1997). *Dynamic path planning on multiple spatial scales*. Proceedings of the International Joint Conference on Artificial Intelligence.
69. **Large, E. W.**, Christensen, H. I., and Bajcsy, R. (1997). *Scaling dynamic planning and control: Cooperation through competition*. Proceedings of the IEEE International Conference on Robotics and Automation.
70. **Large, E. W.** (1996). *Modeling beat perception with a nonlinear oscillator*. Proceedings of the Eighteenth Annual Conference of the Cognitive Science Society.
71. **Large, E. W.** (1995). *Beat tracking with a nonlinear oscillator*. Working Notes of the IJCAI Workshop on AI and Music, pp. 24-31.
72. **Large, E. W.**, Palmer, C., & Pollack, J. B. (1995). Reduced memory representations for music. *Cognitive Science*, *19*, 53-96.
73. **Large, E. W.** (1994). *Models of metrical structure in music*. In Proceedings of the Sixteenth Annual Conference of the Cognitive Science Society (pp. 537 - 542). Hillsdale, N.J.:Erlbaum Press.
74. **Large, E. W.**, & Kolen, J. F. (1994). Resonance and the perception of musical meter. *Connection Science*, *6 (1)*, 177 - 208.
75. **Large, E. W.** (1993). Dynamic programming for the analysis of serial behaviors. *Behavior Research Methods, Instruments, and Computers, 25 (2)*, 238-241.
76. **Large, E. W.**, Palmer, C., & Pollack, J. B. (1991). *A connectionist model of intermediate representations for musical structure*. In Proceedings of the Thirteenth Annual Conference of the Cognitive Science Society (pp. 412 - 417). Hillsdale, N.J.:Erlbaum Press.
77. Brown, D. C., Meehan, E., Sloan, W. N., Horner, R., **Large, E. W.**, Liu, L., Spillane, M., & Kim, M. (1991). Experiences with modeling memory and simple learning in routine design problem solving. In M. Green (Ed.) *Knowledge Aided Design* (pp. 239-259). London: Academic Press.
78. **Large, E. W.** & Brown, D. C. (1990) Knowledge compilation by analogy: Adaptation of design plans by analogical matching and derivational plan transformation. In J. S. Gero (Ed.) *Applications of AI in Engineering V, Vol. 2: Manufacture and Planning, Proceedings of the Fifth International Conference* (pp. 551 - 571). Berlin: Springer-Verlag.
79. Takebayashi., Y, **Large, E. W.**, Souma, S., & Doi, M. (1988). *Intelligent presentation graphics using drawing understanding*. In Proceedings of the Fourth Symposium on Human Interface (pp. 477 - 496). In Japanese.
80. **Large, E. W.**, Souma, S., Doi, M., & Takebayashi., Y. (1988). Architecture for an intelligent presentation graphics system. *37th Spring Meeting of the Information Processing Society of Japan* (pp. 1306 - 1307). In Japanese.

## BOOKS

### *In Preparation*

1. Kim, J. C., Almonte, F. V. & **Large, E. W.** (in preparation). Signal Processing, Plasticity and Pattern Formation in Networks of Neural Oscillators.
2. **Large, E. W.** & Kim, J. C. (in preparation). Musical Neurodynamics.

## PATENTS

### *Under Review*

1. **Large, E. W.** (2011). *Learning and auditory scene analysis in gradient frequency nonlinear oscillator networks*. PCT Patent Application PCT/US11/22993. (Filed Jan 28, 2011).

### *Issued*

2. **Large, E. W.** (2017). *Method and apparatus for nonlinear frequency analysis of structured acoustic signals*. European Patent No. 1774514. Dec 19, 2016.
3. **Large, E. W.** (2016). *System and method for processing acoustic signals which enable a learned response the the input and cochlear modeling in gradient frequency nonlinear oscillator networks*. Japanese Patent No. 5864441. Jan 8, 2016.
4. **Large, E. W.** (2015). *Learning and auditory scene analysis in gradient frequency nonlinear oscillator networks*. Chinese Patent No. 015032700059050. Apr 1, 2015.
5. **Large, E. W.** (2015). *Learning and auditory scene analysis in gradient frequency nonlinear oscillator networks*. United States Patent No. 8,930,292 B2. Jan 6, 2015.
6. **Large, E. W.** (2013). *Rhythm processing and frequency tracking in gradient frequency nonlinear oscillator networks*. United States Patent No. 8,583,442 B2. Nov 12, 2013. (PCT Patent Application PCT/US11/22993. Filed Jan 28, 2011).
7. **Large, E. W.** (2008) *Method and apparatus for nonlinear frequency analysis of structured acoustic signals*. United States Patent No. 7,376,562, May 20, 2008.
8. **Large, E. W.** & Kolen, J. F. (1997). *A method of analysis of signals from nonstationary processes possessing temporal structure such as music, speech, and other event sequences*. United States Patent No. 5,751,899.

## SOFTWARE

**Large, E. W.**, Herrera J. A. and Velasco M. J. (2016). *GrFNNRhythm: A network for simulating the perception of pulse in syncopated rhythms.* https://github.com/MusicDynamicsLab/GrFNNRhythm.

Lerud, K. L., Kim, J. C. & **Large, E. W.** (2016). *GrFNN Cochlea: A canonical nonlinear cochlear model.* https://github.com/MusicDynamicsLab/GrFNNCochlea.

Lerud, K. L., Kim, J. C. & **Large, E. W.** (2016). *GrFNN Brainstem: An oscillatory model of the auditory periphery and brainstem.* https://github.com/MusicDynamicsLab/GrFNNBrainstem.

**Large, E. W.**, Kim, J. C., Lerud, K. L. & Harrell, D. (2016). *GrFNN Toolbox 1.2.1: Matlab tools for simulating signal processing, plasticity and pattern formation in gradient frequency neural networks.* https://github.com/MusicDynamicsLab/GrFNNToolbox.

Berens, P. & **Velasco, M. J.** (2008). Circular Statistics Toolbox. http://www.mathworks.com/matlabcentral/fileexchange/10676.

**Large, E. W.** & Rankin, S. K. (2008). MATLAB Performance Matcher. Florida Atlantic University, Boca Raton, FL. Available at http://www.ccs.fau.edu/~large/demos.html. Also

available as part of the MIDI Toolbox http://www.jyu.fi/hum/laitokset/musiikki/en/research/coe/materials/miditoolbox/.

**PUBLISHED ABSTRACTS**

9. Wasserman, C. S., Kim, J. N., Wei, Y., Skoe, E. Read, H.L., & **Large, E. W.** (2018). Neural Resonance Theory: Testing Dynamical Predictions Using Missing Pulse Rhythms. *Association for Research in Otolaryngology Abstracts*, *41 (PS-864)*, 567.
10. Kim, J. C., & **Large, E. W.** (2016). A gradient frequency neural network model of auditory scene analysis. *Society for Neuroscience Abstracts, 42,* 431.04.
11. **Large, E. W.**, Zion Golumbic, E. M., Schroeder, C. E., Poeppel, D. (2016). Neural entrainment to the beat: The "missing pulse" phenomenon. *Society for Neuroscience Abstracts, 42,* 746.02.
12. Wasserman, C. S., Kim, J. N., **Large, E. W.**, & Skoe, E. (2016). Neural Resonance Theory: Entrainment to Missing Pulse Rhythms. In *Proceedings of the 38th Annual Meeting of the Cognitive Science Society*, pg. 3000, Philadelphia, PA, Aug 10-13.
13. **Large, E. W.** & Herrera, J. (2015). Neural networks for pulse perception in musical rhythm. *Society for Neuroscience Abstracts, 41,* 251.06.
14. Kim, J. C., & **Large, E. W.** (2015). Nonlinear resonance and plasticity as a basis for musical consonance. *Society for Neuroscience Abstracts, 41,* 508.01.
15. Farokhniaee, A., & **Large, E. W.** (2015). Mode-locking behavior of Izhikevich neurons under periodic external forcing, *Bulletin of the American Physical Society, APS March Meeting 2015*, *60 (1),* M45.00005.
16. Lerud, K. D., Kim, J. C., Carney, L. H., & **Large, E. W.** (2015). A canonical nonlinear cochlear model, *Association for Research in Otolaryngology Abstracts*, *38 (PS-368)*, 211.
17. Zion Golumbic, E. M. Velasco, M., Schroeder, C. E., Poeppel, D. & **Large, E. W.** (2012). Neural entrainment to the beat: The "missing pulse" effect. *International Conference on Biomagnetism Abstracts*.
18. Flaig, N. K., Chapin, H. L., Zanto, T. P. & **Large, E. W.** (2014). Dynamic affective and neural responses to expressive timing fluctuations in music. *Society for Neuroscience Abstracts, 40*, 622.23.
19. Lerud, K., Kim, J. C., & **Large, E. W.** (2014). Pitch shift of the residue and its brainstem EEG correlate are explained by nonlinear oscillation. *Journal of the Acoustical Society of America*, *135, (4),* 2166.
20. Large, E. W. (2014). Preferred Tempo and Tempo Matching in Bonobo Apes (Pan paniscus). Symposium: Rhythmic Entrainment in Non-Human Animals: An Evolutionary Trail of Time Perception. In *Proceedings of the 2014 Annual Meeting of the American Association for the Advancement of Science*, Chicago, IL.
21. Lerud, K., Kim, J. C., & **Large, E. W.** (2013). Nonlinear oscillation accounts for the perception of residue pitch and its brainstem EEG correlate. *Society for Neuroscience Abstracts, 39*, 356.06.
22. Large, E. W., & Kim, J. C. (2013). A Universal 'Grammar' for Music. Symposium: Music cognition: Bridging computation and insights from cognitive neuroscience. In *Proceedings of the 35th Annual Meeting of the Cognitive Science Society*, 99-100, Berlin, Germany.

23. Baron, A., **Large, E. W.** & Gray, P. (2012). Preferred tempo and tempo matching in bonobo apes (Pan paniscus). *Society for Neuroscience Abstracts, 38*, 809.26.
24. Velasco, M. J. & **Large, E. W.** (2012). Pulse induction in pseudorandom sequences measured with pulse attribution and tapping rate. *Society for Neuroscience Abstracts, 38*, 910.01.
25. Lerud, K., Kim, J. C., & **Large, E. W.** (2012). A nonlinear dynamical systems approach to pitch perception. *Society for Neuroscience Abstracts, 38*, 462.12.
26. Kim, J. C., & **Large, E. W.** (2012). Stability of consonant pitch intervals in a nonlinear oscillator network model. *Society for Neuroscience Abstracts, 38*, 462.13.
27. Flaig, N. K., Kim, J. C., Krumhansl, C. L., & **Large, E. W.** (2012). Neurodynamic predictions of musical tonality perception. *Society for Neuroscience Abstracts, 38*, 382.15.
28. **Large, E. W.** (2012). Auditory rhythms and neural resonance. *International Conference on Biomagnetism Abstracts*.
29. **Large, E. W.** & Almonte, F. (2011). Human auditory brainstem responses to musical intervals are predicted by phase locked neural oscillation. *Association for Research in Otorhinolaryngology Abstracts*, *34 (897)*, 123.
30. Kim, J. C., **Large, E. W.**, & Flaig, N. K. (2011). Learning musical sequences in a simulated auditory system. *Society for Neuroscience Abstracts, 37*, 693.03.
31. Velasco, M. J. & **Large, E. W.** (2011). Perception of pulse and meter for syncopated rhythms. *Society for Neuroscience Abstracts, 37*, 831.03.
32. Dodel, S. & **Large, E. W.** (2011). Emotional responses in music listening are associated with brain-scale functional connectivity modulations. *Society for Neuroscience Abstracts, 37*, 171.03.
33. **Large, E. W.** & Almonte, F. (2010). Phase-locked neural oscillation predicts human auditory brainstem responses to musical intervals. *Society for Neuroscience Abstracts*, *36*, 481.16.
34. Velasco, M. & **Large, E. W.** (2010). Entrainment to complex rhythms: Tests of a neural model. *Society for Neuroscience Abstracts, 36*, 324.3.
35. Rankin, S. K., **Large, E. W.** (2010). *1/f temporal structure and prediction in rhythmic entrainment*, *Society for Neuroscience Abstracts, 36*, 324.9.
36. Almonte, F., Velasco, M. & **Large, E. W.** (2009). A canonical model for gradient frequency neural networks. *Society for Neuroscience Abstracts*, *35*, 351.3.
37. Chapin, H., **Large, E. W.**, Zanto, T. (2009). Neural responses to complex auditory rhythms: The role of attending. *Society for Neuroscience Abstracts, 35*, 290.2.
38. Rankin, S. K., **Large, E. W.** & Sapp, C. (2009). *1/f* tempo fluctuations in skilled piano performance. *Society for Neuroscience Abstracts*, *35*, 94.19.
39. Rankin, S. & **Large, E. W.** (2008). Fractal tempo scaling and predictive synchrony, *Journal of the Acoustical Society of America*, *124, (4),* 2432.
40. Chapin, H. L. & **Large, E. W.** (2008). Dynamics of emotional communication in music, *Journal of the Acoustical Society of America*, *124, (4),* 2432.
41. Fujioka, T., **Large, E. W.**, Trainor, L. J. & Ross, B. (2008). Time courses of cortical beta and gamma-band activity during listening to metronome sounds in different tempi, *Journal of the Acoustical Society of America*, *124, (4),* 2432.

42. Velasco, M. & **Large, E. W.** (2008). Time-frequency transformation by networks of neural oscillators: Implications for musical structure, *Journal of the Acoustical Society of America*, *124, (4),* 2432.
43. Rankin, S. K., **Large, E. W.**, Fink, P. (2008). Fractal tempo scaling and predictive pulse synchrony in music. *Society for Neuroscience Abstracts*, *34*, 786.3.
44. Chapin, H. L., **Large, E. W.**, Jantzen, K. J., Kelso, J. A. S., Steinberg, F. (2008). Tempo fluctuations in performed music correlate with neural activity and with ratings of emotional intensity. *Society for Neuroscience Abstracts*, *34*, 786.2.
45. Zanto, T. P., Chapin, H.. **Large, E. W.**, Kelso, J. A. S. & Steinberg, F, & (2007). Neural correlates of dynamic attending to syncopated rhythms. *Cognitive Neuroscience Society Abstracts*, *E 88*, 176.
46. Zanto, T. P., Marshall, M. L. Fuchs, A. & **Large, E. W.** (2005). Sparse sampling in auditory fMRI experiments: A combined functional MRI and EEG study. *Society for Neuroscience Abstracts*, *31*, 975.16.
47. **Large, E. W.** (2005). Nonlinear time-frequency analysis: A dynamical systems approach. *Association for Research in Otolaryngology Abstracts*, *28 (1065)*, 372.
48. Snyder, J. S., Zanto, T. P., **Large, E. W.**, & Kelso, J. A. S. (2003). Gamma-band activity during rhythmic processing: Temporal structure, meter, and attention. *Society for Neuroscience Abstracts*, *29*, 486.3.
49. Zanto, T.P., **Large, E. W.**, Fuchs, A., & Kelso, J.A.S. (2003). Gamma band activity during temporally perturbed auditory sequences, *Society for Neuroscience Abstracts*, *29*, 486.18.
50. Snyder, J. S., & **Large, E. W.** (2002). Induced and evoked gamma-band activity during rhythmic auditory stimulation: Correlates of metrical accent and temporal anticipation. *Society for Neuroscience Abstracts*, *28*, 659.8.
51. Nair, D.G., **Large, E. W.**, Steinberg, F.L., & Kelso, J.A.S. (2002). Emotional communication in music performance: A functional MRI study, *Society for Neuroscience Abstracts*, *28*, 659.8.
52. Snyder, J. S., & **Large, E. W.** (2002). Neurophysiological correlates of meter perception. *Cognitive Neuroscience Society Abstracts*. San Francisco, CA.
53. **Large, E. W.** (1999). Simulating meter perception in acoustic signals. *Journal of the Acoustical Society of America, 106 (4),* 2260.
54. Cudmore, R.H., **Large, E. W**., Crawford, J.D. (1998). Auditory temporal computation: A simple network model for feature extraction from communication sounds. *Society for Neuroscience Abstracts*, *24,* 466.
55. **Large, E. W.**, Kozloski, J., Crawford, J.D. (1998). A dynamical model of temporal processing in the fish auditory system. *Association for Research in Otolaryngology Abstracts*, *21 (396)*, 717.
56. **Large, E. W.** (1998). Categorization of temporal intervals. *Journal of the Acoustical Society of America*, *103 (5),* 2853.
57. **Large, E. W.** & Palmer, C. (1996). Nonlinear dynamics of rhythm perception in performed music. *Journal of the Acoustical Society of America, 99 (4)*, 2481-2500.
58. **Large, E. W.** (1992). A neural network model of recoding for musical stimuli. *Journal of the Acoustical Society of America*, *92, (4),* 2404.

## CONFERENCE & WORKSHOP PRESENTATIONS

59. Tichko, P., & **Large, E. W.** (2018). Modeling Infants' Perceptual Narrowing to Musical Rhythms with Gradient Frequency Neural Networks. New England Sequencing and Timing (NEST) 2018, Storrs, CT.
60. Wasserman, C. S., & **Large, E. W.** (2018). Finding the Beat: Testing Dynamical Predictions Using Missing Pulse Rhythms. New England Sequencing and Timing (NEST) 2018, Storrs, CT.
61. Wasserman, C. S., Wei, Y., Kim, J. N., Skoe, E. Read, H.L., & **Large, E. W.** (2018). Finding the Beat: Testing Dynamical Predictions of Neural Resonance Theory Using Missing Pulse Rhythms. In *Proceedings of the 15th Annual International Conference for Music Perception and Cognition*, Montreal, QC, Canada.
62. Kim, J. C., & **Large, E. W.** (2017). Dynamics of melodic embellishment: Pitch interaction in steps and leaps predicts implied harmony in tonal melodies. In *Proceedings of the Society for Music Perception and Cognition*, San Diego, CA.
63. Kim, J. C., & **Large, E. W.** (2017). Entrainment of canonical oscillators to complex rhythms: Temporal receptive field revisited. In *Proceedings of the Society for Music Perception and Cognition*, San Diego, CA.
64. Wasserman, C. S., Kim, J. N., Wei, Y., **Large, E. W.**, Skoe, E. & Read, H.L. (2017). Finding the Beat: Electrophysiological Entrainment to Missing Pulse Rhythms. In *Proceedings of the Society for Music Perception and Cognition*, San Diego, CA.
65. Kim, J. N., Wei, Y., Fitzpatrick, C., & **Large, E. W.** (2017). Beat Perception in Jittered Rhythms: Neural Oscillation or Delay-Based Processing? Society for Music Perception and Cognition 2017 meeting, San Diego, CA.
66. Kim, J. C., & **Large, E. W.** (2017). Harmonic templates emerging in gradient frequency neural networks with Hebbian plasticity. In *Proceedings of the 6th Neurosciences and Music Conference*, Boston, MA.
67. Wasserman, C. S., Kim, J. N., Wei, Y., Skoe, E. Read, H.L., & **Large, E. W.** (2017). Finding the Beat: Neural Entrainment to Missing Pulse Rhythms. In *Proceedings of the 6th Neurosciences and Music Conference*, Boston, MA.
68. Kim, J. C., & **Large, E. W.** (2017). Synchronization of canonical oscillators to syncopated rhythms: The effect of temporal receptive field. New England Sequencing and Timing 2017, Storrs, CT.
69. Kim, J. C., & Large, E. W. (2016). Multiple F0 estimation by gradient frequency neural networks. *6th Annual Seminar on Cognitively Based Music Informatics Research*, New York, NY, Aug 12.
70. Wasserman, C. S., Kim, J. N., **Large, E. W.**, & Skoe, E. (2016). Finding the beat: Simultaneously-recorded cortical and subcortical steady-sate responses to missing pulse rhythms. In *Proceedings of the 24th Annual International Society for Neurofeedback and Research*, in press, Orlando, FL, Sep 21-24.
71. Wasserman, C. S., Kim, J. N., **Large, E. W.**, & Skoe, E. (2016). Finding the Beat: Investigating Neural Resonance using Simultaneously-recorded Cortical and Subcortical Steady-State Responses. *In Proceedings of the 14th Annual International Conference for Music Perception and Cognition*, San Fransisco, CA, Jul 5-8.

72. Kim, J. C., & **Large, E. W.** (2016). A nonlinear dynamical systems approach to auditory scene analysis. *In Proceedings of the 14th Annual International Conference on Music Perception and Cognition,* San Francisco, CA, Jul 5-8.
73. Flaig, N. K., Margulis, E. H., Molfese, P. J., Kroger, C. & **Large, E. W.** (2016). Real or perceived? Neural underpinnings of expectations in the enjoyment of performances. *In Proceedings of the 14th Annual International Conference on Music Perception and Cognition,* San Francisco, CA, Jul 5-8.
74. Wasserman, C. S., Kim, J. N., **Large, E. W.**, & Skoe, E. (2016). Finding the Beat: Neural Responses to Missing Pulse Rhythms. *Frequency Following Response Workshop*, Boston University, Boston, MA, May 19-20.
75. **Large, E. W.** (2016). Neural networks for beat perception in musical rhythm, New England Sequencing & Timing Workshop, UMass, Amherst, MA, Mar 5.
76. Kim, J. N., & **Large, E. W.** Consonance, harmonicity and neural synchronization. *Biennial Conference of the Society for Music Perception and Cognition*, Nashville, TN, Aug 2-5.
77. Kim, J. N., & **Large, E. W.** (2015). Interactions of meter and harmony: An analysis of oscillatory brain dynamics. *Biennial Conference of the Society for Music Perception and Cognition*, Nashville, TN, Aug 2-5.
78. Farokhniaee, A., & **Large, E. W.** (2015). Mode-locking behavior of Izhikevich neuron under periodic external forcing, *International Workshop on Machine learning, Optimization and big Data*, Taormina - Sicily, Italy, Jul 21-24.
79. Farokhniaee, A., & **Large, E. W.** (2015). Mode-locking behavior of Izhikevich neurons under periodic external forcing, *Twenty-Fourth Annual Computational Neuroscience Meeting CNS*2015*, Prague, Czech Republic. Jul 18 - 23.
80. Kim, J. C., & **Large, E. W.** (2014). Pitch dynamics on multiple time scales in a neurodynamic model of melodic perception. *International Conference on Music Perception and Cognition*, Seoul, South Korea, Aug 4-8.
81. Kim, J. N., Kim, J. C.,& **Large, E. W.** (2014). Oscillatory brain dynamics in the processing of implied harmony. *International Conference on Music Perception and Cognition*, Seoul, South Korea, Aug 4-8.
82. Lerud, K., Kim, J. C., & **Large, E. W.** (2014). A neurodynamic account of residue pitch perception. *International Conference on Music Perception and Cognition*, Seoul, South Korea, Aug 4-8.
83. Kim, J. C., & **Large, E. W.** (2013). Oscillatory neurodynamics explain perceptual differences between melodic steps and leaps. *Biennial Conference of the Society for Music Perception and Cognition*, Toronto, ON, Aug 8-11.
84. Kim, J. N., & **Large, E. W.** & Ashley, R. (2013). A brain index of harmonic integration in the perception of tonal melodies. *Biennial Conference of the Society for Music Perception and Cognition*, Toronto, ON, Aug 8-11.
85. **Large, E. W.**, Kim, J. C., Flaig, N. K., Bharucha, J. J., & Krumhansl, C. L. (2013). Neurodynamic constraints on musical languages. *Biennial Conference of the Society for Music Perception and Cognition*, Toronto, ON, Aug 8-11.

86. Lerud, K., Kim, J. C., & **Large, E. W.** (2013). Auditory brainstem EEG, residue pitch, and nonlinear dynamical systems. *Biennial Conference of the Society for Music Perception and Cognition*, Toronto, ON, Aug 8-11.
87. **Large, E. W.** & Almonte, F. (2011). Neurodynamics and learning in musical tonality. Podium Presentation at the *Biennial Conference of the Society for Music Perception and Cognition*, Rochester, NY, Aug 11-14.
88. **Large, E. W.** (2011). Musical tonality, neural resonance and Hebbian learning. Podium Presentation at the *3rd International Conference on Mathematics and Computation*, Paris, France, Jun 15-17.
89. **Large, E. W.** & Velasco, M. J. (2011). Neurodynamics of musical meter. Podium Presentation at the *Rhythm Perception and Production Workshop*, Leipzig Germany, Jul 13-15.
90. Rankin, S. & **Large, E. W.** (2010). Fractal (1/f) structure and predictive entrainment in music, Podium Presentation at the *Northeast Music Cognition Group*, Yale University, New Haven, CT, May 1.
91. **Large, E. W.** & Velasco, M. J. (2010). Neural oscillation: Implications for pulse and meter in complex rhythms, Podium Presentation at the *West Coast Sequencing and Timing Workshop*, UC Santa Barbara, Santa Barbara, CA, Jan 16.
92. **Large, E. W.** & Velasco, M. J. (2009). Modeling pulse and meter as neural oscillation, Podium Presentation at the *Biennial Conference of the Society for Music Perception and Cognition*, Indianapolis, IN, Aug 3-7.
93. Chapin, H., Jantzen, K. J., Kelso, J. A. S., Steinberg, F. & **Large, E. W.** (2009). Emotional and neural response dynamics depend on performance expression and listener experience, Podium Presentation at the *Biennial Conference of the Society for Music Perception and Cognition*, Indianapolis, IN, Aug 3-7.
94. Rankin, S., **Large, E. W.** & Sapp, C. (2009). Fractal structure of tempo fluctuations in skilled piano performance, Podium Presentation at the *Biennial Conference of the Society for Music Perception and Cognition*, Indianapolis, IN, Aug 3-7.
95. Gordon, R. L., Magne, C. L. & **Large, E. W.** (2009). Song prosody: Electrophysiological correlates of temporal alignment and metrical regularity in textsetting, Poster Presentation at the *Biennial Conference of the Society for Music Perception and Cognition*, Indianapolis, IN, Aug 3-7.
96. **Large, E. W.**, Velasco, M. & Gray, P. (2008). Rhythmic analysis of musical interactions between bonobo and human, Podium Presentation at the *10th International Conference on Music Perception and Cognition*, Sapporo, Japan, Aug 25-19.
97. Fujioka, T., **Large, E. W.**, Trainor, L. J. & Ross, B. (2008). Time courses of cortical beta and gamma-band activity during listening to metronome sounds in different tempos, Podium Presentation at the *10th International Conference on Music Perception and Cognition*, Sapporo, Japan, Aug 25-19.
98. Velasco, M. & **Large, E. W.** (2008). Nonlinear time-frequency transformation: Implications for pitch & tonality, Podium Presentation at the *10th International Conference on Music Perception and Cognition*, Sapporo, Japan, Aug 25-19.

99. Chapin, H. L. & **Large, E. W.** (2008). Affective Responses to Music Performance: An fMRI Study, Podium Presentation at the *10th International Conference on Music Perception and Cognition*, Sapporo, Japan, Aug 25-19.
100. **Large, E. W.** & Snyder, J. S. (2008). Dynamics of rhythm perception and attention. Podium presentation at the 3rd International Conference on the Neurosciences and Music III. Montreal, QC, Jun 25.
101. Chapin, H., Zanto, T. P. & **Large, E. W.** (2007). Attending to complex rhythms: An fMRI study, Podium Presentation at *Biennial Conference of the Society for Music Perception and Cognition*, Montreal, QC, Jul 30 – Aug 3, 2007.
102. Gordon, R.L., Magne, C. L. & **Large, E. W.** (2007). The Influence of temporal alignment of lyrics and melody on semantic integration in song: EEG and behavioral evidence. Podium Presentation at Society for Music Perception and Cognition, Montreal, QC, Jul 30 – Aug 3, 2007.
103. Loehr, J., Palmer C. P. & **Large, E. W.** (2007). Synchronizing piano performances to a changing tempo. Podium Presentation at Society for Music Perception and Cognition, Montreal, QC, Jul 30 – Aug 3, 2007.
104. Gordon, R.L. & **Large, E. W.** (2007). EEG correlates of text-setting and semantic integration in song prosody. Podium Presentation at Language and Music as Cognitive Systems Conference. Cambridge, U.K., May 11-13, 2007.
105. Gordon, R.L. & **Large, E. W.** (2007) "Song prosody: EEG study of the influence of textsetting on intelligibility in song". Podium Presentation at Conference on Interdisciplinary Musicology '07. Tallinn, Estonia, Aug 15-19, 2007.
106. Hannon, E. E., Snyder, J. S., **Large, E. W.** & Christiansen (2005). Synchronization and continuation tapping to complex meters. Podium Presentation at the *10th Annual Rhythm Perception and Production Workshop*, Bilzen, Belgium.
107. **Large, E. W.** (2005). A generic nonlinear model for auditory perception. Poster presentation at the Ninth International Symposium on the Mechanics of Hearing, Portland, Oregon, USA 23-28 Jul.
108. Rankin, S.K., **Large, E. W.**, Fink, P. & Houlton, S. (2005). Following Changes in Tempo. Poster presentation at the 2nd International Conference on the Neurosciences and Music. Liepzig, Germany, May.
109. **Large, E. W.** (2005). Tonality and Nonlinear Resonance. Poster presentation at the 2nd International Conference on the Neurosciences and Music. Liepzig, Germany, May.
110. **Large, E. W.** (2004). Nonlinear Time-Frequency Analysis and Auditory Perception. Podium presentation at the 3rd Annual Auditory Perception, Cognition and Action Meeting, Nov.
111. Zanto, T. P., **Large, E. W.**, Fuchs, A., & Kelso, J. A. S. (2004). Gamma-band activity during temporally perturbed auditory sequences. New England Sequencing and Timing Conference. New Haven, CT.
112. Nair, D., **Large, E. W.**, Jantzen, K. J., Steinberg, F. & Kelso, J. A. S. (2004). Limbic and paralimbic responses to music performance: Effects of performance expression and musical training. New England Sequencing and Timing Conference. New Haven, CT.
113. Zanto, T. P., **Large, E. W.** (2003). Gamma-band activity during perturbed auditory sequences. *Rhythm Perception and Production Workshop*, Ile de Tatihou, France, Jul.

114. Snyder, J. S., & **Large, E. W.** (2002). Neurophysiological correlates of meter perception: Evoked and induced gamma-band (20-60 Hz) activity. *Coordination Dynamics International Conference on Brain and Behavior*. Delray Beach, FL.
115. Nair, D.G., **Large, E. W.**, Steinberg, F.L., & Kelso, J.A.S. (2002). Emotional communication in music performance: A functional MRI study, *Dynamical Neuroscience X NIMH Symposium*, Orlando, Florida, Nov 1-2.
116. Nair, D.G., **Large, E. W.**, Steinberg, F.L., & Kelso, J.A.S. (2002). Perceiving emotion in expressive piano performance: A functional MRI Study. *Coordination Dynamics International Conference on Brain and Behavior*, Delray Beach, FL.
117. **Large, E. W.** & London, J. (2002). Non-isochronous accent structures and meter perception. *International Conference on Music Perception and Cognition*.
118. Houlton, S., Fink, P. & **Large, E. W.** (2002). Synchronization with expressive musical performances. *International Conference on Music Perception and Cognition*.
119. **Large, E. W.**, Fink, P., & Houlton, S. (2002). Statistical structure of expressive piano performances in four musical styles. *International Conference on Music Perception and Cognition*.
120. **Large, E. W.** (2000). Tracking simple and complex rhythms. In *Proceedings of the International Conference on Rhythm Perception and Performance*. Aug, 2000.
121. **Large, E. W.** (2000). On the persistence of metrical percepts. In *Proceedings of the International Conference on Music Perception and Cognition*. Aug, 2000.
122. **Large, E. W.** (1999). Auditory attending dynamics. Poster presented at *Dynamical Neuroscience Workshop,* Nov, 1999.
123. **Large, E. W.** (1999). The temporal structure of rhythms and the dynamics of attending. Talk presented at *Debates in Dynamics Workshop*, Penn State University, Aug, 1999.
124. **Large, E. W.** (1999). The birth of a beat: Metrical patterns and category formation. Talk presented at the *Society for Music Perception and Cognition*, Northwestern University, Aug, 1999.
125. Goldenstein, S., Metaxis, D. M., and **Large, E. W.** (1999). Nonlinear Dynamic Systems for Autonomous Agents Navigation. AAAI SS2000, Mar 2000**.**
126. **Large, E. W.** & Palmer, C. (1997). Modeling the perception of meter in musical performance. Notes of the *Society for Music Perception and Cognition*. Boston, Jul.
127. **Large, E. W.** (1997). *Scaling the dynamic approach to path planning*. Proceedings of the IEEE International Symposium on Industrial Electronics.
128. **Large, E. W.** (1995). Nonlinear dynamics and meter perception in musical performance. Notes of the *Society for Music Perception and Cognition*. Berkeley, Jun.
129. **Large, E. W.** (1994). Rhythm Perception and Performance Workshop, Sheffield, England. Jun.
130. **Large, E. W.** (1994). *The resonant dynamics of beat tracking and meter perception*. In Proceedings of the 1994 International Computer Music Conference. Computer Music Association.
131. **Large, E. W.**, & Kolen, J. F. (1993). *A dynamical model of the perception of metrical structure*. Notes of the Society for Music Perception and Cognition. Philadelphia, Jun.

**KEYNOTES, PLENARIES AND INVITED LECTURES**

"Physically embodied music cognition," *International Conference on Music Perception and Cognition,* San Francisco, CA, Jul 6, 2016.

"Musical Neurodynamics: How Music Speaks the Language of the Brain," *CEM15 International Congress on Cognition, Emotion, Motivation*, Hammamet, Tunisia, Nov 4, 2015. (unable to attend).

"Neurodynamics of Music Perception" *International Brain Research Organization: Symposium on Music and the Brain,* Rio de Janeiro, Brazil, July 8, 2015.

"Is Music Perception Neural Resonance?" *New England Music Cognition Group Meeting in Honor of David Wessel,* Wesleyan University, Middletown, CT, Apr 4, 2015.

"Neural networks for pulse perception in musical rhythm," *IGERT J-Term Dinner Talk,* University of Connecticut, Storrs, CT, Jan 15, 2015.

"Neural networks for pulse perception in musical rhythm," *The Guy Van Orden Workshop on Cognition and Dynamics, IX,* University of Connecticut, Storrs, CT, Aug 20-22, 2014.

"Neural networks for pulse perception in musical rhythm," *Cross-Disciplinary and Multi-Cultural Perspectives on Musical Rhythm and Improvisation II,* NYU Abu Dhabi Institute, Abu Dhabi, UAE, Oct 12-15, 2014.

"Signal Processing, Plasticity and Pattern Formation in Networks of Neural Oscillators," *AFOSR Sensory Information Systems Program Review,* Doolittle Institute, Fort Walton Beach, Florida, Oct 6-8, 2014.

"Neurodynamics of music perception," *CHASE Summer School on the Dynamics of Music and Language*, Tenaya Lodge, Yosemite, CA, May 18-20, 2014.

"Neurodynamics of music," *9th Annual NeuroMusic Conference*, McMaster Institute for Music and the Mind, McMaster University, Hamilton, Ontario, Nov 23, 2013.

"Neurodynamics of rhythmic communication," *Musical Rhythm Workshop*, NYUAD, Abu Dhabi, UAE, Mar 19, 2013.

"Neurodynamic constraints on musical languages," *7th Annual Auditory Cognitive Neuroscience Society Meeting*, University of Arizona, Jan 4, 2013.

"Auditory rhythms and neural resonance," *18th International Conference on Biomagnetism*, Paris, France, Aug 26 - 30, 2012.

"Rhythm processing in networks of neural oscillators," *Perspectives on Rhythm and Timing,* University of Glasgow, July 21, 2012.

"Resonating to Rhythm," *Perspectives on Rhythm and Timing,* University of Glasgow, July 20, 2012.

"Musical Communication through Resonance," *Produire Le Temps, IRCAM,* Paris, France, June 15, 2012.

"Resonating to Rhythm," *European Brain and Music Consortium (EBRAMUS) Spring School,* University of Ghent, Belgium, Mar 3, 2012.

"A Universal 'Grammar' for Music," *Mathematical Models of Cognitive Architectures*, Université de la Méditerranée, Marseille, France. Dec 5-9, 2011.

**"**Neurodynamics of Tonality," *The Neurosciences and Music – IV Learning and Memory*, Edinburgh, Scotland, Jun 9-12, 2011.

"Neurodynamics of Music and Auditory Perception," *Max Planck Florida Institute Inaugural Neuroscience Symposium*, Florida Atlantic University, Boca Raton, FL. Sep 28-29, 2010.

"Musical Neurodynamics: Dynamic Patterns and the Experience of Music," *Summer Workshop on Music, Pattern and Mathematics*, Herstmonceux Castle, East Sussex, UK. Aug 9, 2010.
"Nonlinear Signal Processing based on Neural Oscillation," *DARPA/NASA Acoustics Infrastructure Workshop*, NASA Langley Research Center, VA. Mar 9, 2010.
"Nonlinear Signal Processing with Networks of Neural Oscillators," *Neuromorphic Engineering Workshop,* Telluride, Colorado. Jul 6, 2009.
"Music and Dynamical Systems," *Interdisciplinary College 2009,* Guenne, Germany, Mar 8-13, 2009.
"What is Universal in Music?" *Nonlinear Dynamics in Movement and Cognitive Sciences, International Summer School*, Marseilles, France, Jul 16-21, 2007.
"Nonlinear Dynamics in Auditory Perception" *Behavioral & Cognitive Dynamics Workshop*, Cornell University, Aug 6-9, 2007.
"Endogenous metrical rhythm and nonlinear oscillation" *Symposium on Meter Processing, Society for Music Perception and Cognition*, Montreal, QC, Jul 30 – Aug 3, 2007.
"Rhythm and Expectation" *Dialogues across disciplines: Exploring rhythm and the brain*, *Institute for Music and Neurologic Function*. New York, NY. Mar, 2006.
"Limbic and paralimbic responses to music: Effects of performance expression and musical training" *BRAIN Workshop, McMaster University*, Hamilton, ON. Nov 18, 2005.
"Nonlinear oscillation: A musical Universal?" Second Entrainment Network Workshop, Columbus, Ohio. Apr 2005.
"A dynamical systems approach to tonality" *International Conference on Brain, Mind and Culture*, Limassol, Cyprus. Dec, 2004.
"The Role of Attention and Perception" *Cognitive Neuroscience and Music Processing in Human Function*, *Institute for Music and Neurologic Function*. New York, NY. Dec, 2002.
"Representation and Communication in Music" *Coordination Dynamics International Conference on Brain and Behavior*. Delray Beach, Florida. May, 2002.
"A dynamic approach to making decisions and sequencing behaviors" *5th International Symposium on Intelligent Robotics*. Stockholm, Sweden. Jul, 1997.

**INVITED TALKS**

McMaster University, Department of Psychology, Hamilton, ON. Mar, 2018
MIT, Cognitive Rhythms Collaborative, Cambridge, MA. Oct, 2017
Northeastern University, Boston Action Club, Boston, MA. Sep, 2017
New York University, Courant Institute of Mathematical Sciences, New York, NY. Mar, 2017
Stanford University, CCRMA Hearing Seminar, Oct, 2016
New York University, Courant Institute of Mathematical Sciences, New York, NY. Apr, 2016
University of Connecticut, Institute for Brain and Cognitive Sciences, Mar, 2016
Brown University, Perception-Action Seminar, Providence, RI. Oct, 2015
Stanford University, CCRMA Hearing Seminar. Oct, 2015
Boston University, Hearing Research Center, Boston, MA. Apr, 2015
University of Connecticut, Department of Music, Storrs, CT. Nov 7, 2014
University of Conn Health Center, Department of Neuroscience, Farmington, CT. Sep 16, 2014
Stanford University, Center for Computer Research in Music and Acoustics. May, 2014
Air Force Research Laboratories, Wright-Patterson AFB, Dayton, OH. Oct, 2014
Yale University, Haskins Laboratory, New Haven, CT. Mar 28, 2014

University of Connecticut, Department of Physics, Storrs, CT. Nov 8, 2013
University of Connecticut, Department of Psychology, Storrs, CT. Feb 27, 2013
Indiana University School of Medicine, Dept of Otolaryngology, Indianapolis, IN. Nov 14, 2012
University of Utrecht, Dept of Information and Computing Sciences, Utrecht, NL. Feb 27, 2012
Universität Bielefeld, Faculty of Engineering Sciences, Bielefeld, Germany. Dec 10, 2011
Northeastern University, Boston Action Club, Boston, MA. Oct 20, 2011
University of Rochester, Brain & Cognitive Sciences, Rochester, NY. Oct 12, 2011
New York University, Department of Psychology, New York, NY. May 24, 2011
University of California at Santa Barbara, Department of Psychology. Jan 16, 2010
Open University, Faculty of Music, Milton Keynes, England. Dec 7, 2009
Eastman School of Music, University of Rochester, New York. Oct 24, 2009
Wright-Patterson Air Force Base, Air Force Research Laboratory, Jun 28, 2009
Max Planck Institute for Human Cognitive and Brain Sciences, Dept of Psychology, Jun 3, 2009
University of North Carolina, Department of Music, Mar 30, 2009
Air Force Office of Scientific Research, Arlington, VA, January 28, 2009
Stanford University, Center for Computer Research in Music and Acoustics, May 17, 2008
Max Planck Institute for Human Cognitive and Brain Sciences, Dept of Psychology, May 4, 2008
Northwestern University, Department of Communication Sciences and Disorders, Apr 18, 2008
Northwestern University, Department of Psychology, January 17, 2008
McMaster University, Department of Psychology, Nov 29, 2007
Stanford University, Center for Computer Aided Research in the Humanities, Apr 13, 2007
Stanford University, Center for Computer Research in Music and Acoustics, Apr 11, 2007
University of California at Berkeley, Center for New Music and Audio Technologies, Apr 10,2007
University of Montreal, BRAMS, Department of Psychology, Mar 5, 2007
McGill University, CIRMMT Distinguished Lecture on the Science of Music, Oct 26, 2006
University of Montreal, BRAMS, Department of Psychology, Oct 13, 2006
McGill University, Department of Psychology, Sep 12, 2006
Stanford University, Center for Computer Aided Research in the Humanities, May 12, 2006
University of California at Berkeley, Ctr for New Music and Audio Technologies, May 12, 2006
Stanford University, Center for Computer Research in Music and Acoustics, May 11, 2006
Northwestern University, Northwestern Conference on Complex Systems, Apr 21, 2006
Cambridge University, Faculty of Music, Cambridge, England. Dec, 2005
Open University, Faculty of Music, Milton Keynes, England. Dec, 2005
IBM Speech Recognition Group, Boca Raton, FL, Jun 2005
University of Muenster, Institute for Biomagnetism and Biosignal Analysis, May, 2005
The Rotman Research Institute, Baycrest Centre for Geriatric Care, Toronto, January, 2005
Wright-Patterson Air Force Base, Air Force Research Laboratory, January, 2004
IBM T. J. Watson Laboratories, Yorktown Heights, NY, Dec, 2002
The Ohio State University, Center for Cognitive Science, Mar 2000
Pennsylvania State University, Department of Psychology, Aug, 1999
Pennsylvania State University, Department of Computer Science, Aug,1999
Pennsylvania State University, Department of Psychology, Sep, 1998
The Neurosciences Institute, La Jolla, CA, Aug, 1997
University of Pennsylvania, Institute for Research in Cognitive Science, Jun, 1996

Rutgers University, Computer Science Department, Nov, 1996
University of West Florida, Computer Science Department, Apr, 1996
NEC Research Institute, Princeton, NJ. Oct, 1996
Massachusetts Institute of Technology, Media Laboratory, Apr, 1995

## PUBLIC APPEARANCES AND LECTURES

"Notes on the folds: Why music makes us shiver," World Science Festival, New York, NY, Jun 2, 2018.
"Brain Rhythms, Musical Rhythms," The Loxahachee Club, Jupiter, FL, Feb 22, 2018.
"Neuroscience and music," Thelonious Monk Institute of Jazz, Math Science Music, Apr 22, 2016.
"Rhythm: What is it? Who has it? Why?" *Etihad Towers Hotel*, Abu Dhabi, UAE, Mar 18, 2013.
"Music and the Brain" *Museum of Science & Discovery*, Ft. Lauderdale, FL, Jan 30, 2009.
"Music, Neuroscience and Evolution" *Frontiers in Science* Lecture Series, FAU, Oct, 2007.
"What is Universal in Music?" *Brandies Lakes Study Group*, Boca Raton, FL, Jan 25, 2006.

## CONFERENCES, WORKSHOPS & SYMPOSIA ORGANIZED

**Workshop Organizer**, *New England Sequencing and Timing (NEST),* University of Connecticut, Storrs, CT, April 21, 2018
**Workshop Organizer**, *Neural Entrainment and Rhythm Dynamics,* Satellite Conference to Neuromusic 2017, Boston, MA, June 15, 2017
**Workshop Organizer**, *New England Sequencing and Timing (NEST),* University of Connecticut, Storrs, CT, March 25, 2017
**Symposium Organizer**, *Pulse, Meter and Groove,* Society for Music Perception and Cognition, Indianapolis, IN, Aug 4, 2009
**Symposium Organizer**, *Dynamical Approaches in the Study of Music Perception and Performance,* Acoustical Society of America, Miami, Nov 10 – 11, 2008
**Symposium Organizer**, *Rhythms and the Brain: Basic Science and Clinical Applications,* The Neurosciences and Music – III: Disorders and Plasticity, Montreal, Jun 25-28, 2008
**Conference Organizer**, *Entrainment Network IV,* International Conference. Delray Beach, Florida, May 5–8, 2006.
**Workshop Co-Organizer**, *Music and Dynamics,* Society for Music Perception and Cognition Workshop. The Neurosciences Institute, La Jolla, CA, Aug 5, 2005.

## INVITED WORKSHOP PARTICIPANT / PANELIST

"NIH BRAIN Initiative Workshop: Industry Partnerships to Facilitate Early Access to Neuromodulation and Recording Devices for Human Clinical Studies," Neuroscience Center, Rockville, MD, Jun 3-4, 2015.
"Acoustics Infrastructure Workshop," NASA Langley Research Ctr, Mar 9-10, 2010.
"Dynamic Systems Workshop," *National Science Foundation*, Arlington, VA. May 15, 2007.
"Frontiers in Dynamic Systems," *National Science Foundation*, Arlington, VA. Mar 1–2, 2007.
"Brain-wave Entrainment to Rhythmic Stimuli: Interdisciplinary Research and Clinical Perspectives," *Ctr for Computer Research in Music and Acoustics*, Stanford Univ. May 13, 2006.

## EDITORIAL WORK

**Review Panels** National Science Foundation, Perception, Action & Cognition, 2005–2008.

**Funding Agencies** National Institutes of Health, National Science Foundation, Canadian Institutes of Health Research, Netherlands Organisation for Scientific Research Air Force Office of Scientific Research.

**Books** MIT Press, Oxford University Press, Routledge / Taylor & Francis Group

**Journals** Proceedings of the National Academy of Sciences, Nature, Frontiers, PLoS One, Journal of Neuroscience, Journal of Cognitive Neuroscience, Cerebral Cortex, Neuroimage, Brain Sciences, Psychological Review, Perception and Psychophysics, JEP:HPP, Psychological Research, Cognition, Quarterly Journal of Experimental Psychology, Australian Journal of Psychology, Timing and Time Perception, Psychometrika, Advances in Cognitive Psychology, Human Movement Science, Journal of the Acoustical Society of America, Music Perception, Contemporary Music Review, IEEE Transactions on Audio, Speech & Language Proc., IEEE Trans. on Neural Networks, Neural Computation, Connection Science, IEEE Expert, AI Magazine

## PROFESSIONAL MEMBERSHIPS & HONOR SOCIETIES

Society for Music Perception and Cognition, American Association for the Advancement of Science, Acoustical Society of America, Society for Neuroscience, Association for Research in Otolaryngology, Cognitive Science Society, American Psychological Association, Cognitive Neuroscience Society, Institute for Neuromorphic Engineering, New York Academy of Sciences, Association for Computing Machinery, Upsilon Pi Epsilon (Alumnus), Fulbright Association, Scientists Without Borders

## BOARDS

Program Committee, Rhythm Perception and Production Workshop (RPPW) 2015.
Program Committee, International Conference on Computer Music (ICMC) 2015.
Program Committee, Australian Music and Psychology Society (AMPS) 2015.
Executive Committee, *International College*, 2012 –
Scientific Advisory Board, *European Brain and Music Consortium,* 2011 – 2013
Board of Directors, *Fulbright Association, South Florida Chapter*, 2009 – 2010
Scientific Advisory Board, *International Computer Music Conference*, 2009
Scientific Advisory Panel, *New Frontiers in Dynamic Systems*, NSF, 2007 – 2008
Scientific Advisory Board, *Intl Conference on Music Perception and Cognition*, 2002, 2008, 2010, 2012
Scientific Advisory Board, *Institute for Music and Neurologic Function*, 2001 – 2016

## SELECTED SERVICE (UCONN)

Member, Promotion and Tenure Committee, Dept of Psychological Sciences, 2015 – present.
Member, Postdoc Advisory Committee, University of Connecticut, 2015 – present.
Member, Promotion and Tenure Committee, Department of Psychological Sciences, University of Connecticut, 2015 – present.
Member, Brain, Mind and Cognition Strategic Area Advisory Committee, University of Connecticut, Fall 2013.

## TEACHING & ADVISING

### *Undergraduate Courses*

Music Perception & Cognition, Auditory Perception, Psychology of Attention, Cognitive Modeling

### *Graduate Courses*

Intro to Nonlinear Dynamics, Advanced Nonlinear Dynamics, Dynamical Brain Theory, Cognition Dynamics, Cognitive Science Seminar, Music Perception, Auditory Perception, Contemporary Issues in Consciousness Research, Cognition Dynamics, Neuroscience Seminar, Signal Processing by Neural Oscillators, Computational Auditory Scene Analysis, Computational Music Cognition, Weakly Connected Neural Networks, Physiology of Mammalian Auditory Pathway, Auditory Nonlinearities, Attention, Time Perception

### *M.S. and Ph.D. Graduates*

AmirAli Farokhniaee, Ph.D. Physics, 2016
Postdoctoral Fellow, Department of Biomedical Engineering, Case Western Reserve University

Nicole Flaig, M.S. Psychology, 2016
Senior Analyst, The Advisory Board Company, Washington, DC

Summer Rankin, Ph.D. Complex Systems & Brain Sciences, 2010
Postdoctoral Fellow, Department of Otolaryngology, School of Medicine, Johns Hopkins Univ

Reyna Gordon, Ph.D. Complex Systems & Brain Sciences, 2010
Postdoctoral Fellow, Department of Psychology, Vanderbilt Univ

Heather L. Chapin, Ph.D. Complex Systems & Brain Sciences, 2009
Postdoctoral Fellow, Department of Anesthesiology, School of Medicine, Stanford Univ

Theodore P. Zanto, Ph.D. Complex Systems & Brain Sciences, 2006
Assistant Professor, Department of Psychology, University of California San Francisco

Dinesh Nair, Ph.D. Complex Systems & Brain Sciences, 2004
Department of Neurology, Massachusetts General Hospital

Joel S. Snyder, Ph.D. Psychology (Cornell), 2003
Assistant Professor, University of Nevada at Las Vegas

### *Postdoctoral Advisees and Ph.D. Students (Current)*

Ji Chul Kim, PhD, Jung Nyo Kim, PhD, Karl Lerud, M.S., Charles Wasserman, B.S., Yi Wei., M.S.

### *Ph.D. Committees*

Parker Tichko, M.S., Dameon Harrell, M.S.