Alexander J. E. Kell

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Department of Brain and Cognitive Sciences
Massachusetts Institute of Technology
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Research interests

Auditory perception & cognition – computation, neuroscience, behavior
Computational neuroscience
Functional organization of auditory cortex
Deep learning
Natural sound statistics
Similarities & differences between sensory modalities (particularly vision & hearing)

Education & Professional Experience

Columbia University
Postdoctoral researcher at Zuckerman Institute (2019-)
Advisor: Elias Issa

Massachusetts Institute of Technology
Ph.D. student in Brain and Cognitive Sciences (2013-2019)
Advisor: Josh McDermott

Lawrence Berkeley National Lab
Visiting researcher in Life Sciences and Computational Research Divisions (Jan – Mar 2017)

Cold Spring Harbor Laboratory
Computational Neuroscience: Vision (July 2016)

Massachusetts Institute of Technology
Kanwisher Cognitive Neuroscience Lab Technician (2011-2013)
Graybiel Macaque Neurophysiology Lab Technician (2010-2011)

Dartmouth College
B.A. in Neuroscience with High Honors (2006-2010)
Advisor: Jerald Kralik; thesis on executive control and macaque neurophysiology

Beijing Normal University
Studied written and spoken Mandarin Chinese (2007)

Funding

2019-2022: NIH National Research Service Award (F32)
2014-2018: Department of Energy Computational Science Graduate Fellowship

Honors/Awards

2018: Advances and Perspectives in Auditory Neuroscience (APAN) Travel Award
2017: International Conference on Auditory Cortex Travel Award
2017: Cosyne Presenters Award
2015: Vision Sciences Society Best Student Poster Award
2015: Association for Otolaryngology Travel Award

2015: Vision Sciences Society Travel Award
2014: NVIDIA Academic Hardware Donation Program (GPU donation)
2010: Neuroscience Center at Dartmouth Award for Best Thesis Presentation
2009: Rufus Choate Scholar
2008: Citation for Academic Achievement in Advanced Modern Chinese

Papers

Kell A.*, Yamins D.*, Shook E., Norman-Haignere S., McDermott J. A task-optimized neural network replicates human auditory behavior, predicts brain responses, and reveals a cortical processing hierarchy. *Neuron*. 2018.

Carlile S., Ciccarelli G., Cockburn J., Diedesch A., Finnegan M., Hafter E., Henin S., Kalluri S., **Kell A.**, Ozmeral E., Roark C., and Sagers J. Listening Into 2030 Workshop: An Experiment in Envisioning the Future of Hearing and Communication Science. *Trends in Hearing*. 2017.

Conference abstracts

Kell A., McDermott J. Invariance to real-world background noise as a signature of non-primary auditory cortex. San Diego, CA: Society for Neuroscience, November 2018. (**Talk**)

Kell A., Shook E., McDermott J. Evaluating the generality of deep neural networks as a model of human hearing: Comparison with a large set of psychophysical and neural experiments. San Diego, CA: Advances and Perspectives in Auditory Neuroscience (APAN), November, 2018.

Kell A., Shook E., McDermott J. Robustness to real-world background noise: A physiological signature of non-primary auditory cortex. Denver, CO: Computational and Systems Neuroscience (COSYNE), February 2018.

Kell A., Shook E., McDermott J. Cortical robustness to real-world background noise differentiates primary from non-primary auditory cortex. San Diego, CA: Association for Research in Otolaryngology, February 2018.

Shook E., **Kell A.**, McDermott J. Exploring speech-trained deep neural networks as models of human auditory behavior. San Diego, CA: Association for Research in Otolaryngology, February 2018.

Kell A., Shook E., McDermott J. Robustness of cortical sound encoding to synthetic and to real-world background noise. Washington, DC: Advances and Perspectives in Auditory Neuroscience (APAN), November, 2017.

Kell A., McDermott J. Exploring the robustness of cortical sound encoding to real-world background noise. Banff, Canada: International Conference on Auditory Cortex, September, 2017.

Kell A., McDermott J. Robustness to real-world background noise increases from primary to non-primary human auditory cortex. Boston, MA: Acoustical Society of America, June 2017.

Kell A., McDermott J. Robustness to real-world background noise increases from primary to non-primary auditory cortex. Salt Lake City, UT: Computational and Systems Neuroscience (COSYNE), February 2017.

Kell A., McDermott J. Robustness to real-world background noise increases between primary and non-primary human auditory cortex. Baltimore, MD: Association for Research in Otolaryngology, February 2017. (**Talk**)

Kell A.*, Yamins D.*, Norman-Haignere S., McDermott J. Hierarchical computation in human auditory cortex revealed by deep neural networks. Baltimore, MD: Association for Research in Otolaryngology, February 2017. (**Selected for "Poster Blitz" presentation**)

Kell A., McDermott J. Noise-robustness of cortical responses to natural sounds increases from primary to non-primary auditory cortex. San Diego, CA: Society for Neuroscience, November 2016. (**Talk**)

Kell A., McDermott J. Noise-robustness of cortical responses to natural sounds increases from primary to non-primary auditory cortex. San Diego, CA: Advances and Perspectives in Auditory Neuroscience (APAN), November 2016. (**Selected for "Poster Teaser" presentation**)

Kell A.*, Yamins D.*, Norman-Haignere S., McDermott J. Speech-trained neural networks behave like human listeners and reveal a hierarchy in auditory cortex. Salt Lake City, UT: Computational and Systems Neuroscience (COSYNE), February 2016.

Kell A.*, Yamins D.*, Norman-Haignere S., McDermott J. Functional organization of auditory cortex revealed by neural networks optimized for auditory tasks. Chicago, IL: Advances and Perspectives in Auditory Neuroscience (APAN), October 2015. (**Selected for "Poster Teaser" presentation**)

Kell A.*, Yamins D.*, Norman-Haignere S., McDermott J. Functional organization of auditory cortex revealed by neural networks optimized for auditory tasks. Chicago, IL: Society for Neuroscience, October 2015. (**Talk**)

Kell A.*, Yamins D.*, Norman-Haignere S., Seibert D., Hong H., DiCarlo J., McDermott J. Computational similarities between visual and auditory cortex studied with convolutional neural networks, fMRI, and electrophysiology. St. Pete's Beach, FL: Vision Sciences Society, May 2015. (**Best Student Poster Award**)

Yamins D.*, **Kell A.***, Norman-Haignere S., McDermott J. Using speech-optimized convolutional neural networks to understand auditory cortex. Salt Lake City, UT: COSYNE: Computational Systems Neuroscience, March 2015. (**Talk**)

Kell A.*, Yamins D.*, Norman-Haignere S., McDermott J. Deep neural networks trained on speech tasks predict auditory cortex responses to natural sounds. Baltimore, MD: Association for Research in Otolaryngology, February 2015.

Lafer-Sousa R., Conway B., **Kell A.**, Takahashi A., Feather J., Kanwisher N. G. Similar organization of the ventral visual pathway in humans and macaque monkeys: Color regions sandwiched between face and scene regions. Washington, DC: Society for Neuroscience, November 2014.

Kell A.*, Yamins D.*, Norman-Haignere S., McDermott J. Similarities between deep neural networks trained on speech tasks and human auditory cortex. Cambridge, MA: Speech & Audio in the Northeast: SANE 2014, October 2014.

Lafer-Sousa R., **Kell A.**, Takahashi A., Feather J., Conway B., Kanwisher N. G. Parallel processing of colors and faces in human ventral visual stream: functional evidence and technical challenges. St. Pete Beach, FL: Vision Sciences Society, May 2014.

Kell A., Koldewyn K., Kanwisher N. G. The ventral visual pathway in adults with autism. Boston, MA: Boston Autism Consortium, November 2013.

Kell A., Koldewyn K., Kanwisher N. G. The ventral visual pathway in adults with autism. Naples, FL: Vision Sciences Society, May 2013.

Khan S., **Kell A.**, Klepac K., Levine W., Kralik J. Monitoring the mundane: Rhesus macaque ventromedial prefrontal cortex makes lower quality options more engaging. San Diego, CA: Society for Neuroscience, November 2010.

Graduate coursework

CS281: **Advanced Machine Learning** (Harvard) – Adams
6.438: **Algorithms for Inference** – Bresler
6.860/9.520: **Statistical Learning Theory and Applications** – Poggio, Rosasco
18.0851: **Computational Science and Engineering** – Strang
6.338/18.337: **Parallel Programming** – Edelman
9.660/6.804: **Computational Cognitive Science** – Tenenbaum
9.S912: **Vision & Learning: Brains & Machines** – Poggio, Ullman
HST723: **Neural Coding and the Perception of Sound** (MIT/Harvard) – Delgutte, Guinan, Brown
9.011: **Systems Neuroscience** – Miller, Wilson
9.012: **Cognitive Science** – Tenenbaum, Sinha, Gibson
9.S913: **fMRI for Cognitive Neuroscientists** – Kanwisher, Saxe

Professional Talks

November 2018: "Invariance to real-world background noise as a signature of non-primary auditory cortex." Society for Neuroscience Nanosymposium; San Diego, CA
September 2018: "Invariant and hierarchical computation in human auditory cortex." École Normale Supérieure; Paris, France
July 2018: "Invariant and hierarchical computation in human auditory cortex." Computational Science Graduate Fellowship Program Review; Washington, DC
June 2018: "Invariant and hierarchical computation in human auditory cortex." 2018 MIT Brain and Cognitive Sciences Department Retreat; Newport, RI
May 2018: "Understanding auditory cortical computation." Columbia University; New York, NY.
Feb 2018: "Invariance in auditory cortex." Johns Hopkins University; Baltimore, MD
Jan 2018: "Invariance in auditory cortex." Oregon Health Sciences University; Portland, OR
June 2017: "Using deep learning to model and to understand human auditory cortex." Computational Research in Boston and Beyond (CRIBB); Cambridge, MA
February 2017: "Hierarchical computation in human auditory cortex revealed by deep neural networks." Cosyne Workshops; Snowbird, UT
February 2017: "Robustness to real-world background noise increases between primary and non-primary human auditory cortex." Association for Research in Otolaryngology; Baltimore, MD
November 2016: "Noise-robustness of cortical responses to natural sounds increases from primary to non-primary auditory cortex." Society for Neuroscience; San Diego CA
May 2016: "Auditory cortical robustness to real-world background noise." Auditory Cortex Splash Meeting; Cambridge, MA
May 2016: "Using convolutional neural networks to understand auditory cortex." Vision Science Society: Symposium on deep neural networks and biological vision; St. Pete's Beach, FL
May 2016: "Invariance in auditory cortex." MIT Department of Brain + Cognitive Sciences Cog Lunch; Cambridge, MA
October 2015: "Functional organization of auditory cortex revealed by neural networks optimized for auditory tasks." Society for Neuroscience Nanosymposium; Chicago, IL
July 2013: "Functional organization of category-selective visual areas in adults with Autism." State Key Laboratory of Cognitive Neuroscience and Learning; Beijing, China

Teaching Experience

fMRI Methods Short Course at Massachusetts General Hospital (October 2015)
TA.

MIT Center for Brains Minds and Machines Summer School in Woods Hole (Aug-Sept 2015)
TA at three-week summer school for thirty graduate students. Lectured on linear algebra.

9.40: Introduction to Neural Computation (Spring 2015)

TA for Prof. Michale Fee's undergraduate class on biophysics and computational neuroscience. Ran recitations on Poisson processes, spectral analysis, PCA, linear algebra, recurrent neural networks, etc.

MIT Center for Brains Minds and Machines Summer School in Woods Hole (June 2014)
TA for cognitive neuroscience at two-week summer school for thirty graduate students.

Brain Imaging Multimodal Short Course at Massachusetts General Hospital (June 2013)
TA and programmer.

fMRI Methods Short Course at Massachusetts General Hospital (October 2012, March 2013)
TA and programmer.

PSYC 50: Evolutionary Psychology; Dartmouth College (Spring 2009, Winter 2010)
TA and study group leader. Gave a class lecture.

Students supervised

Erica Shook: Center for Brains, Minds, and Machines Undergrad Researcher (Full-time: Summer 2016; Full-time: January – December 2017; Full-time: Summer 2018)

Divya Gopinath: MIT UROP (Spring 2018)

Ariel Herbert-Voss: Center for Brains, Minds, and Machines Summer Undergrad Researcher (Full-time: Summer 2015)

Outreach

Sheep brain dissector (April 2015, April 2016, August 2016, August 2017, April 2018, August 2018)
Represented Brain and Cognitive Sciences Department at prospective undergraduate expo and pre-orientation; dissected sheep brain and walked through gross neuroanatomy with incoming students.

Course Organizer & Head Instructor (November 2013)
The Meat That Makes You Think: Neuroanatomy & Sheep Brain Dissection
(Neuroanatomy crash course for Boston-area high school students.)

Professional Membership and Service

Cosyne workshop: "Understanding neural representations with deep neural networks – progress & limitations" (2017)
Co-organized two-day Cosyne workshop (Computational and Systems Neuroscience).

MIT BCS Seminar Series on Machine Vision & Hearing (2015)
Organized a seminar series on computer vision and machine hearing, which focused on statistical models of natural images and sounds.

MIT Cog Lunch: Organizer (Spring 2015)

Association for Research in Otolaryngology: Member (2014-present)
Society for Neuroscience: Member (2008-present)
Vision Sciences Society: Member (2011-2015)

Early Research Experience

Harvard University

Marc Hauser's Cognitive Evolution Lab Summer Research Assistant (Summer 2009)

Caribbean Primate Research Center
Macaque Field Research Assistant (Summer 2009)

Pioneer Institute for Public Policy Research
Summer Research Assistant (Summer 2006, Summer 2007)

Languages

Programming (Both languages and frameworks)

Fluent:	Python, MATLAB, Bash
Proficient:	TensorFlow
Experience:	Julia, C, C++, OpenACC, Java, Church (probabilistic Scheme), Torch, Lua

Natural

Fluent:	English
Proficient:	Mandarin Chinese, Spanish