BIOGRAPHICAL SKETCH

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NAME: Auerbach, Edward John

eRA COMMONS USER NAME (credential, e.g., agency login): eauerbach

POSITION TITLE: Assistant Professor of Radiology

EDUCATION/TRAINING *(Begin with baccalaureate or other initial professional education, such as nursing, include postdoctoral training and residency training if applicable. Add/delete rows as necessary.)*

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
University of Florida	B.S.	1996	Chemistry
University of Florida	B.A.	1997	Criminology & Law
University of Minnesota	Ph.D.	2003	Biophysical Sciences & Medical Physics

A. Personal Statement

The focus of my research for the past 20 years has been on the improvement of imaging and spectroscopy techniques and equipment for high-field and ultra-high-field magnetic resonance in humans. I was introduced to the field working on one of the first clinical 3 tesla scanners in 1997, and I have worked at 7 tesla or above (9.4 T, 10.5 T) at CMRR since the first 7 tesla whole-body system was introduced there in 1999.

I have extensive experience and expertise in the development and implementation of pulse sequences and image reconstruction algorithms, particularly on the Siemens scanner platforms in use at CMRR (3 T, 7 T, 10.5 T). I also have been responsible for the integration of novel advanced hardware on these systems, including high-performance gradients, high-order dynamic B_0 shims, multi-channel receivers, and multi-channel parallel RF transmit systems.

My pulse sequence and image reconstruction software for MRI and MRS is widely and freely distributed to other researchers in the field. It is used daily in hundreds of research centers around the world, notably for all data collection in the Human Connectome Project.

1. Vu AT, **Auerbach E**, Lenglet C, Moeller S, Sotiropoulos SN, Jbabdi S, Andersson J, Yacoub E, Ugurbil K. High resolution whole brain diffusion imaging at 7T for the Human Connectome Project. Neuroimage. 2015 Nov 15;122:318-31.
2. Ugurbil K, Xu J, **Auerbach EJ**, Moeller S, Vu AT, Duarte-Carvajalino JM, Lenglet C, Wu X, Schmitter S, Van de Moortele P-F, Strupp J, Sapiro G, De Martino F, Wang D, Harel N, Garwood M, Chen L, Feinberg DA, Smith SM, Miller KL, Sotiropoulos SN, Jbabdi S, Andersson JLR, Behrens TEJ, Glasser MF, Van Essen DC, Yacoub E, and WU-Minn HCP Consortium. Pushing spatial and temporal resolution for functional and diffusion MRI in the Human Connectome Project. Neuroimage 2013;80:80–104.
3. Schmitter S, Wu X, **Auerbach EJ**, Adriany G, Pfeuffer J, Hamm M, Ugurbil K, Van de Moortele P-F. Seven-tesla time-of-flight angiography using a 16-channel parallel transmit system with power-constrained 3-dimensional spoke radiofrequency pulse design. Invest Radiol 2014;49(5):314–325.
4. **Auerbach EJ**, Xu J, Yacoub E, Moeller S, Ugurbil K. Multiband accelerated spin-echo echo planar imaging with reduced peak RF power using time-shifted RF pulses. Magn Reson Med 2013;69(5):1261–1267.

B. Positions and Honors

Positions and Employment

1995 – 1997	University of Florida – Undergraduate Research Assistant with Martin T. Vala, Department of Chemistry
1997 – 1998	University of Florida– Research Assistant with Richard W. Briggs and Bruce Crosson, Departments of Radiology and Clinical Health Psychology
1998 – 2003	University of Minnesota – Gradate Research Assistant with Xiaoping Hu and Kâmil Uğurbil, Center for Magnetic Resonance Research, Department of Radiology
2003 – 2005	University of Minnesota – Postdoctoral Associate with Kâmil Uğurbil and J. Thomas Vaughan, Center for Magnetic Resonance Research, Department of Radiology
2004 – 2015	University of Minnesota – Research Associate, Center for Magnetic Resonance Research, Department of Radiology
2015 –	University of Minnesota – Assistant Professor, Center for Magnetic Resonance Research, Department of Radiology

Other Experience and Professional Memberships

1996 –	Member, American Chemical Society
1998 –	Member, International Society of Magnetic Resonance in Medicine
2002 –	Member, The Organization for Human Brain Mapping

Certifications

2002	Siemens NUMARIS Software 4.0 Sequence development, April 12, 2002
2007	Siemens IDEA Imaging Calculation Programming March 15, 2007

Honors

1993	National Merit Scholar
2001	Educational Travel Stipend, ISMRM
2002	Educational Travel Stipend, ISMRM
2004	Educational Travel Stipend, ISMRM
2006	ISMRM Poster Award, Functional Neuroimaging Category

C. Contribution to Science

1. To advance MR imaging techniques using ultra-high magnetic fields and to facilitate the exploration of novel brain and body imaging applications, it has been necessary to develop substantial new hardware such as RF coils and multiple-channel receiver and transmitter systems. I have contributed towards this effort by designing and fabricating hardware to implement multiple-channel RF transmit and receive in a way that it is practical for routine use at 7 T and 10.5 T, in addition to developing pulse sequences and software to implement B1+ shimming techniques and evaluate coil performance.
    a. Adriany G, Van de Moortele P-F, Ritter J, Moeller S, **Auerbach EJ**, Akgün C, Snyder CJ, Vaughan JT, Ugurbil K. A geometrically adjustable 16-channel transmit/receive transmission line array for improved RF efficiency and parallel imaging performance at 7 tesla. Magn Reson Med 2008;59(3):590–597.
    b. Adriany G, **Auerbach EJ**, Snyder CJ, Gozubüyük A, Moeller S, Ritter J, Van de Moortele P-F, Vaughan JT, Ugurbil K. A 32-channel lattice transmission line array for parallel transmit and receive MRI at 7 tesla. Magn Reson Med 2010;63(6):1478–1485.
    c. Schmitter S, Delabarre L, Wu X, Greiser A, Wang D, **Auerbach EJ**, Vaughan JT, Ugurbil K, Van de Moortele P-F. Cardiac imaging at 7 tesla: Single- and two-spoke radiofrequency pulse design with 16-channel parallel excitation. Magn Reson Med 2013;70(5):1210–1219.
    d. Schmitter S, Wu X, Adriany G, **Auerbach EJ**, Ugurbil K, Van de Moortele P-F. Cerebral TOF angiography at 7T: Impact of B1+ shimming with a 16-channel transceiver array. Magn Reson Med 2014;71(3):966–977.

2. One of my primary interests throughout my career has been the development and improvement of fast MR imaging sequences. All MR imaging modalities can benefit from improved speed, which can be used in studies to improve statistical power by acquiring more data in the same amount of time, or to improve temporal resolution, or to simply reduce the length of studies—which is extremely desirable in clinical settings. Toward this end I have developed highly-accelerated imaging sequences which acquire data from multiple slices simultaneously. This technique requires careful RF pulse design to reduce power requirements, which I have also worked on addressing with various optimization approaches.
    a. Moeller S, Yacoub E, Olman CA, **Auerbach EJ**, Strupp J, Harel N, Ugurbil K. Multiband multislice GE-EPI at 7 tesla, with 16-fold acceleration using partial parallel imaging with application to high spatial and temporal whole-brain fMRI. Magn Reson Med 2010;63(5):1144–1153.
    b. Feinberg DA, Moeller S, Smith SM, **Auerbach EJ**, Ramanna S, Glasser MF, Miller KL, Ugurbil K, Yacoub E. Multiplexed echo planar imaging for sub-second whole brain FMRI and fast diffusion imaging. PLoS ONE 2010;5(12):e15710.
    c. **Auerbach EJ**, Xu J, Yacoub E, Moeller S, Ugurbil K. Multiband accelerated spin-echo echo planar imaging with reduced peak RF power using time-shifted RF pulses. Magn Reson Med 2013;69(5):1261–1267.
    d. Wu X, Schmitter S, **Auerbach EJ**, Uğurbil K, Van de Moortele PF. A generalized slab-wise framework for parallel transmit multiband RF pulse design. Magn Reson Med. 2016 Apr;75(4):1444-56. doi: 10.1002/mrm.25689.

3. The highly-accelerated imaging sequences and reconstruction techniques described above have been directly applied to the investigation of neuroscience questions with a very large consortium of collaborators in the Human Connectome Project (HCP), and continue to be used with the various Lifespan HCPs (Baby, Aging, Children and Adolescents). These techniques have been painstakingly refined to be easy to use by all researchers—no MR physics knowledge required—and have been widely and freely distributed to hundreds of research sites around the world (282 institutions as of May 2017).
    a. Smith SM, Miller KL, Moeller S, Xu J, **Auerbach EJ**, Woolrich MW, Beckmann CF, Jenkinson M, Andersson J, Glasser MF, Van Essen DC, Feinberg, DA, Yacoub ES, Ugurbil K. Temporally-independent functional modes of spontaneous brain activity. P Natl Acad Sci USA 2012;109(8):3131–3136.
    b. Smith SM, Beckmann CF, Andersson J, **Auerbach EJ**, Bijsterbosch J, Douaud G, Duff E, Feinberg DA, Griffanti L, Harms MP, Kelly M, Laumann T, Miller KL, Moeller S, Petersen S, Power J, Salimi-Khorshidi G, Snyder AZ, Vu AT, Woolrich MW, Xu J, Yacoub E, Ugurbil K, Van Essen DC, Glasser MF, and WU-Minn HCP Consortium. Resting-state fMRI in the Human Connectome Project. Neuroimage 2013;80:144–168.
    c. Ugurbil K, Xu J, **Auerbach EJ**, Moeller S, Vu AT, Duarte-Carvajalino JM, Lenglet C, Wu X, Schmitter S, Van de Moortele P-F, Strupp J, Sapiro G, De Martino F, Wang D, Harel N, Garwood M, Chen L, Feinberg DA, Smith SM, Miller KL, Sotiropoulos SN, Jbabdi S, Andersson JLR, Behrens TEJ, Glasser MF, Van Essen DC, Yacoub E, and WU-Minn HCP Consortium. Pushing spatial and temporal resolution for functional and diffusion MRI in the Human Connectome Project. Neuroimage 2013;80:80–104.
    d. Van Essen DC, Smith SM, Barch DM, Behrens TEJ, Yacoub E, Ugurbil K, for the **WU-Minn HCP Consortium**. The WU-Minn Human Connectome Project: An overview. Neuroimage 2013;80(0):62–79

4. My early work focused on directly applying advanced FMRI imaging techniques toward the investigation of neuroscience questions. For these projects I developed high-speed MR imaging techniques employed at 4 T, 3 T, and 1.5 T, and also implemented functional imaging protocols and data analysis tools.
    a. Carey JR, Kimberley TJ, Lewis SM, **Auerbach EJ**, Dorsey LL, Rundquist P, Ugurbil KA. Analysis of fMRI and finger tracking training in subjects with chronic stroke. Brain 2002;125(4):773–788.
    b. Crosson B, Sadek JR, Bobholz JA, Gökçay D, Mohr CM, Leonard CM, Maron L, **Auerbach EJ**, Browd SR, Freeman AJ, Briggs RW. Activity in the Paracingulate and Cingulate Sulci during Word Generation: An fMRI Study of Functional Anatomy. Cerebral Cortex 1999;9(4):307–316.
    c. Kimberley TJ, Lewis SM, **Auerbach EJ**, Dorsey LL, Lojovich JM, Carey JR. Electrical stimulation driving functional improvements and cortical changes in subjects with stroke. Exp Brain Res 2004;154(4):450–460.

Complete List of Published Work in MyBibliography:
http://www.ncbi.nlm.nih.gov/sites/myncbi/edward.auerbach.1/bibliography/47840105/public/?sort=date&direction=ascending

D. Research Support

Ongoing Research Support

P41 EB015894 Uğurbil (PI) 6/1/1997-5/31/2018
NMR Imaging and Spectroscopy
The central aim of this Biotechnology Research Center (BTRC) grant is to significantly advance MR based measurement capabilities and their biomedical applications in humans by: 1) developing novel image acquisition and reconstruction technologies and engineering solutions through five TRD (Technology Research and Development) projects, and 2) enabling a large number of Collaborative and Service projects to acquire advanced structural, functional, and physiological information to investigate human organ function in health and disease, targeting both human brain and the abdominal organs.
Role: Co-Investigator

R21 CA201834 Bolan (PI) 12/1/2015-11/30/2017
Advanced Diffusion Imaging of Breast Cancer
The overall goal of this work is develop a breast DWI method that gives accurate quantitative information with anatomical resolution and high image quality by adapting advanced diffusion imaging methods that were initially developed for the Human Connectome Project (HCP). If successful, this would produce higher resolution and better quality breast DWI that could be incorporated into any clinical breast MR imaging exam.
Role: Co-Investigator

Completed Research Support

P30 NS057091 Uğurbil (PI) 9/8/2006-8/31/2012
Neuroscience Cores for MR Studies of the Brain
The goal of this project is to establish Center Core facilities that will augment the existing state-of-the art and unique MR instrumentation resources located in the Center for Magnetic Resonance Research (CMRR) at the University of Minnesota, so as to enable access and utilization of CMRR's resources by a large community of neuroscience researchers, and maximize the impact of modern MR techniques in neuroscience discovery.
Role: Co-Investigator