OMB No. 0925-0001 and 0925-0002 (Rev. 03/2020 Approved Through 02-28-2023)

BIOGRAPHICAL SKETCH

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NAME: Noll, Douglas C.

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POSITION TITLE: Ann and Robert H. Lurie Professor of Biomedical Engineering and 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
Bucknell University, Lewisburg, PA	B.S.	05/1985	Electrical Engineering
Stanford University, Stanford, CA	M.S.	06/1986	Electrical Engineering
Stanford University, Stanford, CA	Ph.D.	08/1991	Electrical Engineering

A. Personal Statement

For nearly 30 years, my laboratory has focused on magnetic resonance imaging (MRI) technology applied to a variety of application areas. Our work has covered MRI acquisition methods, image processing, image reconstruction, interventional MRI, noise and artifact removal, quantitative physiological imaging, and physiological modeling. I have developed extensive collaborations with colleagues in basic and translational neurosciences and as well technical development. My scientific contributions are described in more detail under Section C, below. Along with John Jonides, I co-direct the University of Michigan Functional MRI Laboratory, a research dedicated facility used exclusively for brain imaging research. I along with three other faculty members (Jon-Fredrik Nielsen, Luis Hernandez-Garcia, Scott Peltier) run a robust research group with about 10 students and post-docs doing work on neuroimaging. I have extensive mentoring experience. I have mentored 23 completed Ph.D. student, have 7 current Ph.D. students, and have served on more than 50 other dissertation committees. I have also mentored 4 postdoctoral scientists, including 2 who have received F32 grants, as well as several faculty with K01 grants. I regularly teach graduate level classes in biomedical imaging and statistics and often mentor other students on issues related to these topics. I have substantial experience carrying out federally-funded research projects, both as a PI and a collaborator.

B. Positions and Honors

Professional Positions

1985-1987 Member of technical staff, AT&T Bell Laboratories, Whippany NJ.
1991-1997 Assistant Professor of Radiology, University of Pittsburgh, Pittsburgh, PA.
1991-1994 Visiting Assistant Professor of Computer Science, Carnegie Mellon University, Pittsburgh, PA.
1997-1998 Associate Professor of Radiology, University of Pittsburgh.
1997-1998 Acting Administrative Director, MR Research Center, University of Pittsburgh Medical Center
1998- pres. Co-Director, Functional MRI Laboratory, University of Michigan
1998-2005 Associate Professor of Biomedical Engineering, University of Michigan, Ann Arbor, MI
1999-2006 Associate Professor of Radiology, University of Michigan
2005- pres. Professor of Biomedical Engineering, University of Michigan
2006- pres. Professor of Radiology, University of Michigan
2006-2007 Interim Chair of Biomedical Engineering, University of Michigan
2007-2013 Chair of Biomedical Engineering, University of Michigan

2007- pres. Ann and Robert H. Lurie Professor of Biomedical Engineering, University of Michigan

Other Experience and Professional Memberships

1983- pres. Senior Member, Institute for Electrical and Electronics Engineers (IEEE)
1990- pres. Member and Fellow, International Society of Magnetic Resonance in Medicine (ISMRM)
2001- pres. Editorial Board, *Magnetic Resonance Imaging*
2005- pres. Editorial Board, *Magnetic Resonance in Medicine*
2005- pres. Member and Fellow, Biomedical Engineering Society (BMES)
2006- pres. Member, American Society for Engineering Education (ASEE)
2008-2015 NIH, Clinical Neuroscience and Neurodegeneration study section (CNN, ad hoc, then charter)
1995-pres. NIH, various review panels, > 75 panels
2008-pres. NIH, various review panels, service as Chair or Co-Chair, > 12 panels
2018-2020 ISMRM Annual Meeting Program Committee, Vice Chair and Chair

Honors and Awards:

1985 Graduated summa cum laude, Bucknell University
1994 Isidor I. Rabi Award, Society of Magnetic Resonance
2000 Elected to Board of Trustees, International Society for Magnetic Resonance in Medicine
2000 Biomedical Engineering Departmental Excellence Award, University of Michigan
2001 Elected Fellow, American Institute for Medical and Biological Engineering
2005, ’06, ‘07 Outstanding Teacher Award, Int. Soc. of Magnetic Resonance in Medicine Annual Meeting
2008 Elected Fellow, International Society of Magnetic Resonance in Medicine
2012 Senior Member, Institute for Electrical and Electronics Engineers
2012 Elected Fellow, Biomedical Engineering Society

C. Contribution to Science

1. Since the early days of functional MRI, I have worked on methods for image acquisition for functional MRI. One early contribution was the introduction of spiral k-space acquisition for acquisition of fMRI data (a.), including methods for correction of blurring caused by off-resonance acquisitions. This work was recognized by the 1994 Isador I. Rabi Young Investigator Award from the Society of Magnetic Resonance, which eventually became the ISMRM. In 1998, we introduced a predecessor to the currently popular multiband acquisitions based on rosette k-space acquisitions (b.). In an effort to eliminate the signal losses in some inferior brain regions, we introduced a tailored RF excitation approach to pre-compensate for these losses (c.). More recently, we introduce a new method for fMRI based on a steady-state pulse sequence, known as small-tip, fast recovery (STFR) (d.). We believe this novel approach combines advantages of a 3D acquisition and steady-state pulse sequences with T2*-like contrast. In collaboration with Dr. Luis Hernandez-Garcia, we have also developed approaches to fMRI using arterial spin label (ASL) for perfusion-based fMRI. Collectively, these works demonstrate wide expertise in technical aspect of fMRI acquisition and preprocessing.
   a. Noll DC, Cohen JD, Meyer CH, Schneider W. Spiral k-space MRI of cortical activation. J. Magnetic Resonance Imaging, 5:49-56 1995.
   b. Noll DC, Peltier SJ, Boada FE. Simultaneous multislice acquisition using rosette trajectories (SMART): A new imaging method for functional MRI. Magnetic Resonance in Medicine, 39:709-716, 1998.
   c. Yip CY, Fessler JA, Noll DC. Advanced three-dimensional tailored RF pulse for signal recovery in T2*-weighted functional MRI. Magnetic Resonance in Medicine, 56(5):1050-9, 2006.
   d. Sun H, Fessler JA, Noll DC, Nielsen JF. Steady-State Functional MRI Using Spoiled Small-Tip Fast Recovery Imaging. Magnetic Resonance in Medicine. 2015 Feb;73(2):536-43. doi: 10.1002/mrm.25146. PMCID: PMC4426392.
2. My earliest works in MRI in MRI relate to rapid acquisition methods, notably non-Cartesian k-space scanning methods, and associated image reconstruction methods, and these interests continue to the present. I conducted early work analyzing blur caused by magnetic field inhomogeneities and developed rapid methods for correction of these distortions via the so-called conjugate phase reconstruction using map-based (a.) and automatic de-blurring methods. This work was later advanced using a physics-based modeling approach (b.) with the now-popular conjugate gradient optimization approach that produces improved images, particularly in cases where the field inhomogeneities are rapidly varying. More recently,

we have extended these approaches into computationally efficient methods for parallel image reconstruction for using compressed sensing and other sparse or model based image reconstruction methods (c., d.). Collectively, these works demonstrate expertise in a number of very challenging image reconstruction problems.

a. Noll DC, Meyer CH, Pauly JM, Nishimura DG, Macovski A. A homogeneity correction method for MR imaging with time-varying gradients. IEEE Trans. on Medical Imaging, 10(4):629-637, 1991.

b. Sutton BP, Noll DC, Fessler JA. Fast, iterative image reconstruction for MRI in the presence of field inhomogeneities. IEEE Trans. on Medical Imaging, 22(2):178-188, 2003.

c. Zhao F, Noll DC, Nielsen JF, Fessler JA. Separate magnitude and phase regularization via compressed sensing. IEEE Trans Med Imaging. 31(9):1713-23, 2012. PMCID: PMC3545284.

d. Muckley MJ, Noll DC, Fessler JA. Fast Parallel MR Image Reconstruction via B1-based, Adaptive Restart, Iterative Soft Thresholding Algorithms (BARISTA). IEEE Trans Medical Imaging, 2015 Feb;34(2):578-88. PMCID: PMC4315709

3. I have had a long standing interest in the physiology of the vascular responses that we exploit for functional MRI. This work began with one of the first studies to report non-linearities in the functional MRI response for sensory systems (a.), in which we argued for both neural mechanisms (habituation) as well as vascular mechanism (slowing/broadening of the response function with stimulus duration). This work was followed by modeling of the hemodynamic system (b.), which accurately predicted changes in hemodynamics due to the vascular basal state. We also explored the functional connectivity and showed that the signals seen were due to changes in the relaxation rate rather than in-flow or other artifacts (c.). In more recent work, we developed MRI acquisition methods to examine arterial blood volume (d.), which as the potential to be a more direct measure of neural activity as it is seen as the driving mechanism for both blood flow and positive changes in blood oxygenation. These projects and results demonstrate a commitment to understanding sources of the fMRI signals and taking a quantitative approach to interpreting fMRI results.

   a. Vazquez AL, Noll DC. Non-linear aspects of the blood oxygenation response in functional MRI. NeuroImage, 7:108-118, 1998.

   b. Vazquez AL, Cohen ER, Gulani V, Hernandez-Garcia L, Zheng Y, Lee GR, Kim S-G, Grotberg JB, Noll DC. Vascular Dynamics and BOLD fMRI: CBF Level Effects and Analysis Considerations. NeuroImage, 32(4):1642-55, 2006.

   c. Peltier SJ, Noll DC. T2* dependence of low-frequency functional connectivity. NeuroImage, 16:985-992, 2002.

   d. Jahanian H, Peltier S, Noll DC, Hernandez Garcia L. Arterial cerebral blood volume-weighted functional MRI using pseudocontinuous arterial spin tagging (AVAST). Magn Reson Med. 2015 Mar;73(3):1053-64. doi: 10.1002/mrm.25220.

4. One domain where I am proud of my work is the collaborations with clinical and basic neuroscientists. These collaborations led to a number of methodological innovations as well as well as novel experimental designs. One collaborative project attempted to address high false positive rates in a statistically sound manner while avoiding the overly conservative Bonferroni correction. This widely-cited work led to the use of pixel clustering (contiguity requirements), which maintained the appropriate family-wise error with a relaxed Z threshold. In other work, we designed and carried out one of the first event-related fMRI studies (b.) – one that included an innovative event-related task combined with a parametric manipulation of difficultly (memory load). We also developed a robust approach for evaluating acquisition and processing methods based on test-retest analysis of fMRI data to produce receiver operator characteristic (ROC) curves (c.). I have a long history of collaborative projects with neuroscientist and many joint publications. Of these, I cite a recent paper (d.), in which I worked with a research team from psychiatry to design an experiment using mini-blocks of an event-related facial emotion perception task. There collaborative project have been rewarding for me and have led both advance in methodology and neuroscience.

   a. Forman SD, Cohen JD, Fitzgerald M, Eddy WF, Mintun MA, Noll DC. Improved assessment of significant change in functional magnetic resonance imaging (fMRI): Use of a cluster size threshold. Magnetic Resonance in Medicine, 33:636-647, 1995.

   b. Cohen JD, Perlstein WM, Braver TS, Nystrom LE, Noll DC, Jonides J, Smith EE. Temporal dynamics of brain activation during a non-spatial working memory task. Nature, 386:604-608, 1997.

c. Noll DC, Genovese CR, Nystrom L, Vazquez A, Forman SD, Eddy WF, Cohen JD. Estimating test-retest reliability in functional MR imaging II: Application to motor and cognitive activation studies. Magnetic Resonance in Medicine, 38:508-517, 1997.

d. Briceño EM, Weisenbach SL, Rapport LJ, Hazlett KE, Bieliauskas LA, Haase BD, Ransom MT, Brinkman ML, Peciña M, Schteingart DE, Starkman MN, Giordani B, Welsh RC, Noll DC, Zubieta JK, Langenecker SA. Shifted inferior frontal laterality in women with major depressive disorder is related to emotion-processing deficits. Psychol Med. 8:1-13, 2013. PMCID: PMC4380502

5. A technological area of MRI where I have made substantial contributions is in the domain of RF pulse design for parallel transmit (PTx) system. We introduced what is likely the most popular approach for PTx pulse design (a.) and later extended this work to include large tip-angle pulse design (b.). One challenge to PTx pulse design in selection of the k-space trajectory. Here, developed a fast, greedy method for selecting kx-ky locations for the fast-kz trajectory classes in an approach for which the full trajectory, not just an unordered list of kx-ky locations is optimized (c.). In more recent work, we extended this work to optimization of continuous gradient waveforms approximated by b-slice basis functions. We have also developed other applications of multidimensional excitation pulses with PTx for limited field of view imaging as well as for fat suppression in the presence of large magnetic field inhomogeneities. My expertise in this domain was recognized with the plenary (keynote) presentation on PTx at the annual meeting of the International Society for Magnetic Resonance in Medicine (ISMRM) in 2007.

   a. Grissom WA, Yip CY, Zhang Z, Stenger VA, Fessler JA, Noll DC. A spatial domain method for the design of RF pulses in multi-coil parallel excitation. Magnetic Resonance in Medicine, 56(3):620-9, 2006.

   b. Grissom WA, Xu D, Kerr AB, Fessler JA, Noll DC. Fast large-tip-angle multidimensional and parallel RF pulse design in MRI.. IEEE Trans Med Imaging, 28(10):1548-59, 2009. PMCID: PMC2763429

   c. Yoon D, Fessler JA, Gilbert AC, Noll DC. Fast joint design method for parallel excitation radiofrequency pulse and gradient waveforms considering off-resonance. Magnetic Resonance in Medicine. Jul;68(1):278-85, 2012. PMCID: PMC3939078.

   d. Zhao F, Nielsen JF, Noll DC. Four-Dimensional Spectral-Spatial Fat Saturation Pulse Design. Magnetic Resonance in Medicine. 2014 Dec;72(6):1637-47. doi: 10.1002/mrm.25076. PMCID: PMC4061276.

Complete List of Published Work in NCBI MyBibliography:
http://www.ncbi.nlm.nih.gov/sites/myncbi/douglas.noll.1/bibliography/40495526/public/?sort=date&direction=descending

Complete List of Published Work in Google Scholar:
http://scholar.google.com/citations?user=WhSqRmsAAAAJ&hl=en&oi=ao

D. Additional Information: Research Support and/or Scholastic Performance

Ongoing Research Support

NIH 1R01EB023618-01 (Noll/Fessler) 03/01/2017 – 12/31/2020
Fast Functional MRI with Sparse Sampling and Model-Based Reconstruction
This project will investigate sparse sampling and model-based reconstruction methods that will improve the robustness and sensitivity of gradient echo BOLD fMRI and broaden the scope of applications for fMRI. Also, and administrative supplement (1R01EB023618-02W1) for development of a cross-platform prototyping language for MRI acquisitions and test identical acquisitions on 3T platforms for two different MRI vendors.
Role: MPI

NIH 1U01EB026977-01 (Noll) 09/30/2018 – 06/30/2023
High SNR Functional Brain Imaging using Oscillating Steady State MRI
This project will investigate a novel acquisition scheme based on an oscillating steady state MRI signal to achieve a 2-3 fold increase in signal-to-noise ratio for high resolution fMRI studies.
Role: PI

NIH 1R21AG061839-01A1 (Nielsen) 02/15/2019 - 01/31/2021
Toward robust whole-brain 3D functional MRI at 3T with reduced signal loss artifacts

This project will develop methods separate pure BOLD MRI effects from artifacts caused by air pockets, which will improve fMRI studies in the head that are affected by air pockets. The project will make use of tailored RF pulses and novel extension to the PRESTO method for fMRI.
Role: Co-I

NIH 1 R25 MH071279-11 (Jonides) 09/01/2015 - 08/31/2021
Training in Functional Magnetic Resonance Imaging
The goal of this project is to teach a class covering the physics of MRI and fMRI, the types of data acquisition routines available, experimental design for blocked and event-related paradigms, post-processing routines that are used in fMRI data, coverage of parametric and nonparametric techniques for data analysis, interpretation of brain activations and hands-on experiments in which students collect and analyze data.
Role: Co-I

NIH 1 S10 OD026738-01 (Noll) 09/19/2019 – 09/18/2021
Upgrade for MRI Instrument for Functional Brain Imaging
This is a high-end instrumentation application that proposes to dramatically improve the capabilities of a heavily-used, research dedicated MRI system with improved gradient performance, increase receiver channels and improved subject comfort.
Role: PI

NIH 1 R01 EB028309-01 (Xu) 09/01/19 - 08/31/23
Transcranial Magnetic Resonance guided Histotripsy (tcMRgHt)
The goal of this proposal is to develop the first integrated tcMRgHt system for treatment of brain tumors using mechanical fractionation from focused ultrasound. MRI will be used for targeting, treatment monitoring, and post-treatment assessment.
Role: Co-I

Completed Research Support
1R21EB021562-01 (Hernandez-Garcia) 3/1/2016-12/31/2017
National Institutes of Health
Quantitative blood flow imaging using Spin Labeled MR Fingerprinting
The goal of this project is the development of new, rapid and highly sensitive methods for perfusion imaging using MR fingerprinting technology.
Role: Co-I