Aaron D. Boes

Project Title: *Investigating the neural basis of posterior fossa syndrome*

Requested Amount: $100,000

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ABF Letter of Intent

Letter of Intent Form

Prefix

First Name

Aaron

Last Name

Boes

Suffix

Title

Assistant Professor

Institution

University of Iowa

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University of Iowa Hospitals and Clinics
W278 General Hospital
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City

Iowa City

State

Iowa

Postal Code

52246

E-mail

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3193538587

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Project Details

Project Title

Investigating the neural basis of posterior fossa syndrome

General focus

Brain & Spinal Cord Tumors
Autism & Neurodevelopment

Specific Disease Focus

Posterior fossa syndrome

Project Description

The goal of treating a child with a brain tumor is not simply to prolong life, but rather to maximize the child's quality of life and help them realize their long-term potential. Here we propose to study cognitive problems

that commonly occur as a surgical complication in children with brain tumors of the cerebellum. By understanding the anatomy of this problem using an innovative neuroimaging approach this study could have an immediate clinical impact by improving the surgical approach to childhood cerebellum tumors.

One of the most common sites for brain tumors in children is the cerebellum, a structure in the back of the brain that is essential for coordination of movements and cognition. 1 in every 4 children having a tumor removed from the cerebellum experiences an often-dramatic onset of major cognitive difficulties after the surgery. These post-surgical difficulties may include an inability to speak (mutism), emotional lability, and a host of other problems in behavior and cognition. The duration of symptoms is highly variable, ranging from days to several months or even lifelong disability. This constellation of symptoms following cerebellum surgery is known as posterior fossa syndrome; it has been known and written about in the medical literature for over 60 years but there have not been any strategies that have proven effective in preventing it or treating it. Given the limitations in our knowledge the onset of posterior fossa syndrome is a legitimate cause of major anxiety at a vulnerable time in the child's treatment course, not only for the child experiencing symptoms, but also the family and the care team.

Here, we propose to investigate the anatomy of posterior fossa syndrome using a neuroimaging approach called voxel-based lesion symptom mapping. The clinical course of 115 children with cerebellum tumors will be reviewed, including detailed neuropsychological test results performed before and after the surgery. The anatomical site of the surgical resection will be mapped onto a reference brain and statistically compared between children who had posterior fossa syndrome versus those that did not. This will provide the first large-scale map of the regions of the cerebellum that are critical for developing posterior fossa syndrome. This large dataset is made possible through a unique collaboration between pediatric neuro-oncology teams at the University of Iowa Hospitals and Clinics and Harvard's Massachusetts General Hospital.

How will your project contribute to the treatment, prevention or cure of a neurological disease(s)?

This study will provide unprecedented information about which region or regions of the cerebellum are most critical to the development of posterior fossa syndrome. This anatomical knowledge will be paramount for optimizing the surgical approach to pediatric brain tumors of the cerebellum, such that this region may be avoided whenever possible within the constraints of the primary goal of tumor removal. Moreover, our novel approach for studying brain lesions that takes into account the network connectivity of the lesion site may provide insight regarding novel rehabilitation strategies such as using noninvasive neuromodulation applied to regions of the cerebral cortex that normally interact with the site of the lesion.

Project Budget

Total expense budget

An estimated total is acceptable.

450,000

Value of existing funding or in-kind support

What portion of the above total expense has funding already received or promised?

16,627

Portion to be raised through crowdfunding

How much are you seeking from the crowdfunding platform?

433,373

Attachments and Verifications

Financial Disclosures & Conflicts of Interest Form

Boes disclosure statement.pdf

CV of Principal Investigator

Boes CV 2017.pdf

I understand that the American Brain Foundation will not post approved projects for crowdfunding until documentation of IRB approval or exemption is provided.

Yes

ABF Full Application

Applicant Information

Prefix

Dr.

First Name

Aaron

Last Name

Boes

Suffix

Title

Assistant Professor

Institution Name

University of Iowa

E-mail

aaron-boes@uiowa.edu

Office Phone

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Office Fax

Project Details

Project Title

Investigating the neural basis of posterior fossa syndrome

Disease focus

Brain & Spinal Cord Tumors

Autism & Neurodevelopment

Specific Disease Focus

Posterior fossa syndrome

Project Summary/Abstract

In this grant Dr. Boes proposes to investigate the neural basis of posterior fossa syndrome, a condition in which children undergoing cerebellar tumor removal develop acute cognitive and neurobehavioral symptoms. In the first aim Dr. Boes proposes to perform lesion symptom mapping, a statistical approach to link specific neuropsychological deficits with lesion location using a large existing database. In the second aim Dr. Boes proposes a longitudinal neuroimaging study of pediatric patients undergoing neurosurgery of the cerebellum. Structural and functional imaging will be performed before and immediately after the surgery and three months later in order to assess the structural and functional imaging correlates of posterior fossa syndrome. Together, these aims combine to provide a novel and innovative use of state-of-the-art imaging to a vexing clinical condition. We are optimistic that a better understanding of the neural basis of

posterior fossa syndrome will lead to improved surgical care and potentially improved treatments for this condition.

Project Narrative

Mortality rates have steadily improved for treating pediatric brain tumors and it is increasingly important that treatments maximize long-term outcomes. The cerebellum is one of the most common sites of pediatric brain tumors and 1 in every 4 children having a tumor removed from the cerebellum experiences an often-dramatic onset of major cognitive difficulties after the surgery. Difficulties may include an inability to speak (mutism), emotional lability, and a host of other problems in behavior and cognition with highly variable rates of recovery. Here we propose to study the anatomy of this problem using state-of-the-art innovative neuroimaging approaches that combine lesion mapping and functional imaging. A better understanding of this common surgical complication could have an immediate clinical impact by improving the surgical approach to childhood cerebellum tumors.

Facilities and Equipment

The University of Iowa Hospitals and Clinics (UIHC) provides an ideal atmosphere to collaboratively conduct groundbreaking research in biomedicine that is transferred to exemplary clinical care. UIHC is the largest referral site in the state for childhood brain tumors and this research program will benefit from our strong interdisciplinary clinical program in neuro-oncology, which is housed in a brand new state-of-the-art Children's Hospital. All aspects of the current application were designed to utilize the strengths of successful researchers in pediatric neurology, neuropsychology, neurosurgery and neuroimaging. The Magnetic Resonance Research Facility has dedicated research MRIs at both 3 and 7 Tesla in a brand-new facility. The Iowa Neuroimaging Consortium is a fully staffed resource spanning 4,100 square feet in the College of Medicine. It includes image analysis technicians, system programmers, data core managers, and research assistants. It will provide much of the infrastructure. Finally, our laboratory has extensive experience in pediatric neuroimaging, lesion mapping, and evaluation of neuropsychological performance to ensure the proper collection and analysis of data.

Specific Aims

Aim 1. Perform lesion-symptom mapping of posterior fossa syndrome (PFS).

We will use a large existing database of structural MRI (clinical scans) and neuropsychological test results from pediatric patients before and after cerebellum tumor resection to localize posterior fossa symptoms. In addition, the cerebro-cerebellar networks disrupted by the lesion will be inferred using resting-state functional connectivity MRI from a publically available pediatric connectome dataset. Hypothesis: The profile of post-surgical neuropsychiatric deficits in PFS can be predicted based on lesion location and the associated cerebro-cerebellar network(s).

Aim 2. Perform longitudinal imaging of posterior fossa syndrome recovery

We will use pre- and post-surgical multimodal high-resolution MRI along with detailed neuropsychological testing to longitudinally assess the neural substrates of cognitive impairment in posterior fossa syndrome and the network modifications associated with functional recovery. Hypothesis: Disruption of specific inter-hemispheric cerebro-cerebellar networks will correlate with domain-specific cognitive symptoms (e.g. connectivity between right postero-lateral cerebellum hemisphere and left-sided cortical language areas will be disrupted in the presence of language deficits) and these networks will regain a modified functional connectivity pattern in association with functional improvements.

Research Strategy

Significance, Innovation, Approach, Timeline

Significance

Posterior fossa syndrome (PFS) includes cognitive and neurobehavioral symptoms that occur most commonly after surgical resection of cerebellum tumors in children (1, 2). It occurs in as many as 1 in 4 cerebellar surgeries in pediatric tumor patients (1,3) which is one of the most common sites of primary brain tumors in children. Both the severity and duration of symptoms is highly variable, ranging from days to lifelong disability (4 - 6). The mechanistic basis of PFS from a neuroanatomical and large-scale neural network perspective is poorly understood and has not been investigated using modern approaches for lesion-symptom mapping. However, such information has immediate clinical relevance, as greater anatomical knowledge of regions that contribute to PFS could inform the surgical approach and lead to better outcomes. Knowledge of the network-based correlates of PFS and its recovery may also inform innovative follow-up studies that use noninvasive brain stimulation in a targeted way to affected cerebro-cerebellar networks to augment recovery of function. More broadly, PFS provides a unique window from which to investigate the role of the cerebellum in cognitive development, which has major implications for understanding a variety of neurodevelopmental disorders in which the cerebellum is implicated, including ADHD, autism, and dyslexia (7, 8). As such, insights from this study may extend beyond PFS to a variety of neurodevelopmental conditions.

Innovation

During my residency training in child neurology I developed a novel method for investigating the network effects of focal brain lesions, termed lesion network mapping (9). This work was inspired by a patient encounter; a 17-year-old girl developed visual hallucinations after a punctate infarct to a non-visual region of the thalamus. Traditional lesion mapping of this patient and 22 others with visual hallucinations following subcortical infarcts revealed two weaknesses of traditional lesion mapping: 1) the lesions overlapped at multiple sites, raising the question of whether they failed to localize or localized along different nodes of a single functional network, and 2) the overlap sites occurred in

non-visual regions, but the leading hypothesis for the mechanism of peduncular hallucinosis is that these lesions have their functional effects remotely in higher-order visual cortices. It was unclear how or if these lesion sites related to cortical visual areas. A novel solution to address these two questions was to use the 3D volume of each lesion in a large normative database of functional connectivity MRI to investigate the networks associated with each lesion location, as a way to infer the remote sites impacted by the lesions. Using this approach, 22 of 23 lesions fell along a single network that had connectivity to the ventral extrastriate visual cortex, a region hypothesized to be involved in the generation of hallucinations. I was the lead author describing this novel method applied to four separate lesion syndromes, published in Brain in 2015 (9). The method is gaining momentum this year with an important validation study and several additional high impact publications using the method by our group and others.

The current proposal will build upon this innovative work through a variety of conceptual and technical improvements to lesion network mapping. First, this study will provide the first application of lesion network mapping in the pediatric population, which will require age-matched normative data. This approach will be important in investigating the hypothesis that cerebellar injury disrupts cognition through disruption of specific cerebro-cerebellar networks (10). Next, these experiments will provide the only study design to date of lesion network mapping that includes functional imaging before and after the onset of a lesion, such that predicted network effects of the lesion can be tested explicitly, a critical test of the technique's validity.

Approach

Aim 1. We propose to investigate the anatomy of PFS using a neuroimaging approach called voxel-based lesion symptom mapping. The clinical course of 115 children with cerebellum tumors will be reviewed, including detailed neuropsychological test results performed before and after the surgery. The anatomical site of the surgical resection will be mapped onto a reference brain and statistically compared between children who had PFS versus those that did not. This will provide the first large-scale map of the regions of the cerebellum that are critical for developing PFS. This large dataset is made possible through a unique collaboration between pediatric neuro-oncology teams at Iowa and Harvard's Massachusetts General Hospital.

Aim 2.

30 pediatric patients undergoing cerebellum tumor resection will be recruited prospectively to participate in a longitudinal study involving neuropsychological testing and neuroimaging at three time points, pre-surgical, immediate post-surgical, and three months later. MRI will include structural, diffusion tensor imaging & resting state functional connectivity MRI sequences.

Timeline

This study proposed here will be completed over a three year period (2017 - 2020). Additional funding in the form of an RO1 will be applied for in year 2 (2019).

List up to 5 milestones you will reach within the first 6 months of your study.

- Trace lesion location of over 100 pediatric patients with cerebellar tumor resections and analyze lesion location relative to neuropsychological outcomes.
- Collect data from the initial 5 patients with cerebellar tumor resection to longitudinally monitor recovery and imaging correlates of recovery.

Age of Population Group(s) that will potentially benefit from this research

(check boxes that apply)

Pediactric

Scientific Literature References

Reference 1

Catsman-Berrevoets, C. E.; Aarsen, F. K. The Spectrum of Neurobehavioural Deficits in the Posterior Fossa Syndrome in Children after Cerebellar Tumour Surgery. Cortex 2010, 46, 933--946.

Reference 2

Gadgil, N.; Hansen, D.; Barry, J.; Chang, R.; Lam, S. Posterior Fossa Syndrome in Children Following Tumor Resection: Knowledge Update. Surgical neurology international 2016, 7, S179-83.

Reference 3

Robertson, P. L.; Muraszko, K. M.; Holmes, E. J.; Sposto, R.; Packer, R. J.; Gajjar, A.; Dias, M. S.; Allen, J. C. Incidence and Severity of Postoperative Cerebellar Mutism Syndrome in Children with Medulloblastoma: A Prospective Study by the Children's O

Reference 4

Tamburrini, G.; Frassanito, P.; Chieffo, D.; Massimi, L.; Caldarelli, M.; Rocco, C. Di Cerebellar Mutism. Child's Nervous System 2015, 31, 1841--1851.

Reference 5

Gelabert-González, M.; Fernández-Villa, J. Mutism after Posterior Fossa Surgery. Review of the Literature. Clinical Neurology and Neurosurgery 2001, 103, 111--114.

Reference 6

Rønning, C.; Sundet, K.; Due-Tønnessen, B.; Lundar, T.; Helseth, E. Persistent Cognitive Dysfunction Secondary to Cerebellar Injury in Patients Treated for Posterior Fossa Tumors in Childhood. Pediatric neurosurgery 2005, 41, 15--21.

Reference 7

Wang, S. S.-H.; Kloth, A. D.; Badura, A. The Cerebellum, Sensitive Periods, and Autism. Neuron 2014, 83, 518--32.

Reference 8

Stoodley, C. J. The Cerebellum and Neurodevelopmental Disorders. The Cerebellum 2016, 15, 34--37.

Reference 9

Boes, A. D.; Prasad, S.; Liu, H.; Liu, Q.; Pascual-Leone, A.; Caviness, V. S.; Fox, M. D. Network Localization of Neurological Symptoms from Focal Brain Lesions. Brain : a journal of neurology 2015, 138, 3061--75.

Reference 10

Sagiuchi, T.; Ishii, K.; Aoki, Y.; Kan, S.; Utsuki, S.; Tanaka, R.; Fujii, K.; Hayakawa, K. Bilateral Crossed Cerebello-Cerebral Diaschisis and Mutism after Surgery for Cerebellar Medulloblastoma. Annals of Nuclear Medicine 2001, 15, 157--160.

Budget, Attachments and Acknowledgements

Budget

We recognize that changes may have occurred since the time you submitted your Letter of Intent. Please share the most recent accurate numbers below:

Total Project Budget

$221,627

Total existing funding or in-kind support

$121,627

Amount to be raised through crowdfunding campaign

$100,000

Evidence of institutional support (letter)

Boes-Institutional support.pdf

Full budget

Budget.xlsx

Documentation of IRB/IUCAC approval or exemption, if applicable.

Boes_IRB_posterior_fossa.pdf

Completed conflict of interest & disclosure form

Boes disclosure statement.pdf

I understand that the ABF will not list approved projects for general public crowdfunding campaigns until documentation of IRB/IUCAC approval or exemption is provided.

Yes

I understand that approval of the project to be shared on the crowdfunding campaign site is dependent on providing and working with the ABF staff to create the requisite materials that present the project in an engaging, easy-to-understand website presentation. I am amenable to working with the ABF staff to create such materials.

Yes

I understand that approval once a project has been completed, I will be required to submit a summary of my findings to be posted online (one page), and will submit this in a reasonably timely fashion. I also agree to submit a financial report, and to co-sign a thank you letter with the ABF that will be sent to donors.

Yes

I understand and agree that the ABF may share the information that I provide (including but not limited to the project description and relevant biographical/background details) in conversations with other potential funders outside the website to bolster fundraising efforts.

Yes

American Brain Foundation Release Agreement

American Brain Foundation
Release Agreement – Research

1. **Grant**. For good and valuable consideration, the receipt and sufficiency of which is hereby acknowledged, I grant to the

   American Brain Foundation ("ABF") and to the ABF's affiliates (including the American Academy of Neurology), and their respective contractors, agents, assigns, licensees, and successors (collectively, the "ABF Group"), a worldwide, royalty-free, perpetual, irrevocable right to take and use my image, likeness, voice, verbal statements, written testimonials and name and all images, videos, sound recordings, and written and verbal materials that I provide to the ABF (collectively, the "Materials "), in all forms and media, including composite or modified representations, for the purpose of promoting and supporting the missions of the ABF. For the avoidance of doubt, the Materials include all research project proposal information, project reports and other research-related information submitted to the ABF. I understand and agree that the ABF may publish the Materials on any and all media, including printed matter, promotional materials, e-mail, websites and social media platforms.
2. **Acknowledgement of Use**. I understand that the ABF Group may use the Materials on any and all media, including printed matter, promotional materials, e-mail, websites and social media platforms. I understand that the ABF's use of the Materials may intentionally or unintentionally give rise to the impression that either I or a family member suffers from brain/neurologic disease, and I nevertheless consent to this use. The ABF is not obligated to utilize any of the rights granted in this agreement. I waive the right to inspect or approve any uses of the Materials in connection with this grant.
3. **Warranty**. I warrant that I have the full power to enter into this agreement and to grant the aforementioned rights.
4. **Release**. I release the ABF Group from all liability for any claims that may arise regarding the use of Materials, including any claims of defamation, invasion of privacy, or infringement of moral rights, rights of publicity, or copyright. The ABF is permitted, although not obligated, to include my name as a credit in connection with any use of the Materials.**I have read and understood this agreement, I understand that it contains a release of liability, and I am over the age of 18**. This agreement expresses the complete understanding of the parties and shall be binding on me and my heirs, legal representatives and assigns. I understand that I am entering into a legally binding agreement and that clicking "I Accept" below shall have the same legal effect as my signature on this Release Agreement.

I Accept

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Boes - American Brain Foundation Grant

Grant Start Date 7/1/2017

Personnel	**Effort**	**Cal. Months**
Image Processing Analyst (Joel Bruss)	5%	0.6
Psychologist (Amanda Graft)	4%	0.4

MRI - 1 hour	3 Per Subject
Participant Compensation + Travel	$100 per visit

Base Salary	Requested Salary	Fringe	7/1/2017-06/30/2018 Year 1	7/1/2018-06/30/2019 Year 2	7/1/2019-06/30/2020 Year 3
$ 53,040	$ 2,652	$ 629	$ 3,281	$ 3,346	$ 3,413
$ 89,000	$ 3,212	$ 761	$ 3,973	$ 4,053	$ 4,134
			$ 7,254	**$ 7,399**	**$ 7,547**
Subject costs					
$ 615	Per hour		**$ 25,830**	**$ 23,985**	**$ 23,985**
$ 300	Per Subject		**$ 1,400**	**$ 1,300**	**$ 1,300**
		Total Costs	**$ 34,484**	**$ 32,684**	**$ 32,832**

Participant Breakout	30 Total	14	13	13

	Total
$	10,040
$	12,160
$	22,200
$	73,800
$	4,000
$	100,000

THE UNIVERSITY OF IOWA

Division of Sponsored Programs
2 Gilmore Hall
Iowa City, Iowa 52242-1320
319-335-2123 *Fax* 319-335-2130
dsp@uiowa.edu
http://research.uiowa.edu/dsp

March 10, 2017

American Brain Foundation
201 Chicago Ave
Minneapolis, MN 55415

RE: Proposal created by investigator Dr. Aaron Boes

This letter serves as Institutional Assurance that The University of Iowa fully supports the work of Dr. Aaron Boes, in particular this proposal for "Investigating the neural basis of Posterior Fossa Syndrome." The appropriate programmatic and administrative personnel at the University of Iowa approve this proposal submission and will support the administrative work necessary, should this proposal be funded.

Thank you for considering Dr. Boes for this award. We are very grateful for the opportunity to seek the important and generous support of the American Brain Foundation to further the research work of our faculty.

Sincerely,

Mary Blackwood
Acting for Daniel Reed

Daniel Reed
Vice President for Research & Economic Development

Title: **Posterior Fossa Syndrome in a Medulloblastoma population: analysis by functional MRI imaging**

Sponsor Name: **None**

PI Name: **Jones, Robin** Protocol #: **2014P001592** Type: **New Protocol**

Date Received: **August 13, 2014**

Study Staff

Name	Role	Degree	Organization	Citi Certified
Abrams, Annah	Co-Investigator	MD	MGH > Psychiatry	6/12/2013
Boes, Aaron	Co-Investigator	MD, Ph.D	MGH > Neurology > Neurology Chief Funds	10/9/2012
Gallotto, Sara	Research Coordinator/Manager		MGH > Radiation Oncology	5/1/2013
Jones, Robin	Principal Investigator	MD	MGH > Neurology	11/13/2013
Pulsifer, Margaret	Co-Investigator	Ph.D	MGH > Psychiatry	9/30/2012
Yock, Torunn	Co-Investigator	MD	MGH > Radiation Oncology	3/9/2012

Signatures

PI Name: Jones, Robin, M, MD
Authenticated: August 04, 2014

Sponsor Funding: None

Select the source of funding that will be used to support the proposed research:

- ○ Government / Foundation / Other Non-Profit
- ○ Corporate
- ○ Institutional Award
- ○ Department Funds
- ⊙ None

Is this the primary source of funding?

○ Yes ○ No ⊙ Not applicable

Health / Medical Records

1. Purpose

Briefly describe the purpose of the research:

Medulloblastoma represents the most common malignant cerebellar posterior fossa tumor in children.

Posterior fossa syndrome is seen postoperatively in approximately 25% of patients with medulloblastoma. To date, we have treated 180 medulloblastoma patients with proton beam radiotherapy at the Francis H. Burr Proton Therapy Center (FHBPTC). Data acquired as part of the clinical and research protocols related to the treatment at the FHBPTC has included standard brain MRI imaging pre- and post-operatively, as well as neuropsychological testing. MRI functional connectivity imaging is a tool that can map networks in the human brain. Anatomical predictors of posterior fossa syndrome are not well understood.

We propose to retrospectively investigate the patterns of cerebellar functional connectivity in pediatric medulloblastoma patients using data from MRI images collected as part of treatment protocols at the FHBPTC. We will look at functional connectivity patterns of the lesions using a normative database to determine what regions in the brain are normally connected to this lesion site in the normal population.

We will analyze the data in both patients affected with posterior fossa syndrome as well as age-matched controls from our sample population. In addition, we will incorporate results of neuropsychological analysis to identify variables that may contribute to outcome.

Data resulting from this research will be used for the following. Check all that apply.

- ☑ Publication
- ☑ Oral Presentation
- ☐ Other

Will data resulting from this research ever be submitted to the FDA?

○ Yes ⊙ No

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2. Study Population

Describe the study population, e.g., age, gender, diagnosis. Note: Healthcare providers may be considered subjects if you are studying provider behavior or performance, or analyzing patient outcomes based on provider. In such cases, you must consider the privacy risks and privacy rights of providers.

We will include pediatric patients treated at MGH for medulloblastoma age 0-21 years, inclusive of males and females, from 1/2002 to 12/2014. The age-matched controls are patients from the IRB-approved data repository called "MGH Pediatric Radiation Oncology Database".

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3. Source of Health / Medical Information

Indicate:

☑ Partners Sites

Partners Sites - Check all that apply:

☐ BWH
☐ Faulkner
☑ MGH
☐ NWH
☐ NSMC
☐ PCHI
☐ SRH
☐ McLean
☑ Other

Enter the other sources of health / medical information and move to the box on the right.

IRB #2005P000087 MGH Pediatric Radiation Oncology Database

☐ Non-Partners Sites

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4. Data To Be Collected / Obtained

Check all that apply.

Administrative:

☐ Billing data
☐ Coded encounter data (diagnoses, procedures, dates)
☑ Demographic data (age, gender, vital status)
☑ Personal data (name, address, PCP)

Health / Medical:

☑ Allergies
☑ Discharge Summary
☐ Doctors Orders
☑ History / Physical
☐ Immunizations

☑ Medication List

☑ Office / Clinic Notes

☑ Operative / Procedure Notes (e.g. endoscopy)

☐ Pharmacy

☑ Problem List

Health/Medical Reports/Results:

☐ Blood Bank

☑ Laboratory

☑ Pathology reports (reports only). Complete the Excess Human Material form for use of tissue/slides instead of this form.

☑ Radiology

Sensitive/Personal Information:

☐ HIV Status

☑ Mental Health

☐ Reproductive History (e.g., abortions)

☐ Sexual Behavior/Sexually Transmitted Diseases

☐ Substance Abuse (e.g., drug or alcohol abuse)

☐ Other potentially stigmatizing behaviors

Will any Sensitive/Personal Information listed above be collected?

⊙ Yes ○ No

Explain why the sensitive/personal data checked above is needed to achieve the goals of the study:

Posterior fossa syndrome is a common problem defined by mutism, ataxia and emotional lability. We will need to review their mental health information to better define the emotional symptoms that present in patients with posterior fossa syndrome in order to correlate the anatomic location of the injury in the cerebellum and brainstem with the symptomology.

Other Health/Medical Information:

☑ Other

Specify:

Neuropsychological measures which are a part of the standard medical records and assessments in children with brain tumors.

Have you created a data collection form or other tool for data collection?

○ Yes ⊙ No

Enter specific data variables needed to achieve the goals of your study. Enter one variable and move to the box on the right. Repeat for all variables.

gender

age at treatment
name
medical record number
tumor size
M stage
ataxia grade
mutism grade
CN abnormalities
dysarthria
other neurologic findings
MRI preop date
MRI post op Date
operation date
VP shunt/EVD status
hydrocephalus
handedness
other surgical complications
Neuropsychological measures
emotional lability grade

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5. Data To Be Requested From The Following Time Period (Encounter Dates)

Indicate the time period over which the health / medical information was / will be created as part of clinical care.

From (mm/yyyy):

01/2002

To (mm/yyyy):
For future data, use anticipated project end date.

12/2014

NOTE: This information is needed for the IRB to determine whether the research use of the health/medical information meets the criteria for an exemption from the requirement for IRB review. For more information about HUMAN SUBJECTS RESEARCH or EXEMPT RESEARCH, see the policy 'Exempt Human-Subjects Research.'

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6. Protected (Identifiable) Health Information

PHI refers to health/medical information that is accompanied by any of the listed 18 HIPAA identifiers or by a code where the key to the code that links to the identifiers is accessible to investigators. DE-IDENTIFIED

DATA (without any identifiers or codes that link back to individuals) are not considered PHI, and are not subject to HIPAA regulations.

Will you be recording any of the identifiers listed above with the data or using a code to link the data to any of the identifiers? If yes, than under the HIPAA Privacy Rule provisons the data cannot be considered de-identified and authorization from the subject or a waiver of authorization must be granted by the IRB. When answering this question, consider the need for recording dates or retaining direct identifiers, such as name and/or medical record number, to link data from multiple sources, to avoid duplicating records, or for QA purposes. NOTE: If you are recording medical record number or other identifiers, even if temporarily for QA purposes or to avoid duplicating records, then answer "Yes".

◉ Yes ○ No

Check the identifiers that will be recorded with or linked by code to the data.

☑ Name

☐ Social Security Number

☑ Medical record number

☐ Address by street location

☐ Address by town / city / zipcode

☑ Dates (except year), e.g., date of birth; admission / discharge date; date of procedure; date of death

☐ Telephone number

☐ Fax number

☐ Electronic email address

☐ Web URLs

☐ Internet protocol (IP) address

☐ Health plan beneficiary number

☐ Account number

☐ Certificate / license number

☐ Vehicle identification number and serial number, including license plate number

☐ Medical device identifiers and serial numbers

☐ Biometric identifiers (finger and voice prints)

☐ Full face photographic image

☐ Any other identifier; or combination of identifiers likely to identify the subject (e.g., Pathology Accession #)

Explain why it would be impossible to conduct the research without access to and use of identifiable health / medical information. For example, the data cannot be obtained from electronic health / medical records or databases without access to identifiers or identifiers are needed for prospective data collection.

This in formation is required to initially identify patients with posterior fossa syndrome for this retrospective review. Then we will use the demographics to

match medulloblastoma patients who have not been affected by posterior fossa syndrome for the control group. We also need dates to calculate exact age at the time of treatment.

Will identifiers be removed from the data and destroyed after all of the data has been collected, the study has been completed, or all regulatory and sponsor obligations have been met, consistent with regulatory and institutional research record keeping requirements? For guidance, see the PHRC Recordkeeping and Record Retention Requirements document.

⊙ Yes ○ No

NOTE: Federal regulations mandate that, under a Waiver of Consent / Authorization, identifiers be destroyed as early as possible. De-identified datasets may be retained indefinitely.

6A. Waiver of Informed Consent / Authorization

Explain why the risk to subjects, specifically the risk to privacy, is no more than minimal risk. When addressing this question, describe the measures you have put in place to protect the privacy of subjects and confidentiality of the data; for example: (1) identifiable health information will be stored on a computer on the Partners network with password protections enabled and anti-virus software or an encrypted laptop, with access to data limited to study staff; (2) name and/or medical record number will be replaced with a study ID or code and the key to the code stored in a password protected file; (3) direct identifiers, such as name and medical record number, will be removed once all of the data is collected and analysis performed on de-identified data.

We request a waiver of consent for those patients entered into the database retrospectively, as the use of the requested protected health information (PHI) involves no more than a minimal risk to the privacy of the individual patients based on the following:
(1) we will protect the identifiers from improper use and disclosure by storing the information on a password-protected database which can be accessed only by study personnel, all of whom have completed training in HIPAA guidelines and requirements;
(2) we will destroy the identifiers at the earliest opportunity consistent with the conduct of the proposed clinical research, unless there is a health or research justification for retaining the identifiers or such retention is otherwise required by law; and
(3) the requested PHI will not be reused nor disclosed to any other person or entity, except as required by law or for authorized oversight of the research study.

Explain why the research could not practicably be carried out without the waiver of consent / authorization. When addressing this question, consider the difficulty in locating individuals who may

have moved, the number of subjects and cost and use of limited resources of locating individuals and sending letters and consent forms, and the impact on the scientific validity of the study if you could use only data of individuals from whom you were able to obtain informed consent.

The research cannot practicably be carried out without the waiver of consent given that many of the patients to be included in the study cannot be contacted, either because they have expired or changed address. In addition, informed consent for this research project would compromise the integrity and completeness of the data because many busy patients simply don't have time for a process (read the
consent form, understand and acquiesce and send it back) which doesn't have a direct beneficial or adverse effect on them. The likelihood that we would lose valuable information in this setting is quite high.

NOTE: "Only in a few research studies would it be impossible to obtain informed consent; however in many studies the financial cost would be prohibitive and a potentially poor use of limited research resources." Ensuring Voluntary Informed Consent and Protecting Privacy and Confidentiality, National Bioethics Advisory Commission.

Explain why the rights and welfare of the subjects will not be adversely affected by the waiver of consent / authorization. When addressing this question, consider the individual's right to privacy and the measures you have put in place to protect the privacy of subjects and confidentiality of any data and any health/medical implications for subjects; for example: (1) identifiable data will be stored securely with access limited to study staff; (2) information resulting from this study will not have any important health/medical implications for subjects.

The rights and welfare of the subjects in this study will not be adversely affected by the waiver of consent, as the data will be maintained in a password-protected database which can be accessed only by study personnel. All study personnel have completed training in HIPAA guidelines and requirements; accordingly, they will strictly maintain the confidentiality of the data and will protect the privacy of all patients entered into the database. Moreover, in any reports or presentation of data, there will be no disclosure of any possible patient identifiers.

NOTE: If the research uncovers information about the subjects that has important health / medical implications for them, contact the PHRC to discuss the appropriate process for providing subjects with additional pertinent information.

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7. Research Data

How will research data be recorded and stored?

☑ Electronically

Electronic Research Data

What type of device will the research data be accessed and stored on? Check all that apply.

☑ Desktop computer

☐ Portable device i.e., Laptop, Netbook, Tablet, iPod computer, Cell/Smart phone

☐ USB Flash/Thumb, External Hard Drive

☐ Other device

Portable devices can include cell phone/smart phones, laptops, iPad/tablet computers, iPods or any other electronic device that can communicate wirelessly. For information on portable device security, refer to the Partners Portable Device Security Handbook (PHS Internal only link)

Where is the primary storage location of the device(s)? For example, the laptop is stored in office 123 on White 1 and is secured to a desk with a laptop lock or the hard drive is stored in a locked cabinet in office 123 on White 1 and access is limited to study staff only.

All electronic data contianing patient identifiers will be stored on a Partner's password-protected Desktop computer.

Who will have access to the electronic research data?

The PI and study staff.

NOTE: All computers and portable devices must have password protections enabled; All computers must have active anti-virus software; Laptops, tablet, netbook computers, and USB Flash/Thumb drives must be full disk encrypted; If data will be transmitted outside the Partners firewall, data must be encrypted during transit with the use of SSL/https.

Will data be uploaded to a website/server?

○ Yes ⊙ No

☐ Paper

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8. Sending Health / Medical Information to Collaborators Outside Partners

Will any health / medical information be sent to collaborators outside Partners?

○ Yes ⊙ No

HIPAA And Tracking Disclosures Of Identifiable Health Information (PHI)

1. Disclosures of PHI to persons or entities outside Partners without the written authorization of the subject must be tracked in accordance with Partners policy "Accounting of Disclosures" (PHS Intranet link). NOTE: A code derived from the subject's name is considered identifiable, for example, a code that contains subject initials.

2. Tracking is NOT required for disclosure of LIMITED DATA SETS under a DATA USE AGREEMENT. For more information about LIMITED DATA SETS and DATA USE AGREEMENTS, refer to Partners policy "Limited Data Sets Policy/Data Use Agreements" (PHS Intranet link).

NOTE: Partners (PHS) is the HIPAA covered entity. PHS includes BWH, Faulkner, MGH, McLean, PCHI, SRH, NSMC, and NWH, among others. PHS does not include other Harvard affiliated hospitals, such as BIDMC, DFCI, HSPH, CHB, or MEEI.

Dear Applicant:

In the increasingly complex world of scientific publication, concerns about commercial influence and other possible conflicts make it important for authors to disclose all potential sources of bias. Our system of reviewing conflicts of interest aligns with the policies of the American Academy of Neurology and allows donors to judge whether conflicts exist. Please complete this form, referring to the definitions in the beginning regarding commercial entities, compensation, expert witness, and "immediate family member." At first glance, this task may seem onerous, but will likely take less than 10 minutes.

What to expect: You will be asked whether you have disclosures relating to each question (check yes or no) and will be provided a field in which to list the disclosures. Filling out the forms on the next few screens will be easiest if you have a list of the following items regarding your activity (either commercial or non-profit) and that of any immediate family members during the period of your project. Disclosures are required for any dollar amount, except for gifts valued under $1000. Names of commercial and non-profit entities are required along with specific roles, grant numbers for grants, and specific years. No dollar amounts need to be included. Please indicate complete names of sponsors or companies.

DEFINITIONS

Personal compensation:
Serving on a scientific advisory board
Gifts worth more than $1000
Travel funded by a commercial entity
Serving as a journal editor, associate editor, or on an editorial advisory board
Patents held or pending
Royalties from publishing
Honoraria for speaking engagements
Corporate appointments or consultancies
Speakers' bureaus
Clinical, neurophysiology, or imaging studies in your practice and % effort devoted if the result of this paper will benefit your practice, affiliated unit, or a sponsor

Research support:
Commercial research support
Government research support (including funding organization, grant number, and role)
Academic research support not attributed in the manuscript
Support from a non-profit foundation or society
Stock options for serving on a Board of Directors
License fee payments
Royalty payments from technology or inventions

Stocks, stock options, and royalties
Stock options in a company in which you are (were) an investigator
Stock options in medical industry

Legal proceedings
Expert testimony for a legal proceeding on behalf of industry
Affidavit for a legal proceeding on behalf of industry
Witness or consultant for a legal proceeding on behalf of industry

Optional non-financial
Non-financial disclosures you wish to share

Definitions of Terms in Disclosure Agreement
Commercial entity: A for-profit business that manufactures, distributes, markets, sells, or advertises pharmaceutical or scientific products or medical devices.
Compensation: Anything of monetary value including a salary, honorarium, stipend, gift, or payment of travel-related expenses.
Expert witness: A person who has provided expert medical testimony during a trial or administrative hearing, in a deposition or an affidavit, or in any other type of legal proceeding.
"Immediate family member": Any person who would benefit financially from the publication of the manuscript because of their relationship to the author. This includes a member of an applicant's immediate family or anyone else who has a significant relationship with the applicant.

Please provide all financial relationships (and those of your "immediate family members") from the past two years regardless of whether these relationships are related to the project described in your application.

FINANCIAL DISCLOSURE
Personal Compensation from Commercial and Non-Profit Entities that benefits you directly or indirectly. Within the past two years (and during the course of the study under consideration if the study exceeded two years), I or one of my "immediate family members" received personal compensation for the following:

All compensation received during the past two years regardless of the relationship to your project must be disclosed; for the period exceeding two years, only compensation relevant to the topic of the study needs to be disclosed.

1. Serving on a scientific advisory board or data safety monitoring board. List specific disclosures in the following format: (1) Commercial or non-profit entity (2) Commercial or non-profit entity... If none, please say "None":

None

2. Gifts (other than travel or compensation for consulting or for educational efforts) worth more than USD $1000. List specific disclosures in the following format: (1) Commercial or non-profit entity, brief description of gift, (2) Commercial or non-profit entity, brief description of gift... If none, please say "None":

None

3. Funding for travel or speaker honoraria to the individual from a commercial or non-profit entity not included in the study funding [Exclude CME activities and Grand Rounds]. List specific disclosures in the following format: (1) Commercial or non-profit entity, type of payment, (2) Commercial or non-profit entity, type of payment... If none, please say “None”:

None

4. Serving as a journal editor, an associate editor, or editorial advisory board member. This may include a journal published by your national medical/scientific organization. Please include regardless of whether you receive compensation. List specific disclosures in the following format: (1) Full journal name, role, year(s), (2) Full journal name... If none, please say “None”:

None

5. Patents issued or pending. List specific disclosures in the following format: (1) Brief description of invention/technology, (2) Brief description of invention/technology... If none, please say “None”:

None

6. Publishing Royalties (do not include honoraria for occasional writing). List specific disclosures in the following format: (1) Full title of work, full name of publisher, year(s) of publication (or receipt of royalties), (2) Full title of work... If none, please say “None”:

None

7. Employment. If you are currently employed by a commercial entity, please disclose below. In addition, if your past employment at a commercial entity is directly related to this manuscript, please disclose below. List specific disclosures in the following format: (1) Commercial entity, position, years (2) Commercial entity, position, years... If none, please say “None”:

None

8. Consultancies. List specific disclosures in the following format: (1) Commercial or non-profit entity, (2) Commercial or non-profit entity... If none, please say “None”:

None

9. Speakers' bureau. List specific disclosures in the following format: (1) Commercial or non-profit entity, (2) Commercial or non-profit entity... If none, please say “None”:

None

10. Other activities not covered in designations above (if in doubt, provide full disclosure). List specific disclosures in the following format: (1) Commercial or non-profit entity, brief description of activity, (2) Commercial or non-profit entity... If none, please say “None”:

None

11. Some studies have potential for financial gain for the project investigators or the sponsor. The following question seeks to provide transparency regarding any financial benefits to investigators or sponsors.

Do you perform clinical procedures or imaging studies in your practice or unit that overlap with the content of your proposed project, practice parameter, or clinical practice guideline and would your sponsor or this part of your practice or unit benefit if the conclusions were widely followed?
Note: This is the only item in this Agreement that applies to an interest that is related specifically to this particular study, practice parameter, or clinical practice guideline.

List specific disclosures in the following format: (1) Name of Practice or Research Unit, Clinical procedure/imaging study, % of effort (e.g. 35%), year(s), (2) Name of Practice or Research Unit, Clinical procedure/imaging study, % of effort (e.g., 35%)... If none, please say “None”:

None

RESEARCH SUPPORT
Within the past two years and during the course of the study under consideration if the study exceeded two years, I or one of my "immediate family members" received financial or material research support or compensation from the following:

All support received during the past two years regardless of the relationship to the study must be disclosed; for the period exceeding two years, only support relevant to the topic of the study needs to be disclosed.

12. Commercial entities. List specific disclosures in the following format: (1) Commercial entity, (2) Commercial entity... If none, please say “None”:

None

13. Government entities. List specific disclosures in the following format: (1) Sponsor/funding source, grant number(s), role, year(s), (2) Sponsor/funding source... If none, please say “None”:

NINDS-sponsored R25NS065743-05
Child Health Research Career Development Award 4K12HD027748-24

14. Academic entities other than those attributed in the manuscript. List specific disclosures in the following format: (1) Academic entity, (2) Academic entity... If none, please say “None”:

None

15. Foundations or societies (include grant number if required by funding agency). List specific disclosures in the following format: (1) Full name of Foundation or Society, (2) Full name of Foundation or Society... If none, please say “None”:

Aiming for a Cure Grant

STOCK, STOCK OPTIONS & ROYALTIES

In the past two years and during the course of the study under consideration if the study exceeded two years, I or one of my "immediate family members":

All revenues during the past two years regardless of the relationship to the study must be disclosed; for the period exceeding two years, only revenues relevant to the topic of the study needs to be disclosed.

16. Stock or stock options or expense compensation for serving on a board of directors. List disclosures in the following format: (1) Commercial entity, (2) Commercial entity... If none, please say “None”:

None

17. License fee payments. List specific disclosures in the following format: (1) Invention/technology, source of payment, (2) Invention/technology... If none, please say “None”:

None

18. Royalty payments or have contractual rights for receipt of future royalty payments from technology or inventions (this does not include royalties from publishing). List specific disclosures in the following format: (1) Technology/invention, source of payment, year(s), (2) Technology/invention... If none, please say “None”:

None

19. Stock or stock options in a commercial entity sponsoring research with which the author or "immediate family member" was involved as an investigator (Excludes investments in mutual funds held by the author or dependents). List specific disclosures in the following format: (1) Company, year(s), (2) Company, year... If none, please say “None”:

None

20. Stock or stock options in a commercial entity whose medical equipment or other materials related to the practice of medicine. (Exclude investments in mutual funds held by the author or dependents). List specific disclosures in the following format: (1) Company, year(s), (2) Company, year... If none, please say “None”:

None

LEGAL PROCEEDINGS

In the past two years and during the course of the study under consideration if the study exceeded two years, I or one of my "immediate family members" have (whether or not it pertains to the topic of the current study):

All compensation received during the past two years regardless of the relationship to the study must be disclosed; for the period exceeding two years, only compensation relevant to the topic of the study needs to be disclosed.

21. Given expert testimony, acted as a witness or consultant, or prepared an affidavit for any legal proceeding involving a commercial entity (do not include proceedings for individual patients). You may specify role, e.g., 'expert witness for plaintiff' if desired. (Include year only if activity is directly related to the present study.)

List specific disclosures in the following format: (1) Commercial entity, activity, year(s), (2) Commercial entity, activity, year(s)... If none, please say “None”:

None

OPTIONAL: NONFINANCIAL DISCLOSURE

22. I have chosen to declare one or more non-financial competing interests (e.g., special interest groups you represent or others that may be affected if your paper is published or that could be perceived as biasing the study; the corresponding author should be aware of conflicts of interest that Co-investigators or Contributors may have). Non-financial disclosures will not be published.

List specific disclosures, if none, please say “None”:

None

☑ I have completed this Disclosure Statement fully and to the best of my ability. I understand that all Applicants must complete this Disclosure Statement and that the information disclosed may be published if their project is accepted for crowdfunding.

By my electronic signature, I verify the completeness and accuracy of the contents of this form.

Click in the box above to add your electronic signature

03/18/2017

Date [03/18/2017]

Aaron D. Boes

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(319) 331-5479 • aaron-boes@uiowa.edu

CURRENT POSITION

7/2016 - Current	Assistant Professor Departments of Pediatrics, Neurology & Psychiatry University of Iowa Hospitals and Clinics Iowa City, IA

ADDITIONAL AFFILIATIONS

7/2016 - Current	Non-Clinical Staff \ Courtesy Staff (Research Collaborator) Massachusetts General Hospital Harvard University, Boston, MA

EDUCATION & WORK EXPERIENCE

7/2014 – 6/2016	Attending, Pediatric Neurologist Massachusetts General Hospital Harvard University, Boston, MA
7/2014 – 6/2016	Clinical Neuroscience Fellow & Staff Physician Neuropsychiatry & Noninvasive Brain Stimulation Berenson Allen Center for Noninvasive Brain Stimulation Beth Israel Deaconess Medical Center Harvard University, Boston, MA
7/2013 - 6/2014	Chief Pediatric Neurology Resident Massachusetts General Hospital Harvard University, Boston, MA
7/2011 - 6/2013	Pediatric Neurology Resident Massachusetts General Hospital \ Brigham and Women's Harvard University, Boston, MA
6/2009 - 6/2011	Pediatric Resident Rady Children's Hospital University of California San Diego, San Diego, CA
8/2003 - 5/2009	Scholar, Medical Scientist Training Program M.D. Carver College of Medicine; Ph.D. Neuroscience University of Iowa, Iowa City, IA
8/1999 - 5/2003	Bachelors of Science with Honors and High Distinction Integrative Physiology \ Exercise Science University of Iowa, Iowa City, IA
2001 Spring	Traveling Scholar The University of Wales, Swansea, Wales, UK

HONORS, AWARDS, & OUTSTANDING ACHIEVEMENTS

2016	Biological Psychiatry Travel Fellowship Award
2016	S. Weir Mitchell Award for outstanding achievement in neurology research + $1000 cash prize, American Academy of Neurology & American Brain Foundation
2015	Primary mentor for manuscript awarded Saul R. Korey Award for American Academy of Neurology Best Medical Student Essay, awarded to mentee David Fischer
2013 - 2015	Received highest teaching rating, 'Excellent' by Harvard Medical School students, Neuroanatomy Laboratory
2014	First author on manuscript awarded the prestigious S. Weir Mitchell Award by the American Academy of Neurology
2014, 2015	American Academy of Neurology Scholarship recipient, nominated by Partners Neurology, BIDMC Neurology
2013	Cobb Award & Cash Prize for Best Poster Presentation, Boston Society of Neurology and Psychiatry Cobb Assembly
2011	Named "Highly Cited Author" in 2011 by Social Cognitive and Affective Neuroscience
2008	American Academy of Neurology Saul R. Korey Award, Best medical student essay in experimental neurology
2008	Cognitive Neuroscience Society, Graduate Students Present Award (9 of 300 applicants awarded)
2007, 2008	Wisconsin Symposium on Emotion Scholar Travel Award (15 awarded per year)
2007	Human Brain Mapping Conference, Highest Ranking Abstract (top 65 of 1566) & Travel Fellow Award
2007	NINDS Neuroscience Career Symposium Travel Award
2005	Medical Student Representative, American Academy of Neurology Conference, Miami, FL
2003	University of Iowa Dean's List
2002	Honors Thesis Travel Award
2002	Golden Key National Honor Society Inductee
2002	Czech Heritage Scholarship Award

2002	Phi Beta Kappa Honor Society Inductee
2000	Nile Kinnick Leadership Award

PUBLICATIONS

1. **Boes AD**, Murko V, Wood JL, Langbehn DR, Canady J, Richman L, Nopoulos P: Social function in boys with cleft lip and palate: relationship to ventral frontal cortex morphology. *Behav Brain Res* 2007, 181(2):224-231. PMID: 17537526.

2. **Boes AD**, McCormick LM, Coryell WH, Nopoulos P: Rostral anterior cingulate cortex volume correlates with depressed mood in normal healthy children. *Biol Psychiatry* 2008, 63(4):391-397. PMID: 17916329.

3. **Boes AD**, Tranel D, Anderson SW, Nopoulos P: Right anterior cingulate: a neuroanatomical correlate of aggression and defiance in boys. *Behav Neurosci* 2008, 122(3):677-684. PMID: 18513137.

4. **Boes AD**, Bechara A, Tranel D, Anderson SW, Richman L, Nopoulos P: Right ventromedial prefrontal cortex: a neuroanatomical correlate of impulse control in boys. *Soc Cogn Affect Neurosci* 2009, 4(1):1-9. PMID: 19015086.

5. Van Der Plas EA, **Boes AD**, Wemmie JA, Tranel D, Nopoulos P: Amygdala volume correlates positively with fearfulness in normal healthy girls. *Soc Cogn Affect Neurosci* 2010, 5(4):424-431. PMID: 20150341.

6. Nopoulos P, **Boes AD**, Jabines A, Conrad AL, Canady J, Richman L, Dawson JD: Hyperactivity, impulsivity, and inattention in boys with cleft lip and palate: relationship to ventromedial prefrontal cortex morphology. *J Neurodev Disord* 2010, 2(4):235-242. PMID: 22127933.

7. **Boes AD**, Mehta S, Rudrauf D, Van Der Plas E, Grabowski T, Adolphs R, Nopoulos P: Changes in cortical morphology resulting from long-term amygdala damage. 2011, *Soc Cogn Affect Neurosci* 2012, 7(5):588-595. PMID: 21896493.

8. **Boes AD**, Grafft AH, Joshi C, Chuang NA, Nopoulos P, Anderson SW: Behavioral effects of congenital ventromedial prefrontal cortex malformation. *BMC Neurol,* 2011, 11:151. PMID: 22136635.

9. **Boes AD**, Grafft A, Espe-Pfeifer P, Rowe J, Stein MT: Manipulative and antisocial behavior in an 11-year-old boy with epilepsy. *J Dev Behav Pediatr* 2012, 33(4):365-368. PMID: 22566031

10. **Boes AD,** Duhaime AC, Caruso P, Fischl B: FreeSurfer is useful for the early detection of Rasmussen's encephalitis. *Dev Med Child Neurol.* 2015, PMID: 26174006

11. **Boes AD**, Prasad, S, Pascual-Leone, A, Liu H, Liu Q, Caviness, VS, Fox, MD: Network localization of neurological symptoms from focal brain lesions. *Brain,* 2015, Oct;138:3061-75, PMID: 26264514.

12. Stern AP, **Boes AD**, Haller CS, Bloomingdale K, Pascual-Leone A, Press D. Psychiatrists' attitudes toward transcranial magnetic stimulation. *Biological Psychiatry*, 2015 S0006-3223(15) 659-9, PMID: 26435222

13. Rubio B**, **Boes AD****°**, Laganiere S, Rotenberg A, Jeurissen D, Pascual-Leone, A: Noninvasive Brain Stimulation in Pediatric ADHD: A Review. *Journal of Child Neurology*, 2016, 31(6), p784-796

    ** Indicates authors contributed equally **°** Indicates corresponding author

14. Fischer DB, Perez DL, Prasad S, Rigolo L, O'Donnell L, Acar D, Meadows M, Baslet G, **Boes AD**, Golby AJ, Dworetzky, BA. Right inferior longitudinal fasciculus lesions disrupt visual-emotional integration. *Social Cognitive and Affective Neuroscience, 2016, 11(6): 945-951.*

15. Sutterer M, Bruss J, **Boes AD**, Voss MW, Bechara A, Tranel D. Canceled connections: Lesion-derived network mapping helps explain differences in performance on a complex decision-making task. *Cortex, 2016, 78: 31-43*

16. Laganiere S, **Boes AD**, Fox MD. Network localization of hemichorea-hemiballismus. *Neurology,* 2016. 86 (23): 2187-2195

17. Fischer DB,** **Boes AD**,** Demertzi A, Evrard HC, Laureys S, Edlow BL, Liu H, Saper CB, Pascual-Leone A, Fox MD, Geerling JC. A human brain network derived from coma-causing brainstem lesions. 2016. 687 (23) 2427 -2434

    *** Indicates authors contributed equally*

18. **Boes AD**, Stern AP, Bernstein M, et al. H-Coil Repetitive Transcranial Magnetic Stimulation Induced Seizure in an Adult with Major Depression: A Case Report. Brain Stimul. 2016 Apr 19.

19. Kelly MS, Oliveira-Maia AJ, Bernstein M, Stern AP, Press DZ, Pascual-Leone A, & **Boes, AD.** Initial response to transcranial magnetic stimulation treatment for depression predicts subsequent response. Journal of Clinical Neuropsychiatry. *Epub ahead of print.*

SELECTED CHAPTERS \ ABSTRACTS \ ADDITIONAL PUBLISHED WORKS

1. **Boes AD**, Crawford, J. Rady Children's Hospital Housestaff Manual, Neurology Section. 2010– 2011

2. **Boes AD**, Caviness, VS: Neuroanatomy and Lesion Localization. Book Chapter in Handbook of Pediatric Neurology, 1st edition. Ed. Kathy Sims, Lippincott. 2014

3. **Boes AD**. Contributing author and reviewer for McGraw-Hill Clinical Access \ AccessMedicine Online Edition, Neurology and Pediatric Neurology Content. 2013 - 2015.

4. **Boes AD,** SS Ayache, JP Lefaucheur, A Pascual-Leone, MD Fox. Predicting the network effects of central pain lesions using resting-state functional

connectivity MRI. Resting State MRI Conference, Massachusetts Institute Technology, Boston. *Article in prep*

5. **Boes AD,** Weigand A, Lan MJ, Liston C, Dubin MJ, Pascual-Leone A, Fox MD. Effective rTMS therapy for depression is associated with increased volume of the left subgenual cortex. Brain Stimulation, Vol 8 Issue 5, Page e1.

6. **Boes AD**, Noninvasive Brain Stimulation. Invited review for The Sage Encyclopedia of Intellectual and Developmental Disorders. Chapter submitted.

7. **Boes AD,** Fischer DB, Geerling JC, Saper CB, Fox MD. Hypothalamus-derived sleep- and wake-promoting networks in the human brain. Abstract accepted, 2016 American Academy of Neurology Conference, Vancouver Canada. Article in prep.

8. **Boes AD**, Greve D, Weigand A, Lan MJ, Liston C, Fischl B, Pascual-Leone A, Dubin MJ, Fox MD. Left Dorsolateral Prefrontal Cortex Thickness Increases With Effective rTMS Treatment of Depression. Abstract accepted, 2016 American Neuropsychiatry Association, San Diego, CA

9. Kuceyeski A, Labar DR, Nearing D, Tsagaris Z, Silverstein J, Pepper-Lane H, **Boes AD**, Fox MD, Thickbroom G, Edwards DJ. Predicting motor function after stroke using MRI-based lesion-overlap and transcranial magnetic stimulation metrics. 2016 Human Brain Mapping Conference.

SELECTED INVITED LECTURES AND PRESENTATIONS

1. **Boes AD** (2016) “Left Dorsolateral Prefrontal Cortex Thickness Increases With Effective rTMS Treatment of Depression.” American Neuropsychiatry Association Meeting, San Diego, CA.

2. **Boes AD** (2015) “Pediatric Neurology Emergencies” Child Neurology Course, Harvard Medical School Continuing Medical Education.

3. **Boes AD** (2015) “Network localization of neurological symptoms: from hallucinations to coma.” Neurology Grand Rounds, Massachusetts General Hospital, Boston, MA.

4. **Boes AD** (2015) “Network localization of neurological symptoms” Platform Presentation ‘Neural Circuits and Neuromodulation’ American Academy of Neurology, Washington DC.

5. **Boes AD** (2014 - 2015) “Clinical Applications of TMS in Pediatrics, Transcranial Magnetic Stimulation Course, Harvard Continuing Medical Education Series, Boston, MA.

6. **Boes AD** (2014) “Lesion-based network analysis.” Gabrieli Laboratory, Massachusetts Institute of Technology, Boston, MA.

7. **Boes AD** (2013) “Neural correlates of peduncular hallucinosis.” Mayo Clinic Pediatric Neurology Noon Conference Series.

8. **Boes AD** (2013) “Neural correlates of peduncular hallucinosis.” Neurology Grand Rounds, University of Wisconsin, Madison, WI.

9. **Boes AD** (2013) “Neuroanatomy and neural networks of peduncular hallucinosis.” Platform Presentation, ‘Disturbances of Linguistic, Social, and Other Processes’ American Academy of Neurology. San Diego, CA.

10. **Boes AD** (2010) “Structural neural correlates of depressed mood and fearfulness in children and adolescents.” Invited speaker for Biological Psychiatry Symposium, New Orleans, LA.

11. **Boes AD** (2010) “Antisocial behavior following early-onset ventromedial prefrontal cortex lesion.” American Society for Clinical Investigation / American Academy of Pediatrics Joint Meeting. Chicago, IL.

12. **Boes AD** (2008) “Impulse control and the ventromedial prefrontal cortex.” Graduate Student Award Presentation, Cognitive Neuroscience Society. San Francisco, CA.

TEACHING

2014, 2015	Instructor, Intensive Course in Transcranial Magnetic Stimulation, Harvard Continuing Medical Education Course. 5 day course offered three times per year.
2013 – 2015	Instructor, Laboratory for Nervous System Anatomy, Human Organ Systems, Harvard Medical School

THE UNIVERSITY OF IOWA, Iowa City, IA

2008 Spring	Instructor, Medical Neuroscience Small Group
2007 Spring	Teaching Assistant, Medical Neuroscience Laboratory
2007 Spring	Tutor, Medical Student Counseling Center
2000 - 2003	Tutor, New Dimensions in Learning, Provided tutoring services to underserved and underrepresented students
2000 Spring	Class Research Coordinator, I-Notes, Principles of Biology and Drugs: Their Action, Nature, and Use

PROFESSIONAL MEMBERSHIP & ACTIVITIES

2014, 2015	Co-Chair, TMS Society Pediatric Subcommittee
2008 - Current	Ad-hoc reviewer, including *Cerebral Cortex*, *Biological Psychiatry*, *Neuropsychologia, Annals of Neurology, Sleep*
2005 - Current	American Academy of Neurology Member
2008	American Medical Association Student Member
2007 - 2009	Organization of Human Brain Mapping

2007 - 2009	Cognitive Neuroscience Society
2002 - 2007	Society for Neuroscience

SERVICE AND ADMINISTRATIVE PARTICIPATION

2016	Physician Scientist Mentoring Program, Boston University
2015 - 2016	Course Director for Child Neurology Conference Series, Massachusetts General Hospital
2014-2015	Participated in Resident Selection Committee, Pediatric Neurology, Massachusetts General Hospital
2007-2008	Volunteer Medical Examiner, Free Medical Clinic
2007 Summer	Volunteer Medical Examiner, Free Mental Health Clinic
2006 - 2007	Executive Committee Member, Brain Awareness Week, UI Brain Discovery Fair Planning and Organization
2004 - 2005	President, Medical Student Interest Group in Neurology
2002 - 2003	Undergraduate Representative, UI Student Government Research Council
2002 - 2003	Patient Guide, Free Medical Clinic of Iowa City

GRANT SUPPORT

Completed

2003 – 2005	NIGMS T32GM007337, Medical Scientist Training Program, PI: Steven Lentz. Role: Trainee
2005 - 2008	NINDS/NIA T32NS007421. Neuroscience Training Program. PI: Daniel Tranel. Role: Trainee
2013 - 2015	R25 Grant. NIH/NINDS R25NS065743-05. Mentor: Alvaro Pascual-Leone, M.D., Ph.D.
2014 - 2016	Sidney R. Baer, Jr. Clinical & Research Fellowship, Neuropsychiatry & Noninvasive Brain Stimulation

Current

2016 - 2017	K12 Child Health Research Career Development Award 4K12HD027748-24

Pending

2017 - 2020	Child Neurology Career Development K12
2017	Aiming for a Cure Foundation Grant