2013 Research Annual Report Neurology

Division Details

Division Data Summary

RESEARCH AND TRAINING DETAILS	
Number of Faculty	30
Number of Joint Appointment Faculty	2
Number of Research Fellows	1
Number of Research Students	1
Number of Support Personnel	40
Direct Annual Grant Support	\$6,802,888
Direct Annual Industry Support	\$1,202,848
Peer Reviewed Publications	83

CLINICAL ACTIVITIES AND TRAINING

Number of Clinical Staff	89
Number of Clinical Fellows	3
Number of Clinical Students	0
Number of Other Students	23
Inpatient Encounters	5270
Outpatient Encounters	21.123



Division Photo



Row 1: B Wong, J Xiang, P Horn, J Taylor Row 2: J Vannest, T Arthur, R Arya, A Hershey Row 3: J Wilson, T Glauser, D Gilbert, M Schapiro

Significant Accomplishments

Comprehensive Neuromuscular program

Our Comprehensive Neuromuscular Care Center continues to be a center of excellence for the coordinated care of patients with pediatric neuromuscular disorders, especially Duchenne muscular dystrophy (DMD). More than 80 percent of our DMD patients travel here from other states and nations, including some from as far as Russia and Ireland. We also have become world-class experts in caring for patients with dystrophinopathy. Meanwhile, our new "one stop" interdisciplinary neuromuscular clinic brings specialists from as many as nine different fields to one location to serve our patients with multi-system needs.

Our Research in Neuromuscular Disease

We participate in ongoing industry-sponsored clinical trials as well as in a transcriptomics and proteomics study in DMD. This has been attained through training of residents and fellows and collaboration with multiple divisions, including endocrinology, cardiology and radiology.

Breakthrough Headache Research

Our Headache Center, formed 16 years ago, continues to grow in the management, treatment and understanding of headaches in children, adolescents and young adults. Our multidisciplinary outpatient clinic,

acute treatment center, young adult headache program and a focused inpatient service provide the basis for the research and educational activities, including an UCNS-certified Headache Medicine fellowship. Our research highlights from the past year include an NIH-sponsored study that demonstrated significant effectiveness of cognitive behavioral therapy in a multidisciplinary care model of the treatment of chronic migraine that is comparable to pharmaceutical treatment in adults. We also are comparing the effectiveness of amitriptyline and topiramate in the prevention of pediatric and adolescent migraine (CHAMP) study with significant collaborative effort from Behavioral Medicine and Clinical Psychology, the Center for Clinical and Translation Research and the Department of Biostatistics and Clinical Trials Statistical and Data Management Center at the University of lowa.

Tuberous Sclerosis Program is the World's Largest

Our Tuberous Sclerosis Program, now designated a Center of Excellence, is the largest in the world and the only one that manages every aspect of the disorder in both adults and children. We receive increasing numbers of national and international referrals because our program conducts leading-edge research while offering unique social and emotional support to patients and families, such as our TSC summer camp, the first and only one of its kind. Research conducted or led by our physicians has resulted in 15 peer-reviewed publications over the past year. We also have launched an NIH-sponsored, multisite, national study to continue to improve care for children with TSC.

Research Highlights

Mark Schapiro, MD

We previously showed differences in neural activation during language processing in adolescents and young adults with Down syndrome in comparison with typically developing individuals matched for chronological age. We now show that activation in the adolescents and young adults with Down syndrome differs significantly in magnitude and spatial extent when compared with both chronological and mental age-matched typically developing control groups during a story listening task. These results provide additional support for an atypical pattern of functional organization for language processing in this population.

Reference: Jacola LM, Byars AW, Hickey F, Vannest J, Holland SK, Schapiro MB. Functional magnetic resonance imaging of story listening in adolescents and young adults with Down syndrome: evidence for atypical neurodevelopment. Journal of Intellectual Disability Research, in press.

Movement disorder (Donald Gilbert, MD and Steve Wu, MD)

ADHD/ Tourette Syndrome: We have two ongoing NIH-funded studies of motor cortex physiology as a biomarker of behavioral control impairments and of pharmacological treatment responses in ADHD.

Neuroplasticity: Long Term Potentiation/Depression: Dr. Steve Wu has led a series of exciting studies piloting new methods of using Transcranial Magnetic Stimulation to study long term potentiation and long term depression in motor cortex.

Tourette SyndromeGenetics: We are a site in a new, international, NIMH funded collaborative study of genetics of Tourette Syndrome.

Clinical Trials in Tourette Syndrome: We just completed a phase 2a study of a new pharmacological treatment for Tourette Syndrome, and we are participating in an ongoing study.

Tuberous Sclerosis (Darcy Krueger, MD, PhD and David Franz, MD)

The TSC Center, led by Drs. Franz and Dr. Krueger, has seen considerable expansion in both clinical care and research projects in 2013, building on similar successes of 2012. In 2013 alone, two major NIH-funded research studies and one major multicenter phase III clinical trial were officially launched. Major publications by the group included manuscripts in high-impact journals such as *Lancet*, *Annals of Neurology*, *PlosOne*, and *Chest*.

Epilepsy (Tracy Glauser, MD; Todd Arthur, MD; Hans Greiner, MD; Barb Hallinan, MD; Katherine Holland, MD; Sejal Jain, MD; Diego Morita, MD; Douglas Rose, MD; Shannon Standridge, MD; Jeff Tenney, MD; Cameron Thomas, MD)

The Comprehensive Epilepsy Center discoveries ranged the entire spectrum from clinical trials results through epilepsy surgical evaluation techniques to animal models of epileptogenesis. In the ongoing NIH funded Childhood Absence epilepsy study, 12-month outcome data from the double blind portion of the study confirmed that ethosuximide is the optimal initial empirical monotherapy for CAE and established this study as the first randomized controlled trial meeting International League Against Epilepsy criteria for class I evidence for any type of generalized seizure in adults or children. In addition, this study reported the EEG characteristics of untreated Childhood Absence Epilepsy along with the associations between specific EEG findings and baseline measure of attention and short term outcome. The surgical epilepsy team identified that ictal high-frequency oscillations region was a favorable prognostic indicator for surgical outcome. Lastly, using a transgenic mouse model, the epilepsy basic scientists discovered that deletion of PTEN from postnatally generated dentate granule cells led to hyperactivation of the mTOR pathway and subsequent spontaneous seizures, confirming that these abnormal dentate granule cells can cause epilepsy.

Division Publications

- 1. Amann JP, Glauser T, Chiron C. **Developing antiepileptic drugs in children: balancing protection and access**. *Handb Clin Neurol*. 2013; 111:741-6.
- Amos-Kroohs RM, Williams MT, Braun AA, Graham DL, Webb CL, Birtles TS, Greene RM, Vorhees CV, Pisano MM. Neurobehavioral phenotype of C57BL/6J mice prenatally and neonatally exposed to cigarette smoke. *Neurotoxicol Teratol.* 2013; 35:34-45.
- 3. Arya R, Glauser TA. Pharmacotherapy of focal epilepsy in children: a systematic review of approved agents. CNS Drugs. 2013; 27:273-86.
- 4. Arya R, Greiner HM, Lewis A, Mangano FT, Gonsalves C, Holland KD, Glauser TA. Vagus nerve stimulation for medically refractory absence epilepsy. *Seizure*. 2013; 22:267-70.
- Arya R, Mangano FT, Horn PS, Holland KD, Rose DF, Glauser TA. Adverse events related to extraoperative invasive EEG monitoring with subdural grid electrodes: a systematic review and meta-analysis. *Epilepsia*. 2013; 54:828-39.
- 6. Arya R, Shinnar S, Glauser TA. Corticosteroids for the treatment of infantile spasms: a systematic review. *J Child Neurol.* 2012; 27:1284-8.
- 7. Bigras C, Shear PK, Vannest J, Allendorfer JB, Szaflarski JP. **The effects of temporal lobe epilepsy on scene encoding**. *Epilepsy Behav*. 2013; 26:11-21.
- 8. Buelow JM, Perkins SM, Johnson CS, Byars AW, Fastenau PS, Dunn DW, Austin JK. Adaptive functioning in children with epilepsy and learning problems. *J Child Neurol.* 2012; 27:1241-9.
- 9. Castro OW, Santos VR, Pun RY, McKlveen JM, Batie M, Holland KD, Gardner M, Garcia-Cairasco N,

Herman JP, Danzer SC. Impact of corticosterone treatment on spontaneous seizure frequency and epileptiform activity in mice with chronic epilepsy. *PLoS One*. 2012; 7:e46044.

- Chen Y, Curran CP, Nebert DW, Patel KV, Williams MT, Vorhees CV. Effect of chronic glutathione deficiency on the behavioral phenotype of GcIm-/- knockout mice. *Neurotoxicol Teratol.* 2012; 34:450-7.
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- 12. Edden RA, Crocetti D, Zhu H, Gilbert DL, Mostofsky SH. Reduced GABA concentration in attentiondeficit/hyperactivity disorder. Arch Gen Psychiatry. 2012; 69:750-3.
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- Frank LM, Shinnar S, Hesdorffer DC, Shinnar RC, Pellock JM, Gallentine W, Nordli DR, Jr., Epstein LG, Moshe SL, Lewis DV, Sun S, Team FS. Cerebrospinal fluid findings in children with feverassociated status epilepticus: results of the consequences of prolonged febrile seizures (FEBSTAT) study. J Pediatr. 2012; 161:1169-71.
- Franz DN. Everolimus for astrocytomas in tuberous sclerosis author's reply. Lancet. 2013; 381:1275.
- Franz DN, Agricola KD, Tudor CA, Krueger DA. Everolimus for tumor recurrence after surgical resection for subependymal giant cell astrocytoma associated with tuberous sclerosis complex. J Child Neurol. 2013; 28:602-7.
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- Fujiwara H, Greiner HM, Lee KH, Holland-Bouley KD, Seo JH, Arthur T, Mangano FT, Leach JL, Rose DF. Resection of ictal high-frequency oscillations leads to favorable surgical outcome in pediatric epilepsy. *Epilepsia*. 2012; 53:1607-17.
- 22. Gilbert DL. **Drug Treatments for Tourette Syndrome and Co-Morbid Disorders**. In: JT Walkup, JW Mink, KS McNaught, eds. *A Family's Guide to Tourette Syndrome*. Bloomington, IN: iUniverse Press; 2012:110-124.
- Glauser T, Ben-Menachem E, Bourgeois B, Cnaan A, Guerreiro C, Kälviäinen R, Mattson R, French JA, Perucca E, Tomson T, Guidelines ISoA. Updated ILAE evidence review of antiepileptic drug efficacy and effectiveness as initial monotherapy for epileptic seizures and syndromes. *Epilepsia*. 2013; 54:551-63.

- 24. Glauser TA, Cnaan A, Shinnar S, Hirtz DG, Dlugos D, Masur D, Clark PO, Adamson PC, Childhood Absence Epilepsy Study T. Ethosuximide, valproic acid, and lamotrigine in childhood absence epilepsy: initial monotherapy outcomes at 12 months. *Epilepsia*. 2013; 54:141-55.
- 25. Glauser TA, Loddenkemper T. Management of childhood epilepsy. *Continuum (Minneap Minn)*. 2013; 19:656-81.
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- Graham DL, Amos-Kroohs RM, Braun AA, Grace CE, Schaefer TL, Skelton MR, Williams MT, Vorhees CV. Neonatal +-methamphetamine exposure in rats alters adult locomotor responses to dopamine D1 and D2 agonists and to a glutamate NMDA receptor antagonist, but not to serotonin agonists. Int J Neuropsychopharmacol. 2013; 16:377-91.
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- 48. Morita DA, Glauser TA, Modi AC. **Development and validation of the Pediatric Epilepsy Side Effects Questionnaire**. *Neurology*. 2012; 79:1252-8.
- 49. Morrison JA, Glueck CJ, Daniels SR, Horn PS, Wang P. Determinants of ApoB, ApoA1, and the ApoB/ApoA1 ratio in healthy schoolgirls, prospectively studied from mean ages 10 to 19 years: the Cincinnati National Growth and Health Study. *Metabolism*. 2012; 61:1377-87.
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Faculty, Staff, and Trainees

Faculty Members

Andrew Hershey, MD, PhD, Professor

Leadership Division Director; Director Headache Center

Research Interests Migraine, blood genomics

Todd Arthur, MD, Assistant Professor Research Interests Brain concussion

Anna W Byars, PhD, Associate Professor Research Interests Cognitive effects of epilepsy
James Collins, MD, PhD, Assistant Professor Research Interests Congenital Muscular Dystrophy; Neuromuscular Disease
David Franz, MD, Professor Leadership Director Tuberous Sclerosis program
Research Interests Tuberous sclerosis
Donald Gilbert, MD, Professor Leadership Director Movement Disorders program; Director Neurology Residency Program
Research Interests Tourette syndrome, Transcranial Magnetic Stimulation (TMS)
Tracy A Glauser, MD, Professor Leadership Director Comprehensive Epilepsy program
Research Interests Epilepsy, pharmacology
Hansel Greiner, MD, Assistant Professor Research Interests Epilepsy
Barbara Hallinan, MD, PhD, Assistant Professor Research Interests CSF steroid profiles
Katherine Holland-Bouley, MD, PhD, Associate Professor Research Interests lon channels and epilepsy
Sejal Jain, MD, Assistant Professor Research Interests Epilepsy, sleep
Marielle A Kabbouche, MD, Associate Professor Research Interests Migraine
Darren Kadis, PhD, Assistant Professor Research Interests Neuroimaging and MEG of language
Darcy Krueger, MD, PhD, Associate Professor Research Interests Tuberous Sclerosis
Diego Morita, MD, Assistant Professor Research Interests Epilepsy, pharmacology
Hope O'Brien, MD, Assistant Professor Research Interests Headaches
Douglas Rose, MD, Professor Leadership Director, MEG lab
Research Interests Magneto-Encephalography (MEG)
Mark Schapiro, MD, Professor Research Interests Neurodevelopmental disorders
Matthew Skelton, PhD, Assistant Professor Research Interests Neurobehavioral and neurometabolic

Shannon Standridge, DO, Assistant Professor Research Interests Outcomes study, epilepsy
Mary Sutton, MD, Associate Professor Research Interests Neuro-oncology
Jeffrey Tenney, MD, PhD, Assistant Professor Research Interests Neurophysiology and genesis of absence epilepsy
Cameron Thomas, MD, Assistant Professor Research Interests Neonatal neurology
Jennifer Vannest, PhD, Associate Professor Research Interests Speech and language development
Charles Vorhees, PhD, Professor Leadership Director Animal Neurobehavior Core
Research Interests Drugs/toxicants and brain development
Kristen Wesselkamper, MD, Assistant Professor Research Interests Improvement science
Michael Williams, PhD, Associate Professor Research Interests Drugs/toxicants and brain development
Brenda Wong, MD, Professor Leadership Director Neuromuscular program
Research Interests Duchenne's Muscular Dystrophy, Spinal Muscular Atrophy
Steve Wu, MD, Assistant Professor Research Interests Movement Disorder; Transcranial Magnetic Stimulation (TMS)
Jing Xiang, MD, PhD, Associate Professor Leadership Director MEG Research program
Research Interests MEG
Joint Appointment Faculty Members
Michael Miles, PhD, Professor (Pathology)
Clinical Staff Members
Jamie Capal, MD, Neurodevelopment and neurobehavior Irina Rybalsky, MD, Duchenne's Muscular Dystrophy
Trainees
Ravindra Arva, MD, DM, PGYX All India Institute of Medical Sciences

Haneul Lee, MD, PGYV, Yonsei University
Nina Natarajan, MD, PGYV, University of Cincinnati
Sarah Weatherspoon, MD, PGYV, University of Texas Southwestern
Katrina Peariso, MD, PGYV, University of New Mexico

Thomas Dye, MD, PGYV, St. Louis University
Tanishia Williams, MD, PGYV, University of Medicine & Dentistry of New Jersey
Gewalin Aungaroon, MD, PGYIV, Faculty of Medicine Ramathibodi
Dror Kraus, MD, PGYIV, Hebrew University
Michael Oldham, MD, PGYIV, George Washington University
Cuixia Tian, MD, PGYIV, Medical Center of Fudan University
Vinita Knight, MD, PGYIII, Eastern Virginia Medical School
Kelly Kremer, MD, PGYIII, University of Cincinnati
Michael Sweeney, MD, PGYIII, Medical College of Wisconsin
Marissa Vawter, MD, PGYIII, Indiana University

Division Collaboration

Human Genetics; Neurosurgery; Neuroradiology; Psychology/Neuropsychology; Developmental Pediatrics; Psychiatry » Drs. T.A. Burrow, Derek Neilson, Taoshang Huang, Dr. E. Air, Dr. K. Cecil, Dr. B. Lejeune, Dr. C. Erickson, and Dr. E. Harris

Movement Disorders Clinic/Tourette's Disorder Clinic

Neurosurgery; Anesthesia; Bioinformatics; Radiology » Dr. F. Mangano, Dr. S. Danzer, Dr. J. Pestian, and Drs. J. Leach, M. Gelfand

Comprehensive Epilepsy Program

Pulmonary Medicine; Nephrology; Plastic Surgery; Radiology; Neurosurgery; Cardiology; Human Genetics; Psychiatry; Genetics; DDBP » Drs. L. Young, F. McCormack, Dr. C. Gordon, Drs. M. Care, J. Leach, Drs. K. Crone, M. Care, S. Serai, W. Yuan, Dr. T. Knilans, Dr. B. Schorry, Dr. D. Nelson, Dr. E. Schorry, and Drs. D. Murray, N. Bing; B. Kent

Tuberous Sclerosis Program

Behavioral Medicine and Clinical Psychology; Hematology » Drs. S. Powers, A Lynch-Jordan, L. Crosby, S. Slater and Drs. Karen Kalinyak, Charles Quinn

Headache Center

Cardiology; Developmental and Behavioral Pediatrics; Nutrition; Human Genetics; Gastroenterology; Endocrinology; Orthopedics; Speech Therapy; Rehabilitative Medicine; Pulmonary; Physical Therapy; Pathology; Pediatric Surgery; Anesthesia & Palliative Care; Pain Services; Social Services; Translational Research; Nephrology » Drs. J. Towbin, JL Jefferies, R. Spicer, L. Cripe, Dr. D. Schonfeld, B. Godshall, D. Boutwell, M. Walker genetic counselor, Drs. A Kaul, N. Yazigi, A. Miethke, Drs. M. Rutter, S. Rose, Drs. J. McCarthy, V. Jain, P. Sturm, J. Linck, Dr. M. McMahon, Drs. R. Amin, H. Sawnani, J. Crisalli, A. McCormick, M. McGuire, Drs. L. Miles, K. Bove, Drs. R. Brown, T. Inge, Dr. N. Weidner, M. Meyer, Dr. K. Goldschneider, L. Demosthenes, Dr. J. Molkentin, and Dr. E. Jackson

Comprehensive Neuromuscular Center

Sport Medicine; Physical Medicine & Rehabilitation » Drs. J. Divine, N. Edwards, M. Shaffer and B. Kurowski Concussion Clinic

Neonatology & Pulmonary Biology; Cardiology; Hematology » Drs. B. Haberman, T. Cahill, S. Merhar, N. Monangi, Drs. B. Marino, J. Anderson, and Dr. D. Adams, A. Hammill Neonatal Follow-up Clinic

Pulmonary » Drs. N. Simakajornboon, M. Ednick, J. Crisalli, H. Sawnani, G. McPhail

Sleep Clinic

Human Genetics; Allergy & Immunology; Anesthesiology; Developmental Biology; Experimental Hematology ; Psychiatry; General & Thoracic Surgery; Endocrinology; Neurosurgery; Neuroimaging Research Consortium; Pulmonary Biology » Drs. G. Grabowski, Y. Sun, T. Huang, R. Stottmann, Drs. M. Rothenberg, H. Zhu, Dr. S. Danzer, A. Lepke, Drs. K. Campbell, M. Nafafuku, Drs. R. Waclaw, L. Ehrman, D. Pan, N. Ratner, Dr.C. Erickson; T. Schaefer, Dr. M. Helmrath, Dr. T. Nakamura, Dr. F. Mangano, Dr. W. Yuan, and Dr. J. Bridges

Neurobehavioral Animal Core (Vorhees and Williams lab)

Rehabilitative Medicine » Drs. D. Pruitt, L. Michaud

Pediatric Demyelinating Disease Clinic

Speech Pathology; Pediatric Neuroimaging Research Consortium; Biomedical Informatics; Radiology; Biostatistics & Epidemiology; Heart Institute Research/Heart Institute Neurodevelopmental Clinic; Pulmonary; Autism Speaks; Human Genetics » Dr. E. Redle, Drs. S. Holland, V. Schmithorst, Dr. M. Wagner, Dr. J. Tkach, S. Holland, G. Lee, Dr. M Altaye, Dr. B. Marino, Dr. R. Amin; Keith McConnell - Sr. Biomedical Engineer, Dr. D. Murray, and Dr. E. Schorry

Neuroimaging of Childhood Apraxia of Speech,

Cincinnati MR Imaging of Neural Development-(C-MIND study)

Gastroenterology and Nutrition; Pathology; Neurosurgery » Drs. R. Kohli, S. Xanthakos, Dr. L. Miles, and Dr. F. Mangano

Mltochondrial & Pathological Studies in Epilepsy Surgery/Evaluation of Coenzyme Q10 as a biomarker in liver disease

Child & Adolescent Psychiatry; Physical Medicine & Rehabilitation » Dr. E. Harris and Dr. J. Vargus-Adams MEG Research

Grants, Contracts, and Industry Agreements

Grant and Contract Awards		Annual Direct
GILBERT, D		
2/2-Anomalous Motor Physiology in	ADHD	
National Institutes of Health		
R01 MH 095014	05/01/12-04/30/17	\$168,003
4/8-Collaborative Genomic Studies	of Tourette Disorder	
National Institutes of Health		
R01 MH 092520	09/15/11-06/30/14	\$50,000
GLAUSER, T		
Cincinnati Neuroscience Clinical Tr	ials Research Center	
National Institutes of Health(Univers	ity of Cincinnati)	
U10 NS 077311	09/30/11-08/31/18	\$100,000
Impact of Initial Therapy and Respo National Institutes of Health	nse on Long Term Outcome in Children with CAE	

U01 NS 045911	09/01/10-08/31/14	\$2,539,145
Midazolam for the Pediatric Trials N	letwork	
National Institutes of Health(Duke U	niversity)	
HHSN2752010000031	08/01/12-09/30/13	\$12,838
HERSHEY, A / POWERS, S		
Amitrityline and Topiramate in the F	Prevention of Childhood Migraine	
National Institutes of Health		
U01 NS 076788	9/30/11-8/31/16	\$2,414,730
HOLLAND-BOULEY, K		
Sodium Channel Gene Variation in t	he Treatment of Epilepsy	
National Institutes of Health		
R01 NS 062756	04/01/09-03/31/14	\$192,938
KRUEGER, D		
Early Biomarkers of Autism Spectr	um Disorders in Infants with Tuberous Sclerosis	
National Institutes of Health(Children	n's Hospital Boston)	
U01 NS 082320	09/01/12-08/31/17	\$519,972
Potential EEG Biomarkers and Antie	epileptogenic Strategies for Epilepsy in TSC	
National Institutes of Health(Univers	ity of Alabama-Birmingham)	
P20 NS 080199	09/01/12-08/31/15	\$29,568
Topical Rapamycin Therapy to Alley	riate Cutaneous Manifestations of Tuberous Sclerosis Co	omplex
US Army Medical Research Acquisiti	on Activity(University of Texas Health Science Center-Hous	ton)
W81WH-11-1-0240	08/31/12-08/31/13	\$3,240
TSC Autism Center of Excellence R	esearch Network (TACERN) Research	
Tuberous Sclerosis Alliance(Childre	n's Hospital Boston)	
2012-CRN-01	10/01/12-12/31/13	\$41,118
TSC Neurocognitive Clinical Trial		
Tuberous Sclerosis Alliance		
01-11B	07/01/12-11/30/13	\$54,491
MORAN, M		
Genetic Susceptibility to PCB-Induc	ed Motor Dysfunction	
National Institutes of Health(Norther	n Kentucky University)	
R15 ES 020053	02/18/13-06/30/13	\$5,229
VANNEST, J		
Imaging the Effect of Centrotempor	al Spikes and Seizures on Language in Children	
National Institutes of Health		
R01 NS 065840	09/15/11-06/30/16	\$382,402

Training Grant in Teratology			
T32 ES 07051	07/01/12-06/30/17		\$289,214
		Current Year Direct	\$6,802,888
Industry Contracts			
FRANZ, D			
Novartis Pharmaceuticals			\$453 043
Biocodex			\$9,047
Otsuka America Pharmaceutical Inc			\$51 202
Psyadon Pharmaceuticals, Inc.			\$40,771
HERSHEY, A			<i></i>
Palm Beach Neurology, PA			\$7,700
HOLLAND-BOULEY. K			÷ ; · · · ·
Novartis Pharmaceuticals			\$3.536
KABBOUCHE, M			. ,
Allergan, Inc.			\$6,930
KRUEGER, D			
Lundbeck Inc			\$11,496
Novartis Pharmaceuticals			\$101,411
Novartis, Inc (Children's Hospital Boston)			\$152,759
MORITA, D			
Eisai Medical Service			\$15,775
VORHEES, C			
Council for the Advancement Pyrethroid			\$69,829
WONG, B			
DART Therapeutics			\$47,004
GlaxoSmithKline			\$213,621
PTC Therapeutics, Inc			\$11,088

VORHEES, C

Prosensa Therapeutics	\$7,546
Current Year Direct Receipts	\$1,202,848
Total	\$8,005,736