Part I: General Information

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Place of Birth: Wilmington, Delaware, United States of America

Education and Professional Background

Education

1990 B.A.	Luther College (Decorah, IA), Psychology
1993 M.S.	University of Maryland (College Park, MD), Psychology
1997 Ph.D.	University of Maryland (College Park, MD), Psychology

Academic and Professional Appointments:

1997-2004	Research Associate – Massachusetts Eye & Ear Infirmary
1997-2000	Instructor – Harvard Medical School Department of Otology and Laryngology
1998-1999	Lecturer – MGH Institute of Health Professions
1999-2007	Adjunct Assistant Professor – MGH Institute of Health Professions
2000-2003	Lecturer – Emerson College
2000-2004	Assistant Professor – Harvard Medical School Department of Otology and Laryngology
2004-2006	Lecturer – Boston University
2004-present	Assistant Professor – Harvard Medical School Department of Surgery
2004-present	Assistant Neuroscientist – Massachusetts General Hospital
2005-2006	Neuroscientist Consultant – CACI Inc. (for U.S. Defense Department)
2006-present	Neuroscientist Consultant – BAE Systems National Security Solutions
2006-present	Faculty Member - Speech and Hearing Bioscience and Technology Program of the Harvard-MIT Division of Health Sciences & Technology
2007-present	Associate Professor – MGH Institute of Health Professions

Major Committee Assignments:

2001-2004	MEEI Animal Care and Use Committee

Professional Societies:

1992-present	Society for Neuroscience: Member
1999-present	Boston Area Neuroscience Group: Participant

Awards and Honors:

1993	PHS Individual National Research Service Award
1995	Passed Doctoral Program Comprehensive Exam with Honors
1998	Jack Bartlett Award from the University of Maryland Department of Psychology - awarded annually for excellence in dissertation experimental design.
2002	Fellow of the 50th Anniversary Program for Scholars in Medicine, Harvard Medical School.
2004	The Massachusetts General Hospital Institute of Health Professions Department of Communications Sciences and Disorders Faculty Award for Excellence in Teaching

Part II: Research, Teaching, and Clinical Contributions

A. Narrative report of primary research activities

My early research focused on the neural mechanisms of vocal learning by studying the avian vocal control pathways supporting both learned and innate vocalizations. I described this system by neuroanatomically mapping vocal motor control regions of the parrot forebrain and brainstem, followed by systematic lesioning of these pathways starting peripherally at the cranial nerves and working centrally into the forebrain. Several manuscripts resulted from this work, and aside from human literature, it was one of the first substantial points of comparison for the expansive work in songbird neural circuits serving audio-vocal learning.

My recent research efforts have focused on the development of a neuromotor interface for the control of artificial voice sources and/or input to speech recognition technology. Each year thousands of individuals lose the use of their larynx (voice box) due to disease or injury, and consequently must use an artificial voice source in order to speak. In most cases, the laryngeal nerves and the neuromotor signals that the nerves transmit are healthy at the time of laryngectomy. Our research team has transferred (re-routed) laryngeal nerves to 'host' muscles at the time of laryngectomy so that, after reinnervation, these muscles sustain and naturally amplify the laryngeal nerve signals. My recent publications show the feasibility of obtaining and using these transferred laryngeal motor signals in human laryngectomy patients for prosthetic voice control. I am also investigating the use of face and neck surface EMG signals for speech encoding in both vocally normal and disabled individuals to be implemented in an advanced communication system under support from the US Department of Defense (DARPA).

B. Funding Information

Years covered	*Source*	*Status*	*Project Title*
1993-1996	NIMH (MH1047)	Principal Investigator	Neural mechanisms of vocal learning
1999-2002	Veterans Administration	Investigator	Development of an improved artificial electrolarynx communication system
2002-2003	Harvard Medical School	Scholars in Medicine Fellow	Comparison of electrical and magnetic stimulation of the vagus nerve
2004-2008	R01 DC006449	Investigator	Development of voice neural prosthesis technology
2004-present	Institute of Laryngology and Voice Restoration	Investigator	Voice Restoration Research Program
2005-2007	DARPA Contract # 6800-318	Consultant	Sub-Vocal Speech Exploration

D. Report of Teaching

1. Local contributions

1998-2004 Basic Sciences Course for Medical Residents; Head and Neck: MEEI.
I have given one basic science lecture to the Otolaryngology residents at MEEI each semester since the spring of 1998. My lecture typically deals with neurolaryngolgy and the challenges of establishing a neuromotor interface for artificial voice sources. Preparation involves approximately 6-10 hours per lecture.

2003-2005 Lecture titled: "Development of Voice Neural Prosthesis Technology" for the MGH Institute of Health Professions Communications Sciences and Disorders Program course titled "Laryngectomy Rehabilitation" taught once a year. Approximately 15 graduate students attend this 1.5 hour lecture.

2005-present Lecture titled: "Neuromuscular Control of Voice and Speech" for the Harvard Health Science and Technology Doctoral program Functional Human Anatomy course (HST 718) taught once a year. Approximately 8-10 graduate students attend this 1.5 hour lecture each January.

2005 Lecture titled: "Innovative Future Technologies" for the Harvard Medical School Department of Continuing Education course titled "Laryngeal Surgery and Voice Rehabilitation" held on October 28-29. Approximately 130 individuals were in attendance for this hour of lecture and questions.

2005 Poster titled: "585mn Pulsed Dye Laser for Treatment of Microinvasive Cancer of the True Vocal Folds" presented on June 28th at the Massachusetts General Hospital Clinical Research Day.

2007 Poster titled: "The role of extrinsic laryngeal musculature in vocal hyperfunction for design of an ambulatory biofeedback system" presented on May 3rd at the MGH Institute of Health Professions research day.

2007 Poster titled: "A longitudinal study of post-laryngectomy speech and swallowing respiration patterns" presented on May 3rd at the MGH Institute of Health Professions research day.

2007 Poster titled: "Thermal Damage During Thulium Laser Dissection of Laryngeal Soft Tissue is Reduced with Air-Cooling: An ex-vivo Calf Model Study" presented on May 17th at the Massachusetts General Hospital Clinical Research Day.

2. Regional contributions

1998-present CD-722 Neuroanatomy and Neurophysiology: MGH-IHP
Each year I teach the neuroanatomical and neurophysiological basis of communication and swallowing to approximately 48 Master's students in the Communication Sciences & Disorders program at the MGH Institute of Health Professions. Lecture and lab time average 3 hours per week, with preparation and student contact time totaling approximately 95 hours per semester.

2000-2003 CD-683 Neuroanatomy and Neurophysiology: Emerson College
I taught this required course for graduate students at Emerson College seeking a Master of Science degree in Communication Sciences & Disorders. It met once a week for 3 hours per lecture with approximately 45 students enrolled across two

semesters each year. Lecture and lab time averaged 3 hours per week, with preparation and student contact time totaling approximately 95 hours per semester.

2001-present CD-412 Anatomy and Physiology: MGH-IHP. This is a pre-requisite course for the Speech Language Pathology program taught in the Department of Communications Sciences and Disorders. Lecture and lab time (combined) average 4 hours per week taught over the summer months. Preparation and contact time for the lectures and lab exercises total approximately 90 hours per semester.

2002 Lecture titled: "Voice Replacement: Laryngeal Prosthesis". This 45 minute invited presentation was received by approximately 350 participants of the Annual NIH Neural Prosthesis Workshop in Bethesda, Maryland.

2003 Lecture titled: "Development of Voice Neural Prosthesis Technology", presented at Grand Rounds in the Departments of Otolaryngology - Head & Neck Surgery, Johns Hopkins School of Medicine (10/20/2003). Approximately 40 individuals were in attendance for this 1 hour long presentation, with preparation time totaling approximately 8 hours.

2004-2006 CD-522 Anatomy and Physiology: Boston University. This is essentially the same course as CD-412 described above (but for a different institution).

2006 Lecture titled: "Development of Voice Neural Prosthesis Technology", presented at the Center for the Neural Basis of Cognition and the IGERT on Assistive Technology at Carnegie Mellon University in Pittsburgh, PA (11/28/2006). Approximately 25 individuals were in attendance for this 1.5 hour long presentation, with preparation time totaling approximately 8 hours.

2006 Lecture titled: "Using the Recurrent Laryngeal Nerve to Control a Hands-Free Voice Prosthesis after Total Laryngectomy", presented in the Communications Sciences and Disorders Doctoral Program at the University of Pittsburgh (11/29/2006). Approximately 30 individuals were in attendance for this 1 hour long presentation, with preparation time totaling approximately 8 hours.

2007 Lecture titled: "New Innovations in Rehabilitation of the Laryngectomy Patient", presented at the Surgical Grand Rounds, VA Boston Healthcare System (06/01/2007). Approximately 30 individuals were in attendance for this 1 hour long presentation, with preparation time totaling approximately 8 hours.

2007 Guest appearance on the television show ***Healthline*** (see www.rl.tv), which is a thirty minute program focusing on health issues of particular concern to the elderly. The episode was titled "Voice Disorders" and aired on 8/29/2007 to a potential audience of 38 million subscribers to the Retirement Living channel.

Part III: Bibliography

Original Articles:

1. Heaton, J. T. & Brauth, S. E. The effects of yohimbine as a reversing agent for ketamine-xylazine anesthesia in the budgerigar. Laboratory Animal Science 1992; 42(1):54-56.

2. Brauth, S. E., Heaton, J. T., Durand, S. E., Liang, W. & Hall, W. S. Functional anatomy of forebrain auditory pathways in the budgerigar (*Melopsittacus undulatus*). Brain, Behavior & Evolution 1994;44:210-233

3. Hall, W. S., Brauth, S. E. & Heaton, J. T. Comparison of the effects of lesions in nucleus basalis and Field "L" on vocal learning and performance in the budgerigar (*Melopsittacus undulatus*). Brain, Behavior & Evolution 1994;44:133-148.

4. Heaton, J. T., Farabaugh, S. M., & Brauth, S. E. Effect of syringeal denervation in the budgerigar (*Melopsittacus undulatus*): The role of the syrinx in call production. Neurobiology of Learning and Memory 1995;64:68-82.

5. Cookson, K. K., Hall, W. S., Heaton, J. T., & Brauth, S. E. Distribution of choline acetyltransferase and acetylcholinesterase in vocal control nuclei of the budgerigar (*Melopsittacus undulatus*). Journal of Comparative Neurology 1996;369:220-235.

6. Durand, S. E., Heaton, J. T., Amateau, S. K., & Brauth, S. E. Vocal control pathways through the anterior forebrain of a parrot (*Melopsittacus undulatus*). Journal of Comparative Neurology 1997;377:179-206.

7. Powell, E. F., Dooling, R. J., Larsen, O. N., & Heaton, J. T. Mechanisms of vocal production in budgerigars. Journal of the Acoustical Society of America 1997;101:578-589.

8. Hall, W. S., Cookson, K. K., Heaton, J. T., Roberts, T. F., Shea, S. D., Amateau, S. K., & Brauth, S. E. Cytoarchitecture of vocal control nuclei in nestling budgerigars: Relationships to call development. Brain, Behavior and Evolution 1999;53:198-226.

9. Heaton, J. T., Dooling, R. J., & Farabaugh, S. M. Effects of deafening on the calls and song of adult budgerigars (*Melopsittacus undulatus*). Journal of the Acoustical Society of America 1999;105:2010-2019.

10. Hochman, I. I., Zeitels, S. M., & Heaton, J. T. An analysis of the forces and position required for direct laryngoscopic exposure of the anterior vocal folds. Annals of Otology, Rhinology and Laryngology 1999;108:715-724.

11. Hochman, I.I, Zeitels, S.M., & Heaton, J.T. Exposure and visualization of the glottis for phonomicrosurgery. Operative Techniques in Otolaryngology – Head and Neck Surgery 1999;9:192-195.

12. Heaton, J.T., & Brauth, S.E. The effects of deafening on the development of nestling and juvenile vocalizations in the budgerigar (*Melopsittacus undulatus*). Journal of Comparative Psychology 1999;113:314-320

13. Heaton, J.T. & Brauth, S.E. Effects of lesions of the central nucleus of the anterior archistriatum on contact call and warble song production in the budgerigar (*Melopsittacus undulatus*). Neurobiology of Learning and Memory 2000;73(3):207-242.

14. Heaton, J.T. & Brauth, S.E. Telencephalic nuclei control late but not early nestling calls in the Budgerigar. Behavioural Brain Research 2000;109(1):129-135

15. Heaton, J. T., Kobler, J. B., Goldstein, E. A., McMahon, T. A., Barry, D. T., and Hillman, R. E. Recurrent laryngeal nerve transposition in the guinea pig. Annals of Otology, Rhinology, and Laryngology 2000;109(10):972-980.

16. Goldstein, E.A.; Heaton, J.T.; Kobler, J.B.; Stanley, G.B.; Hillman, R.E. Design and Implementation of a Hands-Free Electrolarynx Device Controlled by Neck Strap Muscle Electromyographic Activity. IEEE Transactions on Biomedical Engineering. 2004;51(2):325-332.

17. Heaton, J. T., Goldstein, E. A., Kobler, J. B., Zeitels, S. M., Randolph, G. W., Walsh, M. J., Gooey, J. E., & Hillman, R. E. Surface Electromyographic Activity in Total Laryngectomees Following Laryngeal Nerve Transfer to Neck Strap Muscles. Annals of Otology, Rhinology, and Laryngology. 2004;113(9):754-764.

18. Hadlock, T., Sheahan, T., Heaton, J.T., Sundback, C., Mackinnon, S., Cheney, M. Baiting the cross-face nerve graph with temporary hypoglossal hookup. Archives of Facial Plastic Surgery. 2004;6:228-233

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20. Heaton, J.T., Kobler, J.B., Hillman, R.E., Zeitels, S.M. A New Instrument for Intraoperative Assessment of Individual Vocal Folds. The Laryngoscope, 2005;115:1223-1229.

21. Hadlock, T.A., Heaton, J.T., Cheney, M., and Mackinnon, S.E. Functional Recovery After Facial and Sciatic Nerve Crush Injury in the Rat. Archives of Facial Plastic Surgery, 2005; 7: 17-20.

22. Zeitels, S.M., Kobler, J.B., Heaton, J.T., Faquin, W. Carbon Dioxide Laser Fiber for Laryngeal Cancer Surgery. Annals of Otology, Rhinology, and Laryngology, 2006; 115(7) 535-541.

23. Hillman, R. E., Heaton, J.T., Masaki, A., Zeitels, S.M., and Cheyne, H.A. Ambulatory monitoring of disordered voices. Annals of Otology, Rhinology, and Laryngology. 2006, 115(11), 795-801.

24. Broadhurst, M.S., Akst, L.M., Burns, J.A., Kobler, J.B., Heaton, J.T., Anderson, R.R., and Zeitels, S.M. Effects of 532 nm pulsed-KTP laser parameters on vessel ablation in the avian chorioallantoic membrane: Implications for vocal fold mucosa. Laryngoscope, 2007; 117(2) 220-225.

25. Goldstein, E.A., Heaton, J.T., Stepp, C.E., Hillman, R.E. Training Effects on Speech Production Using a Hands-Free Electromyographically-Controlled Electrolarynx. Journal of Speech, Language and Hearing Research. 2007; 50, 335-351

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27. Burns, J., Kobler, J.B., Heaton, J.T., Lopez-Guerra, G., Anderson, R.R., and Zeitels, S.M.

Thermal Damage During Thulium Laser Dissection of Laryngeal Soft Tissue is Reduced with Air Cooling: An ex-vivo Calf Model Study. In Press.

Proceedings of Meetings:
1. Brauth, S. E., Heaton, J. T., Shea, S. D., Durand, S. E., & Hall, W. S. Functional anatomy of forebrain vocal control pathways in the budgerigar (*Melopsittacus undulatus*). Annals of the New York Academy of Sciences 1997;807:368-385.

2. Hall, W. S., Cookson, K. K., Heaton, J. T., Roberts, T., Shea, S. D., & Brauth, S. E. Audio-vocal learning in budgerigars. Annals of the New York Academy of Sciences 1997;807:352-376.

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Reviews, Chapters, and Editorials:
1. Hillman R. E., Walsh M., & Heaton J. (2005). Laryngectomy speech rehabilitation: A review of outcomes, *Contemporary Considerations in the Treatment and Rehabilitation of Head and Neck Cancer*, (P. Doyle: Ed.) pp 75-90. ProEd: Austin, TX.

2. Meltzner, G., Hillman R.E., Heaton, J.T., Houston, K., Kobler, J.B., Qi, Y. (2005). Electrolarynx speech: The state-of-the-art and future directions for development, *Contemporary Considerations in the Treatment and Rehabilitation of Head and Neck Cancer*, (P. Doyle: Ed.) pp 571-590. ProEd: Austin, TX.

Theses, Books and Monographs:
1. Heaton, J.T. The role of descending forebrain projections and auditory feedback in budgerigar vocal development [Dissertation]. College Park, Maryland, University of Maryland, 1997. 217 pp.

Abstracts (not redundant with articles, proceedings or monographs):
1. Hall, W. S., Heaton, J. T., Durand, S. E., Amateau, S. & Brauth, S. E. Connections and vocal functions of nucleus dorsomedialis posterior in the budgerigar. Society for Neuroscience Abstracts 1994;20:164

2. Durand, S. E., Heaton, J. T., & Brauth, S. E. Organizational features of budgerigar vocal circuitry relative to songbirds: A distributed versus a hierarchical system. Society for Neuroscience Abstracts 1995;21:963.

3. Hall, W. S., Cookson, K. K., Heaton, J. T., Durand, S. D., Liang, W., & Brauth, S. E. Connections between vocal control nuclei and basal forebrain in the budgerigar. Society for Neuroscience Abstracts 1995;21:963.

4. Heaton, J. T., Dent, M. L., Dooling, R. J., & Brauth, S. E. Lesions of a vocal control nucleus in the budgerigar disrupt production but not perception of contact calls. Society for Neuroscience Abstracts 1995;21:964.

5. Durand, S. E. Heaton, J. T., & Brauth, S. E. Common organizational features in budgerigar and oscine forebrain vocal control systems. Society for Neuroscience Abstracts 1996;22:1402.

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10. Broadhurst, M., Zeitels, S.M, Akst, L., Burns, J., Kobler, J.B., Heaton, J.T., Anderson, R.R. Applications of 532nm Pulsed KTP Laser in Laryngeal Surgery. Australian Society of Otolaryngology, Head & Neck Surgery, Annual Meeting, 2006.

11. Ottensmeyer, M.P., Walsh, C.J., Yip, M., Kobler, J.B., Heaton, J.T and Zeitels, S.M. Intra-operative Laryngoscopic Instrument for Characterizing Vocal Fold Visco-elasticity. ASME Nanotechnology Institute Frontiers in Biomedical Devices Conference in Irvine, California, June 7-8, 2007.

12. Cheyne, H.A., Heaton, J.T., Zeitels, S.M. and Hillman, R.E. Using Ambulatory Phonation Monitoring to Compare Voice use of Talkers With and Without Vocal Pathology in Similar Occupations. Annual Meeting of the American Laryngological Association in San Diego, California, April 27, 2007

13. Kubert, H, Stepp, C., Zeitels, S., Gooey, J., Walsh, M., Prakash, S.R., Hillman, R., Heaton, J.T. Electromyographic Control of a Hands-Free Electrolarynx Using Neck Strap Muscles. Platform presentation at the ASHA Convention, Boston, MA, November 15-17, 2007.

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Part IV: Patents

1. Heaton, J.T. and Kobler, J.B. Aerodynamic Tissue Driver. U.S. Patent Application No.: 20060079737. Serial number 964373.

2. Hillman, R.E., Zeitels, S.M, Kobler, J.B., Heaton, J.T., Goldstein, E.A. Voice Prosthesis with Neural Interface. U.S. Patent Application No.: 20050281412. Serial number 869666.