BIOGRAPHICAL SKETCH

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NAME: Wallace, Mark T.

eRA COMMONS USER NAME (credential, e.g., agency login): mwallace1

POSITION TITLE: Dean, The Graduate School; Professor of Hearing & Speech Sciences, Psychology and Psychiatry

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

INSTITUTION AND LOCATION	DEGREE *(if applicable)*	Completion Date MM/YYYY	FIELD OF STUDY
Temple University, Philadelphia, PA	B.A.	1985	Biology
Temple University, Philadelphia, PA	M.A.	1987	Biology
Temple University, Philadelphia, PA	Ph.D.	1990	Neurobiology

A. Personal Statement

The primary research emphasis of my laboratory has been in furthering our understanding of the brain bases of multisensory processing. Traditionally, this work has been done by examining questions of neural encoding in animal models, with an eye toward revealing how individual neurons and networks of neurons change their encoding processes when confronted with stimuli from two or more sensory modalities. The more recent emphasis within the animal model work within my laboratory has been in characterizing how multisensory systems develop, as well as revealing the developmental and adult plasticity inherent in these systems. Upon moving to Vanderbilt, I have been able to expand these inquiries into humans, with an emphasis on using the foundation derived from our animal studies to better inform our approaches to questions of how multisensory processes influence human perception and performance, and how such processes are altered in clinical circumstances such as autism. As such, our laboratory has developed a series of psychophysical and neuroimaging paradigms designed to better characterize multisensory integration in human subjects, with an emphasis on understanding how these sensory and multisensory changes contribute to the pathophysiology of autism and to higher-order domains of deficit such as social communication. A recent emphasis of the laboratory has been in the domain of prematurity and early postnatal development, with a goal of better understanding how early environmental factors shape the maturation of sensory systems and the higher-order perceptual and cognitive representations built from this sensory foundation.

B. Positions and Honors

1990-1993 Postdoctoral Fellow (NIH NRSA), Department of Physiology, Medical College of Virginia
1993-1994 Assistant Professor, Department of Physiology, Medical College of Virginia
1994-2002 Assistant Professor, Department of Neurobiology & Anatomy; Wake Forest University
1995-1997 Fellow, Winter Conference on Brain Research
1997 Fellow, European Brain Research Organization
2002-2005 Associate Professor, Department of Neurobiology & Anatomy; Wake Forest University
2003 Faculty Excellence Award, Wake Forest University

2006-2008 Associate Professor, Department of Hearing & Speech Sciences; Vanderbilt University
2006-2008 Associate Professor, Department of Psychology; Vanderbilt University
2008-present Professor, Hearing & Speech Science, Psychology and Psychiatry; Vanderbilt University
2008-2016 Director, Vanderbilt Brain Institute
2010-present Associate Director, Vanderbilt Conte Center
2015 Frijda Chair, University of Amsterdam
2015 Louise B. McGavock Endowed Chair, Vanderbilt University
2016-present Dean, The Graduate School

C. Contributions to Science

1. **Conducted some of the pioneering studies illustrating how multisensory neurons in the mammalian brain are built and elaborate their integrative properties**
   In this work, first begun as a postdoctoral fellow, Dr. Wallace focused on the fundamental question of identifying how multisensory neurons in the SC are constructed on the basis of their convergent inputs, and on how these inputs govern the integrative properties of these neurons. The work was predicated on the simple question of asking whether the multisensory properties of these neurons was "built" at the level of the SC, or whether it was reflected from the inputs into the SC. In addition to showing that it is the convergence of unisensory (i.e., visual alone, auditory alone, tactile alone) inputs onto SC neurons that conveys their multisensory characteristics, the work also showed that a subset of cortical inputs to these neurons was essential for their non-linear integrative properties. Wallace and colleagues were the first to show that the governing principles of multisensory integration applied to the awake and behaving preparation as well as to the anesthetized model, and were also the first to extend this work from the classic model (cat) to the non-human primate model.

   a. **Wallace MT**, MA Meredith and BE Stein (1993) Converging influences from visual, auditory, and somatosensory cortices onto output neurons of the superior colliculus. J. Neurophysiol. 69: 1797-1809. [PMID: 8350124]
   b. **Wallace MT** and BE Stein (1994) Cross-modal synthesis in the midbrain depends on input from cortex. J. Neurophysiol. 71: 429-432. [PMID: 8158240]
   c. **Wallace MT**, LK Wilkinson and BE Stein (1996) Representation and integration of multiple sensory inputs in primate superior colliculus. J. Neurophysiol. 76(2): 1246-1266. [PMID: 8871234]
   d. **Wallace MT**, Ramachandran R and Stein BE (2004) A revised view of sensory cortical parcellation. Proc. Natl. Acad. Sci. 101(7): 2167-2172. [PMID: 14766982; PMCID: PMC357070]

2. **Detailed the development of multisensory neurons and multisensory integration in mammalian subcortical and cortical structures, and the plasticity within these representations**
   Although much was known about adult multisensory function and its neural correlates, Wallace and colleagues were the first to detail the neural development of multisensory brain regions, beginning with the well-established SC model and moving into domains of association cortex. The work was foundational in illustrating the developmental progression in both cat and monkey, and in showing that multisensory neurons are absent in the newborn brain, and that they slowly develop during postnatal life. Furthermore, the work showed that early multisensory neurons failed to exhibit the interesting non-linear integrative characteristics that are seen in the adult, and that these properties also develop during postnatal life. The early developmental work was followed up by studies reinforcing that sensory experience plays a key deterministic role in the construction of multisensory circuits and in the integrative features of the neurons that make up these circuits. In short, the work has shown that these circuits are extremely plastic and malleable, and follow the statistical relationships of stimuli in the world that they grow up in.

   a. **Wallace MT** and BE Stein (1997) Development of multisensory neurons and multisensory integration in cat superior colliculus. J. Neurosci. 17: 2429-2444. [PMID: 9065504]
   b. **Wallace MT** and Stein BE (2001) Sensory and multisensory responses in the newborn monkey's superior colliculus. J. Neurosci. 21(22): 8886-8894. [PMID: 11698600]
   c. **Wallace MT**, Perrault TP, Hairston WD, and Stein BE (2004) Visual experience is necessary for the development of multisensory integration. J. Neurosci. 24: 9580-9584. [PMID: 15509745]
   d. **Wallace MT**, Carriere BN, Perrault TJ, Vaughan JW, and Stein BE (2007) The development of cortical multisensory integration. J. Neurosci. 26: 11844-11849. [PMID: 17108157]

3. **Described the changes in multisensory abilities and their neural correlates across lifespan and the plasticity inherent in adult multisensory representations**
Founded in the animal model studies described above, the Wallace lab has sought to detail how multisensory abilities change across the human lifespan, and neural processes that underlie these changes in performance and perception. One element of this work has employed psychophysical tasks to probe multisensory function at ages ranging from childhood to old age (i.e., from 6 to 80), and has described both the extended developmental timeframe in which multisensory functions mature as well as the paradoxical gains in multisensory performance seen with aging. Closely related work has focused on the multisensory plasticity that can be engendered in adults, and has shown that perceptual training can markedly improve multisensory temporal acuity. Neuroimaging work has shown that these changes are accompanied by changes in the functional connectivity within cortical networks. We believe that this work holds great promise for improving sensory and multisensory function in conditions of disease or aging, as well as for the cognitive abilities that are built upon the sensory representations.

    a. Laurienti PJ, Burdette JH, Maldjian JA, and **Wallace MT** (2006) Enhanced multisensory integration in older adults. Neurobiol. Aging 27: 1155-1163. [PMID: 16039016]
    b. Powers AR, Hillock AR and **Wallace MT** (2009) Perceptual training induced narrowing of the multisensory temporal binding window. Journal of Neuroscience 29:12265-12274. [PMID: 19793985; PMCID: PMC2771316]
    c. Powers AR, Hevey MA and **Wallace MT** (2012) Neural correlates of multisensory perceptual learning. Journal of Neuroscience 32: 6263-74. [PMID: 22553032; PMCID: PMC3366559]
    d. Hillock-Dunn AR and **Wallace MT** (2012) Developmental changes in the multisensory temporal binding window persist into adolescence. Developmental Science 15: 688-96. [PMID: 22925516]

4. **Detailed the nature of multisensory processing disturbances in children and adults with autism, and have related these multisensory changes to deficits in social communication**
Upon moving to Vanderbilt, a component of the Wallace laboratory began to examine sensory and multisensory function in autism. This work is founded on the fact that although sensory disturbances are frequently reported in autism, there has been little empirical work focused on identifying the nature of these changes, or on better understanding how they may contribute to the well established deficits in higher-order processing domains. The work has initially focused on the processing of multisensory (i.e., audiovisual) temporal relations, partly because of the evidence for timing-related deficits in autism and partly because audiovisual integration is essential for the construction and maintenance of healthy social and communication skills and representations. In this work, the Wallace lab has found that individuals with autism "bind" audiovisual signals over an abnormally long interval of time, and that this change in temporal binding is associated with weaker multisensory integration and with deficits in social communication.

    a. Woynaroski, T., Kwakye, L., Foss-Feig, J., Stevenson, R., Stone, W. and **Wallace, MT** (2013). Multisensory Speech Perception in Children with Autism Spectrum Disorders, *Journal of Autism and Developmental Disorders* DOI 10.1007/s10803-013-1836-5. [PMID: 23624833; PMC Journal – In Process]
    b. Stevenson, R. A., Siemann, J.K., Schneider, B. C., Eberly, H. E., Woynaroski, T. G., Camarata, S. M. and **Wallace, MT** (2014) Multisensory temporal integration in autism spectrum disorders. *Journal of Neuroscience*, 34:691-697. [PMID: 24431427; PMCID: PMC3891950]
    c. **Wallace, MT** and Stevenson, RA (2014) The Construct of the Multisensory Temporal Binding Window and its Dysregulation in Developmental Disabilities. *Neuropsychologia*, 64C, 105-123. [Invited review]. [PMID: 25128432]
    d. Stevenson, R. A., Segers, M., Ferber, S., Barense, M. D., and **Wallace, MT** (2014). The impact of multisensory integration deficits on speech perception in children with autism spectrum disorders. *Front Psychol, 5*, 379. doi: 10.3389/fpsyg.2014.00379 [PMID: 24904448]

5. **Contributions to graduate education, mentoring and neuroscience leadership**
In addition to the scholarly activities described above, Wallace has played an instrumental role in the development of graduate curricula and training, first as the Director of Graduate Studies at Wake Forest and currently as the Director of the Neuroscience Graduate Program at Vanderbilt. A recent recognition of his efforts in this arena was the awarding of inaugural "Graduate Program of the Year" to the Vanderbilt Neuroscience Graduate Program by the Society for Neuroscience in 2012. Along with this focus on programmatic leadership, Dr. Wallace has mentored a number of pre- and postdoctoral fellows,

many of who now hold tenure track faculty positions at excellent academic institutions. In his former role as the Director of the Vanderbilt Brain Institute, and in his role as the Associate Director of the Vanderbilt/NIMH Silvio O. Conte Center for Basic Neuroscience Research, Wallace has played an instrumental role in facilitating the research excellence within the neurosciences at Vanderbilt. Finally, in his role as the Dean of the Graduate School, Wallace provides an aggressive vision and commitment to elevate the Graduate School to a new level of academic excellence and research leadership by strengthening relationships within the institution, nationally and abroad.

Complete List of Published Work: (as of 22 February 2015)

- ORCID ID: orcid.org/0000-0002-0166-906X
- Scopus author ID: 7401942866
- Full CV from Wallace lab website: http://kc.vanderbilt.edu/multisensory/Media/CV_Wallace.pdf

Scientific Metrics: (as of 14 April 2017)

- Google Scholar profile: https://scholar.google.com/citations?user=83oci4wAAAAJ&hl=en
  H-index: 51; I-10 index: 108; Total citations: 8239
- Research Gate profile: https://www.researchgate.net/profile/Mark_Wallace2
  Cumulative journal impact factor: 334.66; RG score: 40.77 (>95% percentile)

Laboratory Web site: www.wallacelab.org

D. Research Support

Current Grants - Principal Investigator:

U54 09/01/15 – 08/31/20
National Institute of Child Health and Human Development
Vanderbilt Kennedy Center: Sensory and Multisensory Function and Their Role in Autism
Role: PI, Research Project

2T32MH064913 07/16/01 – 06/30/17
National Institute of Mental Health
Training in Fundamental Neuroscience
Role: PI

Current Grants - Co-Principal Investigator:

P50MH09672 08/22/12 – 06/30/17
National Institute of Mental Health
Enduring Effects of Early-Life Serotonin Signaling

6R21MH109225-02 04/30/16 – 02/28/18
National Institutes of Health
Peripersonal Space Representation as a Basis for Social Deficits in Autism and Schizophrenia Spectrum Disorders