

I am pleased to submit this application for promotion to Full Professor. It has been an honor to be a member of the MSU faculty. My contributions to the field were widely recognized before coming to MSU, but, supported by MSU's can-do culture, I have built on this previous unique foundation to establish an even stronger, more impactful, trajectory for my future. Please find below a brief review of my contributions in research, teaching and service.

1. RESEARCH AND SCHOLARSHIP

Since coming to MSU 4 years ago, my research, scholarship, and reputation have thriven. I have authored or co-authored 3 book chapters (including one translated for a Spanish textbook), 28 peer-reviewed manuscripts with an additional 8 in review (8 first author), 10 proceeding papers (4 first author), and more than 150 presentations, including over 30 invited presentations/workshops (4 keynote). My career productivity includes 5 book chapters, 55 peer-reviewed manuscripts (20 first author), 15 proceeding papers (8 first author), and 220 presentations (54 invited). According to Google Scholar, my papers have been cited 1658 times (1189 since 2012), with an h-index of 19 (i10 index, 29). Further, I was asked to be part of a 22-author paper with leaders in my field which developed a consensus statement on proposed notation. My research and expertise have also been included in more than 10 mainstream media reports, helping to make my research attainable to the general public. Finally, I have been made a Fellow of the Acoustical Society of America, one of the large professional societies in my field. In the remainder of this section, please find a summary of my academic focus, contributions to the field, and future plans.

1.1. Focus of Research

My research has examined topics including human bioacoustics (production, instrumentation, analysis and quantification), tissue vibration and injury, general signal processing, and musical acoustics. Nevertheless, my work has predominantly centered on vocal health, with a specific emphasis on the elevated incidence of voice problems among *occupational voice users*, or those individuals who depend on their voice as a primary tool of their trade. A fundamental aspect of this research is an exploration of the factors that affect an individual's susceptibility to vocal injury and ease of recovery, including characteristics of the speaker (e.g., gender, age, primary language), behavior (e.g., voice use, breathing) and environment (e.g., room size, acoustics). Most recently, my research has been supported by a 5-year NIH grant (~\$2 mil.). The goal of this NIH project has been to reveal differences in voice habits and voice disorders for both occupational and non-occupational voice users, particularly to determine gender-specific differences in speech patterns, speech compensatory strategies, and voice production mechanisms.

1.2 Approach to Central Questions in the Field

Multidisciplinary partnerships and methodologies are inherent to my work, in part because my educational background included concentrations in physics, mathematics, computer science and engineering, along with later health-related coursework. To address central questions in the field of occupational vocal health, I have combined these concentrations and incorporated novel uses of existing technology and tools. For example, my current NIH R01 is unique in part because of the broad range of expertise and techniques used, including biomechanical modeling of the speech mechanism, laboratory acoustical recordings synchronized with physiological measures of human subjects, simulated virtual environments, and field measurements. Further, while much of my research has used sample databases (both from our own studies and archival sources), what distinguishes my work is the combination of these large datasets with unique, advanced automated computational analyses. These techniques are incorporated in my current R01, where I also have developed enhanced recording techniques, including methods of adapting off-the-shelf tools to better and more economically capture vocal behavior in clinics, laboratories, and at home. With this experience, I regularly advise (formally and informally) through presentations and consultations on research and/or clinical voice recording technology and related instrumentation (including the system I developed for my own lab).

A fundamental perspective that underlies my approach to research relates to how I mentor. This perspective stems from a conversation I had many years ago with a young researcher whose skills, while superb, had been used exclusively to support the advisor with no mentorship or forethought for her own future career path. Thus, when I now take on a mentee (whether graduate or post-doctoral level), my goal is to balance my current research priorities with each's long-term research and career goals. One way I do this is by treating them as a research *colleague*, rather than a research *tech*. As can be seen in my CV, I rarely if ever publish without including someone I am mentoring in the process. With this expectation, my goal is to teach them firsthand key skills required in academia such as designing studies, structuring papers and presentations, and responding to reviewers without taking offense. Further, as they gain experience, I give them the opportunity (and a duty) to act as a first author. Finally, before they leave my lab, my goal is for each to submit at least one funding proposal, as well as at least one single-author paper (for post-doctoral fellows), related to their own research. While not always realized, I still provide this pathway so that each may, if desired, leave my mentorship with the skills, confidence and credentials necessary to be independent, fundable (and marketable) researchers.

1.3 Key Research Contributions

My early contributions to the field began with an examination of anatomical, physiological and biomechanical aspects of voice production. This work eventually led to a study of why and how the voice fatigues and recovers, particularly in light of those who use their voices extensively in occupational settings (e.g. teachers, singers, broadcasters). This has culminated in my current ongoing exploration of why women have a greater incidence of vocal health issues than men. Because of space, only some research areas will be highlighted below.

What Insights Do Biomechanical Models Provide on Vocal Health? Biomechanical modeling of the laryngeal system is a vital tool that complements traditional clinical and tissue studies and is a fundamental aspect of most of my funded research, including my current NIH R01. Initially recruited for my PhD to develop a model of speech articulators, my modeling work has since increased the field's knowledge of both human and animal physiology. My recognition of gaps in the anatomical and physiologic data drove some of my early studies. More recently, I have led an effort, supported by a large R01 subcontract (my portion, \$464k), to create the groundwork for an innovative database of laryngeal biomechanical properties and anatomical dimensions (National Repository [REDACTED]), including datasets, analysis tools, vocal fold models, and technical tutorials. While still in its early phase (competitive renewal recently funded), the goal of this repository is to create an avenue for sharing crucial findings and tools to improve laryngeal models. In addition to underlying laryngeal data, I have also specifically contributed to the development of laryngeal models, including non-linear continuum-based tissue models that also have contractile properties. From these advancements, I have examined principles such as: (1) nonlinear descriptions of vocally important dynamic structures in the vocal folds; (2) the impact of a dynamic voice (e.g., modulating vocal pitch or singing with vibrato) on voice production (younger tissue versus older tissue); (3) individual gender-based differences in laryngeal tissues on vocal health; and (4) gender-specific sensitivity to variations in lung pressure and muscle activation.

How Much Vocal Load Is Too Much? It is perhaps intuitive that *vocal loading*, or the overuse of the voice, would increase the rate of vocal health issues. My research has contributed to our understanding of the extent of vocal loading that school teachers experience (similar to repetitive motion/vibration injuries). Much of my research has used custom (or adapted) mobile devices to gather data from teachers for extended periods of times (e.g., all waking hours over 2 weeks). Unique techniques were developed to analyze approximately 10,000 hours of voice data to synthesize key findings. These studies show, for example, that an average teacher's voice is subjected to nearly 20,000 instances of vibration (e.g., "ba ba ba" would be 3 instances) and nearly 1 million vocal fold collisions during the course of a school day, about twice that of an average adult. Additionally, the need to quantify women's additional non-occupational vocal load was highlighted by my research that showed female teachers not only vocalized 10% more than males at work, but also 7% more than male teachers outside of work. Further, in another study it was found that teachers (both U.S. and Italian) appear to have fewer vocal problems if they decrease the occurrences of lecture-style class periods—even if they are speaking for the same cumulative amount of time. Finally, a summative examination of previous work was developed as a guide to damage risk criteria for vocal vibration dose, which provides the context for future studies of vocal overuse risk factors.

How Much Time Is Needed for Vocal Recovery? Other key contributions relate to *vocal recovery*, or the return of vocal quality and ability. In a recent analysis from responses of nearly 700 school teachers, it was found that female teachers are more likely to report their lack of vocal recovery than their male counterparts. We have shown that recovery from a heavy bout of voice use followed a chronic dermal wound recovery curve with nearly 80% recovery within 18 hours, with some teachers needing nearly 2 days. This was confirmed in a study of professional singers, illustrating that 1 to 2 days of light voice use is needed after a heavy vocal performance. These findings highlight the significance of the weekend as an important recovery period; however, female teachers, as discussed above, appear to have fewer opportunities for this needed recovery period. These studies were the first of their kind to give real numbers to voice recovery times.

What Is the Impact of Environment and Purpose on Voice Production? My R01 research has been on the forefront in using real and virtual acoustic environments to quantify how people adjust the way they speak to changes in them, even when the environment visually appears the same. This research suggests a significant effect of environmental characteristics on reported vocal fatigue. For example, classroom size and capacity are directly related to vocal complaints. Additionally, we have identified a "sweet spot" for room reverberation (which results in the fewest vocal complaints), which is outside ANSI Standard recommendations for classroom acoustics (which is focused more on the needs of the listener). Further, using extreme range of reverberation times, females tend to use higher vocal effort to compensate for changing room acoustics and more quickly reach a point where their voice quality is rated as dysphonic. Finally, our studies have clarified how speakers adjust their voice patterns to perceived listener needs (e.g., communication partner has a hearing loss) and how these adjustments might change in varying room environments.

1.4 Future Directions

While I am proud of the work I have already conducted, I look forward to the research pathways that are still before me. All of my future research expands my examination of how voice users can maintain healthy voices.

Occupational Vocal Health Although my research recently has identified some key gender-based anatomical and behavioral differences that may partially explain why women appear to be at a greater risk for vocal health issues, we still need to develop better tools for differentiating those (both male and female) at most risk for developing problems. We have been conducting preliminary studies on indices that appear to show what an average teacher's vocal fatigue level is at any given time, and my future research will continue to test and refine these indices. Further, recent preliminary findings suggest that underlying pulmonary function issues as identified by common respiratory tests may increase vocal risks in some individuals. If verified, not only would a simple vocal risk tool to be identified, but low-cost training in better speech breath management could alleviate some teachers' voice problems. My future research (part of renewal to be submitted in 2018) will continue to explore and test this link, including why this identifier seems to be more significant for women.

Further, many of the studies examining voice use (including occupational health) have been conducted with native English speakers. Since coming to MSU, I have recruited non-native English and multilingual researchers to my lab to assist with an exploration of how different languages and/or cultures might impact how the voice is used in occupational and non-occupational settings. With my mentorship, one of these researchers is studying American and Italian school teachers and students in their classroom environments. Further, several members of my lab are comparing specific vocal behavior among bilingual (English-Spanish) and monolingual (English) speakers in real and virtually simulated environments, as well as the impact of these effects on a speaker's vocal health. Finally, I have begun important discussions with 3 key international groups who study this topic (one of which asked me to be a consultant on a funding proposal), with the aim of establishing a cross-cultural research consortium.

I will also further translate my findings for clinicians, as well as various occupational voice use populations. I have already given lectures to select voice users (e.g., lawyers, teachers) and clinicians—most recently a 90-minute international keynote address to an audience of physicians/clinicians. Finally, I have often been an expert resource to journalists developing stories for newspaper, magazine, radio/tv, and online pieces; the most recent being an article in Men's Health.

Aging Voice As an individual ages, the voice becomes less robust. Although the underlying problems with the laryngeal system are not usually life-threatening, the shared physiological territory with critical aerodigestive systems may mean that changes to the laryngeal system may reflect detrimental changes to other critical systems (e.g., respiration, swallowing). My lab is currently finding that traumatic brain injuries (e.g., strokes/concussions) may be identified and tracked by acoustical changes in the voice, and one of my doctoral students is exploring this topic as the subject of his dissertation. Further, we have been collecting an aging voice use database (e.g., speech recordings given by individuals over decades), enhanced by the accessibility and resources of MSU's Vincent Voice Library. This research is unique as the goal is to eventually correlate voice changes with changes in an elderly individual's aerodigestive system. Currently, well over 1000 hours of speaking from 50 individuals (with up to 50 longitudinal years) have been analyzed. From this vast database, we have begun to define statistically significant patterned changes in pitch, breath groups, and speaking time or stamina, as well as the presence of breaks and bobbles. We have already identified some of the largest noticeable changes that seem to manifest between 65-72 years of age. Additionally, we have begun psychoacoustic studies to explore how a listener's estimate of a person's age corresponds with these age-related changes. As we continue to expand our database, we have plan to include coaches and broadcasters in college sports to explore how excessive peaks of voice use on occupational voice users affect the voice as an individual gets older.

Development of New Techniques and Tools I am exploring new tools for remote monitoring and analysis of voice use in everyday environments that are easy to use while still being robust to environmental noise exposure. For example, my lab will begin testing this fall a Smartphone app to monitor vocal health issues (developed by a mentee from another university, funded by NIH). Additionally, while my exploration of the effect of environment on the voice has been beneficial, my NIH R01 renewal will expand this with more real-world testing, as well as more realistic virtual presentation of acoustical variations. We have developed (in collaboration with another university) a new ultra-realistic acoustic simulation environment that will utilize the unique acoustic infrastructure in our College (i.e., anechoic chamber). This real-time convolution system can quickly create and manipulate these acoustical experiences, which can not only extend my current occupational research but has techniques that can be applied to a host of fields (e.g., early childhood development and special education communication, music/theater performance, linguistics, psychology).

Large Data Analysis Early in my career, I was a lead researcher in studies which collected tens of thousands of hours of teachers' voice use. Recently, I have returned to this research with current big data analysis technology that was not readily accessible at the time. To this database is added other physiological measures (e.g., general body activity level, breathing rate)

tracked through mobile technology. This large combined database (>70 voice parameters from each recording sample) is currently being ported to the MSU High Performance Computing Clusters. Using the tools of big data analysis and machine learning, there is the potential for large advances in our understanding of voice problems. Further, my lab has also begun to implement machine learning concepts on the aging voice database mentioned above, in which a Random Forest Regressor engine will be trained to estimate the age of a talker by their voice with better accuracy than the human listeners. The direction will be to merge these technologies, gathering big data and then analyzing the data using big data techniques.

2. TEACHING

My time at MSU has given me the opportunity to further refine my teaching goals. I strongly believe that the best education is a combination of formal instruction, small group work, and one-on-one mentoring. In this light, I hope to expose students to something in class that sparks their interest enough to explore formally or informally outside of class.

2.1 Classroom Teaching

Although I was offered the option of not teaching my first semester at MSU, I wanted to begin interacting with the students immediately. Since then, I have also opted to not exercise all of my available research and administrative buy-outs because I became a professor to teach and mentor students. Thus, during my time at MSU, I've taught 5 different courses, all of which I've developed or done a significant course redesign.

In addition to designing my own classes, I have had an instrumental role in the redesign of the curriculum in general. One key initiative that I have been a part of is the expanded use of hybrid classrooms in our program to facilitate the learning of students during clinical rotations and study abroad. I was also the primary author for our *Academic Progress Review*, a report of a self-study undertaken in accordance with the Academic Governance Program Review (APR) as prescribed by the Academic Council. The goal of this report was to provide a realistic analysis on the progress of the Department pertaining to student learning outcomes and research while balancing the most important issues facing us, with suggested measures to meet departmental goals.

2.2 Mentoring

I am a strong advocate of student participation in mentored projects to reinforce classroom experiences in scientific and health education. Since arriving, over 40 students (or recent graduates) from majors as varied as physics, communications, psychology, packaging, linguistics, urban planning, and engineering have joined my lab. The diversity of majors has allowed me to teach students how to work in multi-disciplinary teams and to appreciate the valuable synergy which stems from such collaborations. When a new student joins my lab, I encourage her/him to first learn teamwork by assisting with existing research projects. When an area fits his/her interests or aspirations, we develop together a related supervised project with a product as the end goal (a poster, presentation or paper). For example, one student contacted me before I came to MSU, eager to participate in my research. After contributing to projects for a semester, she was able to develop a research question that was unique and valuable on its own merits, while still being related to one of my major projects. This research became the basis for her Honors Thesis, and she presented her findings at a conference, where she won a prestigious student award. Her success is not isolated, with 14 awards given to students from my lab. Further, well over 50 presentations and 5 papers have been completed (with more in progress).

The department at MSU does not have an undergraduate major and our MA students are not required to complete a thesis, both of which has limited my ability to function as a named advisor. Nevertheless, I have served on 5 Honors or capstone undergraduate committees from other departments whose topics were directly related to my research (2 current). Further, I have served on 10 Master's committees (chaired 5) and 6 PhD committees (chaired 2). In addition, as the director of the department's doctoral program, I meet regularly with all doctoral candidates to advise them on coursework, research goals, and future plans. Finally, I have mentored 3 post-doctoral researchers in paid positions at MSU (14 1st-author papers published with 5 in review; 49 1st author presentations given; 3 proposals submitted, 1 in preparation, and 1 funded). Two of these researchers have gone on to other positions, the most recent to a tenure-track position at the U-Illinois. Since coming to MSU, I have also continued to mentor individuals from other institutions. I served as the primary mentor for a doctoral student from the U-Kansas, whose dissertation topic was outside his chair's expertise (4 posters, 1 publication, 2 awards). Further, a Master's student from the prestigious Polytechnic University of Turin (Italy) came to MSU on a 6-month visit to do research towards his thesis in my laboratory and continued to work in my lab after his graduation. Finally, I have also mentored young faculty members from other universities, including two as named mentors in ASHA or NIH awards.

3. SERVICE, OUTREACH AND PROFESSIONAL SERVICE

Because of space, I will only highlight some major service experiences at MSU and in the broader community.

3.1 Service within Michigan State University

During my first year, I was a member of curriculum committee, as well as a 3-person advisory committee responsible for a department review (and was a primary author for the review document). I have served on 6 search committees (chaired 4). When I chaired my 1st faculty search committee, I pushed to post the position earlier than traditionally done, giving us a recruitment advantage with tangible hires. I am also proud that I have been asked by the students to serve as the advisor for the past 4 years, only stepping down this year because of increased administrative responsibilities. Outside the department, I was a Department representative to our College Advisory Council (CAC) for 3 years, where I served on the dean search committee. I have also served as the college's representative to the Faculty Senate, University Council, and University Committee on Academic Governance.

I have also served in formal administrative roles. At the beginning of my 2nd year of service on CAC, I was elected chair and was re-elected for a second term. Further, when the previous department chair moved to another institution, I served as the Interim Associate Chair and was later appointed Associate Chair, where I direct the Undergraduate and PhD programs. In this role, I have (among other efforts) revised our graduate school admissions procedures (resulting in an earlier and stronger filled MA group), introduced a department Facebook page, and strengthened our hybrid education program.

Beginning this Fall, I was appointed Associate Dean in the College to assist with special projects. My current projects include assembling a technology committee for the college and working with faculty to develop our emerging interests in computational communication and communication neuroscience. Further, I was appointed Director of the Trifecta Initiative for Multidisciplinary Health Research, for which I have served on its Governing Committee for the past 4 years. In this new responsibility, I work with Dean along with the deans from and to reformulate the vision of this group to better assist new faculty, as well as to align it with the overall mission of funded, impactful, cross-disciplinary research at MSU.

3.2 Service Outside Michigan State University

In 2015, I was elected by my peers in the American Speech-Hearing-Language Association (182k members) to serve on a 7-member coordinating committee of a subspecialty (2k+ members). This committee has been grappling with two key issues in the field: instrumental voice assessment standards and specialty certification. I have also been asked to serve on the Board of Advisors of The Foundation, an international organization dedicated to research, medicine, science, and education with its own journal, annual conference, and funding for scholarships and grants. I am an Associate Editor for a publication of the Society of America, and have acted as a temporary Associate Editor for another flagship journal, *Journal of and Research*. I also serve on the editorial board of the journal of the British

I have been recently asked to organize and chair an international conference at MSU, the International Conference on Physiology and Biomechanics. This conference will bring in international scholars, as well as utilize local talent from MSU's Medicine, and Engineering. Further, I have also served on the advisory or scientific boards for several other conferences. One, which I organized and chaired just before my move to MSU, became the impetus for an important report (of which I am the first signatory) describing the current state of vocal health practice, identifying the holes, and creating a set of guidelines for the future. Additionally, the symposium ended with the proposal of a new international professional association: *Association*. I was elected to be an officer on the steering committee for the launch of this association. Working closely with the rest of the inaugural board, we completed the non-profit status preparation, solidified a slate of officer nominees for our first association vote in 2015, and turned the direction of the association over to these elected leaders. I continue to be involved in the organization in an advisory role as needed.

4. CONCLUSION

In conclusion, I appreciate the opportunity to present this RPT packet for review. I am proud to be a Spartan and love the freedom and support I have been given here, which have allowed me to be a greater asset to the research community. After I am promoted to full professor, I will continue to seek out new ways to serve my department, the College, as well as MSU in general, to establish an even more impactful path for my future.