

Research Overview

Broadly speaking, I'm interested in information; specifically, the relationship between the information which exists in the world and that which exists in our minds. In order to understand any information processing system, we must consider its computational properties, algorithmic implementation, and physical instantiation. I am intrigued by interaction between these levels—how they influence, constrain, or optimize one another to perform cognitive tasks and produce behavior.

My current work focuses on the learning and representation of sound information: how the perceptual system turns acoustic signals into linguistically and musically meaningful structures, and how this process is modified by experience. Language and music are both complex systems of organized sound, but the degree to which they share mental representations and neural resources remains an open question.

The primary goal is to define perceptual properties shared by music and language, and to use these to determine the scope of influence between experience one or the other. The central thesis, informed by current models of perceptual learning, is that perceptually-relevant elements of linguistic and musical structure recruit and tune general auditory mechanisms, and that this leads to predictable cross-domain influence when structural elements of language and music rely on similar acoustic properties. Accordingly, I seek to link phonetic properties tone languages with elements of musical structure, and *vice-versa*.

Current Projects

Experimental work on this project falls into three main threads:

- (i) examining the effects of tone language experience on melody perception;
- (ii) measuring the effects of musicianship on linguistic tone perception; and
- (iii) identifying computational properties common to music and language tasks.

In the first thread, I am examining melody discrimination in native speakers of different languages (including contour tone, register tone, and nontone languages), and in speakers who are learning these languages in adulthood. I have found that melody perception is enhanced among native tone language speakers independently of musicianship, and these enhancements can be linked to the tonal properties of speakers' languages.

In the second thread, I am looking at crossover effects in the opposite direction by assessing the effects of musical training on lexical tone perception among speakers of English who are either musicians, or who undergo laboratory based musical training. Musicians are known to have an advantage in tone perception and learning compared to non-musicians, but differences between various kinds of musical experience, ranging from mere exposure, to participation in musical performance, to explicit aural skills training have yet to be fully examined.

In the third thread, I am investigating how the nature of hearing, speaking, or learning a language is similar (or not) to hearing, playing/singing, or learning a musical system in terms of the abstract properties of the task, such as dealing with variability, attentional demands, and memory constraints, and how these interact with characteristics of individual learners. In particular, I am interested in the process of *normalization*, in which listeners must adjust for superficial acoustic variation from one token to another, such as when we recognize a word spoken by people with very different voices, or by one speaker in different contexts; a similar process takes place in music, when we can recognize a song played on different instruments, or in different keys. I am currently developing experiments comparing the effects of variability on lexical and music perception tasks, and determining whether individual differences in normalization ability can be linked to characteristics such as native or second language lexical tone experience, or degree and type of musical training.

The foundations of these studies are in perceptual learning models, and their results are expected to contribute to discussions on the cognitive modularity of language and music. In addition, this research is relevant to applied fields, including education, where an understanding of how an individual's experiences shape perception, and how sensory systems are changed by teaching methods, will ultimately lead to the development of more effective tools and techniques for language and music education.

Work in Progress

I am currently pursuing outstanding questions and attempting to expand my investigations in several directions addressing cognitive, biological, and educational issues. First, I am expanding the context of experience under investigation. This requires studying a more diverse sample of speakers, including a greater number of languages, multilingual speakers, and those with atypical linguistic or cognitive development. Because both music and language have complex developmental courses, the milestones and critical periods of language and music acquisition need to be compared to chart the developmental course of language–music crossover effects.

Musical form and practice vary widely around the world in a manner similar to that of language. Just as the world's diversity of languages must be considered when developing theories of language, a wider view of musical cultures is necessary to more fully understand music's place in the mind. I am developing studies into the role of musical culture in shaping perception and performance, which will include additional acoustic and temporal properties beyond pitch (*e.g.*, rhythm, timbre).

Finally, I am exploring the way in which language and music training change auditory perception. One goal of this approach is to determine whether and how non-linguistic training can enhance language perception, and whether music perception is improved by other kinds of auditory training. This line of research will provide insight into language and music pedagogy, and help to explain the relationship between language study, participation in music, and academic performance.

Philosophy

The kind of research questions that excite me are those that are at the intersections of traditional subfields, and answering these kinds of questions requires the converging use of many methods. I think of myself equally as a psychologist, linguist, and a cognitive scientist, and my education and prior work have included a variety of techniques, including theoretical description, behavioral experimentation, and neurophysiological studies. In the future, I hope to expand my methodological repertoire and to develop collaborations with researchers with diverse perspectives who can provide theoretical insight and apply technical skills to these interdisciplinary problems. I approach the research process by attempting to be a synthesizer, in the sense described by E.O. Wilson:

...in the twenty-first century, the world will not be run by those possessing mere information alone. Thanks to science and technology, access to factual knowledge of all kinds is rising exponentially while dropping in unit cost. It is destined to become global and democratic. Soon it will be available everywhere on television and computer screens. What then? The answer is clear: synthesis. We are drowning in information, while starving for wisdom. The world henceforth will be run by synthesizers, people able to put together the right information at the right time, think critically about it, and make important choices wisely.

Becoming a scientist means not only mastering a set of theories and tools, but joining a collaborative community based on adherence to the scientific method and principles of academic honesty. For this reason, I have taken a special interest in research ethics and the philosophy of science, both to improve my own work, and to mentor my students and peers on issues of academic integrity.

In addition to responsibility within the community of science, I also perceive an obligation on the part of scientists to communicate their work effectively to the public at large. This has become difficult as many sources of information compete for our attention, science is misunderstood or misused in the public sphere, and our educational system tries to keep up. To this end, I seek to impart the importance of my work through my teaching and in the future I plan to further disseminate my work outside of academia, and to advocate for the social and behavioral sciences more generally. As scholars, we have a role not just in producing research, but in ensuring that it is applied toward human progress. This includes ensuring broad demographic representation within science and academia, and that science (especially social science) takes into account the diversity of human cultures and conditions as it seeks to understand the world. Ultimately, I am driven by an innate curiosity and a love of knowledge for knowledge's sake, but also by a desire to see my work impact the world in a positive way.