Dissertation Proposal

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Requirements:

"defines the plan formulated by the student and the committee regarding (at least):

- *the topic and scope of the dissertation,*
- *method and scope of data collection, and*
- *analysis strategies.*

I see myself as a transdisciplinary researcher: sprawled across worlds, but following a common thread. The closest I've come to a simple description of my focus is *communicative systems*: how agents or components interact to create systems of meaning that, reciprocally, structure their interaction. I also believe that the practice of science itself is deeply political, reflective of the systems of belief and power interacting across interlocking institutions and organizations, and have increasingly oriented my work towards understanding and directly counteracting the ways that neoliberalization and commercial capture of science poison every part of our work.

This dissertation will be in three parts, roughly tracing the development of my thoughts over the past seven years. My work here starts and ends with studying a mouse model of auditory phonetic perception, comprising behavioral neuroscience, an attempted merger of several strains of linguistic, philosophical, and neuroscientific thought, and in the final few months a touch of neurophysiology. That led, perhaps unwisely, to the development of Autopilot: a Python framework for behavioral neuroscientific experiments based in distributed computing, but learning lessons from history and critical technology scholars is mutating into something more like a technical knowledge organization system. Finally in my last year my work has focused on the broader infrastructure and practice of science, and weaving between many fields have tried to plot a course away from the subjugation of basic science to surveillance and information capitalism.

1 Phonetic Perception

1.1 Mice Can Learn Phonetic Categories

I started my work by teaching mice to generalizably discriminate between two sets of naturally produced pitch-shifted consonant-vowel pairs [1]. The idea was to establish phonetic perception in mice as a model that would be useful for twin problems in auditory neuroscience and phonetics: Auditory neuroscientists need better models to move beyond simple stimuli like tone pips and noise to understand how the mammalian auditory system processes the complexity that defines natural sound environments. The long history of phonetics research provides auditory neuroscience with a rich body of work, largely ungrounded in neurophysiological observation, that can inform our experimental designs and structure our predictions. Reciprocally, animal models can augment phonetic research by isolate the specifically auditory component of phonetic perception from the syntactic, semantic, motor, and social influences intrinsic to human perception; and mice provide access to observe and perturb neurophysiological processes unavailable in humans.

The experiment consisted of a two-alternative forced choice task in an arena with three water ports with photosensors to detect when they poked their nose in them. The mice would poke their nose in the center port to hear a consonant-vowel (/CV/) pair beginning with a /b/ or /g/, and then were rewarded if they poked their nose in the correct flanking port corresponding to either consonant. They progressed through several shaping stages that expanded the number of possible /CV/ tokens, adding new speakers and vowels, until they could reliably categorize 20 tokens. The mice then were tested in a generalization task where on a small subset of trials the mice were presented novel tokens. We characterize generalization as the measure of having learned an abstract or at least adaptive notion of the consonant structure, rather than overlearning the training set. We trained two cohorts of mice with different sets of speakers to test whether and how strongly that patterned their responses (vs. learning some "universal" means of categorizing the tokens).

The primary analysis in the paper used a generalized linear mixed model with a logistic link function to predict binary correct/incorrect responses using the type of token (training tokens, generalization tokens, etc.) as a fixed effect nested within each mouse as a random effect. From this we estimated the relative difficulties of different kinds of generalization (eg. to novel speakers vs. novel vowels), and differences in accuracy patterns across mice and cohorts. We tested the predictions of one neurolinguistic model ("Locus equations") and found no behavioral support for them. Finally we lesioned auditory cortex and found that it returned the mice to chance accuracy – indicating that cortex is at least involved in the computation.

DONE

1.2 Models & Mechanisms

This work bookends my PhD, and will be in collaboration with several others in my lab. I will be working on formal modeling of the problem faced by the auditory system, and using the tools I have made to perform a version of the prior experiment such that (a proxy for) the neural activity of the mice can be observed across the learning process. I won't be able to see this project through to completion due to time constraints, but will describe what I will contribute to the work.

test

> Describe modeling work

> Describe behavior task

> Eventually am going to help with analysis and writing.

TODO

2 Autopilot

In our struggle through implementing the speech discrimination task, I learned that the state of neuroscientific behavioral tooling was a few incomplete and rigid packages, but otherwise almost entirely lab-specific code such as that I had experienced. Autopilot is my contribution to that problem[1] [2].

> Design constraints that inform Autopilot

> Components of autopilot

- wrestling with the pi
- hardware
- networking
- interface design

[1] not sure in which direction...

> DLC collaboration [3]

> Wiki and the future

2.1 Interlude: The People's Ventilator Project

> Description of project, the acute need for scientists to use their expertise for social good, and continuation of work from Autopilot [4]

3 Infrastructure

Through my work in Autopilot I became acutely aware of the social dynamics that define infrastructural development. While there is subconscious belief that scientific technology will get, in fits and starts, "better" over time, instead it became abundantly obvious that without specific and strategic intervention, scientific infrastructure is bound to a fate that drains scientific funding and binds every bit of the practice of science to a few massive information conglomerates.

> Research on publisher propaganda networks and capture initiatives

> Field work on researching wiki communities and finding the alt-tech world that is building a better future outside the eyes of the corporate internet.

> Listening to the social scientists about the intrinsic intersection between social and technological systems.

> The "experiment" so to speak is whether it is possible to organize a group of scientists to develop anti-profitable technology and overcome the incentive systems that drive us into serfdom. I will be publicly releasing this and trying a new kind of public contribution

4 Resources

Since not everything is freely available or a DOI-indexed PDF...

- SaundersWehr-JASA2019 - repository with code, data, and retypset version of "Mice Can Learn Phonetic Categories"

5 References

References

[1] Jonny L. Saunders and Michael Wehr. "Mice Can Learn Phonetic Categories". In: *The Journal of the Acoustical Society of America* 145.3 (), pp. 1168–1177. ISSN: 0001-4966. DOI: 10.1121/1.5091776. URL: https://asa.scitation.org/doi/abs/10.1121/1.5091776 (cit. on p. 1).

[2] Jonny L. Saunders and Michael Wehr. "Autopilot: Automating Behavioral Experiments with Lots of Raspberry Pis". In: *bioRxiv* (), p. 807693. DOI: 10.1101/807693. URL: https://www.biorxiv.org/content/10.1101/807693v1 (cit. on p. 2).

[3] Gary A Kane et al. "Real-Time, Low-Latency Closed-Loop Feedback Using Markerless Posture Tracking". In: *eLife* 9 (). Ed. by Gordon J Berman et al., e61909. ISSN: 2050-084X. DOI: 10.7554/eLife.61909. URL: https://doi.org/10.7554/eLife.61909 (cit. on p. 3).

[4] Julienne LaChance et al. "PVP1–The People's Ventilator Project: A Fully Open, Low-Cost, Pressure-Controlled Ventilator". In: *medRxiv* (), p. 2020.10.02.20206037. DOI: 10.1101/2020.10.02.20206037v1. URL: https://www.medrxiv.org/content/10.1101/2020.10.02.20206037v1 (cit. on p. 3).