James Belanger

Computational Neuroscience · NLP & Statistical Modeling of Language in the Brain

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EDUCATION

Rice University *Houston, TX*

B.A. in Cognitive Sciences (Psychology & Linguistics) · Minor in Data Science · Spanish *May 2025*

GPA: 3.94 / 4.0

Relevant Coursework: Statistical Machine Learning, Deep Learning, Data Visualization, Computational Modeling of Cognitive Processes, Quantitative Analysis for the Social Sciences, Engineering Computation, Neuroscience of Language, Neuropsychology of Language & Memory, Research Methods, Phonetics, Advanced Phonology.

RESEARCH EXPERIENCE

Hayden Lab — Dept. of Neurosurgery, Baylor College of Medicine *Houston, TX*

Research Assistant *May 2024 – Present*

- Build single-neuron Poisson GLM encoding models linking human hippocampal firing and LFP activity to syntactic and semantic features of natural speech, using single-unit recordings from neurosurgical epilepsy patients.
- Engineer NLP feature pipelines that extract syntactic and semantic representations from transformer language models (ModernBERT, GPT-4, LLaMA, BERT) and apply concept erasure (LEACE) to dissociate grammar from meaning when predicting neural responses.
- Scaled model fitting and cross-validation onto a SLURM GPU cluster (job-array fan-out across NVIDIA L40 nodes), reducing multi-model analyses from hours to minutes.
- Developed automated spike-sorting and quality-control pipelines (wave_clus, UMAP) for high-density microelectrode recordings.

Martin Lab of Language & Memory — Rice University *Houston, TX*

Research / Lab Assistant *Sep 2022 – May 2025*

- Analyzed phonological and semantic working-memory data across 1,000+ participants using multiple regression, factor analysis, and principal component analysis.
- Built OpenAI Whisper speech-recognition pipelines to transcribe and quantify language production in aphasic patients.
- Designed and ran comprehension and production experiments, integrating psycholinguistic measures with model-derived linguistic features.

Language & Cognitive Development Lab — UC Berkeley *Berkeley, CA*

Summer Research Assistant *Jun – Aug 2023*

- Studied social-cue and priming effects on semantically ambiguous nouns in 50+ children; generated preliminary statistics in R.
- Built a Vosk + Whisper transcription pipeline producing time-stamped transcripts from 150+ hours of audio recordings.
- Presented project and findings to the PI and lab collaborators at the final lab meeting.

PUBLICATIONS

Peer-reviewed journal articles (in press, 2026)

Katlowitz, K. A., Cole, E. R., Mickiewicz, E. A., Shah, S., Franch, M. C., Adkinson, J., **Belanger**, J. L., Mathura, R. K., Meszéna, D., McGinley, M., Muñoz, W., Banks, G. P., Cash, S. S., Hsu, C.-W., Paulk, A. C., Provenza, N. R., Watrous, A., Williams, Z., … Hayden, B. Y., & Sheth, S. A. (2026). Plasticity and language in the anaesthetized human hippocampus. *Nature*. Advance online publication. https://doi.org/10.1038/s41586-026-10448-0

Katlowitz, K. A., **Belanger**, J. L., Ismail, T., Chavez, A. G., Chericoni, A., Franch, M. C., Mickiewicz, E. A., Mathura, R. K., Paulo, D., Bartoli, E., Piantadosi, S. T., Provenza, N. R., Watrous, A. J., Sheth, S. A., & Hayden, B. Y. (2026). Attention is all you need (in the brain): Semantic contextualization in human hippocampus. *Nature Human Behaviour*. In press.

Franch, M. C., Mickiewicz, E. A., **Belanger**, J., Joiner, B., Katlowitz, K. A., Zhu, H., Chavez, A. G., Chericoni, A., Paulo, D., Bartoli, E., Kemmer, S., Piantadosi, S. T., Provenza, N. R., Hennig, J. A., Sheth, S. A., & Hayden, B. Y. (2026). A population code for semantics in human hippocampus. *Nature Neuroscience*. In press.

Yan, X., Chavez, A. G., Franch, M. C., Katlowitz, K. A., Gautam, I., Kim, B., Krishna, A., Shrivastava, A., Van Arsdel, K., **Belanger**, J., Chericoni, A., Ismail, T., Mickiewicz, E. A., Paulo, D., Zhu, H., Goldman, A. M., Krishnan, V., Maheshwari, A., Bartoli, E., Provenza, N. R., Yoo, S. B. M., Hayden, B. Y., & Sheth, S. A. (2026). Shared neural geometries for bilingual semantic representations in human hippocampal neurons. *Cell*. In press.

Preprints (bioRxiv)

Zhu, H., Franch, M., Mickiewicz, E., **Belanger**, J., Cowan, R. L., Katlowitz, K., Chavez, A. G. L., Chericoni, A., Paulo, D., Yan, X., Bartoli, E., Hennig, J., Provenza, N., Smith, E. H., Piantadosi, S., Sheth, S., & Hayden, B. Y. (2026). A geometric foundation for word meaning in the brain. *bioRxiv*. Preprint.

Franch, M., Katlowitz, K. A., Mickiewicz, E. A., **Belanger**, J. L., Mathura, R. K., Zhu, H., … Hayden, B. Y. (2026). Neural signatures of impaired semantic contextualization in Autism Spectrum Disorder. *bioRxiv*. Preprint. https://doi.org/10.64898/2026.03.16.712048

Yan, X., Li, J. A., Franch, M., Zhu, H., Cowan, R. L., **Belanger**, J., Chavez, A. G., Chericoni, A., Ismail, T., Katlowitz, K. A., Kolibius, L. D., Mickiewicz, E. A., Paulo, D., Bartoli, E., Hennig, J. A., Frączek, T. M., Provenza, N. R., Rahimpour, S., Shofty, B., Smith, E., Jacobs, J., Hayden, B. Y., & Sheth, S. A. (2026). Polysemanticity in human hippocampal neurons. *bioRxiv*. Preprint. https://doi.org/10.64898/2026.05.02.722435

Chavez, A. G., Franch, M., Mickiewicz, E. A., Baltazar, W., **Belanger**, J. L., Devara, D., Etta, M., Hamre, T., Ismail, T., Joiner, B., Kim, Y., Kona, A., Mansourian, K., Nangia, A., Pluenneke, M., Soubra, S., Venkateswaran, T., Venkudusamy, K., Chericoni, A., Kabotyanski, K. E., … Hayden, B. Y. (2025). Mirror manifolds: Partially overlapping neural subspaces for speaking and listening. *bioRxiv*. Preprint. https://doi.org/10.1101/2025.09.20.677504

Mickiewicz, E. A., Franch, M., Katlowitz, K. A., Chavez, A. G., Zhu, H., Chericoni, A., Yan, X., **Belanger**, J. L., Ismail, T., Paulo, D. L., Goldman, A. M., Krishnan, V., Maheshwari, A., Bartoli, E., Heilbronner, S. R., Provenza, N. R., Sheth, S. A., & Hayden, B. Y. (2025). A semantotopic map in human hippocampus. *bioRxiv*. Preprint. https://doi.org/10.1101/2025.10.31.685959

SELECT PROJECTS

Autoencoder for Language Comprehension — model integrating grammatical roles, semantic embeddings, and neural activity (gamma power, time-bin vectors) to probe brain–language relationships.

Syntactic Complexity & Working Memory — quantified syntactic features in narrative production across age groups using CoreNLP, Stanza, NLTK, and CLAN.

Dual-Language Speech Transcription — LLM-assisted tool for real-time analysis of syntactic and semantic patterns across two languages.

TECHNICAL SKILLS

Programming: Python, R, MATLAB, Excel VBA, Bash, Git

ML / NLP: PyTorch, TensorFlow, scikit-learn, Hugging Face Transformers, OpenAI Whisper, Word2Vec; LLMs (GPT-4, LLaMA, BERT, ModernBERT)

Statistics & Methods: Poisson & logistic regression, GLMs, ridge regularization, cross-validation, PCA / factor analysis, CCA, SVM, autoencoders, dimensionality reduction, concept erasure (LEACE)

Computing: SLURM / HPC GPU clusters, Google Colab, MLflow, Microsoft Azure

Languages: Spanish (Professional); French, Portuguese, Japanese (Intermediate)

HONORS & AWARDS

Psi Chi Undergraduate Scholarship ($3,000), 2024 · Rice Undergraduate Scholars Program Scholarship ($1,000), 2024 · Owl Edge Summer Experience Fund ($5,000), 2023 · STaRT@RICE Research Scholarship, 2023

Omega Psi Cognitive Science Honors Society, 2024 · Summer Undergraduate Research Symposium — Award of Excellence in Poster Presentation, 2022 · Wiess School of Natural Sciences Endorsement in Science Engagement, 2023

CERTIFICATIONS

Harvard CS50: Introduction to Programming with Python (2023) · Deep Learning Specialization, DeepLearning.AI / Coursera (2024) · Principles of fMRI, Johns Hopkins / Coursera (2024) · NLP with Python & Deep Learning, Udemy (2023–2024)