Christian Brodbeck

Assistant Professor

Department of Computing and Software
McMaster University
brodbecc@mcmaster.ca
christianbrodbeck.net
christianbrodbeck

Positions

2023-present **Assistant Professor**, *Department of Computing and Software, McMaster University*

2020-2023 **Assistant Research Professor**, *Department of Psychological Sciences, University of Connecticut*

2016-2020 **Post-Doctoral Associate**, *Institute for Systems Research*, University of Maryland, College Park, advisor: Jonathan Z. Simon

2014 **Teaching Assistant**, *Brian McElree, New York University*, Cognition

2006–11 **Clinical Assistant**, *Sleep Laboratory Fluntern*, Zurich (part-time)
Anamnestic interviews with patients and polysomnographic data collection.

Education

2011–16 **Ph.D., Psychology, Cognition & Perception**, *New York University, New York*, advisor: Liina Pylkkänen
Dissertation: *Comprehending language in context: The neural basis of reference resolution.*

2003–10 **Licentiate, Psychology (equivalent to Master of Science)**, *University of Zurich*, concentration: Neuropsychology; 1. minor: English Linguistics; 2. minor: Neuroinformatics, thesis advisor: Martin Meyer
Thesis: *Information Structure and the Closure Positive Shift: Event-Related Potentials to Wh-Question Answer Pairs.*

Research

Neurobiology of language: Neural mechanisms of speech perception; Neural representations of linguistic information in continuous speech; Computational models of speech recognition and their relation to human neurobiology; Speech perception in noise; Lifespan changes

M/EEG methods: Temporal dynamics of M/EEG responses to continuous stimuli (temporal response function analysis); Open source M/EEG analysis tools (Eelbrain, MNE-Python); Source localization for single trial M/EEG responses to continuous stimuli; Publications marked †

External Funding

2023 - 2028 "Neurocognitive Mechanisms of Sentence Production Impairment in Aphasia" NIH 1R01DC020483. Amount awarded: $3,092,049. Co-I (PI: Yasmeen Faroqi Shah)

2022 - 2025 "CRCNS US-Spain Research Proposal: Collaborative Research: Tracking and modeling the neurobiology of multilingual speech recognition" NSF IIS-2207770. Amount awarded: $467,255. Co-PI (PI: James S Magnuson)

2021 - 2024 "Collaborative Research: CompCog: Psychological, Computational, and Neural Adequacy in a Deep Learning Model of Human Speech Recognition" NSF BCS-2043903. Amount awarded: $437,171. KP (PI: James S Magnuson)

Preprints

2021 Pifer, M, **Brodbeck, C**, and Faroqi-Shah, Y. 2021. "An Investigation of Neural Mechanisms Underlying Verb Morphology Deficits in Aphasia." In: *bioRxiv*. DOI: 10.1101/2021.05.28.445987.

2017 Puvvada, KC, Villafañe-Delgado, M, **Brodbeck, C**, and Simon, JZ. 2017. "Neural Coding of Noisy and Reverberant Speech in Human Auditory Cortex." In: *bioRxiv*. DOI: 10.1101/229153.

Peer-reviewed articles

2023 *Gaston, P, ***Brodbeck, C**, Phillips, C, and Lau, E. 2023. "Auditory word comprehension is less incremental in isolated words." In: *Neurobiology of Language* 4.1. DOI: 10.1162/nol_a_00084.

*Xie, Z, ***Brodbeck, C**, and Chandrasekaran, B. 2023. "Cortical tracking of continuous speech under bimodal divided attention." In: *Neurobiology of Language* 4.2. DOI: 10.1162/nol_a_00100.

Brodbeck, C, Das, P, Gillis, M, Kulasingham, JP, Bhattasali, S, Gaston, P, Resnik, P, and Simon, JZ. 2023. "Eelbrain, a Python toolkit for time-continuous analysis with temporal response functions." In: *eLife* 12, e85012. DOI: 10.7554/eLife.85012.

Brodbeck, C, Kandylaki, KD, and Scharenborg, O. 2023. "Neural representations of non-native speech reflect proficiency and interference from native language knowledge." In: *Journal of Neuroscience*. DOI: 10.1523/JNEUROSCI.0666-23.2023.

Herrera, C, Whittle, N, Leek, MR, **Brodbeck, C**, Lee, G, Barcenas, C, Barnes, S, Holshouser, B, Yi, A, and Venezia, JH. 2023. "Cortical networks for recognition of speech with simultaneous talkers." In: *Hearing Research* 437.15, p. 108856. DOI: 10.1016/j.heares.2023.108856.

*Equal contribution

2022 Bieber, R, **Brodbeck, C**, and Anderson, S. 2022. "Examining the context benefit in older adults: a combined behavioral-electrophysiologic word identification study." In: *Neuropsychologia* 170.6, p. 108224. DOI: 10.1016/j.neuropsychologia.2022.108224.

Brodbeck, C, Bhattasali, S, Heredia, AC, Resnik, P, Simon, JZ, and Lau, E. 2022. "Parallel processing in speech perception with local and global representations of linguistic context." In: *eLife* 11, e72056. DOI: 10.7554/eLife.72056.

Brodbeck, C and Simon, JZ. 2022. "Cortical tracking of voice pitch in the presence of multiple speakers depends on selective attention." In: *Frontiers in Neuroscience* 16:828546. DOI: 10.3389/fnins.2022.828546.

Kulasingham, JP, **Brodbeck, C**, Khan, S, Marsh, EB, and Simon, JZ. 2022. "Bilaterally Reduced Rolandic Beta Band Activity in Minor Stroke Patients." In: *Frontiers in Neurology*. DOI: 10.3389/fneur.2022.819603.

2021 Gillis, M, Vanthornhout, J, Simon, JZ, *Francart, T, and ***Brodbeck, C**. 2021. "Neural markers of speech comprehension: measuring EEG tracking of linguistic speech representations, controlling the speech acoustics." In: *Journal of Neuroscience* 41.50. DOI: 10.1523/JNEUROSCI.0812-21.2021.

Luthra, S, Li, MYC, You, H, **Brodbeck, C**, and Magnuson, JS. 2021. "Does signal reduction imply predictive coding in models of spoken word recognition?" In: *Psychonomic Bulletin & Review*. DOI: 10.3758/s13423-021-01924-x.

2020 **Brodbeck, C**, Jiao, A, Hong, LE, and Simon, JZ. 2020. "Neural speech restoration at the cocktail party: Auditory cortex recovers masked speech of both attended and ignored speakers." In: *PLOS Biology* 18.10, e3000883. DOI: 10.1371/journal.pbio.3000883.

Brodbeck, C and Simon, JZ. 2020. "Continuous speech processing." In: *Current Opinion in Physiology* 18, pp. 25–31. DOI: 10.1016/j.cophys.2020.07.014.

Das, P, **Brodbeck, C**, Simon, JZ, and Babadi, B. 2020. "Neuro-Current Response Functions: A Unified Approach to MEG Source Analysis under the Continuous Stimuli Paradigm." In: *NeuroImage* 211:116528. DOI: 10.1016/j.neuroimage.2020.116528.

Kulasingham, JP, **Brodbeck, C**, Presacco, A, Kuchinsky, SE, Anderson, S, and Simon, JZ. 2020. "High gamma cortical processing of continuous speech in younger and older listeners." In: *NeuroImage* 222, p. 117291. DOI: 10.1016/j.neuroimage.2020.117291.

Marsh, EB, **Brodbeck, C**, Llinas, RH, Mallick, D, Kulasingham, JP, Simon, JZ, and Llinás, RR. 2020. "Poststroke acute dysexecutive syndrome, a disorder resulting from minor stroke due to disruption of network dynamics." In: *Proceedings of the National Academy of Sciences* 117.52, pp. 33578–33585. DOI: 10.1073/pnas.2013231117.

2019 Matchin, W, **Brodbeck, C**, Hammerly, C, and Lau, E. 2019. "The temporal dynamics of structure and content in sentence comprehension: Evidence from fMRI-constrained MEG." In: *Human Brain Mapping* 40.2, pp. 663–678. DOI: 10.1002/hbm.24403.

2018 **Brodbeck, C**, Hong, LE, and Simon, JZ. 2018. "Rapid transformation from auditory to linguistic representations of continuous speech." In: *Current Biology* 28.24, 3976–3983.e5. DOI: 10.1016/j.cub.2018.10.042.

Brodbeck, C, Presacco, A, Anderson, S, and Simon, JZ. 2018. "Over-Representation of Speech in Older Adults Originates from Early Response in Higher Order Auditory Cortex." In: *Acta Acustica united with Acustica* 104.5, pp. 774–777. DOI: 10.3813/AAA.919221.

† **Brodbeck, C**, Presacco, A, and Simon, JZ. 2018. "Neural source dynamics of brain responses to continuous stimuli: Speech processing from acoustics to comprehension." In: *NeuroImage* 172, pp. 162–174. DOI: 10.1016/j.neuroimage.2018.01.042.

2017 **Brodbeck, C** and Pylkkänen, L. 2017. "Language in context: Characterizing the comprehension of referential expressions with MEG." In: *NeuroImage* 147, pp. 447–60. DOI: 10.1016/j.neuroimage.2016.12.006.

2016 **Brodbeck, C**, Gwilliams, L, and Pylkkänen, L. 2016. "Language in context: MEG evidence for modality general and specific responses to reference resolution." In: *eNeuro* 3.6, ENEURO.0145–16.2016. DOI: 10.1523/ENEURO.0145-16.2016.

2015 **Brodbeck, C**, Gwilliams, L, and Pylkkänen, L. 2015. "EEG can track the time course of successful reference resolution in small visual worlds." In: *Frontiers in Psychology* 6.1787. DOI: 10.3389/fpsyg.2015.01787.

2014 † Gramfort, A, Luessi, M, Larson, E, Engemann, D, Strohmeier, D, **Brodbeck, C**, Parkkonen, L, and Hämäläinen, M. 2014. "MNE software for processing MEG and EEG data." In: *Neuroimage* 86, pp. 446–60. DOI: 10.1016/j.neuroimage.2013.10.027.

2013 † Gramfort, A, Luessi, M, Larson, E, Engemann, DA, Strohmeier, D, **Brodbeck, C**, Goj, R, Jas, M, Brooks, T, Parkkonen, L, and Hämäläinen, M. 2013. "MEG and EEG data analysis with MNE-Python." In: *Frontiers in Neuroscience* 7.267. DOI: 10.3389/fnins.2013.00267.

2011 Hein, G, Lamm, C, **Brodbeck, C**, and Singer, T. 2011. "Skin Conductance Response to the Pain of Others Predicts Later Costly Helping." In: *PLoS ONE* 6.8, e22759. DOI: 10.1371/journal.pone.0022759.

Invited contributions

2018 † Das, P, **Brodbeck, C**, Simon, JZ, and Babadi, B. 2018. "Cortical Localization of the Auditory Temporal Response Function from MEG via Non-convex Optimization." In: *Asilomar Conference on Signals, Systems, and Computers*, pp. 373–377.

2013 **Brodbeck, C** and Silani, G. 2013. "Gender and Social Emotions: A Review of the Neuroscientific Literature on Empathy and its Link to Psychopathy, Antisocial Behavior and Alexithymia." In: *Gender and Emotion: An Interdisciplinary Perspective*. Ed. by I Latu, M Mast, and S Kaiser. Bern: Peter Lang.

Presentations

2023 **Brodbeck, C**. 2023. *Eelbrain for MEG/EEG: Mass-univariate statistics*. Invited talk at NIH Club MEG.

Brodbeck, C. 2023. *Neural mechanisms of Speech processing in continuous speech*. Invited talk at University of Glasgow.

Brodbeck, C. 2023. *Neural mechanisms of Speech processing in continuous speech*. Invited talk at McMaster University.

Brodbeck, C. 2023. *Neural mechanisms of Speech processing in continuous speech*. Invited talk at CUNY Graduate Center.

Crinnion, AM and **Brodbeck, C**. 2023. *Examining phoneme, syllable, and word level representations in continuous speech processing*. Poster at SNL 2023.

Karunathilake, D, **Brodbeck, C**, Bhattasali, S, Resnik, P, and Simon, JZ. 2023. *Progression of acoustic, phonemic, lexical and sentential neural features emerge during speech listening*. Talk at ARO 2023.

Kleinman, D, Campanelli, L, Lee, B, Van Dyke, J, **Brodbeck, C**, and Landi, N. 2023. *Greater reliance on sentence context during naturalistic listening predicts larger reading gains over two years*. Poster presented at the 15th annual meeting of the Society for the Neurobiology of Language.

2022 **Brodbeck, C**. 2022. *Uncovering neural mechanisms for continuous speech recognition with MEG and EEG*. Invited talk at University of Geneva.

Crinnion, AM and **Brodbeck, C**. 2022. *Evaluating effects of phoneme-level and word-level surprisal in continuous speech processing*. Poster at SNL 2022.

Karunathilake, D, **Brodbeck, C**, Bhattasali, S, Resnik, P, and Simon, JZ. 2022. *Progression of acoustic, phonemic, lexical and sentential neural features emerge for different speech listening*. Poster at SNL 2022.

Kleinman, D, Parilla, N, **Brodbeck, C**, Pugh, K, Hoeft, F, and Landi, N. 2022. *Using in-school laboratories to predict reading ability and reading gains from EEG*. Stanford EEG Topics Seminar.

2021 † **Brodbeck, C**. 2021. *Investigating speech processing with Python and Eelbrain*. Invited talk at the Cognition and Natural Sensory Processing Workshop.

Brodbeck, C, Gaston, P, Luthra, S, and Magnuson, J. 2021. *Discovering computational principles in models and brains*. Poster presented at the Annual Conference of the Cognitive Science Society.

Gillis, M, Vanthornhout, J, Simon, JZ, Francart, T, and **Brodbeck, C**. 2021. *Neural Tracking of Linguistic Speech Representations*. Podium presentation at ARO 2021.

2020 **Brodbeck, C**. 2020. *Cortical processing of continuous speech: from sound to words, and effects of selective attention*. Invited talk at University of Massachusetts Amherst.

Brodbeck, C. 2020. *Time-locked cortical processing of continuous speech: from sound to words, and effects of selective attention*. Invited talk at University of Toronto.

Brodbeck, C. 2020. *Time-locked cortical processing of continuous speech: from sound to words, and effects of selective attention*. Invited talk at NeuroSpin, Paris.

Brodbeck, C, Jiao, A, Hong, LE, and Simon, JZ. 2020. *Auditory Cortex Tracks Masked Acoustic Onsets in Background Speech: A Potential Stream Segregation Mechanism*. Poster at CNS 2020.

Brodbeck, C, Jiao, A, Hong, LE, and Simon, JZ. 2020. *Neural speech restoration at the cocktail party: Auditory cortex recovers masked speech of both attended and ignored speakers*. Poster at APAN 2020.

Gaston, P, **Brodbeck, C**, Phillips, C, and Lau, E. 2020. *Cohort entropy and phoneme surprisal during auditory single-word recognition: a temporal response function analysis*. Poster at SNL 2020.

2019 Bieber, RE, **Brodbeck, C**, Yevsukov, V, and Anderson, S. 2019. *Effects of listener age, talker accent, and sentential context on lexical access*. Poster presented at the Aging and Speech Communication Research Conference, Tampa, FL.

Brodbeck, C. 2019. *Time-locked cortical processing of continuous speech: from sound to words, and effects of attention*. Invited talk at UT Health.

Brodbeck, C, Hong, LE, and Simon, JZ. 2019. *Auditory Cortex Tracks Acoustic Onsets of Ignored Speech: A Potential Mechanism in Stream Segregation*. Talk at the MEG North America Workshop.

Brodbeck, C, Hong, LE, and Simon, JZ. 2019. *Rapid time-locked lexical processing of attended but not of unattended continuous speech*. Invited talk at CHSCOM 2019.

Brodbeck, C, Presacco, A, Kuchinsky, S, Anderson, S, and Simon, JZ. 2019. *Increased speech representation in older adults originates from early response in higher order auditory cortex*. Symposium talk at ARO 2019.

Simon, JZ, **Brodbeck, C**, Presacco, A, Kuchinsky, S, and Anderson, S. 2019. *Over-representation of speech in older adults originates from early and late responses in auditory cortex*. Talk at CHSCOM 2019.

2018 **Brodbeck, C**, Hong, LE, and Simon, JZ. 2018. *MEG Responses Track Lexical Processing of Continuous Narrative Speech*. Poster presented at the 11th international conference on the Mental Lexicon.

Brodbeck, C, Presacco, A, Anderson, S, and Simon, JZ. 2018. *Over-Representation of Speech in Older Adults Originates from Early Response in Higher Order Auditory Cortex*. Talk at the International Symposium on Hearing 2018.

Brodbeck, C, Presacco, A, Kuchinsky, S, Anderson, S, and Simon, JZ. 2018. *Origins of cortical over-representation of speech in older adults*. Poster presented at SPLASH 2018.

Brodbeck, C and Simon, JZ. 2018. *Tracking Phoneme Processing During Continuous Speech Perception with MEG*. Poster presented at ARO 2018.

Brodbeck, C and Simon, JZ. 2018. *Using MEG to follow the neural processing of continuous speech, from acoustics to comprehension*. Invited talk at Portland Health and Science University.

Das, P, **Brodbeck, C**, Simon, JZ, and Babadi, B. 2018. *Direct Cortical Localization of the MEG Auditory Temporal Response Function: a Non-Convex Optimization Approach*. Poster presented at SfN 2018.

Matchin, W, **Brodbeck, C**, Hammerly, C, and Lau, E. 2018. *The temporal dynamics of structure and content in the language network*. Talk presented at the 31st CUNY sentence processing conference.

2017 **Brodbeck, C**, Presacco, A, and Simon, JZ. 2017. *Neural Source Dynamics of Brain Responses to Continuous Speech: from Acoustics to Comprehension*. Poster presented at SfN 2017.

Brodbeck, C, Presacco, A, and Simon, JZ. 2017. *Neural source dynamics of brain responses to continuous stimuli with MEG: speech processing from acoustics to comprehension*. Poster presented at the SAND8 workshop.

Brodbeck, C, Presacco, A, and Simon, JZ. 2017. *Tracking Phoneme Processing During Continuous Speech Perception with MEG*. Poster presented at the 6th International Conference on Auditory Cortex.

Brodbeck, C and Simon, JZ. 2017. *Tracking Phoneme Processing During Continuous Speech Perception with MEG*. Poster presented at SNL 2017.

2016 **Brodbeck, C**. 2016. *Unpacking the neural basis of reference resolution: MEG and EEG evidence*. Invited talk at the RefNet round table.

Brodbeck, C, Gwilliams, L, and Pylkkänen, L. 2016. *Modality general and specific brain responses during reference resolution*. Poster presented at the annual meeting of the Cognitive Neuroscience Society.

Brodbeck, C, Gwilliams, L, and Pylkkänen, L. 2016. *Modality general and specific brain responses during reference resolution*. Poster presented at the 28th Annual CUNY Conference on Human Sentence Processing.

2015 **Brodbeck, C**, Gwilliams, L, and Pylkkänen, L. 2015. *EEG can track the time course of successful reference resolution in small visual worlds*. Poster presented at the 7th Annual Meeting of the Society for the Neurobiology of Language (SNL).

2014 **Brodbeck, C**, Gwilliams, L, and Pylkkänen, L. 2014. *Reference resolution and prediction in a visual world: MEG evidence from English and Arabic*. Talk given at the NYUAD Annual Research Conference.

Brodbeck, C and Pylkkänen, L. 2014. *Reference resolution in small visual worlds: the role of the medial parietal lobe*. Talk given at the RefNet Workshop.

2013 **Brodbeck, C** and Pylkkänen, L. 2013. *MEG evidence for immediate reference resolution within a visual world*. Poster presented at the 25th Annual CUNY Conference on Human Sentence Processing.

Software

Programming
- Primary: Python; secondary: R, Matlab, Swift
- Machine learning (Tensorflow)
- Performance optimization with Cython and Numba
- Graphical user interfaces with wxPython and TraitsUI
- Network protocols for distributed computing

Open source
- GitHub: github.com/christianbrodbeck
- Primary developer: Eelbrain (eelbrain.readthedocs.io)
- Contributor: MNE-Python (mne.tools), PySurfer (pysurfer.github.io)
- Minor contributions: SciPy, matplotlib, Mayavi, Pyface, TraitsUI, textgrid.py

Honors and Awards

2020 **Trainee Presentation Award**, *Advances and Perspectives in Auditory Neuroscience (APAN)*

2018 **Student Presentation Award**, *11th International Conference on the Mental Lexicon*

2017 **Travel Award**, *6th International Conference on Auditory Cortex*

2017 **Travel Grant**, *SAND8 Workshop*

2016 **Dean's Student Travel Grant**, *New York University*

2011–16 **Henry M. MacCracken Fellowship**, *New York University*

Service

Reviewed for eLife; Journal of Neuroscience; Journal of Cognitive Neuroscience; NeuroImage; Neuropsychologia; Cognition; Language, Cognition and Neuroscience; Human Brain Mapping; Psychological Science; Neurobiology of Language; Frontiers in Neuroscience

Languages

English Fluent

German Fluent

French Basic

Arabic Basic