

Leonardo S. Barbosa, PhD

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RESEARCH SUMMARY

I develop machine learning models for real-time neurochemical inference from electrochemical data acquired via intracranial electrodes in human patients. My focus is on building deep learning architectures (InceptionTime and related models) that generalize neurotransmitter concentration estimates across probes, labs, and recording conditions. I've spent over a decade thinking about what consciousness is — and how to measure it. From early work on neural markers of awareness in infants and unconscious cognitive processing, to deriving uniqueness proofs for intrinsic information measures and co-authoring the formalization of Integrated Information Theory (IIT) 4.0. I co-founded NebulaNeuro to translate these neurochemical biomarkers into clinical tools for psychiatric disorders.

POSITIONS

Research Assistant Professor · Fralin Biomedical Research Institute, Virginia Tech 2023–present
Senior Research Associate · Fralin Biomedical Research Institute, Virginia Tech 2022–2023
Senior Researcher · Araya Inc., Tokyo, Japan 2021–2022
(Computational neuroscience R&D; whole-brain connectivity modeling with recurrent neural networks)
Post-doctoral Research Associate · University of Wisconsin–Madison 2016–2021
(Advisor: Giulio Tononi. IIT formalization, intrinsic information measures, sleep phenotyping)

EDUCATION

PhD in Cognitive Neuroscience · PSL – École Normale Supérieure, Paris 2012–2016
(Advisor: Sid Kouider. *The Predictive Unconscious: How Predictions Shape Unconscious Perception*)
MSc in Physics (Biophysics & Statistical Mechanics) · University of São Paulo 2009–2011
(Advisor: Nestor Caticha. *Multigrid a Priori Information for Bayesian M/EEG Source Localization*)
BSc in Physics · University of São Paulo 2003–2008

INDUSTRY & ENTREPRENEURSHIP

Co-Founder & Equity Holder · Nebula Neuro 2023–present
Developing AI-driven neurochemical biomarkers from in-vivo human voltammetry for psychiatric applications. Patent-pending technology for real-time monoamine decoding using machine learning enhanced voltammetry (MLEV).
Software Architect & Programmer · Internet Group do Brasil (iG) 2001–2004
(Large-scale web infrastructure; one of Brazil's largest ISPs at the time)

PUBLICATIONS

1,200+ citations · 20 publications · * denotes co-first authorship

- Batten SR*, Hartle AE*, **Barbosa LS***, Hadj-Amar B*, Bang D*, Melville N, Twomey T, White JP, Torres A, Celaya X, McClure SM, Brewer GA, Lohrenz T, Kishida KT, Bina RW, Witcher MR, Vannucci M, Casas B, Chiu P, Montague PR, Howe WM.
Emotional words evoke region- and valence-specific patterns of concurrent neuromodulator release in human thalamus and cortex.
Cell Reports (2025).
- Hartle AE*, Kishida KT*, Sands LP, Batten SR, **Barbosa LS**, Bang D, Lohrenz T, White JP, Sohrabi AK, Calafiore RL, DiFeliceantonio AG, Laxton AW, Tatter SB, Witcher MR, Montague PR, Howe WM.
Caudate serotonin signaling during social exchange distinguishes essential tremor and Parkinson's disease patients.
Nature Communications (2025).
- Lacroix A, Harquel S, Mermillod M, Garrido M, **Barbosa L**, Vercueil L, Aleysson D, Dutheil F, Kovarski K, Gomot M.
Sex modulation of faces prediction error in the autistic brain.
Communications Biology (2024).
- Batten SR, Bang D, Kopell BH, Davis AN, Heflin M, Fu Q, Perl O, Ziafat K, Hashemi A, Saez I, **Barbosa LS**, Twomey T, Lohrenz T, White JP, Dayan P, Charney AW, Figeo M, Mayberg HS, Kishida KT, Gu X, Montague PR.
Dopamine and serotonin in human substantia nigra track social context and value signals during economic exchange.
Nature Human Behaviour (2024).
- Albantakis L*, **Barbosa L***, Findlay G*, Grasso M*, Haun AM*, Marshall W*, Mayner WGP*, Zaeemzadeh A*, Boly M, Juel BE, Sasai S, Fujii K, David I, Hendren J, Lang JP, Tononi G.
Integrated information theory (IIT) 4.0: Formulating the properties of phenomenal existence in physical terms.
PLOS Computational Biology (2023).
- Bang D*, Luo Y*, **Barbosa LS***, Batten SR*, Hadj-Amar B*, Twomey T, Melville N, White JP, Torres A, Celaya X, Ramaiah P, McClure SM, Brewer GA, Bina RW, Lohrenz T, Casas B, Chiu PH, Vannucci M, Kishida KT, Witcher MR, Montague PR.
Noradrenaline tracks emotional modulation of attention in human amygdala.
Current Biology (2023).
- Marshall W, Grasso M, Mayner WGP, Zaeemzadeh A, **Barbosa LS**, Chastain E, Findlay E, Sasai S, Albantakis L, Tononi G.
System Integrated Information.
Entropy (2023).
- Barbosa LS, Marshall W, Albantakis L, Tononi G.
Mechanism integrated information.
Entropy (2021).
- Barbosa LS**, Marshall W, Streipert S, Albantakis L, Tononi G.
A measure for intrinsic information.
Scientific Reports (2020).
- Plante DT, Cook JD, **Barbosa LS**, Goldstein MR, Prairie ML, Smith RF, Riedner BA.
Establishing the objective sleep phenotype in hypersomnolence disorder with and without comorbid major depression.
Sleep (2019).
- Barbosa LS**, Kouider S.
Prior expectation modulates repetition suppression without perceptual awareness.
Scientific Reports (2018).
- Barbosa LS**, Vlassova A, Kouider S.
Prior expectations modulate unconscious evidence accumulation.
Consciousness and Cognition (2017).

Amaral SR, Baccalá LA, **Barbosa LS**, Caticha N.

Backward renormalization-group inference of cortical dipole sources and neural connectivity efficacy.
Physical Review E (2017).

Kouider S, Long B, Le Stanc L, Charron S, Fievet AC, **Barbosa LS**, Gelskov SV.

Neural dynamics of prediction and surprise in infants.
Nature Communications (2015).

Sun Y, Giavazzi M, Adda-Decker M, **Barbosa LS**, Kouider S, Bachoud-Lévi AC, Jacquemot C, Peperkamp S.

Complex linguistic rules modulate early auditory brain responses.
Brain and Language (2015).

Kouider S, Andrillon T, **Barbosa LS**, Goupil L, Bekinschtein TA.

Inducing task-relevant responses to speech in the sleeping brain.
Current Biology (2014).

Kouider S, Stahlhut C, Gelskov SV, **Barbosa LS**, Dutat M, de Gardelle V, Christophe A, Dehaene S, Dehaene-Lambertz G.

A neural marker of perceptual consciousness in infants.
Science (2013).

SELECTED PRESENTATIONS

Computationally assisted multi-analyte voltammetry and its application for real-time monitoring of neurochemicals in vivo · *Monitoring Molecules in Neuroscience* · Chapel Hill, USA 2024

Whole brain connectivity analysis during movie-watching using recurrent neural networks reveals specific spatio-temporal structure · *NEURO2022* · Okinawa, Japan 2022

Neural networks for concurrent, sub-second neurotransmitter detection · *NAISys, Cold Spring Harbor Laboratory* · NY, USA 2020

How much of a difference does it make to me? Looking for an intrinsic measure · *Causation and Complexity* · Melbourne 2018

AWARDS & FELLOWSHIPS

Swartz Foundation Fellow for Theory in Neuroscience 2020

Full funding, 5th Latin American School for Education, Cognitive and Neural Sciences · Chile 2015

CNPq Masters Scholarship · Conselho Nacional de Desenvolvimento Científico e Tecnológico, Brazil 2009–2011

TEACHING

Statistics and Probability (4h/week) · Psychology, Université Grenoble-Alpes 2022

Teaching Assistant, Physics for Biological Sciences (8h/week) · University of São Paulo 2008