

Dr. Sandra Martin

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Research Group Cognition & Plasticity

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» I am a cognitive neuroscientist with a focus on computational modeling of brain signals in language and cognition across the adult lifespan. My work integrates fMRI, TMS, and behavioral measures with machine learning and large language models to quantify prediction, semantic control, and executive functions.

I have extensive experience developing and implementing robust analytical workflows in Python and R, and I am particularly interested in bridging neural data and representations from modern NLP models. I am committed to open and reproducible research practices, and strive to implement these principles in my work by sharing data and code, using open-source software, and publishing results in open-access journals.

METHODS & COMPUTATIONAL SKILLS

Machine learning & statistics

Linear and generalized mixed-effects models for large lifespan datasets; GAM/GAMM approaches for reaction time and reading data; Bayesian hierarchical sequential sampling (HSSM toolbox)

Deep learning & NLP

Use of transformer-based language models (e.g., GPT-2) to derive surprisal, entropy, and contextual embeddings as predictors of behavior and brain activity in naturalistic language tasks; Working with large text corpora and LLM tools (HuggingFace ecosystem, API-based models) for building linguistic predictors and designing language stimuli

Neuroimaging

fMRI acquisition and analysis (GLM, MVPA, seed-based and whole-brain connectivity, network and graph analysis) in large lifespan cohorts; Integration of behavioral, neurostimulation, and physiological measures (e.g., eyetracking, heart-brain coupling); Familiarity with EEG/MEG analysis concepts and their use for connectivity and prediction

Programming

Extensive use of Python (and Matlab) for neuroimaging and machine learning, including data processing (numpy, pandas, scipy), analysis libraries (nilearn, SPM12, HSSM), and deep-learning (PyTorch, HuggingFace transformers); Advanced statistical modeling in R (lme4, mgcv, brms), including development of custom packages for teaching and reproducible analysis workflows; Experience running large-scale analyses on high-performance computing (HPC) systems using SLURM for job scheduling, version-controlled pipelines (Git), and Linux-based, scripted end-to-end workflows (Bash)

Experimental Methods

fMRI; sMRI; eyetracking; TMS; tDCS; PsychoPy

PROFESSIONAL EXPERIENCE

Postdoctoral Researcher

since 09/2023

MPI for Human Cognitive and Brain Sciences, Research Group Cognition and Plasticity

Project: *Executive and domain-specific processes in predictive language processing across the adult lifespan*

- Lead development of computational models linking GPT-2-based surprisal and behavioral/fMRI measures of language prediction across the adult lifespan.
- Coordinate a multi-site project combining neuroimaging, TMS, and behavioral data; responsible for analysis pipelines and supervision of doctoral and MA students.
- Design and preregister experiments and analysis plans.

Doctoral Researcher

2018–2023

MPI for Human Cognitive and Brain Sciences Leipzig & University Hospital Leipzig

Project: *Age-related effects on domain-specific and domain-general neural network interactions in semantic cognition*

Speech-Language Pathologist

2015–2017

Median Klinik Berlin Kladow, Clinic for neurological rehabilitation

Research Intern

2014–2015

NeuroCure Clinical Research Center, Charité Berlin

Student Assistant

2012–2013

Center for Language and Cognition, University of Groningen, The Netherlands

EDUCATION

Dr. rer. med. in Cognitive Neuroscience (PhD)

2018–2023

Medical Faculty, Leipzig University

Supervisors: Prof. Dr. Gesa Hartwigsen & Prof. Dr. Dorothee Saur

Thesis title: *The aging brain in semantic cognition—Insights from fMRI and TMS*

Grade: *Magna cum laude*, Award date: 19/09/2023

M.Sc. in Neuro- and Clinical Linguistics

2012–2014

University of Potsdam, Germany, & University of Groningen, Netherlands

Thesis title: *Improving communication in aphasia: A comparison of naming- and discourse-based treatment, both facilitated by transcranial direct current stimulation*

Grade: Excellent (1.1)

B.A. in Linguistics

2007–2012

Humboldt-Universität zu Berlin, Germany

Grade: Excellent (1.3)

2009 – 2010 Erasmus exchange student at Université Aix-Marseille, France

HONORS & AWARDS

Travel award

02/2025

Dallas Aging and Cognition Conference (DACC)

Poster prize

06/2023

Psychologie und Gehirn (PuG)

PhD fellowship (80,000 €)

2018–2022

German Academic Scholarship Foundation (Studienstiftung des deutschen Volkes)

Full stipend for graduate program

Poster prize

11/2020

Meeting of the German Society for Clinical Neurophysiology and Functional Imaging (DGKN)

First prize at Science Slam

02/2019

20th Annual Meeting of the German Association of Speech-Language Therapy

Travel grant (1,500 €)

2014

Erasmus Mundus program

Erasmus Mundus stipend (24,000 €)
Erasmus Mundus Program European Union
Full stipend for Master's studies

2012–2014

DAAD PROMOS stipend (2,000 €)
German Academic Exchange Service

2011

GRANTS & PROPOSALS

Marie Skłodowska-Curie Postdoctoral Fellowship submitted 09/2025
Applicant and main PI; full proposal submitted to Horizon Europe MSCA-PF2025 call.
Project on predictive dynamics in language comprehension across the adult lifespan (PREDYNA-AGE).

DFG Collaborative Research Centre (SFB) in preparation
Co-applicant / contributing PI on project module on computational models of language–brain mappings; proposal currently in development for DFG SFB submission.

MENTORING & SUPERVISION

Co-Supervision of doctoral researchers

Merle Schuckart (PhD Psychology University of Lübeck, 2022-present), Laura Nieberlein (PhD Psychology Leipzig University, 2021-present), Matteo Ferrante (PhD Psychology Leipzig University, 2022-present)

Master thesis

Alina Leiss (M.Sc., 2025-present, Leipzig University), Yulia Guseva (M.Sc., 2024-2025, Mind & Brain, Humboldt University Berlin), Flavia Ercoli (M.Sc., 2024-2025, University of Amsterdam), Pia Siegel (M.Sc., 2023-2024, Leipzig University), Katharina Polsterer (M. A., 2022, University of Groningen), Regine Frieling (M. A., 2021, University of Cologne)

Interns / Student assistants

Niklas Kröner-Weigl (Doctoral student, Max Planck School of Cognition), Johannes Kim (M.Sc., 2025, Maastricht University), Jim Krups (M.Sc., 2025, Leipzig University), Alina Leiss (M.Sc., 2025, Leipzig University), Lena Radach (M.Sc., 2024, University of Göttingen), Hanna Weigand (B.Sc., 2024, University of Würzburg), Christian Koblitz (M. Sc., 2023, Leipzig University), Marcel Blumenthal (M. Sc., 2023, Leipzig University), Madeleine Mesgarian (B. Sc., 2023, Freie Universität Berlin), Caroline Duchow (M. A., 2019, University of Erfurt), Annika Dunau (M. A., 2018, Leipzig University)

TEACHING

Introduction to Advanced Statistical Modeling 05/2025, 04/2024, 04/2023
MA block seminar on Linear and Non-linear mixed-effects regression, Department of Psychology, Ghent University, Belgium

Seminar Perception and Action since Winter 23/24 every semester
MA program Brain & Behavior, Wilhelm Wundt Institute of Psychology, Leipzig University

Language and Aging 05/2023
Guest lecture IMPRS graduate school NeuroCom, Leipzig, Germany

Workshop: Introduction to Data Analysis in Cognitive Neuroscience 10/2022
Master's program Cognitive Neuroscience, University of Amsterdam

Workshop: Data analysis with R 06/2021
Summer School, German Association of Speech-Language Therapy. I built an R package for the workshop: gitlab.gwdg.de/sandra.martin/r-workshop-summer-school-2021

Workshop: Aphasia as a network disorder—Implications for speech-language therapy 10/2019
German Society for Aphasia Research

Slides for selected lectures and workshops are available on my OSF site:  osf.io/hvzu2/

PUBLICATIONS

- [11] Feng, Z.*, **Martin, S.***, Numssen, O., Weise, K., Jing, Y., Gerardos, G., Martin, C., Hartwigsen, G., & Knösche, T. (accepted at *Translational Psychiatry*). Target-specificity and repeatability in neurocardiac-guided TMS for heart-brain coupling. *Preprint* doi:10.1101/2025.02.19.638988
- [10] Schuckart, M.*, **Martin, S.***, Tune, S., Schmitt, L.-M., Hartwigsen, G., & Obleser, J. (2025). Executive resources shape the effects of language predictability across the adult lifespan. *eLife*, 14. doi:doi.org/10.7554/eLife.108176.1
- [9] **Martin, S.***, Ferrante, M.* Bruera, A., & Hartwigsen, G. (2025). Causal contributions of left inferior and medial frontal cortex to semantic and executive control. *Communications Biology*, 8(1), 1343. doi:10.1038/s42003-025-08848-5
- [8] Nieberlein, L., **Martin, S.**, Williams, K. A., Gussew, A., Cyriaks, S. D., Scheer, M., Rampp, S., Prell, J., & Hartwigsen, G. (2024). Semantic integration demands modulate large-scale network interactions in the brain. *Human Brain Mapping*, 45(18), e70113. doi:10.1002/hbm.70113
- [7] **Martin, S.** & Hartwigsen, G. (2024). The dynamics of neuroplasticity in the recovery from post-stroke aphasia: Commentary on Billot and Kiran. *Brain & Language*, 258, 105479. doi:10.1016/j.bandl.2024.105479
- [6] Numssen, O., **Martin, S.**, Williams, K., Knösche, T., & Hartwigsen, G. (2024). Quantification of subject motion during TMS via pulsewise coil displacement. *Brain Stimulation*, 17(5), 1045-1047. doi:10.1016/j.brs.2024.08.009
- [5] **Martin, S.**, Frieling, R., Saur, D., & Hartwigsen, G. (2023). TMS over the pre-SMA enhances semantic cognition via remote network effects on task-based activity and connectivity. *Brain Stimulation*, 16(5), 1346-1357. doi:10.1016/j.brs.2023.09.009
- [4] **Martin, S.**, Williams, K., Saur, D., & Hartwigsen, G. (2023). Age-related reorganization of functional network architecture in semantic cognition. *Cerebral Cortex*, 33(8), 4886-4903. doi:10.1093/cercor/bhac387
- [3] Kuhnke, P., Chapman, C., Cheung, V., Turker, S., Graessner, A., **Martin, S.**, Williams, K., & Hartwigsen, G. (2022). The role of the angular gyrus in semantic cognition: A synthesis of five functional neuroimaging studies. *Brain Structure and Function*, 228, 273–291. doi:10.1007/s00429-022-02493-y
- [2] **Martin, S.**, Saur, D., & Hartwigsen, G. (2022). Age-dependent contribution of domain-general networks to semantic cognition. *Cerebral Cortex*, 32(4), 870–890. doi:10.1093/cercor/bhab252
- [1] Darkow, R., **Martin, S.**, Burchert, F., Meinzer, M., & Flöel, A. (2015). Effects of tDCS on spontaneous speech in aphasia: A study of naming and discourse treatment [in German]. *Sprache, Stimme, Gehör*, 39, 140-145. doi:10.1055/s-0035-1559656

BOOK CHAPTERS

Martin, S. & Hartwigsen, G. (2025). Semantic and syntactic networks in the brain. In: Sidiropoulos, K. (eds) *Transcranial Electrical Stimulation in Aphasia and Acquired Language Disorders*. Springer, Berlin, Heidelberg. doi:10.1007/978-3-662-70454-7_7

Hartwigsen, G. & **Martin, S.** (2025). Plasticity and reorganisation in the language network after stroke. In: Sidiropoulos, K. (eds) *Transcranial Electrical Stimulation in Aphasia and Acquired Language Disorders*. Springer, Berlin, Heidelberg. doi:10.1007/978-3-662-70454-7_10

TALKS

About my research

Language Testing and Brain Surgery Lab, University of Groningen 12/2025
How executive functions shape language processing across the adult lifespan (Invited)

Berlin Neuroscience Meeting 10/2025
The interplay of semantic memory and executive functions across the adult lifespan: Multimodal perspectives

Dynamics of Brain and Language Lab, Geneva University Neurocenter	07/2025
<i>Executive control in language processing across the adult lifespan: Multimodal perspectives</i>	
Institute Colloquium, Max Planck Institute for Human Cognitive and Brain Sciences	02/2025
<i>The interplay of semantic memory and executive functions across the adult lifespan: Multimodal perspectives</i>	
Cognitive Aging Lab, University of Geneva	01/2025
<i>The interplay of semantic memory and executive functions across the adult lifespan: Multimodal perspectives (Invited)</i>	
German Society for Aphasia Rehabilitation (GAB)	10/2024
<i>The neural basis of semantic control: A voxel-based study in chronic aphasia</i>	
Psychologie und Gehirn (PuG)	05/2024
<i>Beyond motor effects: Repetitive TMS in cognitive control and the impact of protocol selection</i>	
Symposium on individualized TMS in cognition (chair)	
German Society for Neurorehabilitation (DGNR)	12/2023
<i>Functional interactions and plasticity in the language network—Insights from young and aging brains</i>	
Symposium on neurorehabilitation, plasticity, and learning	
Korea Institute for Advanced Study (KIAS)	11/2022
Center for Artificial Intelligence and Natural Sciences	
<i>The aging brain in semantic cognition—Insights from fMRI and TMS</i> (Invited)	
Würzburger Aphasietage	03/2022
Aphasia as neural network disorder	
German Association of Speech-Language Therapy (dbs e.V.)	11/2021
<i>Non-invasive brain stimulation techniques in language rehabilitation</i>	
Psychologie und Gehirn (PuG)	06/2021
<i>The role of domain-general networks in semantic processing in the young and the aging brain</i>	
Symposium "Cognition and plasticity in the aging brain" (chair)	
German Academic Scholarship Foundation	03/2021
<i>Domain-general networks in semantic processing in the aging brain</i>	
Annual meeting for doctoral students of the German Academic Scholarship Foundation (Studiens-tiftung des deutschen Volkes).	
Clinic Christophsbad, Göppingen, Germany	04/2019
<i>The application of non-invasive brain stimulation techniques in neurorehabilitation</i> (Invited)	
German Society for Aphasia Rehabilitation (GAB)	11/2014
<i>Expressing your own intentions with aphasia: A comparison of a naming and a discourse treatment, both enhanced by transcranial direct current stimulation</i>	
About Open Science	
Colloquium at MPI for Human Cognitive and Brain Sciences	01/2022
<i>Advancing the responsible conduct of research at the MPI CBS</i>	
Invited talk to present a recommendations paper I wrote together with other researchers from MPI CBS (available here: osf.io/9n2at/)	
Research Interactions Symposium by Wiley	06/2021
<i>Trust in science: How early career researchers benefit from open and transparent research practices</i>	
Invited talk at symposium organized by Wiley.	

Slides for selected talks are available on my OSF site:  osf.io/hvzu2/

CONFERENCE PROCEEDINGS & POSTERS (SELECTED)

- Martin, S.**, Schuckart, M., Obleser, J., & Hartwigsen, G. 04/2025
Robust predictive mechanisms in aging: Insights from behavioral and neuroimaging research, Cognitive Neuroscience Society, Boston, USA
- Martin, S.**, Schuckart, M., Obleser, J., & Hartwigsen, G. 02/2025
Robust predictive mechanisms in aging: Insights from behavioral and neuroimaging research, Dallas Aging and Cognition Conference, Dallas, USA
- Martin, S.**, Kuhnke, P., Chapman, C., & Hartwigsen, G. 06/2024
Aging effects on task-based activity and functional networks during semantic processing and rest, OHBM, Seoul, South Korea
- Numsseen, O., **Martin, S.**, Williams, K., Knösche, T., & Hartwigsen, G. 06/2024
A quality metric to assess pulsewise coil displacements during TMS, OHBM, Seoul, South Korea
- Schuckart, M., **Martin, S.**, Tune, S., Schmitt, L.-M., Hartwigsen, G., & Obleser, J. 06/2024
No free lunch in language prediction – Limitation of cognitive resources reduces the impact of surprisal at multiple time scales, HörHanse, Lübeck, Germany
- Ferrante, M., **Martin, S.**, & Hartwigsen, G. 10/2023
Probing the functional relevance of pre-SMA and aIFG for controlled semantic processing with transcranial magnetic stimulation, Society for the Neurobiology of Language (SNL), Marseille, France
- Martin, S.**, Schuckart, M., Obleser, J., & Hartwigsen, G. 10/2023
The impact of domain-general cognitive load on language processing in the aging brain, Society for the Neurobiology of Language (SNL), Marseille, France
- Schuckart, M., Tune, S., Schmitt, L.-M., Hartwigsen, G., **Martin, S.**, & Obleser, J. 07/2023
No free lunch in language prediction – Limitation of cognitive resources reduces the impact of surprisal at multiple time scales, Salzburg Mind and Brain Annual Meeting, Salzburg, Austria
- Martin, S.**, Frieling, R., Saur, D., & Hartwigsen, G. 06/2023
Facilitatory stimulation of the pre-SMA enhances semantic cognition via remote network effects in task-based activity and connectivity, selected for poster flash session with additional talk. Psychologie und Gehirn (PuG), Tübingen, Germany
- Martin, S.**, Frieling, R., Saur, D., & Hartwigsen, G. 03/2023
Facilitatory stimulation of the pre-SMA has distinct effects on task-based activity and connectivity networks in healthy aging, selected as "hot abstract" with talk. Congress for Clinical Neuroscience (DGKN), Hamburg, Germany, Clinical Neurophysiology 148:e5-e6
- Martin, S.**, Frieling, R., Saur, D., & Hartwigsen, G. 02/2023
Facilitatory stimulation of the pre-SMA has distinct effects on task-based activity and connectivity, Brain Stimulation, Lisbon, Portugal
- Martin, S.**, Saur, D., & Hartwigsen, G. 06/2021
Age-dependent contribution of domain-general networks to semantic cognition, OHBM, virtual edition
- Martin, S.**, Saur, D., & Hartwigsen, G. 11/2020
The multiple-demand network in language processing of the young and the aging brain, Congress for Clinical Neuroscience (DGKN), virtual edition, Clinical Neurophysiology 131:e201-e202
- van Scherpenberg, C., **Martin, S.**, Hartwigsen, G., Obrig, H., & Beese, C. 09/2019
Age-related decline of semantic inhibition despite the preservation of semantic memory, PaePsy, Leipzig, Germany
- Martin, S.**, Saur, D., & Hartwigsen, G. 08/2019
The multiple-demand network in language processing: Its role in the aging brain, Society for the Neurobiology of Language (SNL), Helsinki, Finland
- Martin, S.**, Darkow, R., Burcher, F., Meinzer, M., & Flöel, A. 09/2014

Improving communication in aphasia: A comparison of naming- and discourse based treatment, both facilitated by transcranial direct current stimulation (tDCS), Science of Aphasia, Venice, Italy

Darkow, R., Meinzer, M., **Martin, S.**, Würtz, A. & Flöel, A.

12/2013

Transcranial direct current stimulation and aphasia, German Society for Neurorehabilitation, Berlin, Germany

OPEN SCIENCE

fMRI Preregistration template

2021

Co-author of widely used template doi:10.23668/psycharchives.5121

Panelist at discussion on Research Data Management, Max Planck Digital Library

05/2021

Open Access Ambassador of the Max Planck Society

2019-2020

Doing Good – Scientific Practice under Review

11/2019

Organizer of a 2-day symposium on Open Science and Good Scientific Practice at MPI CBS, Leipzig

Open Science Initiative MPI CBS

since 2018

Co-founder of the initiative

OUTREACH

- *Long Night of Sciences Leipzig*, Tour of TMS lab 2025, 2024, 2023

- Workshop "Introduction to Programming in Neuroscience" at *Girls' and Boys' Day* 2022, 2023

- Article about my research at MDR Wissen (in German), 09/2021: Link to article

- Co-author on the *Blog Thinky & Brain*, 08/2020: Link to article

- Guest at the *Orion Open Science Podcast*, 11/2019: Link to episode

ACADEMIC SERVICE

Ad-hoc-reviewing	Brain, Brain Communications, Brain & Language, Cerebral Cortex, Frontiers in Psychology, Imaging Neuroscience, Journal of Neuroscience, Journal of Gerontology, Nature Human Behaviour, NeuroImage, NeuroImage Clinical
Professional memberships	Society for the Neurobiology of Language (SNL), Cognitive Neuroscience Society (CNS), Organization for Human Brain Mapping (OHBMM)