Leonardo Cerliani, PhD

Neuroimaging researcher in brain connectivity (github)

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Professional Summary

2020 - 2021	Researcher in Neuroimaging: cortical layer-specific fMRI Netherlands Institute for Neuroscience, Amsterdam
2019 - 2020	Researcher in Neuroimaging for Sensory Processing Dept. of Psychology, University of Amsterdam
2018 - 2019	Researcher in Neuroimaging for Neuropsychiatry Dept. of Psychiatry, Academisch Medisch Centrum Amsterdam
2018	Project Engineer for Vertical Farming and ETL Developer A Lab Vertical Farm and Leaseplan Bank, Amsterdam
2017	Neuroimaging Software Development in Python Max Planck Institute for Human Cognitive and Brain Sciences
2014 - 2017	Researcher in Comparative Brain Connectivity Brain and Spine Insitute (ICM), Hôpital Pitié-Salpêtrière, Paris
2012 - 2014	Postdoctoral Fellow in Neuroimaging for Neuropsychiatry Netherlands Institute for Neuroscience, Amsterdam
2007 - 2012	Postdoctoral Fellow in Neuroimaging for Neuroanatomy University Medical Center Groningen

Education

PhD in Cognitive Science
2006 - University of Torino

Internships in Neuroimaging
2005 U. of Chicago Medical Center
2006 Neurological Institute Besta

M.A. in Philosophy
with courses in Neuroanatomy, Neuropsychology, Cognitive Science
2002 University of Torino

Publications

Updated 8 March 2023

32 peer-reviewed publications, of which
9 as first or senior author, 2070 citations, h-index = 21

Full list available here Selected papers below.

Data Analysis

- Resting-state and task-based fMRI, ICA, PPI, Functional connectivity, Clustering, Gradient analysis, layer-specific fMRI, tractography (*in vivo* and *post mortem*)
- Parametric and nonparametric inferential Statistics
- Multivariate: Clustering, PCA, ICA, t-SNE, UMAP, Laplacian Eigenmaps

Neuroimaging experience

- 3D, 4D Image preprocessing, segmentation, registration, analysis
- Expert user of: FSL, Caret, Mango
- Image Modalities: fMRI task-based and resting-state, structural (T1w) MRI, diffusion-weighted imaging
- Experience with large MRI datasets and parallel processing on computer clusters

Coding environments

Matlab, R and R/Shiny, Python, Bash scripting

Awards

- 2017 - International Neuroinformatics Coordinating Facility Grant for Brain Parcellation Software Development
- 2015 - Brain Award for Scientific Excellence, by the Royal Dutch Academy for Arts and Sciences

Languages Italian (native), English (fluent), French (fluent), Dutch (fair)

Research Highlights

- Pioneered the use of Laplacian Eigenmaps to the show gradients of connectivity in the Insula (Cerliani L. et al. 2012)
- Discovered increased directional subcortico-cortical interaction in Autism Spectrum Disorder (Cerliani et al. 2015, Lorenzini et al. 2021)
- Devised an original method based on Tensor ICA and repeated clustering to detect interindividual differences in fMRI data of language production (Cerliani et al. 2017)

Research interests

- Paradigms and methods for connectional neuroimaging
- Connectional neuroanatomy of the insular region
- Network-level signatures of Autism
- Comparative Neuroanatomy

References

- Prof. Marco Catani, NatBrainLab, King's College, London, *marco.1.catani@gmail.com*
- Prof. Michel Thiebaut de Schotten, Brain and Spine Institute, Paris *michel.thiebaut@gmail.com*
- Prof. Christian Keysers - Netherlands Institute for Neuroscience *c.keysers@nin.knaw.nl*
- Prof. Danierl Margulies - Paris Brain Institute, Leipzig, *daniel.margulies@cnrs.fr*
- Dr. Alberto Bizzi - Neurological Institute Besta, Milan, *alberto_bizzi@fastwebnet.it*

First and last author publications

Full list of publications available here

Cerliani L, Bhandari R, De Angelis L, van der Zwaag W, Bazin P-L., Gazzola V, Keysers C, (*2022*) Predictive coding during action observation - a depth-resolved intersubject functional connectivity study at 7T. Cortex 148:121:138.

Lorenzini L, van Wingen G, **Cerliani L** *(2021)* Atypically high influence of subcortical activity on primary sensory regions in autism. NeuroImage Clinical 32:102839.

Cerliani L, Rouw R (2020) *Increased orbitofrontal connectivity in misophonia.* bioRXiv*****

Cerliani L, D'Arceuil H, Thiebaut de Schotten M. (2017) Connectivity-based parcellation of the macaque frontal cortex, and its relation with the cytoarchitectonic distribution described in current atlases. Brain Structure and Function 222(3):1331-1349

Cerliani L, Aquino D, Contarino V, Bizzi A. (2017) *Disentangling subgroups of participants using different cognitive strategies to perform the verb generation task: a data-driven fMRI study*. Cortex 86:247-259

Cerliani L, Thomas RM, Thioux M, Mennes M, Keysers C. (2015) *Increased functional connectivity between subcortical and cortical resting-state networks in Autism*. JAMA Psychiatry 72(8):767-777

Metting Z*, **Cerliani L***, Rödiger LA, van der Naalt J. (2013) *Pathophysiological concepts in mild traumatic brain injury: diffusion tensor imaging related to acute perfusion CT imaging.* PLoS O§ne, 8(5):e64461. **equal contribution*

Nieuwenhuys R, Broere CAJ, **Cerliani L**. (2014) *A new myeloarchitectonic map of the human neocortex based on data from the Vogt-Vogt school*. Brain Structure and function, 220(6):3753-5

Cerliani L, Thomas RM, Jbabdi S, Siero JCW, Nanetti L, Crippa A, Gazzola V, D'Arceuil H, and Keysers C. (2012) *Probabilistic tractography recovers a rostrocaudal trajectory of connectivity variability in the human insular cortex.* Human Brain Mapping, 33(9):2005-34

** this project could not further advance due to reasons independent from the first author.*

Projects

Cortical layer-specific fMRI (Amsterdam, NL: nov 2020 - nov 2021)

Even simple behaviours require the interaction between many different regions of the cerebral cortex. Each cortical region has input and output channels in different cortical layers: layers II and IV "listen" to the incoming information from other regions, while layers III and IV "speak" with other cortical regions.

To understand how behaviour emerges from brain activity, we need to know not only which brain regions are particularly busy during that behaviour, but also how they interact with each other, that is, who is speaking and who is listening.

Only in recent times ultra-high field (7T) magnetic resonance imaging (MRI) made it possible to acquire images which reflect brain activity in different layers of the cortex. Because of the very high spatial resolution of these images, with respect to conventional low-resolution MRI, the entire analytic strategy has to be re-though from

scratch. However, this approach has the potential to deliver the first anatomically-informed neuroimaging instrument to examine directional brain connectivity.

In the present project, we expose participants to movies depicting either predictable or unpredictable actions, and we measure brain activity in the posterior parietal lobe, which is known to be involved in action prediction. We expect that predictable actions will elicit higher activity in output channels directed to the frontal lobe, while unpredictable movies will elicit higher activity in input channel from the frontal lobe and the occipito-temporal cortex.

Directional influence of subcortical over cortical regions in Autism (Amsterdam, NL: feb 2019 - may 2021)

We previously demonstrated a robust effect of atypical hyperconnectivity between subcortical nuclei (thalamus and basal ganglia) and primary sensory regions in Autism. However, the directionality of this effect was left undecided by the nature of the functional connectivity methods used. In the present study, we investigated the directional connectivity between these regions during development. We found a strong evidence in support of a delayed segregation between subcortical and cortical regions in Autism, related to the persistent atypical influence of subcortical processes on primary sensory regions. This finding supports the hypothesis that in Autism an excessive amount of unwanted and unprocesses sensory information reaches the cortex, which is likely impacting cognitive functioning in everyday situations where it is beneficial to limit the influence of basic sensory information on cognitive processing, such as activities focused attention or social interactions.

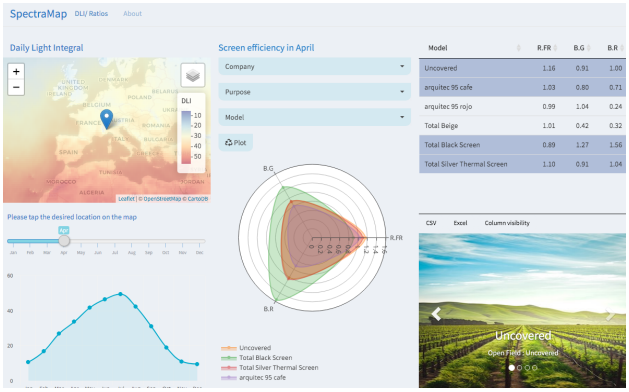
Neuroimaging of Misophonia (Amsterdam, NL: nov 2019 - nov 2020)

I analyzed a dataset of diffusion-weighted and task-based fMRI data from a sample of 20 people with misophonia and 20 matched control participants. Misophonia is a condition leading to a disproportionate emotional reaction to specific auditory stimuli of otherwise normal intensity - e.g. sound of eating an apple.

I carried out a voxelwise analysis of microstructural indicators (FA,MD), differences in whole-brain probabilistic tractography, standard GLM and Psychophysiological interaction. I then wrote the methods and results parts of the tractography paper and the entire paper on fMRI data, soon to be submitted.

Data analysis and Web app development for Agriculture (Amsterdam, NL / Helsinki, FI: mid-2018 - oct 2019)

In collaboration with dr. Titta Kotilainen (luke.fi) and Prof. Matthew Robson (U. of Helsinki) I developed a web app in R/Shiny to model the impact of different plant-covering materials on the available light spectrum, according to the location and month of the year. The modelling is based on NASA historical remote sensing for AOD500nm, ozone, precipitable water in the last 10-20 years. In addition, the app provides Daily Light Integral calculations based on satellite images of surface incoming shortwave radiation, a quantity which is useful to estimate the amount of photosyntetically active light available in different periods of the year and for different locations in the world. More information and the app are available at this link.



Preprocessing of imaging and phenotypical data from the UK BioBank for deep learning analysis in Psychiatry - Amsterdam Medical Center, Dept. of Psychiatry (Amsterdam, NL: dec 2018 - sep 2019)

We are developing deep neural networks model mostly aimed at diagnosis prediction based on MRI data. In the first months I completed the following steps:

- Preprocessing the ABIDE I+II resting state fMRI and anatomical data
- Developed a Multi Layer Perceptron to classify people with Autism. Current CV accuracy: ~68%
- Complete a study on Autism diagnosis prediction using a 1D convolutional neural network on rs-fMRI time courses. Final accuracy ~68.5%. Paper accepted for oral presentation in the 2019 IJCNN conference in Budapest, Hungary, in June 2019.
- Developed a classification pipeline to determine people with probable Current, Remitted, Lifetime Depression, based on demographic and behavioural report.

Project Engineer - A Lab Vertical Farm (Amsterdam, NL: 2018 - 2019)

Besides preparing the remote sensing system for the Vertical Farm and volunteering in the farm, I developed a data management system in Javascript using Google Apps. With this system, the volunteers can use their phone to initiate, monitor and update crop batch activities such as sowing, germination, transplantation and harvesting using their own phone. The system can be accessed at http://bit.ly/farmV3production

ETL for financial accounting at LeasePlan Bank - NextGen Metrics B.V. (Amsterdam, NL : November 2017 - April 2018)

In a team of two, we developed a complete ETL system of financial data for accounting purposes using IBM Datastage.

- We designed the hierarchy of jobs needed to automatically ingest the data and control the process flow
- I was designed the Datastage Jobs (i.e. workflows) from beginning to end, test them and write the documentation for the entire system

Software development for Neuroimaging analysis - Max Planck Institute for Human Cognitive and Brain Sciences (Leipzig, DE : April - June 2017)

I developed a CLI software to perform preprocessing and time-course correlation analysis of MRI functional medical images to detect patterns in high-dimensional brain connectivity matrices. The software enables researcher and clinician to perform connectivity-based brain parcellation.

- Implemented the data engine to comply with FSL software - the field standard - to estimate anatomical brain connectivity. Data injection was optimized using Pandas to cope with datafiles of ~1GB size.
- Designed the computational engine using NumPy for matrix manipulation and Scikit-Learn for K-means clustering implementation.

- Implemented the Principal Components Analysis based on standard NumPy eigen decomposition and tested against SPSS results for compliance.
- The software was designed in a modular way to easily allow the integration of other dimensionality reduction methods besides K-means and PCA

Research on data-driven detection of intersubjective variability from functional MRI data - Brain and Spine Institute (Paris, FR - September 2016 - April 2017)

I devised an original data analysis procedure to identify different patterns of brain activity during a language production task, in absence of behavioural differences. This study represented a benchmark to develop analytical strategies to assess the probability of language recovery after brain accident.

- Conceived the methodology starting from the results of Independent Component Analysis (ICA) of functional MRI data using FSL
- Implemented the methodology using repeated k-means clustering in Matlab and Python, and used it for data analysis
- Wrote and published the results as first author on an International Peer-Reviewed Journal (Cortex).

Research on Connectivity-based clustering of the frontal lobe in high-resolution *post-mortem* Magnetic Resonance Images

I carried out an MRI data analysis aimed at estimating the amount of regions in the frontal lobe which are relatively segregated from each other with respect to their connectivity with the rest of the brain. Besides the research value, this work was aimed at establishing a novel method for connectivity-based brain parcellation, testing against previous methods, and producing the code for further use in related studies.

- I devised an original spatial alignment procedure of the brain images due to their peculiar nature (i.e. *post mortem*)
- I developed the code in Matlab to integrate the results derived from the PCA analysis performed in SPSS, and perform further analysis on intersubjective variability and description of whole-brain connectivity
- I wrote the manuscript and published it on an International Peer-Reviewed Journal (Brain Structure and Function).

Data preprocessing and analysis of large databases of 1000+ MRI medical images - Netherlands Institute for Neuroscience (Amsterdam, NL : November 2012 - May 2014)

We developed an analytic technique to assess the interaction between brain networks in functional MRI images of the brain based on probabilistic ICA, and to compare the results in participants with and without a diagnosis of Autism. I published the results as first author in JAMA Psychiatry (I.F. 15.307 - ranked #3 worldwide for Psychiatry Journals).

- Developed the hypotheses for the study, envisioned the analytical strategy, wrote Matlab code to perform the analyses and the final published report.

- Performed Quality Control on the acquired Magnetic Resonance Images and aggregated them in the first large-scale (~1100 datasets) Autism neuroimaging database (ABIDE) as the only site in The Netherlands.
- Designed bash code based on the FSL software library to perform parallel computation on remote computer clusters (Zernike) and local 90-cores machine.
- Performed Exploratory Data Analysis in Matlab and implemented a meta-ICA procedure to reduce the noise in the data and capitalize on the reproducibility of the results in a resampling scheme.
- Designed a command-line interface for the FSL 'randomise' software to perform inferential statistics in a nonparametric permutation fashion based on the General Linear Model from the Matlab interface.

Diffusion-Weighted Imaging platform developer and Brain Connectivity Analysis Specialist - Brain Imaging Center, University Medical Center Groningen (May 2007 - May 2012)

I was in charge of setting up the research line on Diffusion-Weighted MRI end-to-end - image acquisition settings, preprocessing pipeline, analytical methods - and to provide training and consultancy in this field for other researchers and students in my Centre.

- Responsible for the initial setup of the methodology in the Brain Imaging Center and the group for Brain Connectivity Analysis in my Lab.
- Designed the parameter set for high angular resolution acquisition of Diffusion-Weighted MR images, optimized for image quality and acquisition time.
- Provided workshops and carried out extensive training in MR image preprocessing, fiber tractography and microstructural integrity quantification for researchers, PhD and Master students using FSL and Matlab.
- Performed extensive quality control of the acquired images and provided consultancy for resolving acquisition problems.
- Provided consultancy for brain connectivity analysis and works co-authoring in the Research Centre for the entire period.
- Supervised and trained 4 Master and PhD student candidates in neuroimaging data analysis and coding in Matlab and Bash.

Research on Structures of Connectivity in the Human Brain - Brain Imaging Center, University Medical Center Groningen (May 2007 - May 2012)

My task was to perform research and publish reports in international peer-reviewed journals on open questions at my choice regarding anatomical brain connectivity using MRI data.

- Autonomously developed experimental hypoteses starting from the relevant literature.
- Performed the experiments and the image analysis using FSL and Caret. Developed the code for connectivity analysis in Matlab.
- Developed new analytical strategies for dimensionality-reduction of brain anatomical connectivity data, and pioneered the use of nonlinear dimensionality reduction (Laplacian Eigenmaps, implemented in Matlab) in this research line.
- Responsible for preparing the journal reports and supervising other researchers in the same process. The research line led to 6 publication in International Peer-Reviewed journals (Neuroimage, Human Brain Mapping, PLoS One, Brain Structure and Function).

Ultrasound recording and data analysis - Brain Imaging Center, University Medical Center Groningen (May 2007 - May 2012)

I was responsible for setting up from scratch the instruments and the quantitative analysis of rodents ultrasound generation in the context of a larger experiment.

- Selected, acquired, installed and tested the instrumentation for ultrasound recording and ultrasound reproduction.
- Performed power spectrum analysis and visualization of the ultrasonic calls.
- Wrote the technical and in general relevant parts of the published manuscript (PLoS One).
- Trained other researchers in using the experimental setting and troubleshooting the problems.