Dr Petra Vértes – *Curriculum Vitae*

University of Cambridge, UK   **Email:** pv226@cam.ac.uk

The aim of my research is to uncover the neurobiological basis of complex psychiatric disorders which have a developmental component, such as depression and schizophrenia. To this end, I use computational methods and concepts from physics and network science to integrate insights across multiple scales and modalities, from behaviour and large-scale brain organization, down to the cellular, molecular, and genetic level. I collaborate widely and work with a range of multivariate data, with a focus on neuroimaging, genetic and transcriptomic data, as well as connectomic data across scales and species – from the human brain to the C. elegans nervous system.

Website: https://www.psychiatry.cam.ac.uk/groups/systems-and-computational-neuroscience-group/

Employment

2023 - Present Professor, Department of Psychiatry, University of Cambridge
2019 - 23 Assistant Professor, Department of Psychiatry, University of Cambridge
2018 - 19 Lecturer and PI, School of Mathematical Sciences, Queen Mary University of London
2018 - 18 Senior Research Associate, Department of Psychiatry, University of Cambridge
2014 - 18 MRC Fellow in Bioinformatics, Department of Psychiatry, University of Cambridge
2010 - 14 Research Associate, Department of Psychiatry, University of Cambridge

Education

2006 - 10 PhD, Theoretical Physics, University of Cambridge
2002 - 06 MSci, Theoretical Physics, University of Cambridge. Grade: 1st
2001 - 02 Université Libre de Bruxelles, Belgium. Grade: 1st. Completed the first year of an undergraduate degree in Physics (to reach 18 years of age after skipping a school year).

Other Appointments

2024 - Present EBRAINS 2.0 Advisory Board
2023 - Present Advisory Board member, British Chapter of NetSci network science society
2023 - Present Trinity College Dublin Institute of Neuroscience, Scientific Advisory Board
2022 - Present EBRAINS Science and Technology Committee member
2022 - Present Cambridge Neuroscience Steering Committee member
2020 - Present Visiting Researcher, Laboratory of Molecular Biology, Cambridge
2019 - Present Editorial Board Member of the Journal of Physics: Complexity
2018 - Present Associate Editor of the journal Network Neuroscience (MIT Press)
2018 - Present Fellow of the MQ mental health charity
2018 - 21 Turing Fellow, Alan Turing Institute, London
2014 - Present Member of the Center for Science and Policy (CSaP), Cambridge, UK
2012 - 16 Wolfson College Research Associate
2012 - Present Co-founder and organiser of Cambridge Networks Network
2011 - Present Reviewer for Cambridge University Press (publisher of academic books), and for 19 scientific journals including Science, Brain, Neuron, PNAS, Trends in Cognitive Sciences, Biological Psychiatry, Journal of Neuroscience, Cerebral Cortex, etc.

Awards and Prizes

2024 Nominated for Francis Crick Medal and for Erdős Rényi Prize – outcome pending
2021 Selected in top 5 candidates for the Universal Scientific Education and Research Network (USERN) prize but didn't submit final materials due to pandemic and in-person attendance
2016 Awarded the Top 100 Global Thinkers award, Foreign Policy Magazine
2010 Selected to attend the Lindau Nobel Laureate Meeting
2010 Selected to present my work in the House of Commons at the SET for Britain event
2009 Abdus Salam Prize for best graduate-level research in the Cavendish Laboratory
2006 European Science, Engineering & Technology (SET) Award for Computational Science
2003 & 2006 Awarded Trinity Hall College prize

Research Funding

10/2023 - 10/2027 John Templeton Foundation – £1,100,000 (Under review, Co-PI)
  "Brain Network Development Under Adversity"
05/2023 - 06/2024 Centre for Integrative Neuroscience Discovery– £50,000 (PI)
  "Developing neuroinformatic phenotypes for human cerebral organoid models of neurodevelopmental disorders"
09/2022 - 11/2022 Cambridge Biomedical Research Centre – £15,000 (PI)
  "Neuroinformatic Consequences of MECP2 Deficiency in Models of Rett Syndrome"
10/2020 - 03/2022 The Alan Turing Institute – £125,000 (co-PI)
  "Towards Incoherent Speech as a Predictor of Psychosis Risk"
03/2018 - 05/2023 MQ Transforming Mental Health Charity – £225,000 (PI)
  "Genetic and Genomic Drivers of Network Phenotypes in Health and Disease"
02/2014 - 02/2018 Medical Research Council – £280,000 (PI)
  "Modelling the Development of Complex Brain Networks"

Recent Invited Talks (selected from over 60 talks)

2024 NetSci Colloquium (online)
2022 Organisation of Human Brain Mapping Educational Workshop (Glasgow)
2022 Cambridge Neuroscience Interdisciplinary Seminar (Cambridge, online)
2021 FLUX Congress (international conference, online)
2021 Conference for Complex Systems (Lyon, online)
2021 Tomography, Neuroscience and Image Reconstruction (Milano, online)
2021 Leeds Applied Nonlinear Dynamics (Leeds, online)
2021 Turing Center for Living Systems (Marseilles, online)
2021 MQ Science Summit (London, online)
2020 Organisation of Human Brain Mapping (Montreal, online)
2020 NetSci (Rome/online)

Organisation and Fundraising for Scientific Meetings and Fora

Ongoing organizational roles
2021 - Present Co-organise the fortnightly seminar series "Making Connections: The Brain and Other Complex Systems" (held online, ~250 subscribers to mailing list).
2020 - Present Co-organise a seminar series on topics related to academic life and general scientific skills. Sessions which I personally lead include: "How to PhD", "Knowledge management tools", "Conferences, Fellowships and Grants", "Careers outside academia" and "Parenthood in academia".

2012 - Present Co-founded and run the Cambridge Networks Network (CNN), a multidisciplinary forum for academics sharing an interest in complex networks (currently over 550 members). We publish a newsletter and regularly host the Cambridge Networks Day conference, attended by 150 participants from fields as diverse as neuroscience, engineering, economics, architecture, and genetics. http://www.cnn.group.cam.ac.uk/

Fundraising
2012 - Present Raised over £25,000 for organization of academic and outreach events.

Previous organizational roles
2023 Programme Committee Member, CompleNet (Aveiro, Protugal)
2020 Programme Committee Member, 11th International Conference on Complex Networks (Exeter)
2019 Co-organised the Network Neuroscience Satellite to NetSci2019 conference (online)
2018 Co-organised the international conference: Complex Networks 2018 (hosted in Cambridge)
2018 Programme Committee Member, International Conference on Network Science (Paris)
2018 Co-organised the Network Neuroscience Satellite to NetSci2018 conference (Paris)
2017 Programme Committee Member, 6th International Conference on Complex Networks and their Applications (Lyon)

Engagement with the Public, Patients, Philanthropists and Policy Makers

I am regularly interviewed by popular science press and broadcasters including the New Scientist (2022), WIRED (2020) and the BBC Radio 4 programme "All in the mind" (2016). Most recently I was interviewed for a Channel 4 TV documentary on the adolescent brain with British comedian, writer and producer Kathy Burke (2022).

I also regularly organise and participate in public engagement events, including events, blogs and tweets organised by the mental health charity MQ (2018-present), science communication videos produced by the Allen Institute for Brain Sciences (2016), several collaborations with artists (2016 aerial theatre company, 2016 film maker, 2015 poet), contributing to public lectures at the Cambridge Science Festival (2013, 2011), delivering a public lecture at the Oxford Brain Day (2012) and organizing public lectures for the Festival of Neuroscience (2012).

I am especially interested in engaging with those who have lived experience of mental health difficulties. Since 2018 I have been in close contact with a network of families and advocates with lived experience via the mental health charity MQ. As an MQ fellow I also regularly participate in events hosting current and prospective donors for both MQ and the University of Cambridge.

Dr Petra Vértes – Contributions to Science

University of Cambridge, UK   ***Contact:*** *pv226@cam.ac.uk*

Human brain network structure, function and development

Over the last 10 years I have worked extensively with human brain networks, where nodes represent large-scale anatomical brain regions and links represent structural or functional connections derived from neuroimaging data. These non-invasive, macroscopic methods have proven important in describing both healthy adult brain organization, and how it changes with age, cognitive demand, or disease – see for example [11, 17]. My work aims to go beyond descriptive studies of brain networks, towards network-based approaches yielding mechanistic insight or predictive utility. For example, I showed that the complex network topology of human brain networks could be largely accounted for by a generative model, and that the same model with slightly detuned parameters was also able to capture the abnormal network properties previously observed in people with schizophrenia [57]. This led to a suite of studies on generative network modelling of both typical and atypical brain development (for example [14]). As a second example, my recent collaboration with Prof Amit Etkin at Stanford University has led to the discovery of a combined cognitive and network-based marker, which discriminates between four classes of subjects suffering from PTSD and predicts their response to treatment [24].

Linking macro-scale brain networks to micro-scale processes

Over the last 5 years I have been working with a range of multivariate biological data such as flow-cytometry, protein interaction networks, microarray, and gene co-expression networks in psychiatric cohorts (see for example [33]). I also pioneered the integration of such micro-scale biological data with whole-brain neuroimaging observations [1, 41, 48]. This has led to a series of high-profile studies in both rodent and human brain networks. For example, we showed that schizophrenia-related changes in brain structure observed by MRI occur preferentially in regions that over-express risk genes for schizophrenia in the healthy adult brain [25], such that there is a genomic patterning of regions vulnerable to schizophrenia.

Linking connectomics research across scales and species

Alongside my work on human and other mammalian brain networks, I also study brain networks at the cellular scale, in the C. elegans nervous system and more recently in Drosophila. These gold-standard neuronal connectomes provide an ideal testbed for methodological innovations and for discovering general principles of brain network organization [4, 36, 43, 52, 55]. For example, in collaboration with Prof Laszlo Barabási (Northeastern University), we recently developed and applied a control theoretic framework successfully predicting the role of many neurons in C. elegans locomotor behaviour [36]. These predictions include a recapitulation of known experimental results, and novel prediction of several previously unknown neuronal roles that we verified by laser ablation experiments. This work has sparked interest in applications of target control principles to brain networks for both scientific and therapeutic purposes.

[References refer to full publications list below]

Dr Petra Vértes - Publications

University of Cambridge, UK   ***Contact:*** *pv226@cam.ac.uk*

My work involves interdisciplinary collaborations often resulting in papers with multiple first or last authors from diverse fields. In these cases, all first/last authors are highlighted and marked with a star.

Number of peer-reviewed primary research papers: 63 published
Citations: 9525 (Google Scholar), H-index: 44 (Google Scholar)

Key primary research papers are at reference number:
1, 4, 11, 17, 19, 24, 25, 33, 36, 41, 52, 57

Book chapters:

Vértes PE "Connectomes, generative models, and their implications for cognition." (2020)
The Cognitive Neurosciences, 6/e. Edited by Gazzaniga, Mangun and Poeppel (MIT Press).

Review papers and invited commentaries:

1. **Vértes PE** "Computational models of typical and atypical brain network development" (2022) ***Biological Psychiatry*** 93(5), 464-470.
   https://www.biologicalpsychiatryjournal.com/article/S0006-3223(22)01771-1/fulltext

2. Betzel R and **Vértes PE** "Organizing principles of the C. elegans contactome" (2021) ***Cell Systems*** 12(7), 689-691. https://www.nature.com/articles/s41467-021-24430-z

3. **Vértes PE** and Seidlitz J "Towards a natural history of schizophrenia" (2019) ***Brain*** 142(12):3669-3671. doi:10.1093/brain/awz353 https://pubmed.ncbi.nlm.nih.gov/31789366/

4. Morgan S, White SR, Bullmore ET and **Vértes PE** "A network neuroscience approach to typical and atypical brain development" (2018) ***Biological Psychiatry: Cognitive Neuroscience and Neuroimaging*** doi:10.1016/j.bpsc.2018.03.003.
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6986924/

5. **Vértes PE** and Bullmore ET "Annual Research Review: Growth connectomics - the organization and reorganization of brain networks during normal and abnormal development" (2015) ***Journal of Child Psychology and Psychiatry***, 56 (3): 299-320.
   https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4359009/pdf/jcpp0056-0299.pdf

6. Bullmore ET and **Vértes PE** "From Lichtheim to rich club: brain networks and psychiatry" (2013) ***JAMA Psychiatry***, 70 (8): 780-782.
   http://jamanetwork.com/journals/jamapsychiatry/article-abstract/1695603

Primary research papers:

1. Dear R, Seidlitz J, Markello RD, Arnatkeviciute A, …, and **Vértes PE** "Three transcriptional axes underpin anatomy, development, and disorders of the human cortex" (2024) *Nature Neuroscience* 27, 1075–1086 https://www.nature.com/articles/s41593-024-01624-4

2. Suárez LE, Mihalik A, Milisav F, Marshall K, Li M, **Vértes PE***, Lajoie G, Misic B "Connectome-based reservoir computing with the conn2res toolbox" (2024) *Nature Communications*, 15, 656. https://www.nature.com/articles/s41467-024-44900-4

3. Orellana SC, Bethlehem RAI, Simpson-Kent IL, **van Harmelen AL*, Vértes PE* , Bullmore ET*** "Childhood maltreatment influences adult brain structure through its effects on immune, metabolic, and psychosocial factors" (2024) *PNAS* 121(16) e2304704121 https://www.pnas.org/doi/full/10.1073/pnas.2304704121

4. Ripoll Sanchez L, Watteyne J, Sun H, Fernandez R, …, **Vértes PE* and Schafer WR*** "The neuropeptidergic connectome of C. elegans" (2023) *Neuron* 111(25) 3570-3589. https://www.cell.com/neuron/pdf/S0896-6273(23)00756-0.pdf

5. Buch A, **Vértes PE,** Seidlitz J, Kim SH, Grosenick L and Liston C. "Molecular and network-level mechanisms explaining individual differences in autism spectrum disorder" (2023) *Nature Neuroscience* 26(4), 650-663 https://api.repository.cam.ac.uk/server/api/core/bitstreams/32fb39c5-edbc-4ff3-b1e4-6a02695e2e83/content

6. Beets I, …, **Vértes PE,** Mirabeau O, Schoofs L "System-wide mapping of peptide-GPCR interactions in C. elegans" (2023) *Cell Reports* 42(9) 113058 *https://www.cell.com/cell-reports/pdf/S2211-1247(23)01069-0.pdf*

7. Wagstyl K, Adler S, Seidlitz J, Vandekar S, Mallard TT, ..., **Vértes PE**, ..., and Raznahan A "Transcriptional cartography integrates multiscale biology of the human cortex" (2023) *Elife* 12 RP86933 *https://elifesciences.org/articles/86933.pdf*

8. Carozza S, Holmes J, **Vértes PE**, Bullmore ET, Arefin T, …, and Astle D "Early adversity changes the economic conditions of structural brain network organisation" (2023) *Developmental Psychobiology 65(6)*; e22405 https://onlinelibrary.wiley.com/doi/epdf/10.1002/dev.22405

9. Nettekoven C, Diederen K, ..., **Vértes PE**, ..., Morgan SE* and McGuire P* "Semantic speech networks linked to formal thought disorder in early psychosis" (2023) *Schizophrenia Bulletin* 49 suppl. 2 pp. S142–S152 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC10031728/pdf/sbac056.pdf

10. Talishinsky A, Downar J, RAI, **Vértes PE**, ..., Liston C "Distinct transcriptomic signatures predict sex-specific connectivity changes in depression" (2022) *Nature Communications*, 13(1), 1-20. https://www.nature.com/articles/s41467-022-32617-1

11. Dorfschmidt L, Bethlehem RAI, Vása F, Romero-Garcia R, ..., **Vértes PE* and Bullmore ET*** "Sexually divergent adolescent brain network development is co-located with imaging and transcriptomic phenotypes of depression" (2022) *Science Advances*, 8 (21), eabm7825. https://www.science.org/doi/full/10.1126/sciadv.abm7825

12. Bethlehem RAI, Seidlitz J, White SR, Vogel JW, Anderson KM, ... **Vértes PE**, ..., and Alexander-Bloch AF "Brain charts for the human lifespan" (2022) *Nature*, 604 (7906), 525-533. https://www.nature.com/articles/s41586-022-04554-y

13. Wagstyl K, Whitaker KJ, Raznahan A, Seidlitz J, **Vértes PE**, ..., and Adler S "Multi-centre Epilepsy Lesion Detection (MELD) Project: Predictors of lesion location and postsurgical seizure freedom in focal cortical dysplasia" (2022) *Epilepsia*, 63(1):61-74. https://www.medrxiv.org/content/10.1101/2021.02.01.21250734v1.full

14. Akarca D, **Vértes PE**, Bullmore ET and Astle D "A generative network model of neurodevelopmental diversity in structural brain organization" (2021) *Nature Communications*, 12, 4216. https://www.nature.com/articles/s41467-021-24430-z

15. Morgan SE, Diederen K, **Vértes PE**, ..., and McGuire P "Natural Language Processing markers in first episode psychosis and people at clinical high-risk" (2021) *Translational Psychiatry*, 11, 630. https://www.nature.com/articles/s41398-021-01722-y

16. Aruldass AR, Kitzbichler M, Morgan SE, Lynall M-E, Turner L, **Vértes PE**, ..., and Bullmore ET "Dysconnectivity of a brain functional network was associated with blood inflammatory markers in depression" (2021) *Brain Behav. Immun*. 98:299-309. doi:10.1016/j.bbi.2021.08.226 https://pubmed.ncbi.nlm.nih.gov/34450247/

17. Vása F, Romero-Garcia R, Kitzbichler MG, Seiflitz J, ..., **Vértes PE* and Bullmore ET*** "Conservative and disruptive modes of adolescent change in human brain functional connectivity" (2020) *PNAS*,117 (6), 3248-3253. https://www.pnas.org/doi/10.1073/pnas.1906144117

18. Romero-Garcia, Seidlitz J, Whitaker KJ, ..., **Vértes PE* and Bullmore ET*** "Schizotypy-related magnetization of cortex in healthy adolescence is colocated with expression of schizophrenia-related genes" (2020) *Biological Psychiatry*, 88(3) 248-259. https://europepmc.org/article/med/32029217

19. Seidlitz J, Nadig A, Liu S, Bethlehem RAI, **Vértes PE**, ..., and Raznahan A "Transcriptomic and cellular decoding of regional brain vulnerability to neurodevelopmental disorders" (2020) *Nature Communications* 11(1) 1-14. https://www.nature.com/articles/s41467-020-17051-5.pdf

20. Vaghi M, Moutoussis M, Vása F, Kievit RA, Hauser TU, **Vértes PE**, ..., and Dolan RJ, and NSPN Consortium "Compulsivity is linked to reduced adolescent development of goal-directed control and frontostriatal functional connectivity" (2020) *PNAS*, 117 (41), 25911-25922. https://www.pnas.org/content/pnas/117/41/25911.full.pdf

21. Wittenberg GM, Greene J, **Vértes PE**, Drevets WC and Bullmore ET "Major depressive disorder is associated with differential expression of innate immune and neutrophil-related gene networks in peripheral blood: A quantitative review of whole genome transcriptional data from case-control studies" (2020) *Biological Psychiatry*, 88(8), 625-637. https://www.biologicalpsychiatryjournal.com/article/S0006-3223(20)31591-2/abstract

22. Pavlovic DM, Guillaume BRL, Towlson EK, ..., **Vértes PE**, ..., and Nichols T "Multi-subject stochastic blockmodels for adaptive analysis of individual differences in human brain network cluster structure" (2020) *Neuroimage*, 116611. https://europepmc.org/article/med/32058004

23. Montagnese M, Knolle F, Haarsma J, ..., **Vértes PE**, ..., Murray GK and NSPN Consortium "Reinforcement learning as an intermediate phenotype in psychosis? Deficits sensitive to illness stage but not associated with polygenic risk of schizophrenia in the general population" (2020) *Schizophrenia Research*, 222:389-396. doi:10.1016/j.schres.2020.04.022 https://europepmc.org/article/MED/32389614

24. **Etkin A*, Fonzo G*, Wu W*, Huemer J*, Patenaude B*, Vértes PE*,** ..., and O'Hara R "Using fMRI connectivity to define a treatment-resistant form of post-traumatic stress disorder" (2019) *Science Translational Medicine* 11 (486), eaal3236. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6980337/

25. Morgan SE, Seidlitz J, Whitaker KJ, ..., **Vértes PE* and Bullmore ET*** "Cortical patterning of abnormal morphometric similarity in psychosis is associated with brain expression of schizophrenia-related genes" (2019) *PNAS*, 116 (19), 9604-9609. https://www.pnas.org/content/pnas/116/19/9604.full.pdf

26. Towlson EK, **Vértes PE**, Muller U and Ahnert SE "Brain networks reveal the effects of antipsychotic drugs on schizophrenia patients and controls" (2019) *Frontiers Psychiatry*, 10, 611. https://www.frontiersin.org/articles/10.3389/fpsyt.2019.00611/full

27. Mihalik A, Ferreira FS, Rosa MJ, Moutoussis M, Ziegler G, ..., **Vértes PE**, ..., and Mourao-Miranda J "Brain-behaviour modes of covariation in healthy and clinically depressed young people" (2019) *Scientific Reports*, 9 (1), 1-11. https://www.nature.com/articles/s41598-019-47277-3

28. Paquola C, Bethlehem RAI, Seidlitz J, Wagstyl K, ..., **Vértes PE**, ..., Bullmore ET and NSPN Consortium "A moment of change: shifts in myeloarchitecture characterise adolescent development of cortical gradients" (2019) *eLife*, 8:e50482, doi:10.7554/eLife.50482. https://elifesciences.org/articles/50482

29. Grydeland H, **Vértes PE**, Vása F, Romero-Garcia R, Whitaker KJ, ..., and Bullmore ET "Waves of maturation and senescence in micro-structural MRI markers of human cortical myelination over the lifespan" (2019) *Cerebral Cortex*, 29(3), 1369-1381. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6373687/

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31. Towlson EK, **Vértes PE**, Yan G, Chew YL, Walker DS, Schafer WR and Barabasi A-L "Caenorhabditis elegans and the network control framework-FAQs" (2018) *Phil Trans B*, 373 (1758) 20170372 https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6158218/

32. Romero-Garcia R, Whitaker KJ, Vása F, Rubinov M, Steidlitz J, Shinn M, Fonagy P, Dolan RJ, Jones PB, Goodyear IM, the NSPN Consortium, **Vértes PE* and Bullmore ET*** "Structural covariance networks are coupled to expression of genes enriched in supragranular layers of the human cortex" (2018) *Neuroimage* 171:256-267. https://www.sciencedirect.com/science/article/pii/S1053811917310844

33. **Leday G*, Vértes PE*,** Richardson S, Greene JR, Khan S, Henderson R, Freeman TC, Regan T, Pariante CM, Harrison NA, MRC Immunopsychiatry Consortium, Perry HV, Drevets WC, Wittenberg GM and Bullmore ET "Replicable and coupled changes in innate and adaptive immune gene expression in two case-control studies of blood microarrays in major depressive disorder" (2018) *Biological Psychiatry*, 83 (1), 70-80. http://www.biologicalpsychiatryjournal.com/article/S0006-3223(17)31617-7/fulltext

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organisation and predict inter-individual cognitive variation" (2018) *Neuron* 97 (1), 231-247.
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36. **Yan G*, Vértes PE*, Towlson EK*,** Chew YL, Walker DS, Schafer WR and Barabasi A-L "Experimental test of network control: Functional predictions in the Caenorhabditis elegans nervous system" (2017) *Nature* 550: 519-523.
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https://www.nature.com/articles/s41598-017-03394-5

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