KAMILA JOZWIK

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EDUCATION

Sir Henry Wellcome postdoctoral fellow (neuroscience) 2018 - present
Massachusetts Institute of Technology & **University of Cambridge**

Humboldt postdoctoral fellow (neuroscience), **Free University Berlin** 2017

PhD, Biological Sciences (genomics), **University of Cambridge** 2011 - 2016

MPhil, Biological Sciences (molecular biology), **University of Cambridge** 2010 - 2011

BSc, Biotechnology, **University of Warsaw** 2007 - 2010

RESEARCH EXPERTISE

Neuroscience

Overview

My work has focused on understanding how the human brain processes visual information. Recognizing the parallels to my PhD in genomics where I dissected genes in molecular pathways, I have used the concept of *dimensions* as a theoretical framework. A dimension is defined as a measurable extent of a particular kind of information - here "building blocks" of object recognition (e.g., "curved", "being unpredictable", or non-nameable principal components). My research strategy is to disentangle and quantify dimensions of visual object recognition at different levels of abstraction, using modelling (conceptual and computational) and experimental approaches (fMRI, M/EEG, behaviour). Using the dimensionality framework, my work so far has led to novel insights about feature and category representations, face recognition, animacy, and topographical organisation in the brain. I have acquired new datasets, built novel methodological tools, and challenged existing models and theories in object recognition as described below. Investigating specific dimensions clarifies what type of information is being processed and provides a trackable system to build an intuition of how the brain implements object recognition.

Features and categories

I compared the contribution visuo-semantic models, consisting of human-generated labels of higher-level object features and categories to explain inferior temporal cortex (IT) representations and behaviour. I showed that both features and categories explain IT representations but categories dominate behaviour. I asked which representational features are currently unaccounted for in neural timeseries data, estimated for multiple areas of the human ventral stream via source-reconstructed magnetoencephalography (MEG) data. I found that while early visual areas are better explained by deep neural networks features, higher-level cortical dynamics are best accounted for by visuo-semantic models. (with Nikolaus Kriegeskorte and Marieke Mur)

Face similarity and identity dimensions and face recognition models

I designed an efficient behavioural task to collect dissimilarity and same/different identity judgements for pairs of realistic faces. The stimuli densely sampled geometric relationships in a face space derived from principal components of 3D shape and texture (Basel Face Model, BFM). In a comparison against alternative models, I found that BFM distance was competitive with representational distances in state-of-the-art image-computable deep neural networks (DNNs), which underscores the statistically-tuned nature of face encoding. (with Nikolaus Kriegeskorte)

Animacy dimensions

I investigated the importance of five dimensions of animacy: "being alive", "looking like an animal", "having agency", "having mobility", and "being unpredictable" in brain (fMRI, EEG) and behaviour (property and similarity judgments) of 19 subjects using a stimulus set of images that disentangles the five dimensions (optimized by a genetic algorithm). I found that animacy is multidimensional and our results show that distinct dimensions are differentially represented in human brain and behaviour. (with Nikolaus Kriegeskorte and Radoslaw Cichy)

Topographically organised dimensions in human, monkey, and deep neural networks

I explored dimensions in a topographical DNN (that have a physical layout of neurons on the artificial tissue map) and I found that the dimensionality of this model is closer to the dimensionality of neural representations in monkey IT. I also used the topographical model as a hypotheses generator and found that beyond face-like or body-like dimensions, other spatially organised dimensions exist. I

also compared dimensionality in human intracranial recordings, monkey electrophysiology data, and a wide range of DNNs. I found that the best models of monkey brain align with the best models of human brain but the dimensionality of DNNs is too high compared to that of monkey brains. (with Nancy Kanwisher and James DiCarlo)

Genomics
Functional dissection of hormonal gene transcription in breast cancer (PhD thesis)
I characterised the roles of transcription factors and the mechanism underlying the deposition of enhancer histone modification during breast cancer progression. (with Jason Carroll)

The role of sex hormones in the development of autism
I contributed to the characterisation of neurogenesis in induced pluripotent stem cells (iPSC) from autistic individuals. (collaboration with Simon Baron-Cohen)

PUBLICATIONS

JOURNAL PUBLICATIONS

• **Jozwik*, K.M.**, O'Keeffe*, J., Storrs*, K.R., Guo, W., Golan, T., Kriegeskorte, N. (2022)
"Face dissimilarity judgements are predicted by representational distance in morphable and image-computable models". *Proceedings of the National Academy of Sciences* (*contributed equally)

• **Jozwik, K.M**. (2021)
" The Self-Assembling Brain: How Neural Networks Grow Smarter" *Science* (book review)

• Adhya, D., Swarup, V., Nagy, R., Dutan, L., Shum, C., Valencia-Alarcón, E.P., **Jozwik, K.M.**, Mendez, M.A., Horder, J., Loth, E., Nowosiad, P., Lee, I., Skuse, D., Flinter, F.A., Murphy, D., McAlonan, G., Geschwind, D.H., Price, J., Carroll, J., Srivastava, D.P., Baron-Cohen, S. (2021)
"Atypical neurogenesis in induced pluripotent stem cell (iPSC) from autistic individuals" *Biological Psychiatry* (contributed to the design of genomics analyses and processing samples)

• Cichy, R.M., Kriegeskorte, N., **Jozwik, K.M.**, van den Bosch, J.J.F., Charest, I. (2019)
"The spatiotemporal neural dynamics underlying perceived similarity for real-world objects" *Neuroimage* (collected and analysed part of the behavioural data)

• **Jozwik, K.M**., Kriegeskorte, N., Storrs, K.R., Mur, M. (2017)
"Deep convolutional neural networks outperform feature-based but not categorical models in explaining object similarity judgments" *Frontiers in Psychology*

• **Jozwik, K.M.**, Kriegeskorte, N., Mur, M. (2016)
"Visual features as stepping stones toward semantics: Explaining object similarity in IT and perception with non-negative least squares" *Neuropsychologia*

• **Jozwik, K.M.**, Chernukhin, I., Serandour, A.A., Nagarajan, S., Carroll, J.S. (2016)
"FOXA1 directs H3K4 monomethylation at enhancers via recruitment of the methyltransferase MLL3" *Cell Reports*

• **Jozwik, K.M.**, Carroll, J.S. (2012)
"Pioneer factors in hormone dependent cancers" *Nature Reviews Cancer*

PEER-REVIEWED CONFERENCE PUBLICATIONS

• **Jozwik, K.M.**, Lee, H., Kanwisher, N. and DiCarlo, J.J. (2019)
”Are topographic deep convolutional neural networks better models of the ventral visual stream?” *Conference on Cognitive Computational Neuroscience*

• **Jozwik, K.M.**, Kriegeskorte, N., Cichy, R.M., Mur, M. (2018)
”Deep convolutional neural networks, features, and categories perform similarly at explaining primate high-level visual representations” *Conference on Cognitive Computational Neuroscience*

• **Jozwik, K.M.**, Charest, I., Kriegeskorte, N. and Cichy, R.M. (2017)
”Animacy dimensions ratings and approach for decorrelating stimuli dimensions” *Conference on Cognitive Computational Neuroscience*

PREPRINTS

• **Jozwik, K.M.**, Elias Najarro, E., Bosch, JJF., Charest, I., Kriegeskorte, N., and Cichy, RM. (2021)
" Disentangling dimensions of animacy in human brain and behaviour" *bioRxiv*

• **Jozwik, K.M.**, Kietzmann, T.C., Cichy, RM., Kriegeskorte, N., Mur, M. (2021)
" Deep neural networks and semantic models explain complementary components of human ventral-stream representational dynamics" *bioRxiv*

• Lee, H., Margalit, E., **Jozwik, K.M.**, Cohen, M.A., Kanwisher, N., Yamins, D.L.K, DiCarlo, J.J. (2020).
"Topographic deep artificial neural networks reproduce the hallmarks of the primate inferior temporal cortex face processing network" (performed analyses on wiring cost calculations and neural fits). *bioRxiv*

• **Jozwik, K.M.**, Schrimpf, M., Kanwisher, N. and DiCarlo, J.J. (2019)
"To find better neural network models of human vision, find better neural network models of primate vision"} *bioRxiv*

• **Jozwik, K.M.**, Lee, M., Marques, T., Schrimpf, M., Bashivan, P. (2019)
"Large-scale hyperparameter search for predicting human brain responses in the Algonauts challenge"} *bioRxiv*

FELLOWSHIPS

• Sir Henry Wellcome Postdoctoral Fellowship, University of Cambridge and Massachusetts Institute of Technology, "Explaining the heterogeneity and topography in inferior temporal cortex with deep neural networks", (4 years extended by maternity leave, £250,000), 2018-2023

• Humboldt Foundation Postdoctoral Fellowship, Free University Berlin, "The spatio-temporal representation of objects in visual and semantic domains in human brain and machine" (6 months, €25,630), 2017

• Corbridge Cambridge Trust Scholarship for MPhil Studies, University of Cambridge, "The mechanisms of DNA repair", 2010

• MRC Weatherall Institute of Molecular Medicine Studentship, Oxford University, "Roles of Raly protein in DNA repair", 2010

• Amgen Foundation Research Scholarship, University of Cambridge, "Roles of ATRIP protein in DNA repair", 2009

• Molecular Biosciences International Student Scholarship, Aarhus University, "Mechanisms of transcription", 2009

AWARDS

• Best Poster Award at McGovern Institute at MIT Retreat, 2019

• Churchill College By-Fellowship, 2019

• International Brain Research Organization Stipend, 2016

• Organization for Human Brain Mapping Merit Abstract Award, 2016

• Concepts, Actions and Objects Conference Abstract Award, 2016

• Cambridge University Representative for Global Young Scientists Summit, 2013

• Path to Harvard Competition Winner, Academic Visit to Harvard University, 2010

TRAVEL GRANTS

• Elsevier/*Vision Research* Travel Award, 2016

• Free University Dean's stipend, 2016

• Grant to attend CSHL Computational Neuroscience: Vision Course, 2016

• Grant to attend Computational Vision Summer School at Black Forest, 2015

• Guarantors of Brain Travel Grant, 2015

• Grindley Travel Grant from Experimental Psychology Society, 2015

• Cambridge Philosophical Society Conference Grant, 2015

• Amgen Scholars Travel Award, 2013

• Darwin College Conference Grant, 2013

SELECTED INVITED AND CONFERENCE TALKS

Invited Talk at Western University, “Disentangling five dimensions of animacy in human brain and behaviour”, 2022

Talk at Applied Vision Association Spring 2022 meeting, “Face dissimilarity judgements are predicted by representational distance in morphable and image-computable models”, 2022

Talk at Mathematics of Neuro-Science symposium, International Conference of Numerical Analysis and Applied Mathematics, “Deep neural networks and semantic models explain complementary components of human ventral-stream representational dynamics”, 2021

Talk at European Conference on Visual Perception, " Disentangling dimensions of animacy in human brain and behaviour”, 2021

Talk at University of Cambridge Research Staff Symposium, "Predicting human and monkey visual brain representations with biologically-inspired deep neural networks”, 2021

Invited Talk, Simons Collaboration on the Global Brain Postdoc Meeting, "Brain-inspired deep learning models to study visual object representations in humans and monkeys”, 2020

Invited Talk at Brown University, "Predicting human and monkey visual brain representations with biologically-inspired deep neural networks", 2020

Data Blitz Talk, 7th Cambridge Neuroscience Symposium: Artificial and Biological Cognition, "Are topographic deep convolutional neural networks better models of the ventral visual stream?”, 2019

Invited Talk at Symposium: How Humans and Machines Learn to See?, "Brain-inspired deep neural network models of object recognition in humans and monkeys", 2019

Invited Talk at Boston College, "Dissecting object recognition in humans, primates and deep neuronal networks”, 2019

Invited Talk at Harvard Vision Lab, "Dimensions of object recognition in humans, primates and deep neuronal networks”, 2018

Invited Talk at MRC Cognition and Brain Sciences Unit, "Mechanisms of object recognition in humans, primates and deep neuronal networks”, 2018

Talk at Center for Brains, Minds and Machines retreat, "Explaining brain area scaling and topography in monkey and human IT with deep neural networks”, 2018

Talk at nanosymposium at Society for Neuroscience conference, "Representation of visual features and categories across space and time in human, monkey, and convolutional neural networks”, 2018

Talk at Organization for Human Brain Mapping Conference, “Explaining high-level visual object representations with weighted representational modeling”, 2016

Talk at Concepts, Actions and Objects Conference, "Visual features versus categories:
Explaining object representations in primate IT and deep neural networks with weighted representational modelling”, 2016

Talk at Nanosymposium at Society for Neuroscience conference, "Visual features as stepping stones toward semantics: Explaining object similarity in IT and perception with non-negative least squares”, 2015

SUPERVISION AND TEACHING

Designed project, provided one-to-one supervision, supervised report writing by undergraduate and graduate students in neuroscience at Free University Berlin and MIT, 2017-current

Designed and taught "Object recognition" lectures at "Cognitive Science" PhD course (9.012**)** at MIT, Student evaluation 4.93 (1-5 scale), 2020

Organised, designed and taught undergraduate and graduate course "Deep neural networks as a window into the human brain" at MIT, Student evaluation 4.60 (1-5 scale), 2020

Gave tutorial at Cambridge Methods in Cognitive Neuroscience Day, ”Predicting human and monkey visual brain representations with biologically-inspired deep neural networks”, 2019

Led team of two postdocs and two graduate students for the submission of computational models of visual system to the Algonauts Challenge that resulted in independent bioRxiv paper, 2018

Gave tutorial at Cambridge Vision Workshop, "Weighted representational modelling in deep neuronal networks", 2016

Gave tutorial at MRC Cognition and Brain Sciences Methods Day, "Weighted representational modelling in fMRI and behaviour", 2015

ACADEMIC SERVICE

Reviewer at Science; Nature; Nature Human Behaviour; Nature Communications; Neuroimage; PLOS Computational Biology; PLOS One; Human Brain Mapping; Journal of Experimental Psychology Human Perception and Performance; IEEE Journal of Biomedical and Health Informatics; Molecular Autism; Royal Society Open Science; Conference on Neural Information Processing Systems; Cognitive Computational Neuroscience Conference; Brains, Minds and Machines Summer Course, 2016-present

Co-organizer and co-chair of workshop: ”Challenges for deep neural network models of visual cognition: From incorporating biological constraints to predicting correlational and causal experimental outcomes”, Computational and Systems Neuroscience Conference, 2019

Academic interviewer at Center for Brains, Minds and Machines, MIT, 201

Debate chair and moderator "How do deep neural networks differ from brains" at Center for Brains, Minds and Machines retreat, MIT, 2018

Public engagement lecturer "Deep neural networks: from recognising objects to making art" at Berlin Night of Science, Free University Berlin, 2017

Membership: Center for Brains, Minds & Machines; Society for Neuroscience; Vision Sciences Society; Organization for Human Brain Mapping, 2016-present

REFEREES

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