



THE UNIVERSITY OF
CHICAGO

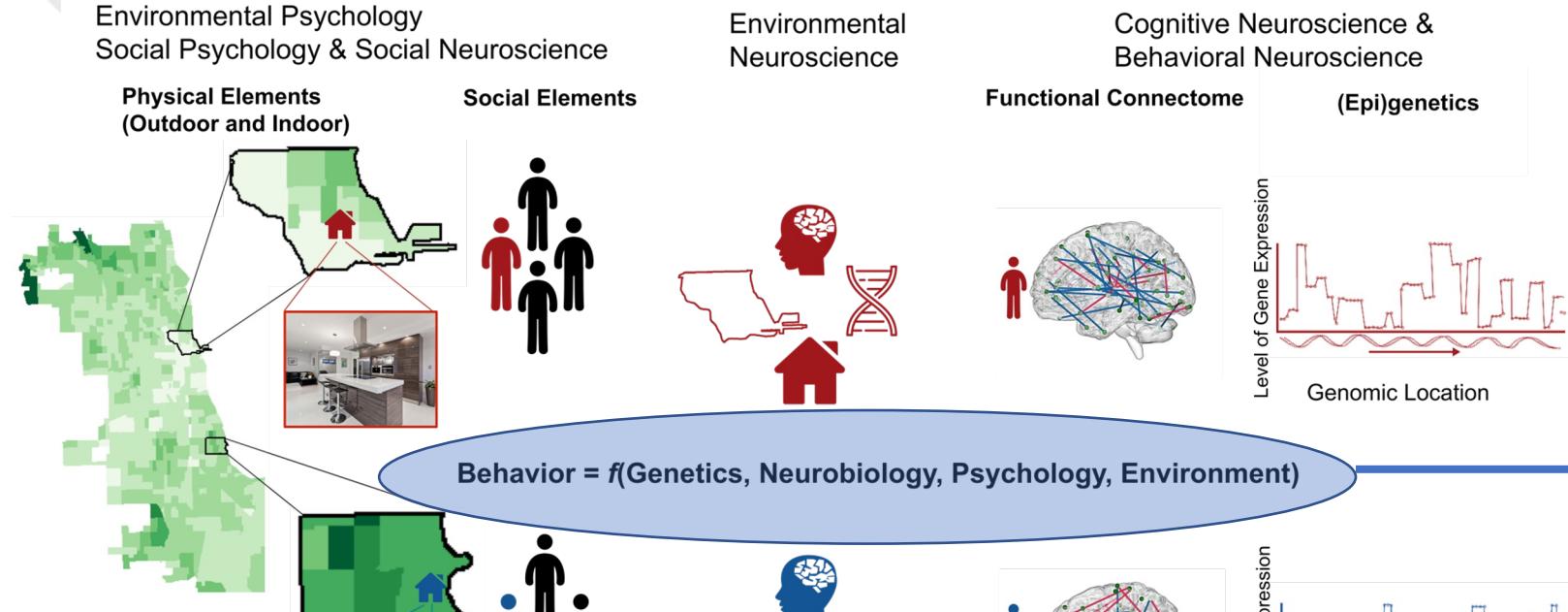


Environmental Neuroscience

Marc G. Berman, PhD
Director, Environmental Neuroscience Lab
Associate Professor of Psychology
Faculty Co-Director, Masters of Computational Social Science Program
Chair, Department of Psychology
Member, U. Chicago Neuroscience Institute

Generative Approach

Environmental Neuroscience



Mechanistic Approach

Lewin said
Human behavior
 $= f(\text{Person, Env})$

We are inspired by
that but we want
to turn that heuristic
into quantitative
models

Levels of Analysis:

- Quantification of Physical Environments (Interior and Exterior)
- Individual Behavior (e.g., memory, attention and self-control)
- Functional and structural neuroimaging
- Genetics systemic (e.g., genetic susceptibility)
- Social Context and Social Behavior

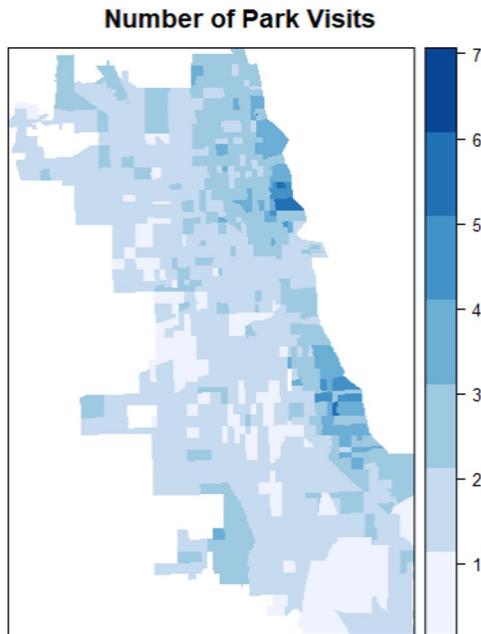
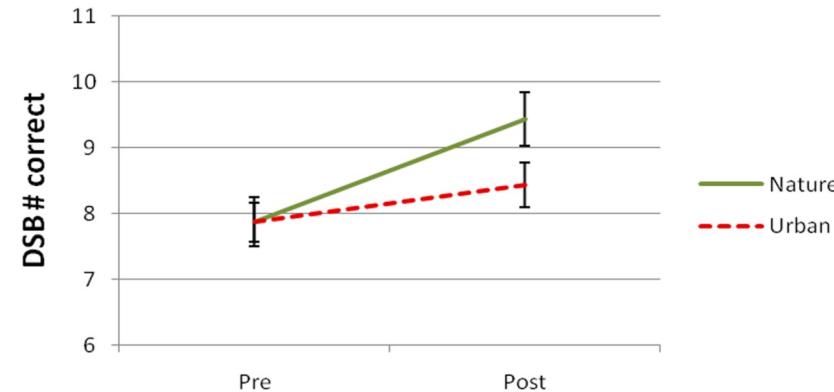
Levels of Analysis:

- Functional and Structural Neuroimaging
- Neuroscience Molecular
- Epigenetic
- Cellular

The benefits of interacting with nature



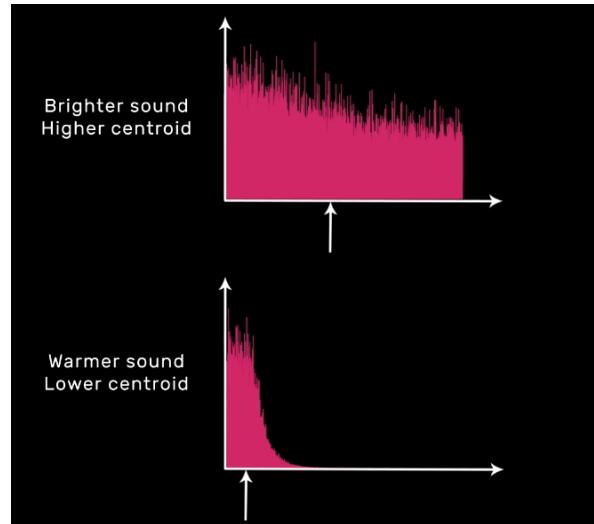
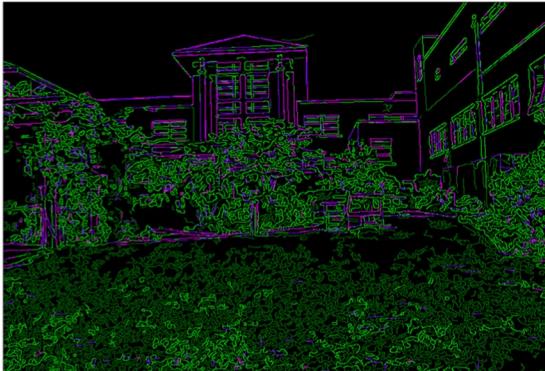
DSB: Nature Walk vs. Urban Walk



Reductions in crime

Visual and Acoustic Features of Nature

Curved Edges and Straight Edges



Higher Shannon Entropy

Lower Shannon Entropy

From these low-level visual and acoustic features we can predict the naturalness of images (Berman et al., 2014 *PLoS ONE*, the preferences of images (Kardan et al., 2015, *Frontiers in Psychology*), the orderliness of scenes (Kotabe et al., 2017, *JEP:General*), the preference of indoor and outdoor exteriors and their naturalness (with no overt nature present, Coburn et al., 2019, *Journal of Environmental Psychology*) and the preferences of nature and urban sounds (Van Hedger et al., 2019, *Cognitive Science*)

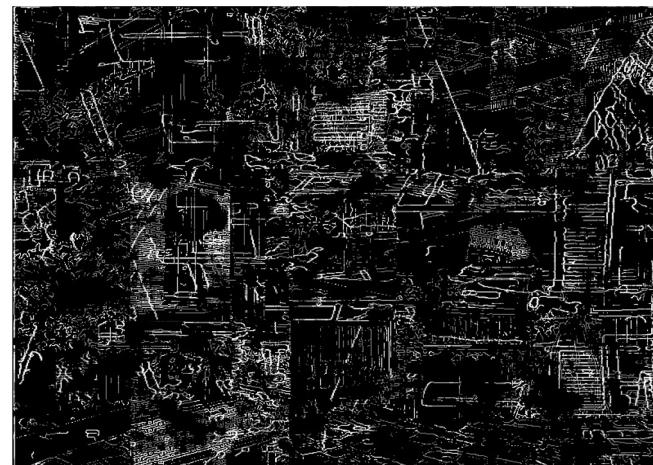
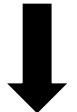
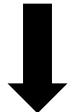
Low-level features, independent of semantics can cause changes in thought and cause cheating



Kate Schertz
Ph.D. (now at
Michigan)

Changes in thought:

Schertz et al., (2020)
Attention, Perception & Psychophysics



Hiroki Kotabe
Ph.D. (at the
Block)

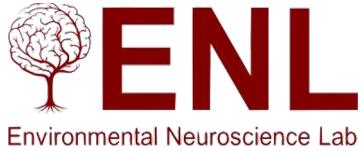
Changes in cheating:

Kotabe et al., (2016)
Journal of Experimental Psychology: General

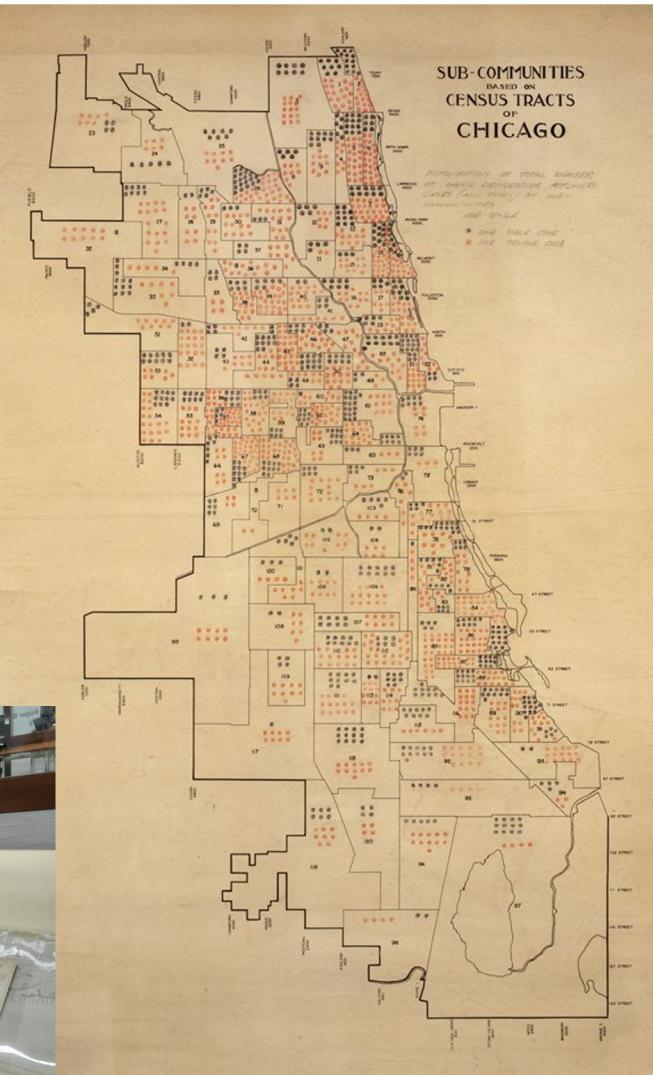
This does not mean that cities are bad for mental health



Andrew Stier
Ph.D.
(now at SFI)



Luis Bettencourt, PhD
Director of the Mansueto
Institute for Urban
Innovation

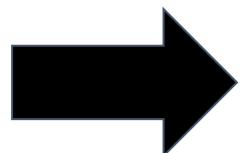


Ernest Burgess map of bipolar depression in Chicago

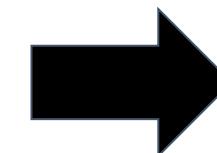
Effects of city size and city infrastructure on depression



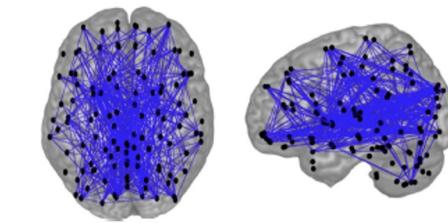
Infrastructure
networks of cities



Social networks



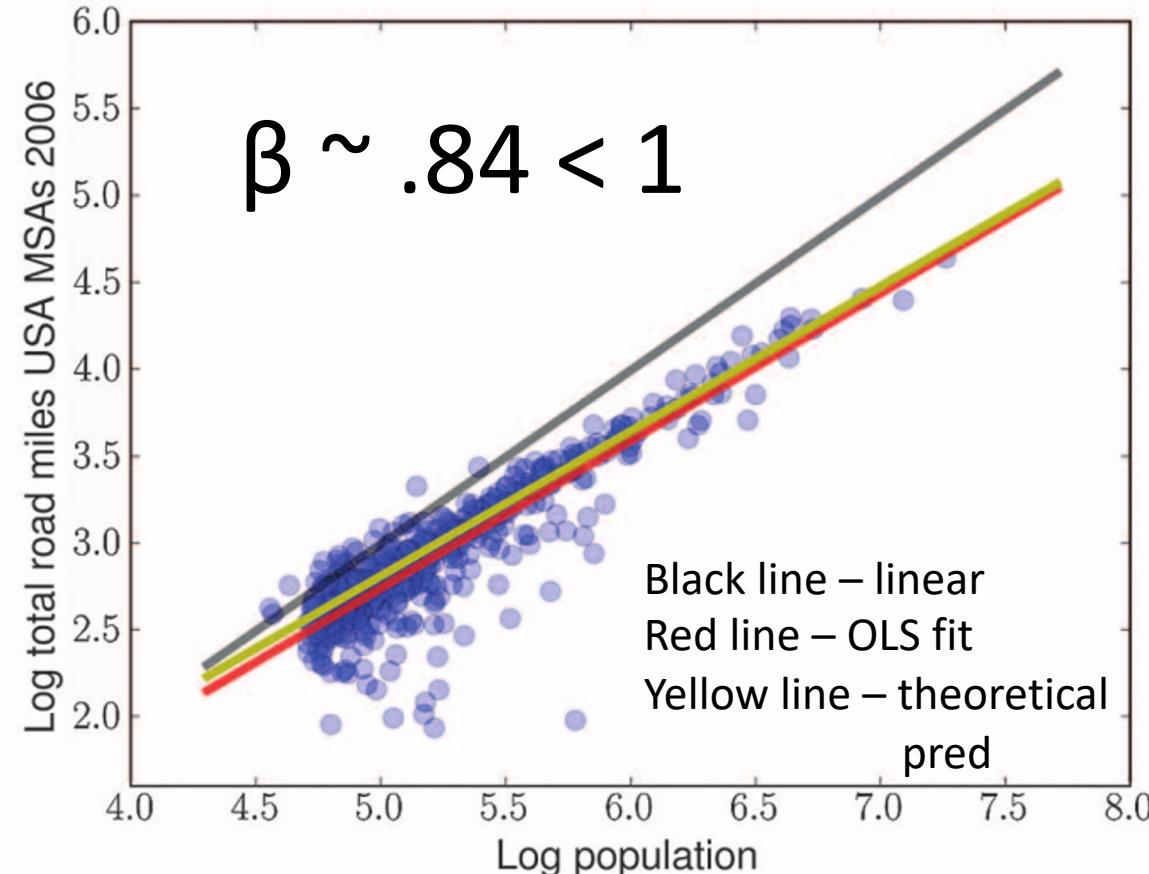
Depression
likelihood



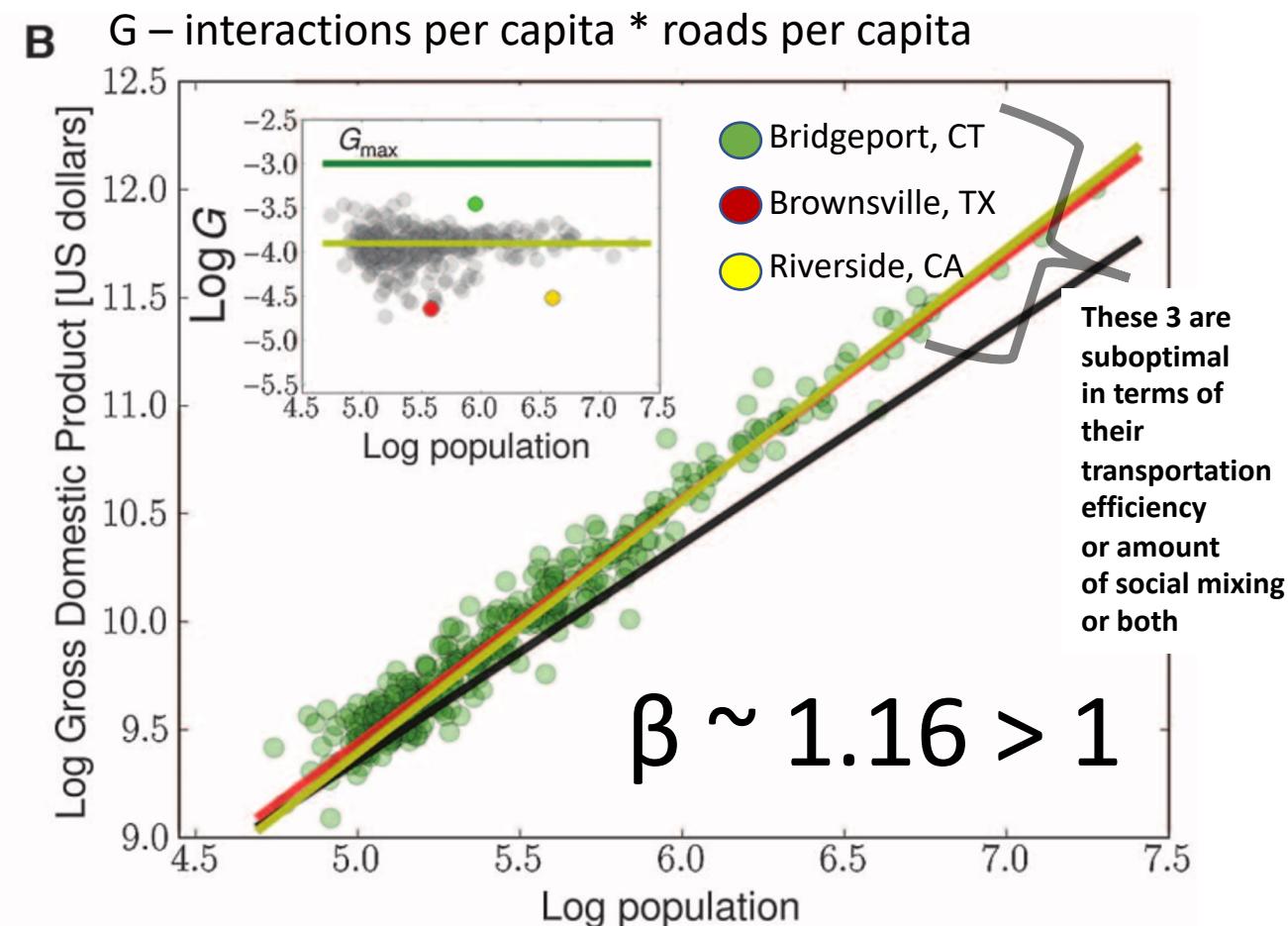
Berman et al.,
2014, *NeuroImage*

Power Law Scaling of Urban Quantities

A

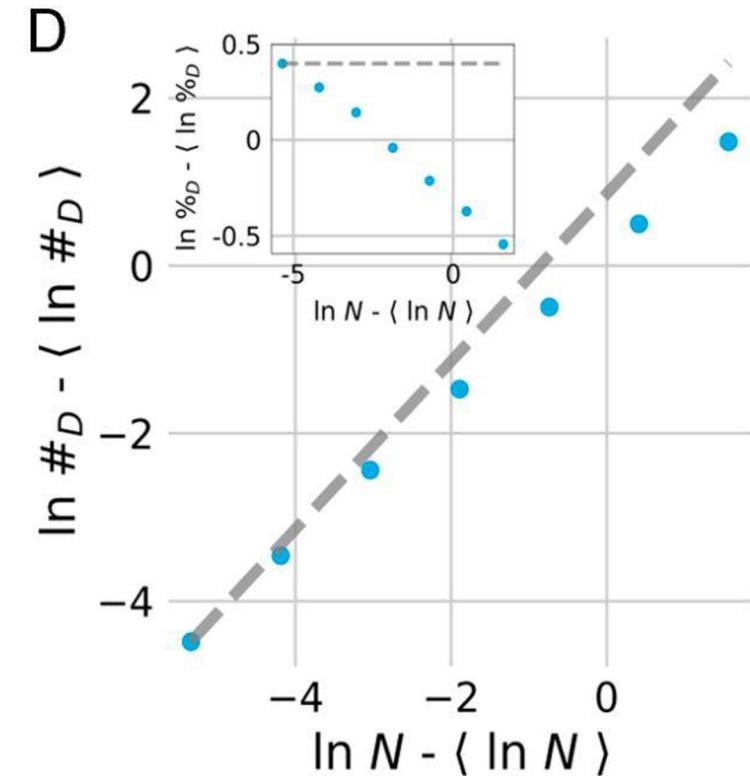
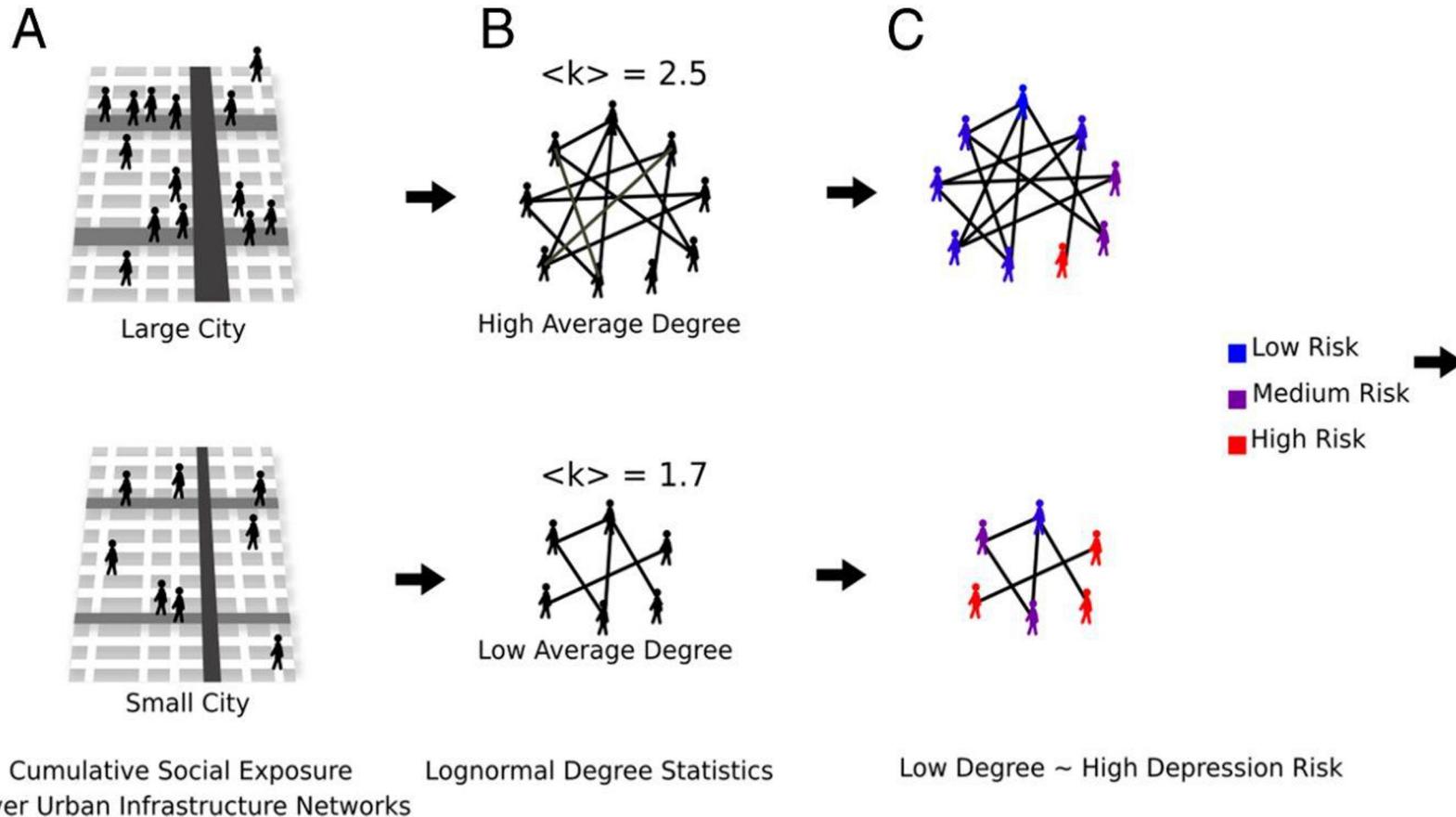


B

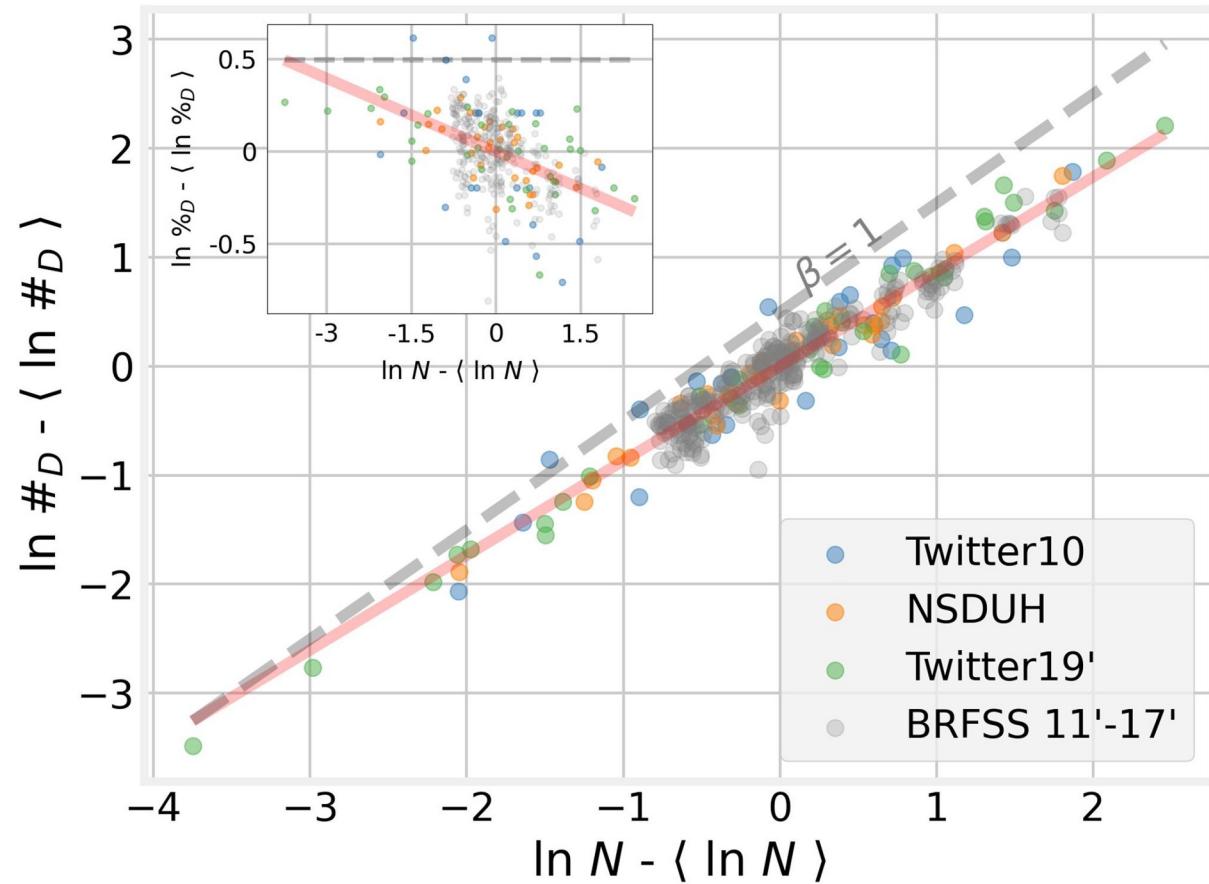


$$Y = Y_0 N^\beta \longleftrightarrow \log Y = \log Y_0 + \beta * \log N$$

Our model/simulation

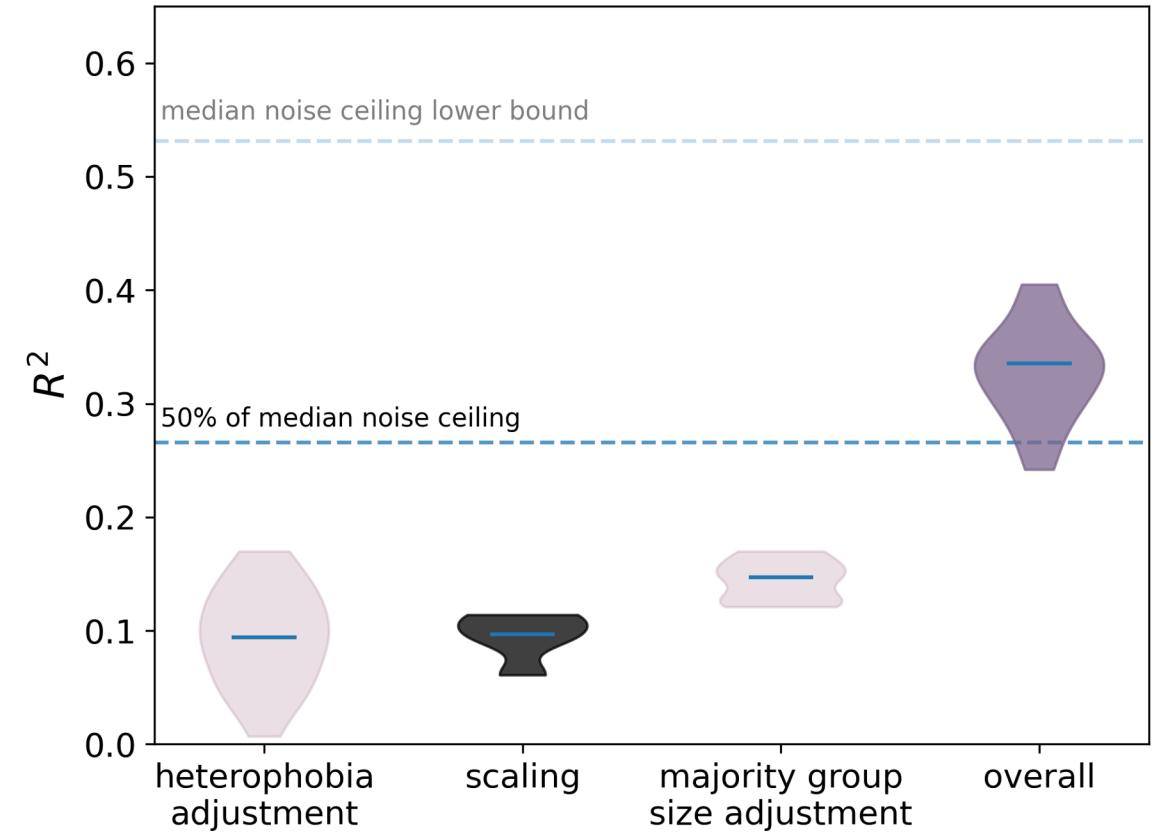
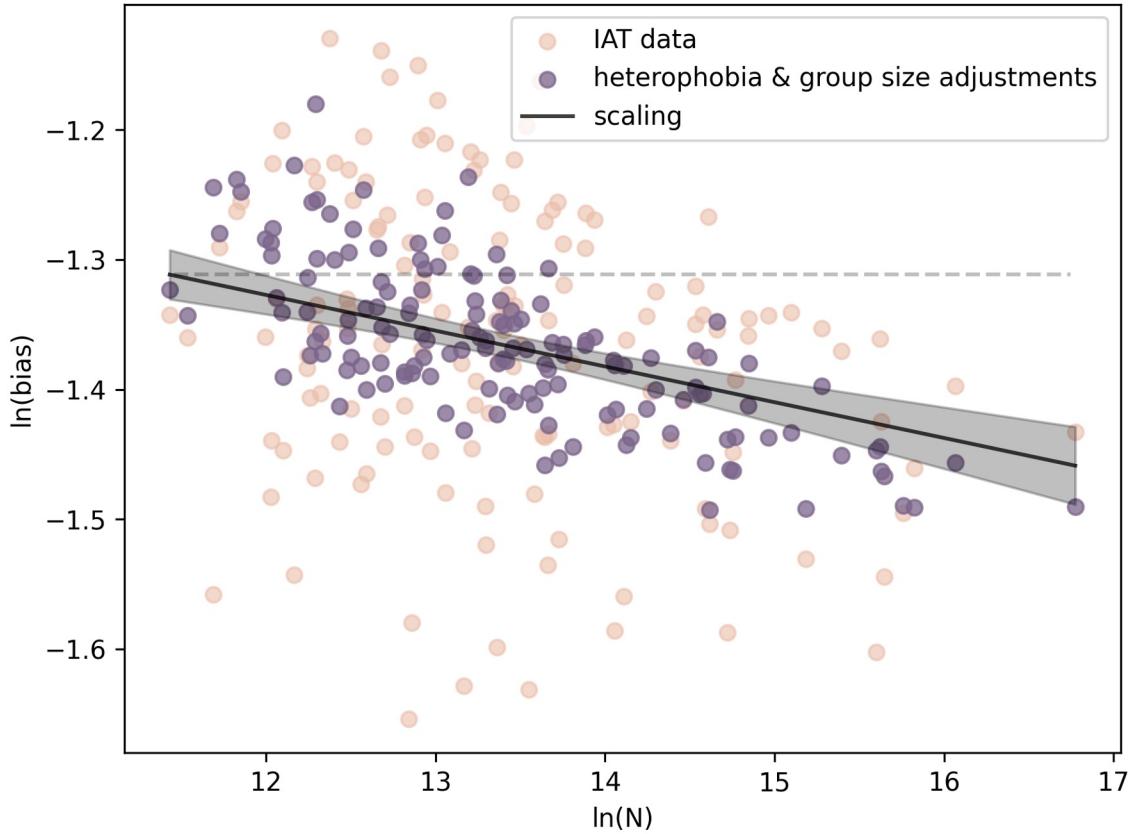


Empirical data match the model's predictions

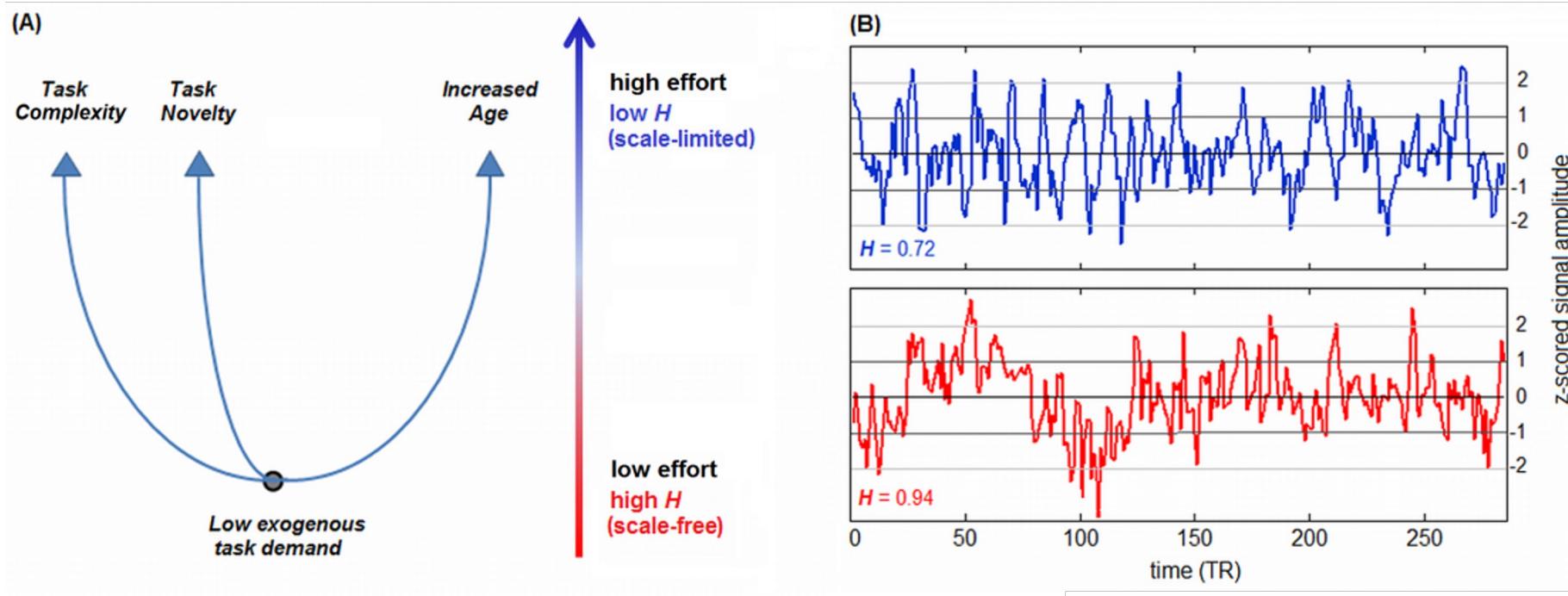


The city size effect holds at the individual level controlling for race, ethnicity, education, and income

Population Scaling, segregation and majority group size all predict implicit biases (data from > 3M people)



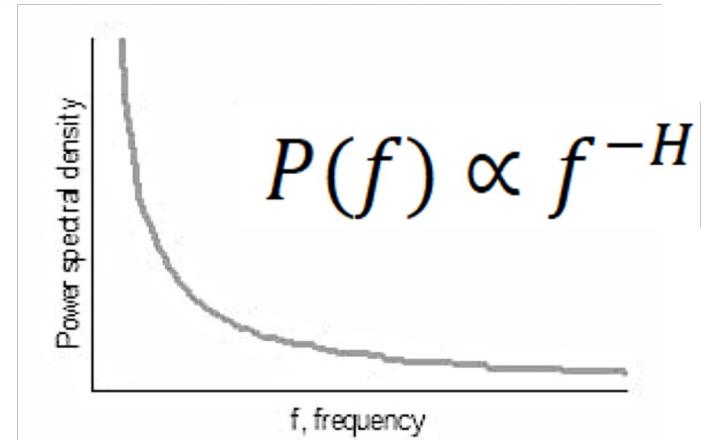
We also do Neuroscience: A way to quantify cognitive effort



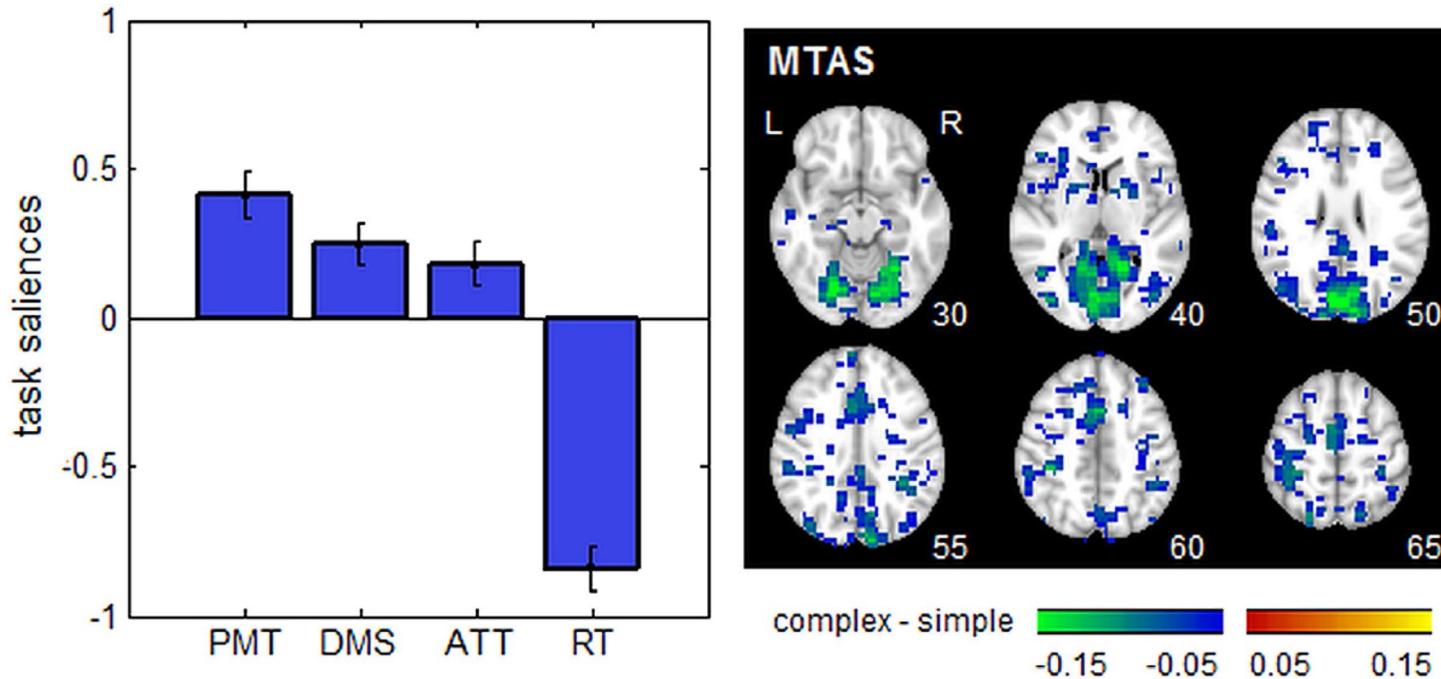
Churchill et al., (2016)
Scientific Reports



Dr. Nathan Churchill
St. Mike's Hospital
University of Toronto



Effects of Task Complexity (partial least squares multivariate analysis)



Churchill et al., (2016)
Scientific Reports

We also find

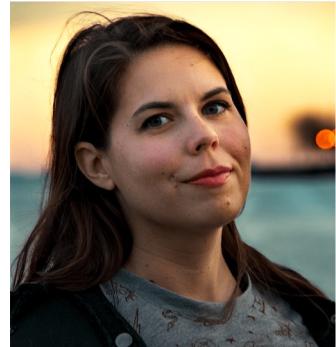
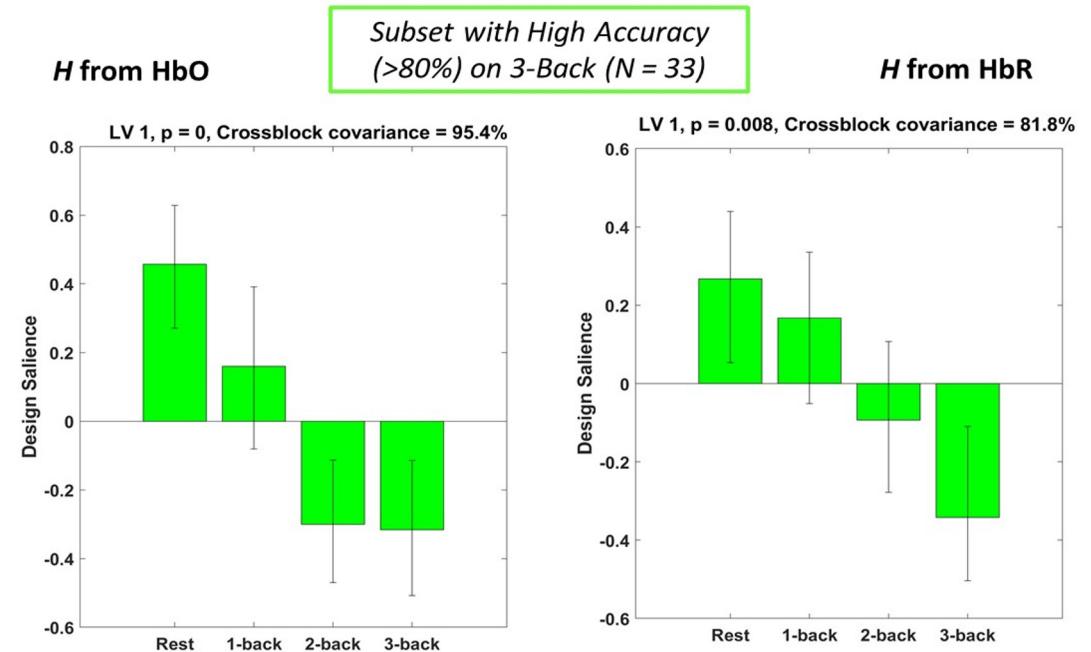
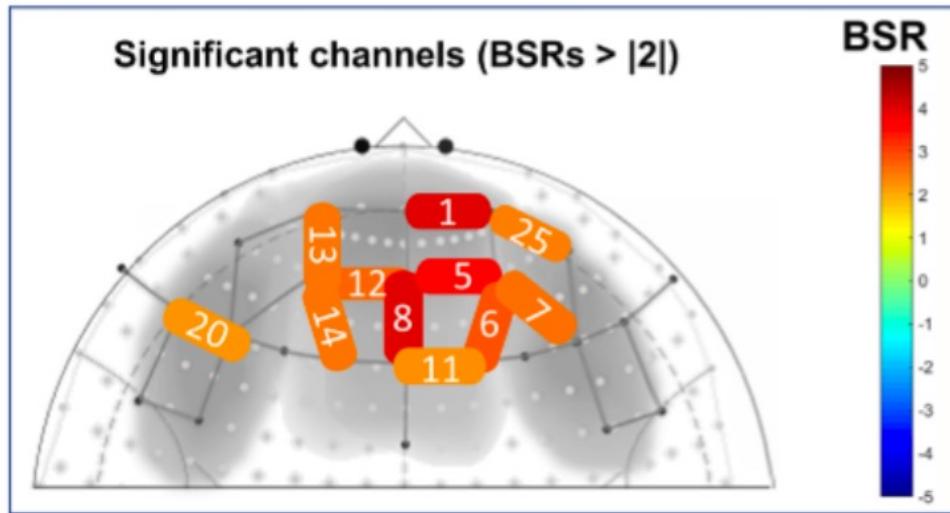
Hurst increases when we are well practiced on a task vs. just learning it (more fractal with more practice)

Hurst decreases as we age (older adults vs. younger adults performing the same task at 80% accuracy; less fractal with increased age)

Churchill et al., (2016)

Scientific Reports

fNIRS (\sim .02 - .4 Hz; similar hemodynamics to fMRI)



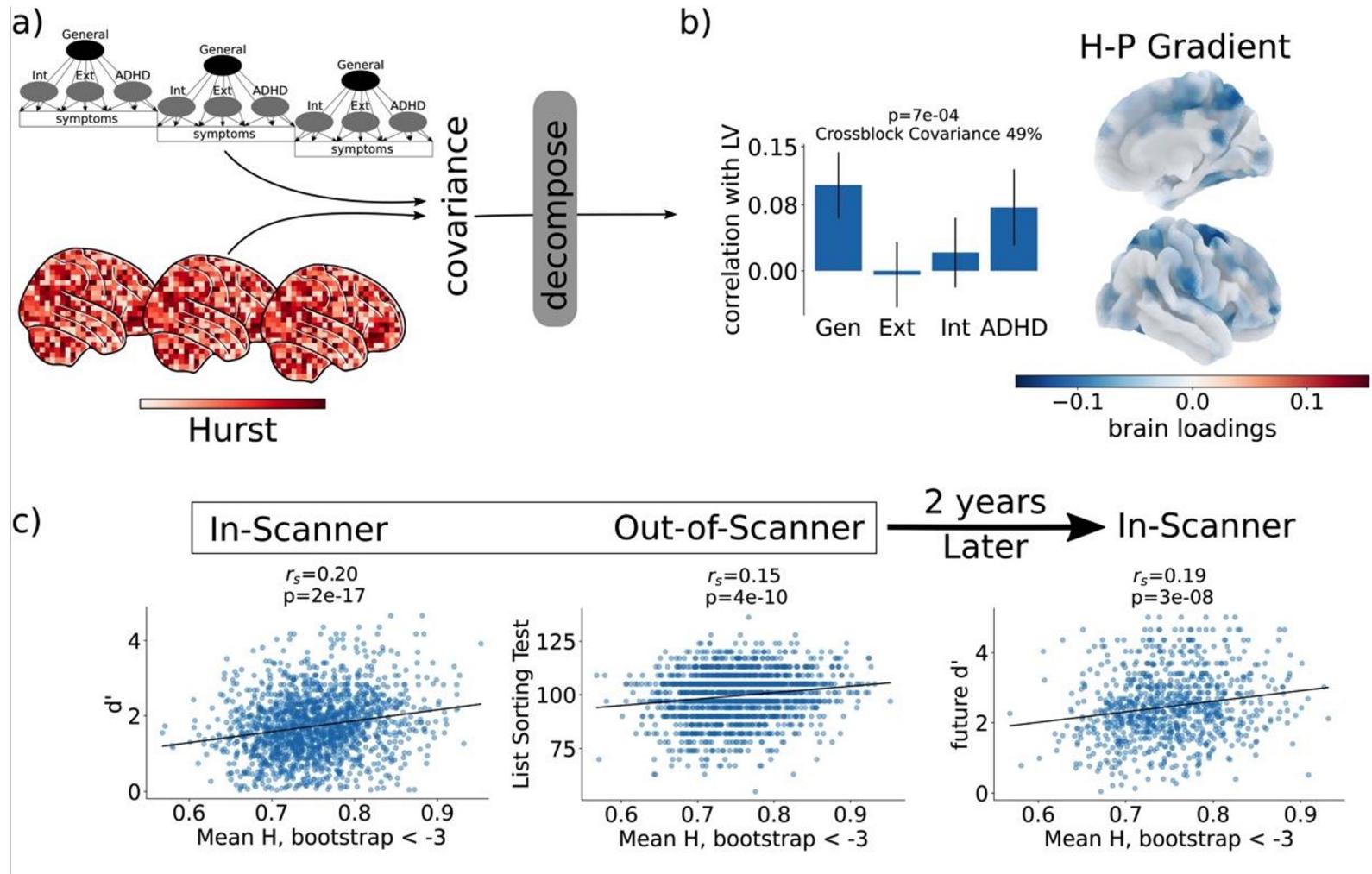
Kim Meidenbauer
Ph.D. Assistant
Professor
Washington State U.

Meidenbauer et al., (2022), Cortex

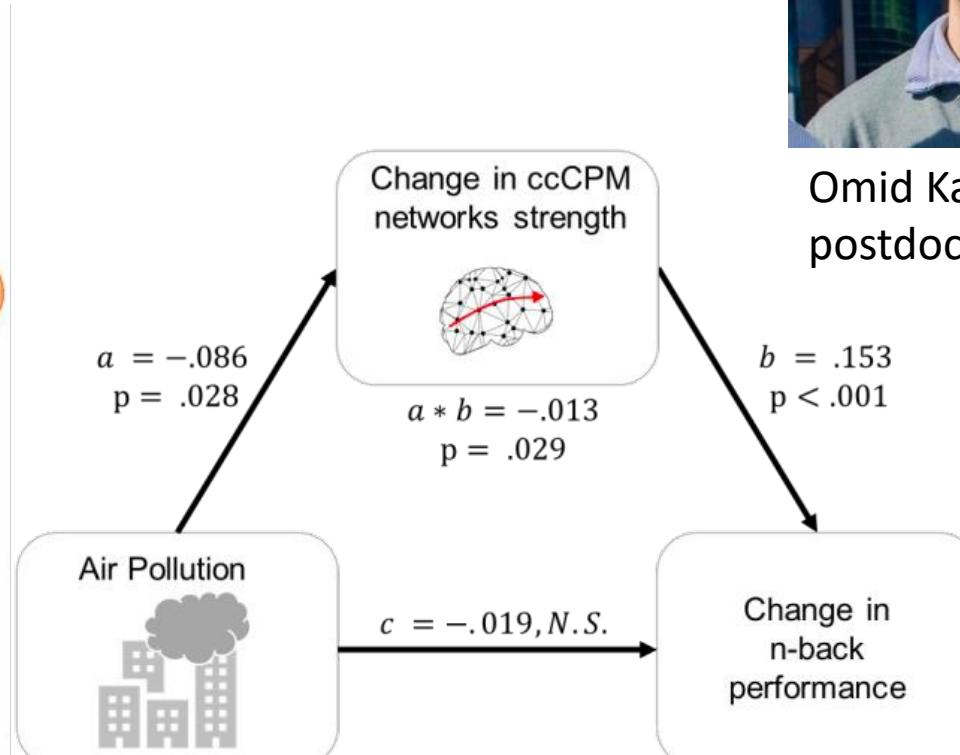
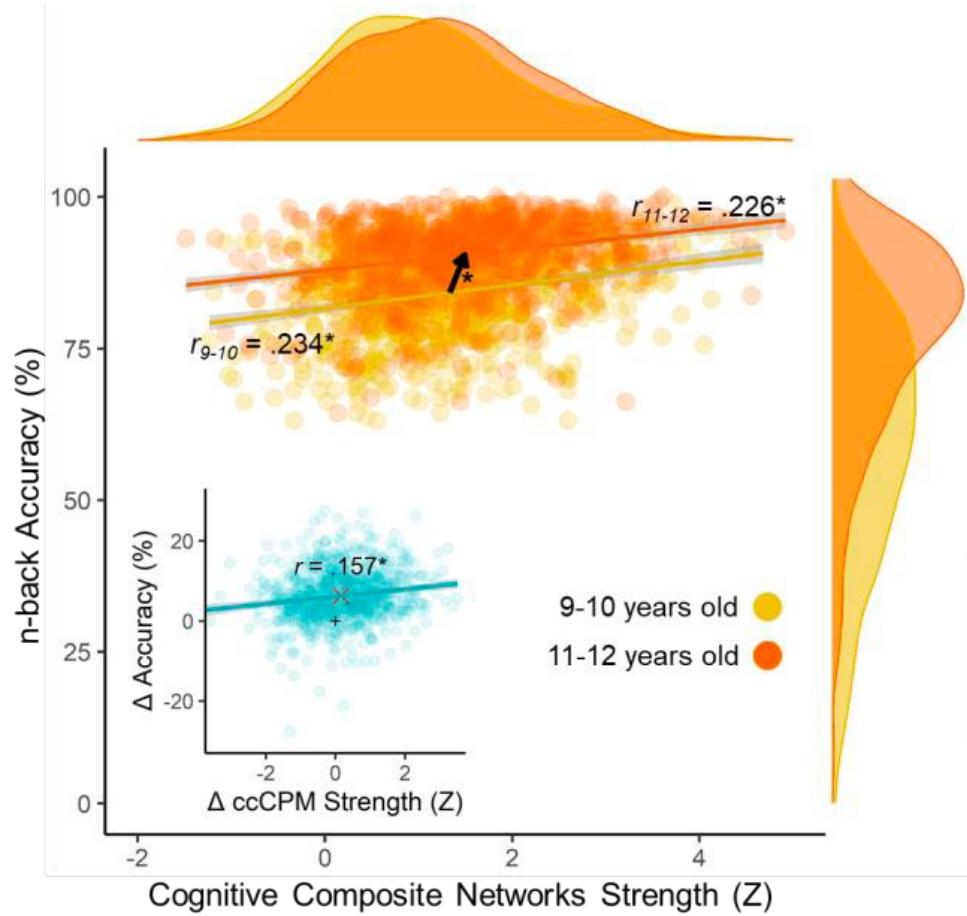
Does Hurst relate to psychopathology and cognitive performance in kids (9-11 olds; ABCD sample)? Yes



Andrew
Stier,
Ph.D.



Bringing it together



Omid Kardan Ph.D.
postdoc at Michigan

Kardan et al., under review