HealthManagement.org
The Journal

LEADERSHIP • CROSS-COLLABORATION • WINNING PRACTICES

VOLUME 19 • ISSUE 5 • 2019 • € 22

ISSN = 1377-7629

Silver Tsunami

- TURNING THE SILVER TSUNAMI INTO A SILVER LINING, *A. LOURENÇO*
- MANAGING THE WHOLE HEALTH OF THE AGEING POPULATION, *C. BUCKLEY*
- OPPORTUNITIES AND RISKS OF DIGITAL HEALTH: OLDER PEOPLE'S PERSPECTIVE, *E. HUCHET*
- ANTI-AGEING THERAPIES: FROM BASIC SCIENCE TO HUMAN APPLICATION, *M. ABDELLATIF & S. SEDEJ*
- AGEISM IN HEALTHCARE: WHY IT HAS TO STOP, *L. AYALON*
- SECRETS OF LONGEVITY - THE IKARIA STUDY, *P. PIETRI*
- FRAILSAFE SYSTEM: AN INNOVATIVE APPROACH ON FRAILTY, *S. MOZA ET AL.*

SINGAPORE: TRANSFORMATIVE SHIFTS IN HEALTHCARE MANAGEMENT, *E. F. SOH*

EUSOBI 2019, *G. FORRAI*

VENDOR-DRIVEN STANDARDS FOR INTEROPERABILITY, *D. HANCOCK*

BREXIT: WREAKING HAVOC IN HEALTHCARE?, *M. DAYAN ET AL.*

LEADING CHANGE AS A PHYSICIAN, *X. CORBELLA & E. O' SULLIVAN*

INNOVATION AND INSPIRATION FOR HEALTHCARE - HOW TO CHANGE FERTILITY CARE WITH VALUE-BASED HEALTHCARE, *M. CURFS*

INNOVATIVE HEALTHCARE STRATEGIES, *P. FACON*

GAME-CHANGING MEETING OF MINDS: RADIOLOGY AND IMAGING INFORMATICS, *E. RANSCHAERT*

IMAGE INFORMATION DELIVERY IN THE AI ERA: TWO LIKELY SCENARIOS, *S. R. BAKER.*

THE SEX AND GENDER INFLUENCE ON HYPERTENSION, *S. SHAH PARESH ET AL.*

HOW THE BRAIN WORKS: LOOKING INSIDE TO TARGET TREATMENTS, *S. MULDOON*

NEW MANAGEMENT PATHWAYS IN CARDIOVASCULAR RISK FACTORS, *R. VIDAL PEREZ*

TACKLING THE FIVE ESSENTIAL LEVERS OF THEATRE EFFICIENCY, *D. THORPE*

How the Brain Works: Looking Inside to Target Treatments

Sarah Muldoon
Assistant Professor
of Mathematics
Faculty Member Computational
and Data-Enabled Science
and Engineering and
Neuroscience programs
University at Buffalo
Buffalo, United States

smuldoon@buffalo.edu

@SarahFMuldoon

Summary: Groundbreaking study at the University at Buffalo uses brain stimulation to assess how large-scale patterns of brain activity could vary between cognitive systems and across people.

Our research at the University at Buffalo explores brain activity and its association with cognitive systems. Each cognitive system consists of a network of brain regions that are linked to different functions. We use computational modeling to investigate how the brain works by mapping out the different regions of the brain and how they are connected in different people. In each subject's brain, a single region was stimulated. A mathematical framework then measured how brain activity synchronised across the various cognitive systems.

Understanding individual variability in brain networks is going to be increasingly important as we attempt to develop personalised medical treatment strategies. We need to know which parts of the brain are subject to more variability and we need frameworks that allow us to measure this variability. Our chimera framework allows for a quantitative assessment of which cognitive systems are more variable across individuals in their response to stimulation. Knowing that a particular brain region shows a highly variable response to stimulation across individuals can help clinicians as they develop a personalised treatment strategy and understanding how these patterns change in different diseases will be important future work.

Findings from the study confirm and extend knowledge of brain structure-function relationships. They also demonstrate that you can investigate critical cognitive states where a balance between integration and segregation is required for adaptive cognition. The methodology was applied to brain networks derived from healthy individuals. Quantifying patterns of synchronisation in other populations and measuring the differences between what is observed in healthy populations might lead to further insight into how structural changes impact function.

In reality, neuronal activity patterns that are observed in the brain using different functional measurement techniques, such as functional magnetic resonance imaging (MRI), electroencephalography, magnetoencephalography, and positron emission tomography, are a result of a complex neurophysiological activity that develops on top of the structural connectivity infrastructure. We used computational simulations to perform in silico stimulations experiments and measure the resulting patterns of synchronisation. However, the cognitive-chimera framework is not limited to simulated data and could be applied to experimental data of all types.

Future research can extend the silico experiments to examine chimera states using experimental data, providing opportunities to enhance performance in healthy participants or individualise medicine in clinical populations. Brain stimulation is currently used as a treatment option for certain disorders (eg Parkinson's disease). It could be the case, that this framework could help clinicians identify new stimulations sites that drive brain networks into desired states or help clinicians understand why treatment isn't as effective in certain people. There's a lot that we still don't know about how brain stimulation works, but our chimera framework allows us to start measuring the effects of stimulation and understand how variable it is across people and brain regions.

This study provides a way to quantify and describe patterns of partial synchronisation that are observed in the brain. We can use this framework to understand individual variability in healthy populations and to understand how different cognitive systems change their patterns of interactions in non-healthy populations.

The research was a collaboration between UB, ARL, Columbia University, the University of Pennsylvania, Carnegie Mellon University and the University of California, Santa Barbara. The study was funded under an Army Collaborative Technology Alliance (**cancta.net**). ■

KEY POINTS

- Individual variability in brain networks is going to be increasingly important to develop personalised medical treatment strategies.
- This framework could help clinicians identify new stimulation sites that drive brain networks into desired states and also help clinicians understand why treatment isn't as effective in certain people.
- This framework provides a way to quantify and describe patterns of partial synchronisation that are observed in the brain.

REFERENCES

Bansal K et al. (2019) Cognitive chimera states in human brain networks. Science Advances Vol 4