



October 22-23, 2020

Virtual Meeting

6th Annual Meeting of the

**SOCIETY FOR THE
NEUROSCIENCE OF
CREATIVITY**

www.tsfnc.org

**6th Annual Meeting of the
Society for the Neuroscience of Creativity**

October 22nd – October 23rd, 2020

Program Booklet

Program Co-chairs:

Yoed Kenett, Technion - Israel Institute of Technology

Darya Zabelina, University of Arkansas

Conference Website: <https://www.tsfn.org/2020-conference>

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Welcome Note from the President

It is a great pleasure to welcome you to SfNC 2020! I am all the more grateful to be able to welcome you this year after wondering six months ago whether we would be able to gather at all. In a year when many of the plot twists have been dark, the energizing journey from disappointment over the cancellation of our Boston meeting in March to excitement about our online meeting in October has been a delightful exception. This happy twist was authored by an extraordinary group of SfNC Organizing Committee members and SfNC Digital Curators with the help of many other volunteers. The talent and dedication of these teams has been remarkable to observe. If you see them around, maybe at the cafe or the library of our gathertown space, you might offer a word of thanks. Their effort was animated by the enthusiasm of the creativity community to come together in spite of the challenges this year has presented, beginning with the overwhelmingly positive response to our March poll asking whether you would attend a rescheduled SfNC 2020. The result of this energy, vision, and grit is an amazing program of scholarly presentations, highlighted by three keynote addresses I can't wait to see, and an online meeting experience that we hope goes beyond the ordinary Zoom-athon. On behalf of everyone at SfNC, I invite you to wander around, find old friends, find new friends, catch the conversation with producer Ian Brennan about Grammy-nominated musical creativity in Malawi's largest prison, and of course check out the newest and most exciting research in our field. Thanks for being part of SfNC 2020 and for all your contributions to our field and our community. Enjoy the meeting!



Adam Green, SfNC President
On Behalf of the SfNC Executive Committee and Organizing Committee

SfNC Leadership Committees

SfNC Executive Committee

David Beversdorf, University of Missouri (Treasurer)
Evangelia Chrysikou, Drexel University
Adam Green, Georgetown University (President)
David Kraemer, Dartmouth College
Manish Saggar, Stanford University
Indre Viskontas, USF & SF Conservatory of Music
Emmanuelle Volle, ICM, INSERM, Sorbonne University, Paris, France

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Mark Beeman, Northwestern University
Robert Bilder, UCLA
Keith Holyoak, UCLA
John Kounios, Drexel University
Daniel Schacter, Harvard University

SfNC 2020 Organizing Committee

Roger Beaty, Pennsylvania State University
Bradley Ferguson, University of Missouri
Yoed Kenett, Technion - Israel Institute of Technology (Co-Chair)
Naama Mayselless, Stanford University
Darya Zabelina, University of Arkansas (Co-Chair)
Claire Zedelius, University of California, Santa Barbara

SfNC 2020 Digital Curation Committee:

Romi Banerjee, Indian Institute of Technology Jodhpur
Mafalda Cardoso-Botelho Peña, Universidad de Deusto
Emily Dyke, Georgetown University
Will Orwig, Harvard University
Anna Smith, Duke University

Program at a Glance

Time (EST)	DAY 1 - 22.10.2020
10:45	President's Opening Remarks: Adam Green
11:10 - 11:55	Keynote: Teresa Amabile
12:00 - 1:15	Talk Session 1
1:15 - 1:30	Break / Open Conversation
1:30 - 2:00	Blitz Session 1
2:00 - 2:30	Panel: How to make it as a creativity researcher
2:30 - 3:30	Poster Session 1 (parallel rooms)
3:30 - 3:45	Break / Open Conversation
3:45 - 4:15	Blitz Session 2
4:15 - 5:00	Keynote 2: Ellen Winner
5:00 - 6:00	Gather.Town Social Hour
6:00 - 6:30	Creativity in Context: A conversation with Ian Brennan

Time (EST)	DAY 2 - 23.10.2020
11:00 - 11:45	Keynote 3: Jonathan Schooler
11:45 - 1:00	Talk Session 2
1:00 - 1:15	Break / Open Conversation
1:15 - 2:15	Poster Session 2 (parallel rooms)
2:15 - 3:15	Open Conversation / Networking Opportunity / Break
3:15 - 3:45	Blitz Session 3
3:45 - 4:00	Talk: NSF programs that fund cognitive neuroscience and research on creativity
4:00 - 4:15	Closing Remarks

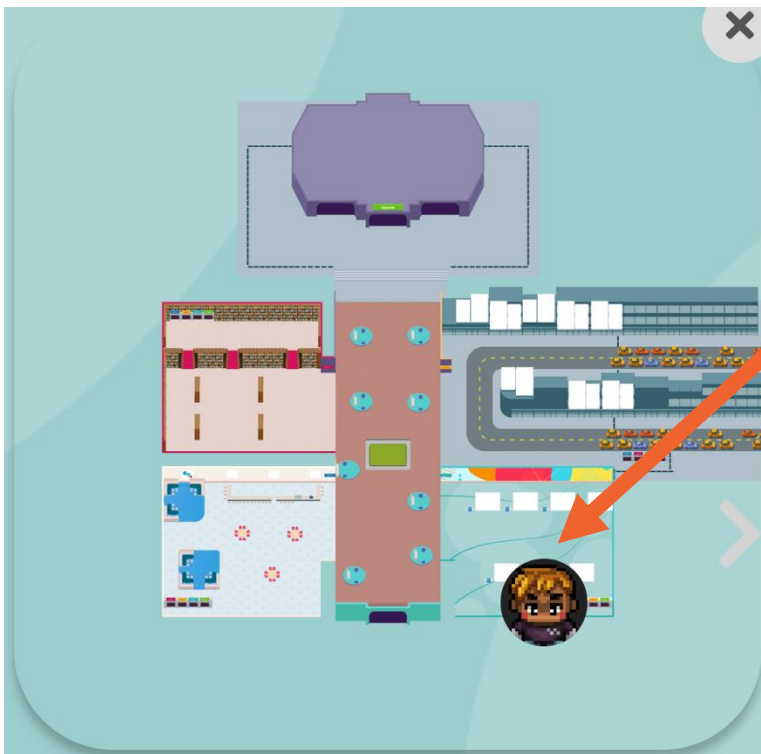
Poster Schedule

Day	Time (EST)	Session	Room 1	Room 2	Room 3
1	2:30 - 3:00	1	Memory &	Electrophysiology	Music
	3:00 - 3:30	2	Executive Processes	Insight	Artistic Creativity
2	1:15 - 1:45	1	Domain Creativity	Methods	Pharmacology & Altered States
	1:45 - 2:15	2	Education & Social Context	Brain Stimulation	Personality



SfNC Initiatives and Events

SfNC initiatives and special events reflect SfNC's mission to engage and connect the diverse stakeholders in creativity (the creativity community) toward advancing the science of creativity and maximizing the impacts of this science beyond the laboratory. The following pages provide updates on SfNC initiatives and events over the last year.



To learn more about ongoing initiatives and events at SfNC, please visit the **Projects and Announcements Room** in Gather.town during this year's meeting.

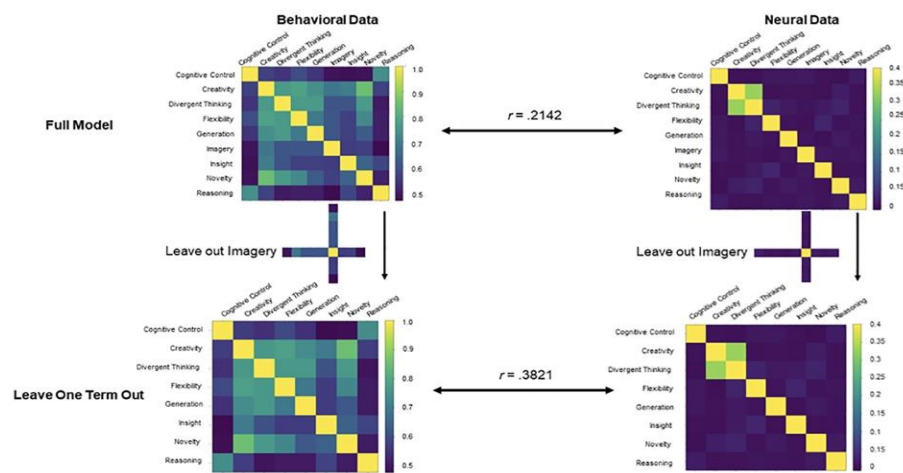


A priority for the advancement of creativity research is to develop greater precision and consistency in the terms we use for creativity-related constructs and, especially, in the tasks we use to measure these constructs. SfNC is seeking to advance the ontological development of creativity research along multiple convergent lines. The first published work from this research (described below) began at the 2019 SfNC meeting in San Francisco by asking our members (THANK YOU!) about the meaning and measurement of creativity-related constructs. **To read more about SfNC’s ongoing work on the ontology of creativity, please visit the Projects and Announcements room in Gather.town during this year’s conference.**

Toward a Neurally-Informed Ontology of Creativity Measurement

The SfNC NeuroOntology project is an ongoing effort focused on developing approaches by which the field of creativity neuroscience can leverage data collected from thousands of neuroimaging studies to inform and improve the definition and measurement of key creativity-related constructs. Data collection for this project began at the 2019 SfNC meeting in San Francisco where creativity researchers and other creativity scholars were surveyed about the relationships between creativity constructs and the tasks used to measure these constructs. Based on these data, and data collected from other creativity researchers, a team of SfNC members has demonstrated proof-of-concept for a novel NeuroOntology method for creativity measurement. Using representational similarity analysis as a meta-analytic tool, the authors compare models derived from neural data to models defined by the ways creativity researchers think about creativity constructs. This approach makes it possible to iteratively test which sets of tasks provide a similarity structure that best reflects the similarity structure of a set of constructs. As more detailed and larger datasets become available, this method has potential to refine the choice of constructs the field uses to define creativity, as well as the choice of tasks used to measure those constructs in the lab. A paper reporting this method is now published in the *NeuroImage* special issue on Creativity and the Brain.

Behavioral and neural results for the full model space of constructs and a reduced set of constructs. *Top row, left:* Similarity matrix defined by experts through pairwise ratings of terms. These ratings are scaled to range from 0 to 1 (1 = complete conceptual overlap between terms). *Top row, right:* Similarity matrix defined by NeuroSynth term-based meta-analyses. Each of the FDR-corrected NeuroSynth meta-analytic association z-maps were Spearman-correlated with each other to create a measure of how similar the patterns of neural activity associated with those terms are to each other. *Bottom row, left:* A reduced construct space is defined by removing the term *Imagery* from the expert similarity matrix. *Bottom row, right:* A reduced construct space is defined by removing the term *Imagery* from the neural similarity matrix. In this example, correlation between the expert model and neural model improves when the construct *Imagery* is removed.



Kenett, Kraemer, Alfred, Colaizzi, Cortes, & Green (2020) *NeuroImage*.

NeuroImage Special Issue: Creativity and the Brain

A special issue of *NeuroImage* on “Creativity and the Brain” was developed in partnership with SfNC and guest-edited by SfNC Executive Committee members. The motivations for this special issue reflect the goals of SfNC. SfNC was formed with the charter to foster interdisciplinary research on neural and cognitive bases of creativity and related processes, and to provide an inclusive forum for communicating this research so that it has maximal impacts for education, health, innovation, and artistic performance. SfNC seeks to achieve a force-multiplier effect by combining the energy sources surrounding creativity neuroscience so that they can inform each other toward advancing the field. The *NeuroImage* special issue brings together both expository and new empirical work from creativity neuroscience labs across the globe. We hope that this special issue can contribute to 1) mapping the diversity of creativity neuroscience to increase mutual awareness within the field and increase awareness of creativity neuroscience in the broader cognitive neuroscience community, and 2) highlighting promising research directions toward stronger coalescence around methods and questions that have potential to catalyze basic understanding of how creativity happens in the brain and how to enhance it.

We were excited to receive far more manuscripts submitted for the special issue than we anticipated. The extraordinarily high quality of these manuscripts made for many difficult editorial decisions (a good problem to have). **Forty-one papers** were ultimately accepted for publication, representing the diversity of creativity neuroscience, and the current and emerging directions in our field. **The images on the next pages represent the conceptual geometry and physical geography of creativity research in the special issue.**

**Check out the accepted
manuscripts in the
NeuroImage Special Issue
Room
in Gather.town during SfNC
2020!**



The below images depict summary statistic as a graph for the 41 articles included in the special issue. The graph represents similarity across the included articles. The similarity was assessed by comparing keywords provided with each article. To generate similarity score between any two articles, we first embedded each set of keywords using the Universal Sentence Encode (Cer et al. 2018), followed by assessing the euclidean distance between embeddings. The resulting similarity matrix was visualized in a 3-D force layout as a graph, where nodes represent articles and edges represent similarity. The colors represent the methods used in the research (Figure 1), and the geographical locations of the labs where the research was done (Figure 2). The size of the node represents number of participants in the study.

Figure 1. Methods

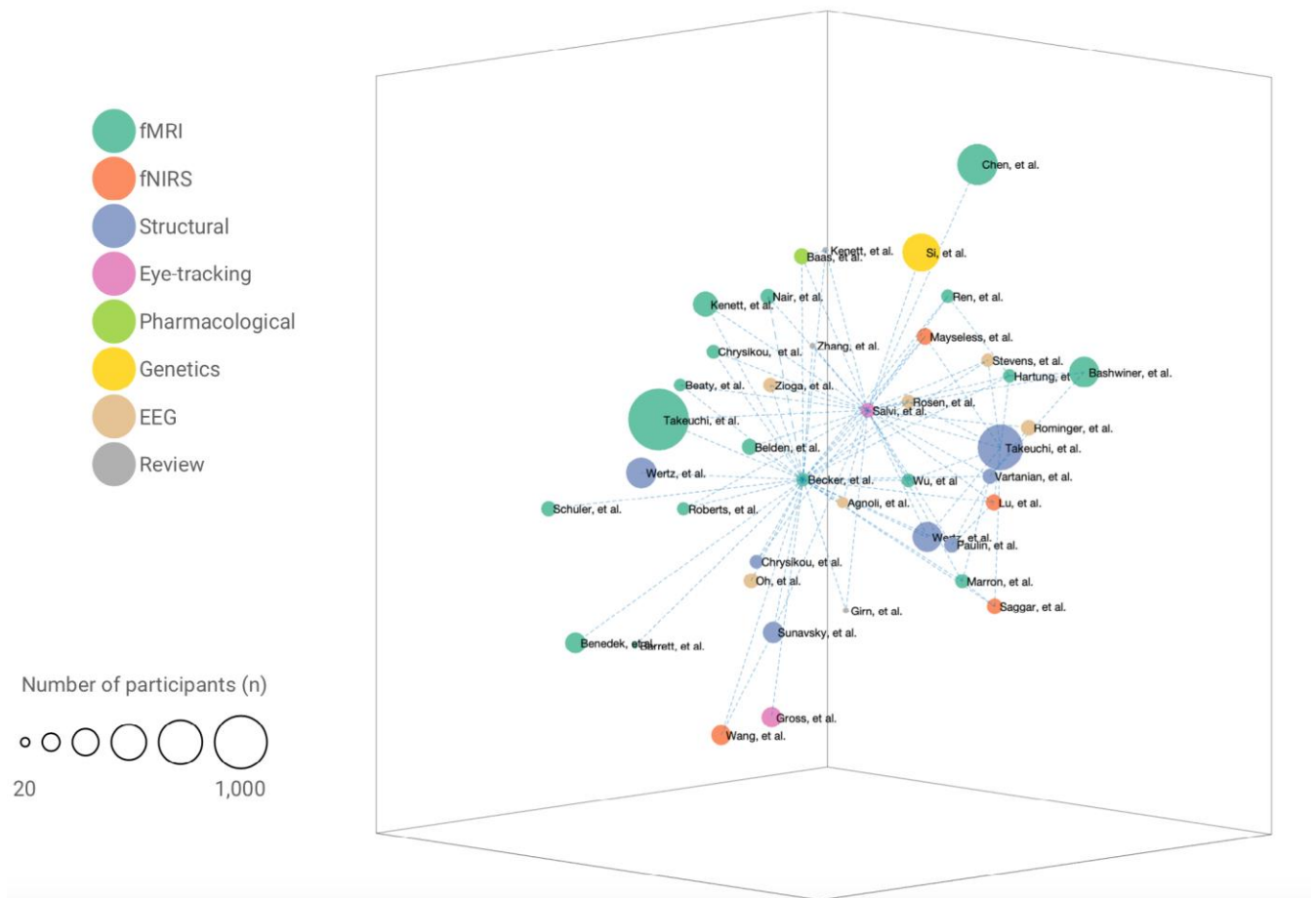
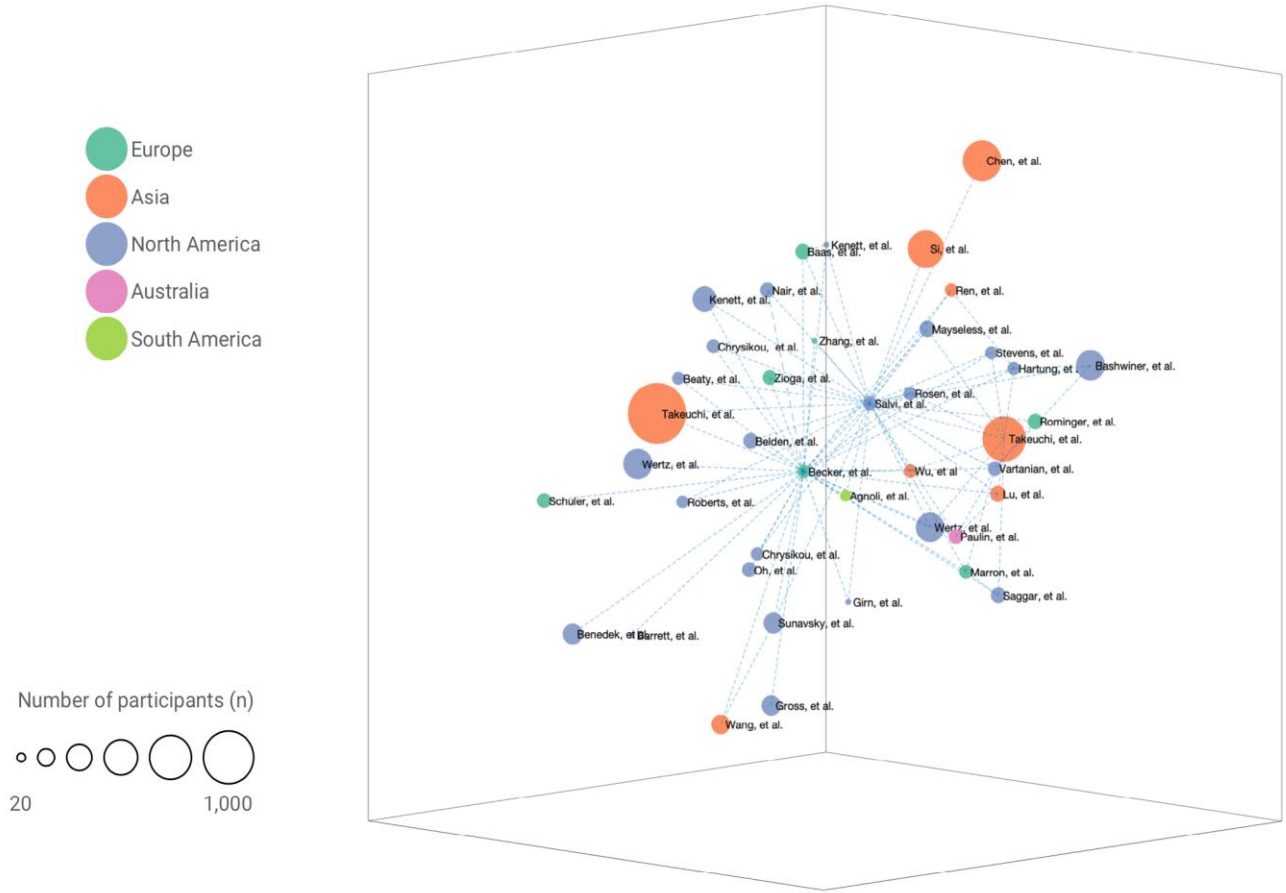


Figure 2. Geographical Locations





SfNC Masterclass



In October 2019, SfNC partnered with the ICM* to organize a “creativity masterclass” in Paris geared toward executives in industry and educational domains. This 2-day workshop focused on current neuroscientific knowledge regarding how creativity works in the mind and brain, as well as cognitive and brain-based methods for measuring and bolstering creative abilities. Participants came from various fields, including education, management consulting, and R&D departments of large companies from pharmaceutical companies to the fashion and gaming industries. Participants were quite enthusiastic about the masterclass, which SfNC aims to repeat in the future in this and other settings.



*[ICM](#) is an international neuroscience Institute, based in Paris, France, affiliated with Sorbonne University

Invited Presentations

Keynote Talks

October 22nd, Thursday: 11:10 - 11:55 (EST)

Teresa Amabile, Harvard University

Keynote 1: A Labor of love: Insights from a creativity research program ([Abstract](#))

October 22nd, Thursday: 4:15 - 5:00 (EST)

Ellen Winner, Boston College & Harvard Project Zero

Keynote 2: Creativity in child art: How to nurture it, how to kill it ([Abstract](#))

October 23rd, Friday: 11:00 - 11:45 (EST)

Jonathan Schooler, University of California, Santa Barbara

Keynote 3: Creativity, curiosity and mind-wandering: The upside of a mind in flight ([Abstract](#))

Panel Discussion, October 22nd, Thursday, 2:00 – 2:30 (EST)

How to make it as a creativity researcher ([Abstract](#))

Presenters:

Indre Viskontas, University of San Francisco

John Kounios, Drexel University

Psyche Loui, Northeastern University

Roger Beaty, Penn State University

Adam E. Green, Georgetown University

Talk, October 23rd, Friday, 3:45 – 4:00 (EST)

NSF programs that fund cognitive neuroscience and research on creativity ([Abstract](#))

Presenters:

Gregg Solomon, National Science Foundation

Robert Ochsendorf, National Science Foundation

Special Event, October 22nd, Thursday, 6:00 – 6:30 (EST)

Creativity in Context: a conversation with Grammy-winning Music Producer Ian Brennan ([Abstract](#))

Presenters:

Indre Viskontas, University of San Francisco

Ian Brennan

Talk Sessions

Talk Session 1, October 22nd, Thursday

12:00 - 12:15 (EST)

SemDis: An open platform for automated creativity assessment via semantic distance ([Abstract](#))

Presenters:

Roger E. Beaty, Pennsylvania State University

Dan R. Johnson, Washington and Lee University

12:15 - 12:30 (EST)

Dynamic balance between default and control networks predicts individual creative thinking ability: Findings from the Creative Connectome and Reproducibility Project ([Abstract](#))

Presenters:

Qunlin Chen, Southwest University & Penn State University

Yoed N. Kenett, Technion - Israel Institute of Technology

Zaixu Cui, University of Pennsylvania

Mathias Benedek, University of Graz

Jiang Qiu, Southwest University

Roger E. Beaty, Pennsylvania State University

12:30 - 12:45 (EST)

The role of executive function in young children's divergent thinking ([Abstract](#))

Presenters:

Julie Vaisarova, University of Minnesota

Stephanie M. Carlson, University of Minnesota

12:45 – 1:00 (EST)

Real-world creativity studies and their application to various industries ([Abstract](#))

Presenter:

Monica Lopez-Gonzalez, Johns Hopkins University

1:00 - 1:15 (EST)

Neurosciences in companies: Innovation and decision-making ([Abstract](#))

Presenters:

Renata Coura, Neurotelos SAS

Sylvie Granon, Université Paris-Sud

Talk Session 2, October 23rd, Friday

11:45 - 12:00 (EST)

The costs and benefits of semantic memory structure in generating original ideas ([Abstract](#))

Presenters:

Yoed N. Kenett, Technion - Israel Institute of Technology

Roger E. Beaty, Pennsylvania State University

Richard W. Hass, Thomas Jefferson University

Daniel L. Schacter, Harvard University

12:00 - 12:15 (EST)

EEG correlates of flexibility during divergent thinking ([Abstract](#))

Presenters:

Serena Mastria, University of Bologna

Sergio Agnoli, University of Bologna

Marco Zanon, University of Udine

Selcuk Acar, The State University of New York

Mark A. Runco, The State University of New York

Giovanni E. Corazza, University of Bologna

12:15 - 12:30 (EST)

Creativity anxiety: An affective barrier to creative achievement ([Abstract](#))

Presenters:

Richard Daker, Georgetown University

Robert Cortes, Georgetown University

Zhiting Ren, Southwest University

Jiang Qiu, Southwest University

Ian Lyons, Georgetown University

Adam E. Green, Georgetown University

12:30 - 12:45 (EST)

Sleep, dreams and capturing creativity ([Abstract](#))

Presenters:

Adam Haar Horowitz, Massachusetts Institute of Technology

Pat Pataranutaporn, Massachusetts Institute of Technology

Blitz Sessions

Blitz Session 1, October 22nd, Thursday

1:30 - 1:35 (EST)

Biases in language production are reflected in musical improvisation: Evidence from large-scale corpus analysis ([Abstract](#))

Presenters:

Hannah M. Merseal, Pennsylvania State University

Roger E. Beaty, Pennsylvania State University

1:35 - 1:40 (EST)

The neural dynamics of musical creativity in jazz pianists ([Abstract](#))

Presenters:

Patricia A. Da Mota, Aarhus University, Oxford University & University of Minho

Henrique M. Fernandes, Aarhus University, Oxford University & University of Minho

Eloise Stark, Oxford University

Joana Cabral, Oxford University & University of Minho

Ole A. Heggli, Aarhus University

Nuno Sousa, University of Minho

Morten L Kringelbach, Aarhus University, Oxford University & University of Minho

Peter Vuust, Aarhus University

1:40 - 1:45 (EST)

Modelling musical creativity in the brain: Predicting transitions of brain dynamics between modes of music preparation ([Abstract](#))

Presenters:

Henrique M. Fernandes, Aarhus University, Oxford University & University of Minho

Patricia A. Da Mota, Aarhus University, Oxford University & University of Minho

Eloise Stark, Oxford University

Peter Vuust, Aarhus University

Gustavo Deco, Universitat Pompeu Fabra

Morten L Kringelbach, Aarhus University, Oxford University & University of Minho

1:45 - 1:50 (EST)

Brands in creative processes - A field study with advertising agencies ([Abstract](#))

Presenters:

Catia Alves, Nova School of Business and Economics

Irene Consiglio, Nova School of Business and Economics

Luis Martinez, Nova School of Business and Economics

Blitz Session 2, October 22nd, Thursday

3:45 - 3:50 (EST)

Art as creative inspiration ([Abstract](#))

Presenters:

Edward A. Vessel, Max Planck Inst. for Empirical Aesthetics

Dominik Welke, Max Planck Inst. for Empirical Aesthetics

Isaac Purton, New York University

3:50 - 3:55 (EST)

Cortical activity tracks fractal complexity in both artistic and mathematical images, but with different mechanisms ([Abstract](#))

Presenters:

Stephanie Kane, University of Arkansas

Rebecca White, University of New Hampshire

Eric Rawls, University of Minnesota Medical School

Carl E. Stevens, Jr., University of Arkansas

Darya L. Zabelina, University of Arkansas

3:55 - 4:00 (EST)

Percolating ideas: The effects of caffeine on creative thinking and problem solving ([Abstract](#))

Presenters:

Darya L. Zabelina, University of Arkansas

Paul Silvia, University of North Carolina at Greensboro

4:00 - 4:05 (EST)

'Walk in My Shoes' - An assessment of an experiential intervention to use creativity to engender empathy ([Abstract](#))

Presenters:

Micah Kessel, Northeastern University

Anna Ciaunica, Institute of Philosophy Porto

Blitz Session 3, October 23rd, Friday

3:15 - 3:20 (EST)

Neuromodulation of executive control and default mode networks to enhance verbal creativity ([Abstract](#))

Presenters:

Robert A. Cortes, Georgetown University

Yangping Li, Shaanxi Normal University

Adam E. Green, Georgetown University

Roger E. Beaty, Pennsylvania State University

3:20 - 3:25 (EST)

The role of the motor system in generating creative thoughts ([Abstract](#))

Presenters:

Heath Matheson, University of Northern British Columbia

Yoed N. Kenett, Technion - Israel Institute of Technology

3:25 - 3:30 (EST)

The creative foraging game: A high resolution probe to the computational mechanisms of creative search ([Abstract](#))

Presenter:

Yuval Hart, Hebrew University of Jerusalem

3:30 - 3:35 (EST)

Thinking outside the box alone or in social context: From laboratory to school teaching methodologies ([Abstract](#))

Presenters:

Anaëlle Camarda, Mines ParisTech

Mathieu Cassotti, University de Paris

Poster Sessions

(Click on a category to see its detailed schedule)

Day	Time (EST)	Session	Room 1	Room 2	Room 3
1	2:15 - 2:45	1	<u>Memory & Executive</u>	<u>Electrophysiology</u>	<u>Music</u>
	2:45 - 3:15	2	<u>Processes</u>	<u>Insight</u>	<u>Artistic Creativity</u>
2	1:00 - 1:30	1	<u>Domain Creativity</u>	<u>Methods</u>	<u>Pharmacology & Altered States</u>
	1:30 - 2:00	2	<u>Education & Social Context</u>	<u>Brain Stimulation</u>	<u>Personality</u>

Poster Session – 1, October 22nd, Thursday

Room – 1, Session – 1 & 2, Memory & Executive Processes

Time (EST) Title & Authors

- 2:30 - 2:34 **Inter- & intra-individual differences in associative distance predicts problem solving success**
Derek M. Ellis, Arizona State University
([Abstract](#))
- 2:34 - 2:38 **Does episodic memory contribute to creative writing?**
Ruben D.I. van Genugten, Harvard University
Roger E. Beaty, Pennsylvania State University
Kevin P. Madore, Harvard University
Daniel L. Schacter, Harvard University
([Abstract](#))
- 2:38 - 2:42 **Does boredom inspire creativity?**
Lauren E. Flynn, University of New Hampshire
Catherine A. McGrath, University of New Hampshire
Caitlin S. Mills, University of New Hampshire
([Abstract](#))
- 2:42 - 2:46 **Mednick's (1962) theory of creativity revisited: The effect of word type on associative fluency**
Deana Vitrano, University at Albany
Jeanette Altarriba, University at Albany
Deniz Leblebici-Başar, Istanbul Technical University
([Abstract](#))
- 2:46 - 2:50 **Individual differences in patterns of semantic distance**
Katherine L. Alfred, Dartmouth College
Megan E. Hillis, Dartmouth College
David J. M. Kraemer, Dartmouth College
([Abstract](#))
- 2:50 - 2:54 **To Inhibit or to disinhibit? Cognitive control enhances generation of ideas**
Tal Ivancovsky, Bar-Ilan University
Moshe Bar, Bar-Ilan University
([Abstract](#))

- 2:54 - 2:58 **Creative problem solving in aging: The role of executive functions, divergent thinking, and risk taking**
 Alice Cancer, Catholic University of the Sacred Heart
 Paola Iannello, Catholic University of the Sacred Heart
 Carola Salvi, University of Texas at Austin
 Alessandro Antonietti, Catholic University of the Sacred Heart
[\(Abstract\)](#)
- 2:58 - 3:02 **Metacontrol of human creativity: The neurocognitive mechanisms of convergent and divergent thinking**
 Weitao Zhang, Leiden University
[\(Abstract\)](#)
- 3:02 – 3:06 **Dopamine supports originality: The relationship between eye blink rate, originality, and flexibility in divergent thinking**
 Sergio Agnoli, University of Bologna, Marconi Institute for Creativity
 Serena Mastria, University of Bologna, Marconi Institute for Creativity
 Marco Zanon, SISSA Scuola Internazionale Superiore di Studi Avanzati
 Giovanni Emanuele Corazza, University of Bologna, Marconi Institute for Creativity
[\(Abstract\)](#)

Poster Session – 1, October 22nd, Thursday

Room – 2, Session – 1, Electrophysiology

Time (EST) Title & Authors

- 2:30 - 2:34 **Alpha power over right/mid-frontal brain regions support the generation of remote associations in higher creative individuals**
 Ioanna Zioga, Queen Mary University of London
 Yoed N. Kenett, Technion - Israel Institute of Technology
 Caroline Di Bernardi Luft, Queen Mary University of London
[\(Abstract\)](#)
- 2:34 - 2:38 **Facilitating creativity: Using machine learning EEG classification to provide neurofeedback in a divergent thinking task**
 Carl E. Stevens Jr., University of Arkansas
 Darya L. Zabelina, University of Arkansas
[\(Abstract\)](#)
- 2:38 - 2:42 **Decoding moment of insight: Single-trial classification of insight and analytic problem solving using Multivariate Pattern Analysis (MVPA) on pre-solution EEG data**
 Yongtaek Oh, Drexel University
 Christine Chesebrough, Drexel University
 John Kounios, Drexel University
[\(Abstract\)](#)
- 2:42 - 2:46 **Facilitating problem solving with targeted memory reactivation during in-lab overnight sleep**
 Kristin E. G. Sanders, University of Notre Dame
 Kara R. H. Dastrup, Northwestern University
 Lane Patterson, Northwestern University
 Anjan Ghosh, Northwestern University
 Ken A. Paller, Northwestern University
 Mark Beeman, Northwestern University
[\(Abstract\)](#)

- 2:46 - 2:50 **Can stereotype threat boost performance? The impact of stereotype threat on neural correlates of creative performance in female engineers**
 Rafał Jończyk, Adam Mickiewicz University, Pennsylvania State University
 Yushuang Liu, Pennsylvania State University
 Danielle Dickson, Pennsylvania State University
 Gul E. Kremer, Iowa State University
 Zahed Siddique, University of Oklahoma
 Janet G. van Hell, Pennsylvania State University
[\(Abstract\)](#)

Poster Session – 1, October 22nd, Thursday

Room – 2, Session – 2, Insight

Time (EST) Title & Authors

- 3:00 - 3:04 **An examination of the hypotheses of the Dynamic Framework of mind wandering**
 Anna P. Smith, Duke University
 Nick Brosowsky, Duke University
 Paul Seli, Duke University
[\(Abstract\)](#)
- 3:04 - 3:08 **Identification of brain regions underlying spatial insight problem solving**
 Takeshi Ogawa, ATR
 Takatsugu Aihara, ATR
 Okito Yamashita, ATR, RIKEN-AIP
[\(Abstract\)](#)
- 3:08 - 3:12 **Evidence for the relationship between Aha moments, analogical reasoning, and conceptual change**
 Christine B. Chesebrough, Drexel University
 John Kounios, Drexel University
 Lila Chrysikou, Drexel University
[\(Abstract\)](#)
- 3:12 - 3:16 **The predictive power of insight problem-solving: The case of fake news**
 Carola Salvi, University of Texas at Austin
 Nathaniel Barr, Sheridan College
[\(Abstract\)](#)
- 3:16 - 3:20 **Reduced certainty preference after solving problems with insight than solving with analysis**
 Yuhua Yu, Northwestern University
[\(Abstract\)](#)

Poster Session – 1, October 22nd, Thursday

Room – 3, Session – 1, Music

Time (EST) Title & Authors

- 2:30 - 2:34 **Dual-process contributions to creativity in jazz improvisations: An SPM-EEG study**
 David S. Rosen, Drexel University
 Yongtaek Kim, Drexel University
 Brian Erickson, Drexel University
 Fengqing Zhang, Drexel University

Youngmoo Kim, Drexel University
John Kounios, Drexel University
([Abstract](#))

2:34 - 2:38 **Training-dependent changes of cortical network dynamics in musicians**
Alexander Belden, Wesleyan University, Northeastern University
Tima Zeng, Wesleyan University
Emily Przysinda, Wesleyan University
Psyche Loui, Wesleyan University, Northeastern University
([Abstract](#))

2:38 - 2:42 **The effects of musical improvisation instruction on visual and auditory statistical learning**
Martin Norgaard, Georgia State University
Joanne A. Deocampo, Georgia State University
Lauren E. Garber, Georgia State University
Samantha N. Emerson, Boys Town National Research Hospital
Christopher M. Conway, Boys Town National Research Hospital
([Abstract](#))

2:42 - 2:46 **Effects of music listening on Resting State Spectral Frequency measures and Independent Components of EEG**
Kate E. Eskine, Wheaton College
([Abstract](#))

Poster Session – 1, October 22nd, Thursday

Room – 3, Session – 2, Artistic Creativity

Time (EST) Title & Authors

- 3:00 - 3:04 **Creative paintings reveal gender differences in the allocation of spatial attention**
Chichun E. Sun, University of Florida
Benjamin Chapin, University of Florida
Kenneth M. Heilman, University of Florida; North Florida/South Georgia Veterans Affairs Medical Center
([Abstract](#))
- 3:04 - 3:08 **Subtly and creatively revealing emotional valence in paintings**
Karly A. Landvay, University of Florida
Kenneth M. Heilman, University of Florida
([Abstract](#))
- 3:08 - 3:12 **Becoming artists: Using creative writing to change the brain**
Dawson C. Hill, University of Minnesota
([Abstract](#))
- 3:12 - 3:16 **The cognitive appraisal of skilled performative movement**
Michelle C. Lerner, Temple University
([Abstract](#))
- 3:16 - 3:20 **Dance expertise modulates emotion sensitivity: insights from face processing and embodied cognition using Somatosensory Evoked Potentials**
Vasiliki Meletaki, City, University of London
Bettina Forster, City, University of London
Beatriz Calvo-Merino, City, University of London
([Abstract](#))

- 3:20 - 3:24 **High scores on the Thought Impact Scale are associated with more frequent engagement in common creative and artistic activities among U.S. adults**
Olafur S. Palsson, University of North Carolina at Chapel Hill
([Abstract](#))

Poster Session – 2, October 23rd, Friday
Room – 1, Session – 1, Domain Creativity

Time (EST) Title & Authors

- 1:15 - 1:19 **Increasing creative performance through basketball**
Thomas Kanatschnig, University of Graz
Andreas Fink, University of Graz
Silvia E. Kober, University of Graz
([Abstract](#))
- 1:19 - 1:23 **Your brain on comedy: Neural activity associated with verbal improvisation in professional comedic improvisers**
Karen Chan Barrett, University of California San Francisco
Sammy Wegent, Speechless, Inc., San Francisco
Anthony Venezia, Speechless, Inc., San Francisco
Lauren Jacobs, University of California San Francisco
Patpong Jiradejvong, University of California San Francisco
Charles J. Limb, University of California San Francisco
([Abstract](#))
- 1:23 - 1:27 **Functional activity and connectivity during creative ideation in product design engineers**
Gerard Campbell, University of Strathclyde
Alex Duffy, University of Strathclyde
Laura Hay, University of Strathclyde
Sam Gilbert, University College London
Chris McTeague, University of Strathclyde
Damien Coyle, Ulster University
Madeleine Grealy, University of Strathclyde
([Abstract](#))
- 1:27 - 1:31 **Cracking the joke: Reexamining humor's relationship with creative problem-solving**
Christopher C. Simmons, University of Massachusetts Dartmouth
([Abstract](#))
- 1:31 - 1:35 **Contribution of semantic memory and fluid reasoning to creativity problem solving in Chefs**
Maddi Ibarbia, BCBL - Basque Center on Cognition, Brain and Language
Kshipra Gurunandan, BCBL - Basque Center on Cognition, Brain and Language
Manuel Carreiras, BCBL - Basque Center on Cognition, Brain and Language
Pedro M. Paz-Alonso, BCBL - Basque Center on Cognition, Brain and Language
([Abstract](#))
- 1:35 - 1:39 **Is creativity domain-specific or domain-general? An ALE meta-analysis across 5 domains**
Steven Brown, McMaster University
Eunseon Kim, McMaster University
([Abstract](#))
- 1:39 - 1:43 **Flexible semantic network structure supports creative metaphor ability**

Yangping Li, Pennsylvania State University, Shaanxi Normal University,
Yoed N. Kenett, Technion - Israel Institute of Technology
Roger E. Beaty, Pennsylvania State University
([Abstract](#))

Poster Session – 2, October 23rd, Friday

Room – 1, Session – 2, Education & Social Context

Time (EST) Title & Authors

- 1:45 - 1:49 **Pedagogical influence on creativity: Preliminary evidence from resting-state fMRI data**
Solange Denervaud, Lausanne University Hospital
Roger Beaty, Pennsylvania State University
Patric Hagmann, Lausanne University Hospital
([Abstract](#))
- 1:49 – 1:53 **Fear, problem-solving, and socio-cognitive polarization during the early peak of the COVID-19 pandemic**
Mason McClay, University of Texas at Austin
Carola Salvi, University of Texas at Austin
Paola Iannello, University Cattolica del Sacro Cuore
Alice Cancer, University Cattolica del Sacro Cuore
Sabrina Rago, University Cattolica del Sacro Cuore
Joseph E. Dunsmoor, University of Texas at Austin
Alessandro Antonietti, University Cattolica del Sacro Cuore
([Abstract](#))
- 1:53 – 1:57 **The mobile technology crisis: Smartphone addiction is linked with sower divergent thinking scores**
Joshua D. Upshaw, University of Arkansas
Carl E. Stevens, Jr., University of Arkansas
Darya L. Zabelina, University of Arkansas
([Abstract](#))
- 1:57 - 2:01 **Imagination and social media use in young adults**
Whitney Davis, University of Arkansas
Joshua Upshaw, University of Arkansas
Darya L. Zabelina, University of Arkansas
([Abstract](#))
- 2:01 - 2:05 **The effect of social cognition style on creative potential**
Nuoya Tan, University College London
([Abstract](#))
- 2:05 - 2:09 **The relation between creativity and STEM learning among preschoolers**
Allyson Snyder, University of Virginia
([Abstract](#))

Poster Session – 2, October 23rd, Friday

Room – 2, Session – 1, Methods

Time (EST) Title & Authors

- 1:15 - 1:19 **Spontaneous and deliberate modes of creativity: Multitask eigenconnectivity analysis captures latent cognitive modes during creative thinking**

Hua Xie, Stanford University
Roger E. Beaty, Pennsylvania State University
Sahar Jahanikia, Stanford University
Caleb Geniesse, Stanford University
Neeraj S. Sonalkar, Stanford University
Manish Saggar, Stanford University
([Abstract](#))

- 1:19 - 1:23 **The impact of adding a fourth item to the traditional 3-item Remote Associates Test**
Jose A. Diaz Jr., Baylor University
Michael K. Scullin, Baylor University
Alex Beaujean, Baylor University
Steve Nelson, Baylor University
([Abstract](#))
- 1:23 - 1:27 **Applications of graph theory in creativity: A study of resting state functional connectivity and divergent thinking**
William Orwig, Massachusetts General Hospital
Roger Beaty, Pennsylvania State University
Ibai Diez Palacio, Massachusetts General Hospital
Jorge Sepulcre, Massachusetts General Hospital
([Abstract](#))
- 1:27 - 1:31 **The role of creativity and fractality in visual pareidolia**
Antoine Bellemare, Concordia University
Yann Harel, University de Montreal
Karim Jerbi, University de Montreal
([Abstract](#))
- 1:31 - 1:35 **Investigation of the neurophysiological mechanisms of internal attention in creative cognition**
Simon M. Ceh, University of Graz
Sonja Annerer-Walcher, University of Graz
Christof Koerner, University of Graz
Mathias Benedek, University of Graz
([Abstract](#))
- 1:35 - 1:39 **Static and dynamic network re-configuration in creative brain networks**
Abhishek Uday Patil, Vellore Institute of Technology
Sejal Ghate, Vellore Institute of Technology
Deepa Madathil, Vellore Institute of Technology
Ovid J.L. Tzeng, Academia Sinica
Hsu-Wen Huang, City University of Hong Kong
Chih-Mao Huang, National Chiao Tung University
([Abstract](#))

Poster Session – 2, October 23rd, Friday Room – 2, Session – 2, Brain Stimulation

Time (EST) Title & Authors

- 1:45 - 1:49 **Learning preferences as an index of individual differences in cognitive flexibility**
Hayley E. O'Donnell, Drexel University
Evangelia G. Chrysikou, Drexel University
([Abstract](#))

- 1:49 - 1:53 **Enhancing creativity by altering the frontoparietal control network functioning using transcranial direct current stimulation**
Adi Lifshitz Ben-Basat, Ariel University
Nira Mashal, Bar-Ilan University
([Abstract](#))
- 1:53 - 1:57 **The effect of transcranial Random Noise Stimulation (tRNS) over the dorsolateral prefrontal cortex on divergent thinking, convergent thinking and insight problem solving**
Javier Peña, University of Deusto
Agurne Sampedro, University of Deusto
Naroa Ibarretxe-Bilbao, University of Deusto
Leire Zubiaurre-Elorza, University of Deusto
Natalia Ojeda, University of Deusto
([Abstract](#))
- 1:57 - 2:01 **tDCS modulates the interactions of brain networks related to creative thinking**
Koji Koizumi, The University of Tokyo
Kazutaka Ueda, The University of Tokyo
Ziyang Li, The University of Tokyo
Masayuki Nakao, The University of Tokyo
([Abstract](#))
- 2:01 - 2:05 **Executive control network transcranial alternating stimulation (tACS) modulates visual analogical reasoning**
Robert A. Cortes, Georgetown University
Robert G. Morrison, Loyola University Chicago
Sydney Samoska, Loyola University Chicago
Sara Temelkova, Loyola University Chicago
Shana Ward, Loyola University Chicago
Adam E. Green, Georgetown University
([Abstract](#))
- 2:05 - 2:09 **Examining prefrontal cortex contributions to cognitive flexibility with noninvasive electric brain stimulation**
Kent Hubert, Drexel University
Maria Mukhanova, Drexel University
Evangelia G. Chrysikou, Drexel University
([Abstract](#))

Poster Session – 2, October 23rd, Friday

Room – 3, Session – 1, Pharmacology & Altered States

Time (EST) Title & Authors

- 1:15 - 1:19 **Exploring brain white matter correlates of creativity in schizophrenia**
Agurne Sampedro, University of Deusto
Javier Peña, University of Deusto (javier.pena@deusto.es)
Naroa Ibarretxe-Bilbao, University of Deusto
Alberto Cabrera-Zubizarreta, OSATEK Hospital of Galdakao
Ainara Gómez-Gastiasoro, University of Deusto
Pedro Sánchez, Hospital Psiquiátrico de Álava
Nagore Iriarte-Yoller, Hospital Psiquiátrico de Álava
Edorta Elizagarate, Hospital Psiquiátrico de Álava

Cristobal Pavan, Hospital Psiquiátrico de Álava
Isabel Hervella, Hospital Psiquiátrico de Álava
Mikel Tous-Espelosin, University of the Basque Country
Sara Maldonado-Martin, University of the Basque Country
Natalia Ojeda, University of Deusto

[\(Abstract\)](#)

1:19 - 1:23 **Polygenic risk score for bipolar disorder associates with divergent thinking and structures of the prefrontal cortex**

Hikaru Takeuchi, Tohoku University

[\(Abstract\)](#)

1:23 - 1:27 **Experience with drugs modulates the belief that drug use impacts creativity: A focus on marijuana**

Wayne R. Hawley, Edinboro University of Pennsylvania
Heather T. Snyder, Edinboro University of Pennsylvania
James C. Kaufman, University of Connecticut

[\(Abstract\)](#)

1:27 - 1:31 **Psychedelic use and divergent thinking scores predict how we judge the self and others**

Trey Brashert, Stockton University
Marcello Spennella, Stockton University
Jennifer Lyke, Stockton University
David Rosen, Stockton University, Drexel University

[\(Abstract\)](#)

1:31 - 1:35 **The missing link: Exploring the link between altered states of consciousness and creative cognition**

Shadab Tabatabaeian, University of California Merced

[\(Abstract\)](#)

1:35 - 1:39 **Effects of methylphenidate on verbal creativity, verbal fluency, and convergent thinking tasks in adults with Attention-Deficit/Hyperactivity Disorder**

Carina Appling, University of Missouri
Brad Ferguson, University of Missouri
Alyssia Gonzalez, California State University San Marcos
Andrea Schaeffer, University of Missouri
Molly McBride, University of Missouri
David Wang, Emory University
Eric Hart, University of Missouri
David Beversdorf, University of Missouri

[\(Abstract\)](#)

1:39 - 1:43 **Rostral anterior cingulate thickness predicts the emotional psilocybin experience**

Cory M. Riecken, University of Missouri
Candace R. Lewis, Translational Genomics Research Institute

[\(Abstract\)](#)

Poster Session – 2, October 23rd, Friday

Room – 3, Session – 2, Personality

Time (EST) Title & Authors

1:45 - 1:49 **Scientific studies do not support stronger visuospatial and creative abilities in dyslexia**
Gabrielle-Ann Torre, Georgetown University

Don Compton, Florida State University
Adam E. Green, Georgetown University
Guinevere Eden, Georgetown University
([Abstract](#))

1:49 - 1:53

A personality network analysis of scientific and artistic creativity
Qunlin Chen, Southwest University, Pennsylvania State University
Alexander P. Christensen, University of North Carolina at Greensboro
Yoed N. Kenett, Technion - Israel Institute of Technology
David M. Condon, University of Oregon
Robert M. Bilder, University of California Los Angeles
Jiang Qiu, Southwest University
Roger E. Beaty, Pennsylvania State University
([Abstract](#))

1:53 - 1:57

Reframing anxiety: How domain anxieties affect performance on cognitive tasks framed as domain-specific
Griffin A. Colaizzi, Georgetown University
Richard J. Daker, Georgetown University
Ariana M. Mastrogriannis, Georgetown University
Adam E. Green, Georgetown University
([Abstract](#))

1:57 - 2:01

Relationships between behavioral correlates of openness to experience
Madeleine E. Gross, University of California Santa Barbara
Claire M. Zedelius, University of California Santa Barbara
Jonathan W. Schooler, University of California Santa Barbara
([Abstract](#))

2:01 - 2:05

Creativity through functional MRI and the five-factor model of personality
Phoebe L. Cohen, University of Miami
([Abstract](#))

2:05 - 2:09

The cognitive neuroscience of the dark side of creativity: A proposal
Hansika Kapoor, University of Connecticut, Monk Prayogshala
([Abstract](#))

2:09 - 2:13

Adopting an eccentric mindset enhances divergent thinking
Nicole C. Catanzarite, University of Maryland
Proma Rahman, University of Maryland
Ethan Cheng, University of Maryland
Kevin N. Dunbar, University of Maryland
([Abstract](#))

Keynote Abstracts

A Labor of love: Insights from a creativity research program

Teresa Amabile, Harvard University (tamabile@hbs.edu)

In this talk, I will briefly describe my creativity research program of 40+ years, the main insights it has yielded, and the still-ongoing revisions of my theory of creativity over the years. I will highlight a few personal lessons, as well as some thoughts on the future of creativity research.

Creativity in child art: How to nurture it, how to kill it

Ellen Winner, Boston College and Harvard Project Zero (ellen.winner@bc.edu)

The art of young children is playful, exploratory, non-realistic, and expressive -- at least in Western societies over the last few centuries. In the elementary school years, children strive towards realism, they become increasingly self-critical, and their art becomes stereotyped. Traditional methods of art education suppressed children's early creativity by focusing on copying and technical precision. The aim was to make children's art adult-like as soon as possible. With the advent of progressive education, young children's art was valorized as especially creative, and educators strove to harness this early creativity and to counter its decline in middle childhood. Progressive art education has often been misunderstood as "anything goes," but I will present two examples of highly structured progressive art education where children's natural creativity in art is fostered (without also hindering their developing inclinations towards realistic representation): the Reggio Emilia schools in Italy today, for children up to six years of age, and Victor D'Amico's methods for older children at the Museum of Modern Art in New York in the 1940s. In both cases children surprise us with what they are capable of in terms of artistic thinking.

Creativity, curiosity and mind-wandering: The upside of a mind in flight

Jonathan Schooler, University of California, Santa Barbara (jonathan.schooler@psych.ucsb.edu)

This talk reviews evidence that mind wandering flights of fancy can serve as a critical source of inspiration. Studies from both the lab and the field will be combined with theoretical analysis and historical anecdotes to draw inferences regarding the types of mind-wandering that may be conducive to creative ideas. Several topic areas seem especially promising including thoughts involving bizarre or meaningful themes, and musing about topics that one finds especially interesting (mind wandering).

Panel Abstract

How to make it as a creativity researcher

Indre Viskontas, University of San Francisco (indre.viskontas@gmail.com)

John Kounios, Drexel University

Psyche Loui, Northeastern University

Roger Beaty, Penn State University

Adam E. Green, Georgetown University

The panel will feature junior and senior creativity researchers, including a recent NSF program director, who will discuss challenges, opportunities, and effective strategies for crafting a career in cognitive and brain-based creativity research. This session is open to all attendees, with Q & A focused on questions from emerging and mid-career scholars interested in mapping paths to advance their careers and contribute to the field.

Invited Talk Abstract

NSF programs that fund cognitive neuroscience and research on creativity

Gregg Solomon, National Science Foundation (gesolomo@nsf.gov)

Robert Ochsendorf, National Science Foundation (rochsend@nsf.gov)

Directorate for Social, Behavioral, and Economic Sciences (SBE) will describe current research funding opportunities at the National Science Foundation (NSF) for research cognitive neuroscience and research on creativity. Program Directors advise researchers on their proposal submissions, create funding solicitations, oversee the review process for hundreds of proposals a year, and manage portfolios of ongoing research projects. In this session, they will present overviews of funding opportunities in each directorate as well as relevant cross-directorate programs. They will discuss the kinds of proposals appropriate for each, along with conceptual, methodological, and expository tips for writing successful research proposals. Funding programs to be discussed include Developmental Science (DS), Cognitive Neuroscience, Perception, Action, Cognition (PAC), Science of Learning (SL), EHR Core Research (ECR), Discovery Research PreK-12 (DRK-12), Advancing Informal STEM Learning (AISL), and Integrative Strategies for Understanding Neural and Cognitive Systems (NCS). The session will include opportunities for direct interaction with individual Program Directors.

Special Event Abstract

Creativity in Context: a conversation with Grammy-winning Music Producer Ian Brennan

Indre Viskontas, University of San Francisco (indre.viskontas@gmail.com)

Ian Brennan

When Ian Brennan traveled with his crew and equipment to the biggest prison in the poorest country in Africa, he had no idea that Malawi's first Grammy nomination would be the result. Join him in conversation with neuroscientist and musician Indre Viskontas as they discuss the role that music can play in the lives of the disenfranchised: from people who are imprisoned to those with developmental disabilities.

Talk Session Abstracts

Talk Session 1, October 22nd, Thursday

SemDis: An open platform for automated creativity assessment via semantic distance

Roger E. Beaty, Pennsylvania State University (rebeaty@psu.edu)

Dan R. Johnson, Washington and Lee University

Conducting creativity research often involves asking several human raters to judge participants responses to creativity tasks, such as judging the novelty of ideas from the alternate uses task (AUT). Although such subjective scoring methods have proved useful, they have two inherent limitations, labor cost (raters typically code thousands of responses) and subjectivity (raters vary on their perceptions and preferences), raising classic psychometric threats to reliability and validity. We sought to address the limitations of subjective scoring by capitalizing on recent developments in automated scoring of verbal creativity via semantic distance, a computational method that uses natural language processing to quantify the semantic relatedness of texts. In five studies, we compare the top performing semantic models (e.g., GloVe, continuous bag of words) previously shown to have the highest correspondence to human relatedness judgements. We assessed these semantic models in relation to human creativity ratings from a canonical verbal creativity task (AUT) and novelty/creativity ratings from two-word association tasks. We find that a latent semantic distance factor, comprised of the common variance from five semantic models, reliably predicts human creativity ratings, with a near-perfect correlation between novelty ratings and semantic distance. We also replicate an established experimental effect in the creativity literature (the serial order effect) and show that semantic distance correlates with other creativity measures, demonstrating convergent validity. We provide an open platform to efficiently compute semantic distance (SemDis), including tutorials and documentation.

Dynamic balance between default and control networks predicts individual creative thinking ability: Findings from the Creative Connectome and Reproducibility Project

Qunlin Chen, Southwest University & Penn State University (cqlllogic@gmail.com)

Yoed N. Kenett, Technion - Israel Institute of Technology

Zaixu Cui, University of Pennsylvania

Mathias Benedek, University of Graz

Jiang Qiu, Southwest University

Roger E. Beaty, Pennsylvania State University

Increasing evidence indicates that creative thinking relies on a complex interplay between the default network (DN) and executive control network (ECN). This connectivity profile has been associated with different creative tasks and domains, across both event-related and resting-state fMRI investigations. We aimed to further characterize the dynamic interplay between DN-ECN connectivity in relation to individual creative ability. We introduce the Creative Connectome and Reproducibility Project (CCRP), a multi-center project including structural MRI, resting-state fMRI, and creative performance data from four centers in China, Japan, Europe, and the United States. Here, we applied time-resolved network analysis to investigate the relationship between creative performance and the dynamic reorganization of DN and ECN. Across multiple sites, we find consistent evidence that creative performance can be reliably predicted from the number of times that an individual switches between integrated and segregated brain states. Further, we find an inverted-U relationship between creative performance and the balance between DN and ECN, measured by the ratio of relative “dwell time” in the two systems, indicating that a moderate degree of DN and ECN cooperation may be conducive to generating creative

ideas. This work provides new insight into the relationship between creativity and DN-ECN connectivity, and it suggests that an "optimal balance" between DN-ECN integration and segregation may support creative performance.

The role of executive function in young children's divergent thinking

Julie Vaisarova, University of Minnesota (vaisa001@umn.edu)

Stephanie M. Carlson, University of Minnesota

Early childhood, a time when executive function (EF) rapidly develops and imagination surges, offers an intriguing window on the link between EF and creative thinking. Research on early childhood creativity, however, remains sparse. We addressed this gap in two studies using the Alternate Uses Task (AUT) to examine the idea that EF supports divergent thinking by helping children override rote, easily accessible knowledge. In these studies, typically developing 4-(N = 52), 5-(N = 74), and 6-year-olds (N = 50) completed the AUT with objects ranging from very familiar to novel, as well as behavioral tests of EF. 4-year-olds generated significantly more unique ideas for novel than familiar objects, and 5-year-olds showed a similar, though only marginal, effect. In both studies, older children also gave more ideas for familiar, but not novel, objects. Although these patterns are broadly consistent with developing EF helping to override prior object knowledge, EF did not moderate the effect of object familiarity on AUT scores, either between-(Study 1) or within-children (Study 2), and it was negatively associated with fluency for 4-($r_s = -.35$; $p < .05$) and 5-($r_s = -.31$; $p < .05$) but not 6-year-olds. Overall, our results do not clearly support the claim that EF helps children override rote knowledge and thereby produce more/more unusual ideas. However, they do suggest that EF influences young children's idea-generation and this effect may change with age. Future analyses will further probe the role of EF by examining its relation to AUT flexibility scores. The results will be discussed in light of methodological considerations related to assessment of young children's creative thinking.

Real-world creativity studies and their application to various industries

Monica Lopez-Gonzalez, Johns Hopkins University (mlopezg1@jhu.edu)

The human behavioral repertoire is diverse. Our cognitive flexibility to adapt to ever-evolving environments in novel ways has allowed us to flourish within a vast array of contexts. This adaptive, situational capacity manifests itself across long stretches of time and during short, spontaneous moments. Despite the crucial importance of environment to engendering creative thinking and doing, the cognitive neuroscience literature on creativity, problem-solving, and decision-making remains largely limited to ecologically unreal and highly-controlled experiments. I argue that a more nuanced account of human creativity requires a cross disciplinary, real-world approach that examines how real-time environmental variability shapes cognitive processes. In this talk, I discuss the unique creation of original live theatrical and film works with real-time musical improvisation as a window into the relationship between environment and cognition. First, I present a novel experimental paradigm that merges questions, theories, and methods from both the Sciences and the Arts. The resulting cognitive behavioral model identifies the complex roles of emotion, knowledge, and reactive skill within real-time improvisatory and collaborative creativity. Second, I present examples of the above model as applied to multiple contexts: teaching creativity in the classroom, motivating brain-inspired computing for driverless car technology, and redefining end-user education within cybersecurity. Together, these studies and applications question the theoretical foundation of the cognitive neuroscience of creativity by redefining the core of empirical investigation and broadening the goals of research.

Neurosciences in companies: Innovation and decision-making

Renata Coura, Neurotelos SAS (renata.coura@neurotelos.com)

Sylvie Granon, Université Paris-Sud

The aim of this talk is to provide feedback on how neuroscience of creativity is needed and can influence the corporate world. Global markets are becoming more and more complex, unpredictable and

unstable. Organizations are suffering from low productivity and burn outs, in environments of chronic stress, competition, aggressive communication and unhappiness. Companies are now realizing the impact of the human aspects over results. They are seeking solutions to foster a creative, innovative and collaborative environment, without knowing exactly how to do it yet. Managers are key to the change process. But they are often too busy dealing with day to day operations to spend time and mental energy reflecting on how to make corporate culture evolve and in which direction. Training sessions in change management have flourished. However, many of them keep at a very theoretical and surface levels, which makes it difficult for managers to take up the concepts, identify their - their company's - goals, and navigate towards them. Moreover, neurosciences are up-to-date and many non-neuroscientists are taking advantage of it and transmitting erroneous information. So how we neuroscientists can contribute directly to society and corporate world? And how can we share our knowledge in a practical way and prevent trivialization of neurosciences by non-scientists. Here, I'll make a feedback from 2-years, and more than a thousand hours, work with directors and top managers from big companies, applying neurosciences for decision making, stress management and innovation. Which tools and approaches that works and what are the possible new fields of research that can be open from there.

Talk Session 2, October 23rd, Friday

The costs and benefits of semantic memory structure in generating original ideas

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Roger E. Beaty, Pennsylvania State University

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Recent empirical and computational studies highlight the role of semantic memory structure in facilitating creative thinking. Semantic memory structure is theorized to support spreading of activation through concepts within semantic memory, facilitating the combination of concepts into novel and original ideas. However, whether the structure of semantic memory may incur any costs on creative thinking has not been explored. We examine such a possible cost of a semantic memory structure on generating responses in a divergent task, by borrowing a studied phenomenon from episodic memory known as the fan effect: increasing knowledge about a concept leads to increasing interference from conceptually related information. We test whether cue association size—an index of semantic richness reflecting the average number of associates to a concept—impacts the quantity (fluency) and quality (originality) of responses generated during the alternate uses task (AUT). We hypothesized that low-association AUT cues benefit originality at the cost of fluency because such cues are embedded within a sparser semantic ‘neighborhood’ thus yielding lesser interference from closely-related concepts. This hypothesis was confirmed in a series of experiments. Furthermore, we found an interaction with individual differences in fluid intelligence in the low-association AUT cues, suggesting that constraints of sparse semantic knowledge can be overcome with top-down intervention. The findings indicate that semantic richness differentially impacts the quality and quantity of generated ideas, and that cognitive control processes can facilitate idea production when conceptual knowledge is limited.

EEG correlates of flexibility during divergent thinking

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EEG alpha synchronization, especially in posterior parietal cortical regions of the right hemisphere, has been referred to as being indicative of high internal processing demands that are typically involved in divergent thinking (DT). During the course of DT, as ideation proceeds, ideas tend to become more creative, being more likely to be drawn from new conceptual categories through the use of the cognitive mechanism of flexibility. The present study investigated whether EEG alpha synchronization can be modulated by flexibility in DT by comparing cortical activation patterns during the switch of category (or switching, i.e., shifting from one conceptual category to another) and the stay in the same category (or clustering, i.e., remaining within the same conceptual category during ideation). Twenty participants were required to generate alternative uses of everyday objects (alternative uses task) during EEG recording. The results revealed that whereas the clustering condition showed a typical lateralization with lower alpha (8-10 Hz) synchronization in posterior parietal cortical areas of the right hemisphere, switching evoked posterior parietal lower alpha synchronization over both right and left hemispheres. These findings indicate that switching and clustering might reflect different (brain) mechanisms in divergent thinking, and that switching in comparison to clustering appears to require a larger investment of cognitive resources due to the exploratory process of moving from one semantic conceptual category to another in the course of creative ideation.

Creativity anxiety: An affective barrier to creative achievement

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Creative abilities drive progress in a wide array of fields and are increasingly central to economic development. Barriers that hold individuals back from reaching their creative potential are therefore crucial to identify and understand so that they can be overcome. Recently, we identified one such possible barrier to the fulfillment of creative potential: creativity anxiety, or anxiety at the prospect of having to think creatively. Across a series of studies across diverse national and cultural contexts, we validated the Creativity Anxiety Scale and found that individual differences in creativity anxiety reliably predict differences in creative achievement (Daker et al., 2019). We also found that individuals high in creativity anxiety are more likely to avoid career paths they see as creative, suggesting real-world impacts of creativity anxiety on career trajectories. Finally, using resting state fMRI to identify functional network correlates of creativity anxiety, we found that the creativity anxiety-related networks identified in one sample successfully predicted individual differences in creativity anxiety in a separate sample. These results indicate a generalizable neural marker of creativity anxiety. Implications of these findings for the development of creative ability and future directions are discussed.

Sleep, dreams and capturing creativity

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Pat Pataranutaporn, Massachusetts Institute of Technology

There is a great deal of anecdotal evidence, yet little experimental data, supporting the role of sleep in generating creative solutions. Further, few tools exist to encounter a solution in sleep and dreams purposefully, as opposed to by happenstance. We present a wearable electronic technology, the Dormio, built to incubate specific problems in sleep and automatically capture dream reports. We present a series of experiments suggesting that use of the Dormio enables a) incubation of specific themes into dreams and b) improved performance on the Alternative Uses Task, Verb Generation Task, and Creative Storytelling Task post-sleep. We further present a novel strategy for computational measurements of creativity using word vectors, and demonstrate its sensitivity to post-sleep changes in creative output. We hope these tools can enable more neuroscientific work on the contributions of sleep and dreams to creativity.

Blitz Session Abstracts

Blitz Session 1, October 22nd, Thursday

Biases in language production are reflected in musical improvisation: Evidence from large-scale corpus analysis

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Producing language involves the real-time sequencing of words into phrases, leading to considerable demands on working memory that can be relieved by ordering biases in spoken utterances. One such bias is called easy-first: the tendency for more easily-accessible phrases to occur earlier in an utterance, allowing for incremental planning of more complex phrases. Recent evidence suggests that this bias may extend beyond language to affect other domains involving real-time action sequencing. In the current study, we sought to test for the presence of the easy-first bias in a creative domain that similarly requires real-time action sequencing: musical improvisation. Using a corpus of 456 transcribed improvisations from eminent jazz musicians (e.g., Charlie Parker, John Coltrane), we tested for easy-first on multiple definitions of easiness over the phrase and over the corpus: interval frequency, interval size, interval variety, pitch variety, and direction changes. Similar to language production, our findings suggest that expert improvisers consistently retrieve “easier” melodic sequences before generating more complex and novel sequences, indicating a similarity in the domain-general sequencing biases that facilitate the spontaneous production of music and language.

The neural dynamics of musical creativity in jazz pianists

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One of the defining elements of jazz is the ability to improvise. The neuroscience of jazz improvisation has shown promising results for understanding domain-specific and domain-general processes of creativity. However, until date no previous studies have examined how different modes of improvisation (musical creativity) evolve over time and which cognitive mechanisms are responsible for different stages of musical creation. Here, we used fMRI to measure for the first time the dynamic neural substrates of musical creativity in 16 skilled jazz pianists while they improvised freely (iFreely), and by melody (iMelody), and contrasted with resting-state. We used the leading eigenvector dynamics analysis (LEiDA) to explore the whole-brain dynamics underlying spontaneous musical creation. Our results reveal a substate comprising areas of the dorsal DMN, the left ECN, the anterior salience, language and precuneus networks with significantly higher probability of occurrence in iFreely than in iMelody. In addition, iFreely is also linked to an increase prevalence and dynamic attachment to this substate and to a “global” substate. Such indicates that a more freely mode of improvisation (iFreely) requires an increased dynamic convergence to networks comprising brain areas involved in processes linked to creativity (generation, evaluation, prediction, and syntactic processing). iMelody, a more constrained mode of improvisation involves a higher recurrence of brain regions involved in auditory and reward

processes. This study brings new insights into the large-scale brain mechanisms supporting and promoting the complex process of creativity, specifically in music improvisation in jazz.

Modelling musical creativity in the brain: Predicting transitions of brain dynamics between modes of music production

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Creativity depends on two things: making unfamiliar combinations of familiar ideas, and doing so aptly, or appropriately. Different cognitive processes involved in the generation of new ideas are tightly sustained by a dynamic interplay between multiple brain networks. In music improvisation, memory retrieval reveals crucial in the recalling of prior knowledge and the flexible rearrangement of information to create novel and aesthetically pleasant sequences. To this date, no study has explored how the brains of creative people are capable of maintaining efficient dynamics between memory and novel sequence creation. Here, we propose to combine structural and functional neuroimaging data of 16 skilled jazz musicians with whole-brain computational modelling to shed new light into the brain regions and properties of the local dynamics supporting rich and coordinated state transitions between familiar (play-by-memory) and creative (free-improvisation) modes of music production. Our results from network-model perturbations show that a transition from memory to creativity is associated with increased neural dynamic richness. This occurs when the noise level of brain regions involved in cognitive processes important for creativity is increased. Interestingly, a transition between creativity to a memory-based state is promoted when decreasing the level of dynamic expansion (higher synchronicity) of regions involved in memory retrieval, planning, motor, executive and emotion control. Our study may provide relevant contributions to the development of efficient strategies to compensate for the memory and creativity deficits common in many neuropsychiatric conditions.

Brands in creative processes - A field study with advertising agencies

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In this research, I theorize that brands affect the creative process. On the one hand, intrinsic motivation and passion for the work might boost creativity (Amabile, 1994; Sasser, 2012); therefore, creatives who work for brands they like would produce more creative work. On the other hand, working with liked brands may produce a sense of satisfaction with an admiration of the brand's status quo, discouraging the search for creative ideas. Within this stream of research, I am also investigating the accuracy of creatives' rating of their own creative output (self-rating creativity), depending on brand liking. Since previous work reported bias on creatives' evaluations of their own work (Berg, 2016). In study 1, 100 professional ad creatives produced commercials for their most liked and disliked brand, within subjects. Three advertising directors judged creatives' work. Results showed that brand liking improve ad originality but impair accuracy of self-rated creativity. In study 2, professional ad creatives (N = 95) wrote commercials for a target brand. In this case, consumers were the judges. Results show a positive effect of brand liking on relevance (i.e., the extent to which the commercial was meaningful or appropriate) (Smith & MacKenzie, 2007) but not on originality as before. I speculate that consumers and managers evaluate originality and relevance differently, as previously suggested (Kover, 1995). Regarding self-rated creativity, brand liking significantly moderates the effect. Self-rated creativity was correlated with

consumers' creativity when brands were disliked replicating study 1. In my planned studies, I intend to understand the mechanism for these results.

Blitz Session 2, October 22nd, Thursday

Art as creative inspiration

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What inspires you? Moments of creative inspiration, externally evoked motivation for creative activity, are critical pivot points that mark the transition from creative ideation to actualization of an idea. We hypothesize that the state of being aesthetically moved, a critical moment during aesthetic reception, is similar to the state of being creatively inspired, and that aesthetically moving experiences can serve as primes of creative inspiration. In Experiment 1, 25 participants had to write short creative texts in response to "aesthetic" prompts (visual artworks they highly-liked) or "non-aesthetic" prompts (triads of unrelated words). Participants then rated how inspired they had felt during idea generation. Ratings of felt inspiration were significantly higher for aesthetic vs. non-aesthetic prompts ($p < .001$). In Experiment 2, 34 participants performed the same task with prompts consisting of highly-liked, disliked, or novel artworks they didn't rate in advance. While pre-exposure to the stimuli had no significant effect, felt inspiration was significantly higher for liked vs. disliked prompts ($p < .001$), and post-test aesthetic ratings of novel artworks were positively correlated with felt inspiration. Furthermore, inspiration ratings correlated positively with the amount of produced text. Being aesthetically moved increases the likelihood of creative inspiration, a finding with implications both for the study of creative and aesthetic processes and also for the potential role of the arts in educational settings.

Cortical activity tracks fractal complexity in both artistic and mathematical images, but with different mechanisms

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Previous electrophysiological studies have shown that viewing fractal patterns of differing dimensions in natural scenery and in computer-generated fractals leads to differences in brain activity. However, few studies have investigated electrophysiological brain activity in human-generated artistic fractals of varying dimensions. This study aimed to investigate differences in brain electrical activity while participants viewed and rated artistic- versus computer-generated mathematical fractals. Fractal dimensions describe how fractal patterns at different magnifications combine to form their final shape and fall between Euclidean dimensions (e.g., a line, $D=1$, and a filled plane, $D=2$). We recorded EEG while participants ($N = 19$) viewed a range of normally distributed fractal images with dimensions between 1.12 and 1.98 and rated how much they liked each image. Half of the fractal images were artistic (Jackson Pollock white layers), and each artistic fractal had a mathematical twin (random Cantor set) with the same dimension. EEG were decomposed to a time-frequency representation, and single-trial Spearman correlations were computed between fractal dimension and time-frequency EEG. Significance of correlations were tested using cluster-based permutation analysis. Results revealed that for the mathematical fractals, low-frequency power over central scalp locations accurately tracks fractal dimension. However, for the artistic fractals, low-frequency phase over parietal regions accurately track

fractal dimension. This demonstrates that different brain regions (central versus parietal) and mechanisms (power versus phase) track complexity of artistic and mathematical fractal.

Percolating ideas: The effects of caffeine on creative thinking and problem solving

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Paul Silvia, University of North Carolina at Greensboro

Caffeine is the most widely consumed psychotropic drug in the world, with numerous studies documenting the effects of caffeine on people's alertness, vigilance, mood, concentration, and attentional focus. The effects of caffeine on creative thinking, however, remain unknown. In a randomized placebo-controlled between-subject double-blind design, the present study investigated the effect of moderate caffeine consumption on creative problem solving (i.e., convergent thinking) and creative idea generation (i.e., divergent thinking). We found that participants (N = 88) who consumed 200 mg of caffeine (approximately one 12 oz cup of coffee) showed significantly enhanced problem-solving abilities. Caffeine had no significant effects on creative generation or on working memory. The effects remained after controlling for participants' caffeine expectancies, whether they believed they consumed caffeine or a placebo, or for changes in mood. Possible mechanisms and future directions are discussed.

'Walk in My Shoes' - An assessment of an experiential intervention to use creativity to engender empathy

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Anna Ciaunica, Institute of Philosophy Porto

Imagine a giant sparkly shoe 'walking' around the country, allowing the public to walk in the shoes of a person with a different gender identity, race, and/or socio-economic background. Can this experience induce thinking 'outside the box' or engender creative cognition? This project is designed to assess how the creation of subjective realities in experimental environments, may increase the validity of the subject's experience, and thus, provide deeper insight into behavior, while also potentially shaping it. Despite the digital communications boom, and the increasing science curiosity of younger generations, most scientific researchers are highly limited in their abilities to robustly, viscerally, and accurately communicate the experiential "proof" or "reality" of their findings to the general public. They rely on two-dimensional modes of storytelling - literature, videos, podcasts - that are often transactional, one-sided, and non-transformative. Here, we wondered whether a bidirectional intervention, one in which listeners are also participants in the conversation, might lead to greater openness to new experiences, a personality trait associated with creative cognition. We propose to mount this experience in the footprint of a traditional poster, and observe how members of the SfNC interact with us and other poster presenters after experiencing the intervention.

Blitz Session 3, October 23rd, Friday

Neuromodulation of executive control and default mode networks to enhance verbal creativity

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Previous neuroimaging research has found that creative thinking is related to functional connectivity between default mode (DMN) and executive network regions (ECN), as well as frontal alpha oscillations.

Although this connectivity pattern has been demonstrated in several studies, this line of research is strictly correlational. Here we utilized transcranial alternating current stimulation (tACS) at alpha frequency (10 Hz) to entrain cortical oscillations within the ECN and between DMN-ECN to determine the causal role of both networks (together and separately) in creative idea generation and evaluation. Creative idea generation and evaluation are measured separately using a new split-task version of the Alternative Uses Task. Responses will be scored for originality (using human raters) and semantic distance (using SemDis). Data collection is currently ongoing. 30 participants have thus far participated in a between-subjects design with three conditions: 1) Within ECN: synchronized alpha tACS to RDLPFC and LDLPFC, 2) Between DMN-ECN: synchronized alpha tACS to RDLPFC and Precuneus, and 3) Sham stimulation. The findings will extend the correlational literature on DMN-ECN functional connectivity by determining whether causally facilitating DMN-ECN coupling differentially impacts creative idea generation and evaluation.

The role of the motor system in generating creative thoughts

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Yoed N. Kenett, Technion - Israel Institute of Technology

Neurocognitive research is pertinent to developing mechanistic models of how humans generate creative thoughts. Such models usually overlook the role of the motor cortex in creative thinking. The framework of embodied or grounded cognition suggests that creative thoughts (e.g. using a shoe as a hammer, improvising a piano solo) are partially served by simulations of motor activity associated with tools and their use. The major hypothesis stemming from the embodied or grounded account is that, while the motor system is used to execute actions, simulations within this system also support higher-order cognition, creativity included. That is, the cognitive process of generating creative output, not just executing it, is deeply embedded in motor processes. Here, we highlight a collection of neuroimaging research that implicates the motor system in generating creative thoughts, including some evidence for its functionally necessary role in generating creative output. Specifically, the grounded or embodied framework suggests that generating creative output may, in part, rely on motor simulations of possible actions, and that these simulations may be partially implemented in the motor regions themselves. In such cases, action simulations (i.e. reactivating or re-using the motor system), do not result in overt action but instead are used to support higher-order cognitive goals like generating creative uses or improvising.

The creative foraging game: A high resolution probe to the computational mechanisms of creative search

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Creative exploration and discovery moments propel human progress in many fields such as the arts, sciences, engineering, and design. Despite its importance, not much is known on the dynamics of creative search, meaning how do people reach creative solutions and transition between them. In this talk I will describe a novel paradigm - The Creative Foraging Game (CFG). In the game, players create shapes from 10 connected squares, and save to the 'gallery' the shapes they deem interesting and beautiful. The game records all moves, timings, and gallery choices players make. We find that people's search exhibits exploration-exploitation dynamics. In exploration, players meander around, and move on paths that are 3 times longer than optimal paths. During exploitation phases players move optimally between gallery shapes. Interestingly, exploration-exploitation durations across individuals are highly correlated along a line between a mercurial quick-to-discover/quick-to-drop strategy and a thorough slow-to-discover/slow-to-drop strategy. The automated and fine-grained details of creative search in the CFG allow to construct players' meaning landscape and to characterize its dynamics via a mathematical model. We find that players' search is scale invariant and suggest a specific computational mechanism termed fold-change detection, where the system responds to relative changes in the signal

(meaning) rather than to its absolute levels. Taken together, the CFG paradigm offers an automatic, high resolution probe to creative search combined with a specific mathematical model to describe it.

Thinking outside the box alone or in social context: From laboratory to school teaching methodologies

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Mathieu Cassotti, University de Paris

Currently, there are large expectations towards the development of creativity at school. Nevertheless, generating new ideas to solve a creative problem might be more difficult as it seems, and children, adolescents or adults are often blocked by cognitive or social biases that constrain the exploration of alternative original ideas. However, to date, few studies have examined whether social evaluation or group brainstorming may constrain or facilitate creative ideation in children and adolescents and whether the effect of social contexts on creativity changes with age. Therefore, the aim of this presentation is to examine how social evaluation influences creative idea generation from childhood to adulthood and whether specific pedagogical interventions can help children to overcome cognitive and social biases in creative ideation. In a series of experimental studies in children, adolescents and adults, we have demonstrated that 1) social evaluation by an adult has an opposite effect on creative idea generation in children and adolescents. While the social scrutiny of an adult decreases creativity in children, it increases creative ideation in adolescents 2) overcoming fixation to explore creative solutions involves inhibitory control and the ability to detect that initial responses that come quickly to mind are not original, 3) pedagogical interventions based on recent cognitive model of creativity may increase children ability to explore creative ideas. As such, these findings provide cues to help children and adolescents overcome systematic difficulties they might face to solve creatively problems in various social contexts.

Poster Abstracts

Poster Session – 1, October 22nd, Thursday

Room – 1, Session – 1 & 2, Memory & Executive Processes

Inter- & intra-individual differences in associative distance predicts problem solving success

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Individuals solve a variety of problems every day. One task commonly used to measure problem solving is the compound remote associates task (CRA). Crystallized intelligence is predictive to CRA ability. However, there is little to no research on how that information is stored and structured in memory and whether it affects problem solving ability. Participants completed an associative fluency task that used the cues of subsequent CRA problems as prompts. When the participant elicited the solution of a CRA problem earlier in the fluency task they were more likely to solve that CRA problem than when it was elicited later in the fluency task. Additionally, participants who on average elicited solutions earlier across the totality of the fluency task solved more CRA problems. These findings provide preliminary evidence that the structure of semantic memory affects problem solving ability.

Does episodic memory contribute to creative writing?

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Previous research indicates that episodic retrieval, or the retrieval of details from memories that are specific to time and place, contributes to divergent thinking. However, this research has relied on standard laboratory tests of divergent thinking, such as generating creative uses for objects; it is unknown whether episodic retrieval also contributes to everyday, domain-specific forms of creativity. Here we test whether episodic retrieval improves performance on one such domain-specific task: creative writing. In two experiments, we use an episodic specificity induction (ESI) that selectively impacts tasks that draw on episodic retrieval. If episodic retrieval contributes to creative writing, then the ESI should increase the number of details that people subsequently generate on a creative writing task. We find mixed evidence that the ESI increases the number of details participants generate. Additional studies will be needed to more definitively characterize the contributions of episodic memory retrieval to creative writing.

Does boredom inspire creativity?

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Catherine A. McGrath, University of New Hampshire

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Boredom is often thought to be detrimental to productivity in schools and workplace institutions. Despite its negative reputation, other studies suggest that boredom may have benefits like facilitating creativity, perhaps through periods of incubation that allow for mind wandering. Here we build on this literature to determine: 1) if and how boring vs. engaging stimuli promote creativity; and 2) if freely-moving thought relates to creativity differently during boring vs. engaging stimuli. Participating college students (N = 118) completed an online-adapted Alternate Uses Task (AUT), where they were asked to type alternate uses for items such as 'brick' or 'paperclip' Following the AUT task, they viewed either an 'engaging' or 'boring' video of similar length and probes measuring freely-moving thought were randomly presented throughout. At the end of the clip, participants were immediately given another 45

seconds to input any additional alternate uses they thought of during the video. Participants who watched the boring video did not come up with more additional alternate uses compared to the engaging condition; but they did report more freely-moving thought. The amount of freely-moving thought reported during the video also moderated the effect of condition on post-video alternate uses: freely-moving thought was positively related to post-video alternate uses in the engaging condition ($\rho = .231$), but negatively related to post-video alternate uses in the boring condition ($\rho = -.124$). The findings suggest that promoting freely-moving thought in more engaging settings may be used to enhance creativity, but also highlight the need for further research.

Mednick's (1962) theory of creativity revisited: The effect of word type on associative fluency

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Jeanette Altarriba, University at Albany

Deniz Leblebici-Başar, Istanbul Technical University

Creative thinking is a necessary skill for producing useful and original ideas. Mednick (1962) proposed a theory relating creative thinking to associative fluency. Mednick suggested that highly creative individuals can produce more associations to a stimulus than less creative individuals, which allows them to reach more creative solutions. The current study further investigated Mednick's theory by a) examining how the relationship between creativity and associations changes when the word type of the stimulus changes, b) using several creativity tasks including Mednick's Remote Associates Task (RAT), and c) examining the role of other factors in the relationship, such as intelligence, verbal fluency, and demographics. Participants first completed an associative fluency task with four different types of words (i.e., high frequency concrete, low frequency concrete, high frequency abstract, and low frequency abstract), then completed several creativity tasks (the Alternate Uses Task, the RAT, and the Runco Ideational Behavior Scale) and other tasks (Raven's Standard Progressive Matrices, a verbal fluency measure, and a demographics survey). Participants were categorized as highly creative or less creative based on a composite measure of the creativity tasks. Highly creative individuals produced more associations overall, supporting Mednick's theory. Furthermore, high frequency stimuli elicited more associative responses than low frequency stimuli, but no differences emerged for concrete versus abstract stimuli. The current work has implications for strengthening creative thinking skills, particularly in less creative individuals.

Individual differences in patterns of semantic distance

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Megan E. Hillis, Dartmouth College

David J. M. Kraemer, Dartmouth College

An individual's ability to link distant concepts in novel ways is a critical component of creativity, and it can be quantified by measuring the semantic distance between the two items (Christensen & Schunn, 2007; Green et al., 2009; Holyoak and Thagard, 1995). Although previous work has studied semantic mapping across domains (see Thompson-Schill, 2003 for review), much work remains to be done to understand the neural structure of these semantic architectures and how the localization and structure of those architectures differ depending on various individual differences. Using a model of semantic distance between stimuli (presented both in word and picture forms), we used representational similarity analysis to identify individual differences in the representation of semantic concepts. Further, we find that these differences in the patterns of neural activity in Neurosynth-defined regions such as the speech production network correlate with the degree to which individuals preferentially attend to word or picture stimuli. These results indicate that individual differences in biases toward a particular content type is tied to clear differences in the representation of semantic architecture.

To Inhibit or to disinhibit? Cognitive control enhances generation of ideas

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Moshe Bar, Bar-Ilan University

It is increasingly acknowledged that creativity involves two phases: a generation phase, where a combination of remote associations is activated in a novel manner, and an evaluation phase, in which ideas are being logically valued. Inhibitory control is thought to be involved in both phases of creativity, but there is a debate on whether its involvement improves or hinders creativity. Alternatively, we propose that flexible alterations between these two states would benefit creativity best. Therefore, the purpose of the current study to better understand the influence of inhibition during the creative process. To do so, participants were asked to switch between classic creativity task (AUT) and a response-inhibition task (stop-signal task; SST). Participants were assigned to three conditions (25% signal/50% signal/ no signal) and were asked to generate alternative uses before and after each of the three blocks of the SST (T=4). Results indicated that compared to control, while there were no significant differences in baseline and T2, there was an additive inhibition effect which enhanced creative performance in T3 and T4. As hypothesized, the control group had significantly faster RT's in the SST, ruling out an alternative explanation of boredom. The results partially support our model according to which there is a U-shaped relationship between inhibitory control and creativity: while some cognitive control is needed to generate original ideas; excessive control might hinder creativity as it may lead to premature closure of ideas that could otherwise be further developed.

Creative problem solving in aging: The role of executive functions, divergent thinking, and risk taking

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Executive functions, especially inhibition, play a crucial role in creative processes. Studies on patients demonstrated that neurological conditions causing high levels of impulsivity and inhibitory control deficits, such as basal ganglia and frontal lesions, are associated with increased creative thinking. However, the role of inhibition in creativity across the life-span of healthy populations has been scarcely investigated. Aging is, indeed, associated with the reduction of the executive functions and specifically inhibitory mechanisms efficiency. Thus, we hypothesized that aging may modulate people's performances in different creative problem-solving tasks. To this aim, we administered the Compound Remote Associate (as a measure of convergent thinking) and the Alternative Uses Task (as a measure of divergent thinking) to a group of 60 healthy adults, divided into two age groups of young adults (20-26 yrs) and older adults (60-70 yrs). Participants were also tested on a list of potential cognitive predictors of creative problem solving, i.e., impulsivity, risk taking (through the Domain-Specific Risk-Taking scale), verbal working memory, and decision-making style. Results showed that older age, impulsivity, and financial risk taking predicted negatively convergent thinking abilities, whereas positively predicted divergent thinking and verbal working memory. Our findings confirmed the importance of executive functions in creative problem solving and that impulsivity impairs convergent thinking.

Metacontrol of human creativity: The neurocognitive mechanisms of convergent and divergent thinking

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Creativity is a complex construct that would benefit from a more comprehensive mechanistic approach. Two processes have been defined to be central to creative cognition: divergent and convergent thinking. These two processes are most often studied using the Alternate Uses Test (heavily relying on divergent thinking), and the Remote Associates Test (heavily relying on convergent thinking, but also likely involving divergent processes in insight trials). Although creative acts should be regarded compound

processes, most behavioral and neuroimaging studies ignore the composition of basic operations relevant for the task they investigate. In order to provide leverage for a more mechanistic, and eventually even comprehensive computational, approach to creative cognition, we compare findings from divergent and convergent thinking studies and review the similarities and differences between the two underlying types of processes, from a neurocognitive perspective. In this narrative review, we discuss a broad scope of neural correlates of divergent and convergent thinking. We provide a theoretical integration, by suggesting that creative cognition in divergent- and convergent-thinking heavy tasks is modulated by metacontrol states, where divergent thinking and insight solutions in convergent-thinking tasks seem to benefit from metacontrol biases towards flexibility, whereas convergent, analytical thinking seems to benefit from metacontrol biases towards persistence. These particular biases seem to be reflected by specific brain-activation patterns, involving left frontal and right temporal / parietal networks.

Dopamine supports originality: The relationship between eye blink rate, originality, and flexibility in divergent thinking

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Research demonstrated an association between creativity and the dopaminergic (DA) system: certain dopamine levels can indeed influence specific indicators of the creative performance. In particular, the individual spontaneous eye blink rate (EBR, a marker of dopaminergic functioning) emerged to predict flexibility in divergent thinking (DT). This relationship followed an inverted U-shape function such that a medium EBR level is associated with higher flexibility levels. Importantly, flexibility is strongly related to originality, which is reflected by the uncommonness, remoteness, and cleverness of ideas, due to the fact that switching between conceptual categories is predictive of more remote and clever ideas. However, research revealed that the ability to generate original ideas is not associated with EBR. It is worth highlighting that past research used 'objective' scoring methods based on the uncommonness dimension of originality. In the present study, we focused on the relationship between EBR and originality as measured not only in terms of uncommonness dimension, but also in terms of remoteness and cleverness of ideas. Results confirmed both the quadratic association between flexibility in DT and ERB and a positive linear association between flexibility and originality. More importantly, we also found a quadratic association between EBR and originality. Finally, we showed that this relationship was fully mediated by flexibility. These findings provide support to the claim that the DA system is a biological predictor of creative performance, and that EBR is non-linearly and indirectly associated to originality via the explanatory mechanism of flexibility.

Poster Session – 1, October 22nd, Thursday

Room – 2, Session – 1, Electrophysiology

Alpha power over right/mid-frontal brain regions support the generation of remote associations in higher creative individuals

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Little is known about the neural mechanisms underlying the spontaneous generation of creative ideas. We aimed to investigate the role of alpha oscillations during the production of spontaneous remote associations, and how they vary in relation to individual differences in creative ability. Participants were

presented with a stimulus word and were asked to produce as many associative responses as possible in 2 minutes to a set of cue words, while having their EEG recorded. Participants also underwent a battery of creativity tests, which were used to divide them into lower and higher creativity groups. To estimate the semantic proximity of the word streams that participants produced, we used forward flow (www.forwardflow.org) which employs co-occurrence statistics of words in textual corpora to compute the semantic distance between consecutive associative responses. At the behavioral level, higher creative participants generated significantly more responses compared to lower creative participants. While higher creative participants did not generate more remote associations than lower creative participants, forward flow was positively correlated with general creativity. At the neural level, the generation of semantically distant concepts was associated with higher alpha frequency activation over right and mid frontal areas, but only for higher creative participants. This activation has been previously linked to increased cognitive control and inhibition mechanisms of the prefrontal cortex. Thus, we suggest that enhanced alpha oscillations at right/mid-frontal areas relate to the spontaneous generation of semantically remote concepts, uniquely in higher creative individuals.

Facilitating creativity: Using machine learning EEG classification to provide neurofeedback in a divergent thinking task

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Previous EEG studies have found spectral differences between individuals who are more and less creative, and between conditions that differ in creative demand. Differences have been most consistently reported in the alpha band (Benedek, 2018). In the current study, a spectrally weighted common spatial patterns approach was used to reduce data dimensionality and extract EEG features, and a quadratic discriminant analysis machine learning algorithm was used to classify more and less creative brain states. Twenty-nine participants completed an Alternate Uses Task (AUT; adapted from Abraham et al., 2014, and Jauk et al., 2017), in which they thought of Normal or Uncommon (creative) uses for everyday objects (e.g., brick). We hypothesized that a) reaction time would be greater for the Uncommon condition, compared to Normal, b) alpha power would be greater for the Uncommon condition, c) EEG data would be reliably classified based on condition, and d) more and less creative individuals would be successfully classified. We found that both reaction time and alpha power were significantly greater for the Uncommon condition, compared to Normal. Classification accuracy for the two conditions varied widely among individuals (36.7% to 93.3%), with a mean of 63.9%. For more vs. less creative individuals, 82.3% classification accuracy was attained. Using the same version of the AUT and the same condition classification strategy, future studies will determine whether neurofeedback training based on subject-specific classification models can facilitate easier access to, and the improved maintenance of, more creative brain states.

Decoding moment of insight: Single-trial classification of insight and analytic problem solving using Multivariate Pattern Analysis (MVPA) on pre-solution EEG data

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Problem solving by insight involves a sudden realization of the solution (Aha! phenomenon) and it is a widely studied topic in the neuroscience of creativity. There have been various attempts to discover neural signatures of insight using electroencephalography (EEG) as a neuroimaging modality, but traditional EEG analyses often use trial averaging in order to suppress inter-trial variability within subject. The use of Multivariate Pattern Analysis (MVPA) to decode single trials of EEG data could provide information that would otherwise not be observed if the data is collapsed to a mean. We collected EEG data from 30 participants while they are engaged in an anagram task. For each trial, participants pressed

mouse button to indicate the time of solution realization followed by reporting whether they solved the problem using of insight or analysis. The pre-solution EEG data was time-frequency transformed and dimensionality reduction was applied using principal component analysis (PCA). We trained two machine learning classifiers to discriminate insight and analytic trials using [1] time-frequency representation and [2] a subset of principal components. Both classifiers resulted in classification accuracy greater than chance level, while classifier trained using principal components resulted in better classification accuracy. Careful approach should be taken in the interpretation of features that were used in the classifier, but the result suggests that spectro-temporal patterns of EEG activity can be used to decode the use of insight and analytic methods at the trial level, which could provide meaningful information about neural dynamics of insight problem solving.

Facilitating problem solving with targeted memory reactivation during in-lab overnight sleep

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Numerous anecdotes and several experiments suggest that sleep facilitates problem solving, especially when the solution requires thinking about the problem in a new way. In a recent study (Sanders et al., 2019) participants attempted to solve puzzles, each paired with a distinct sound cue, during an initial evening session; then, while participants slept at home in their own beds, we presented some of the sounds associated with participants' unsolved puzzles. In the morning, participants solved more of their previously unsolved puzzles that were Cued during sleep than those that were not cued. The current study used the same general paradigm, except 40 participants slept in the lab while full EEG was recorded throughout the night, allowing the collection of better and additional sleep measures. Across participants, following the first night of sleep, participants solved more Cued than Uncued puzzles. Moreover, this cueing effect positively correlated with the number of cues presented and negatively correlated with measures of sleep disruption. However, following the second night, participants solved reliably fewer Cued than Uncued puzzles. Thus, across the two nights overall, we did not observe a cueing effect on morning solving. Differences between the two sessions suggest sound cues may not have been as effective on the second night of sleep.

Can stereotype threat boost performance? The impact of stereotype threat on neural correlates of creative performance in female engineers

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Engineering is amongst the few STEM fields that have witnessed a stable gender disparity, with few women becoming engineering majors. Women's low representation in engineering has been attributed to negative stereotypes of their abilities (Cheryan et al., 2017), including creative abilities (Proudfoot et al., 2015). We used EEG to evaluate the impact of stereotype threat on creative performance in female engineers. 27 female engineering undergraduates were asked to generate alternate uses of 8 everyday objects and provide solutions to 8 hypothetical situations while undergoing electrophysiological recording. Items related to engineering knowledge (e.g. alternate uses of a pipe) and general knowledge (e.g., alternate uses of a pencil). Idea generation for each item lasted 2 minutes. During a break halfway

through the experiment, a male student provided a critical evaluation of the participants' performance referring to their gender (stereotype threat). We computed task-related power changes in lower (8-10Hz) and upper (10-12Hz) alpha frequency band during creative ideation periods before and after administration of the stereotype threat. Analyses demonstrate increased event-related alpha synchronization in the lower and upper alpha band in the post-threat condition, irrespective of item type. This finding indicates that the stereotype threat may have increased internal attention demands ('reliving' the threat in the mind's eye; Benedek, 2018). Alternatively, the stereotype threat may have motivated our participants to do better, increasing their creative potential. Both accounts will be further validated by correlating the EEG data with ideation originality scores.

Poster Session – 1, October 22nd, Thursday

Room – 2, Session – 2, Insight

An examination of the hypotheses of the Dynamic Framework of mind wandering

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Despite the fact that some of the world's most innovative thinkers have attributed their creative insights to undirected thinking, there has been a relative dearth of research examining a possible link between such thinking and creative problem-solving. Here, we examined the possibility that one mental process that may support spontaneous creative insights is the recently proposed Freely-Moving Thought (FMT) dimension of mind wandering, which characterizes thoughts that are unconstrained by executive control. In this study, we sought to confirm or dispel intuitions put forth by the field regarding the relationships between FMT and mental health, cognitive performance, trait-level propensities for the mind to wander, and creative ability. To do so, we probed participants on the task-relatedness of their thoughts, the intentionality of their mind-wandering, and the extent to which their thoughts moved freely during a 2-back task. Contrary to expectation, we found that participants who reported higher levels of FMT tended to score lower on a subsequent test of divergent thinking, the Alternate Uses Task (AUT), as well as experience a detriment to task performance. This may be consistent with the current understanding among creativity researchers that insight arises from a give-and-take between unconstrained thought and more directed focus. Only a modest, positive relationship between FMT and OCD emerged ($p < .05$), counter to the hypothesis that FMT would be antithetical to disorders characterized by repetitive thought patterns. These results invite more research into optimization of thought constraint thought probes, in both framing and content.

Identification of brain regions underlying spatial insight problem solving

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Creative insight is one of the most essential cognitive functions to overcome an impasse that is a situation in which the thinker does not know what to do next. Solving the impasse requires representation change of the problem. It is well-known that insight problem solving has been often involved with 'Aha!' experience when solving a difficult problem. To deal with insight problem solving, researchers have examined brain activities using the verbal insight problem tasks, and identified insight-specific brain regions in the right anterior temporal lobe (ATL) and the left dorsolateral prefrontal cortex (DLPFC). However, spatial insight problem solving has been poorly understood. Here, we have focused on processes of the spatial-mathematical insight problem using the matchstick arithmetic task (MA). We have conducted fMRI experiments with healthy participants for three days. We collected fMRI data

about 172 questions for each participant. All answered questions were labelled one of three solutions such as quick, analytical or insight. As a result of the general linear model (GLM) analysis, we identified insight-specific activity in the left ATL compared to the analytical solution. In addition, we found the medial default mode network (DMN) as insight-specific regions compared to the quick solution. In contrast, opponent contrasts have been extracted in bilateral DLPFC, posterior parietal, and occipital regions that are parts of the central executive and dorsal attention network. Our result indicated that the function of spatial insight-specific solving may be different from verbal insight problem solution.

Evidence for the relationship between Aha moments, analogical reasoning, and conceptual change

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Previous research has assumed, but not demonstrated, that the experience of insight (i.e., the ‘aha moment’) can play a role in analogical reasoning, especially with far or distant analogies. We tested this assumption with a novel paradigm that induces conceptual expansion during analogical induction. Participants viewed a series of sequentially displayed three-pair verbal analogies of the form A:B::C:D::E:F. The A:B and C:D pairs of the each set exemplified similar semantic relationships [EXAMPLE]. The E:F pair was either semantically closely related (‘conceptually consistent’) or distant from (‘conceptually expansive’) the A:B::C:D pair. Participants described the single conceptual relationship exemplified by the A:B and C:D analogies of each set before and after the E:F pair was displayed and rated of the intensity of the insight experience (0-10 scale) when they understood the full three-pair analogy set. Participants reported more intense ‘aha’ responses on sets with in expansive E:F pair than sets with a conceptually consistent E:F pair, suggesting a key role for affective, insight-like experiences during far analogical reasoning. The intensity of ‘aha’ responses provided was also predicted separately by the degree of conceptual change on each trial, as measured by the difference in participants’ first and second explanations of the analogies. This finding provides direct evidence towards the theory that insight experiences can serve as an affective indicator of representational change. These effects were found in a sample of university undergraduates and replicated in a demographically diverse sample of MTurkers.

The predictive power of insight problem-solving: The case of fake news

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Insight problem-solving is a well-studied area of creativity research, with significant progress made toward understanding its situational, cognitive, and neural correlates. However, little work has explored the extent to which insightfulness predicts differences in other aspects of reasoning and belief. Given that problems solved via sudden insight are highly accurate, we hypothesized that this skill could reflect advantages also in people’s ability to discern fake information from real. Previous research has shown that performance on other problem-solving tasks (e.g., the Cognitive Reflection test - CRT) predicts differences in susceptibility to fake news, bullshit receptivity, and overclaiming, yet, whether this relation holds for insight problem-solving remains unexplored. Thus we administered to our sample a set of Compound Remote Associates, CRT problems, fake news, bullshit receptivity, and overclaiming scales. Results indicate that insightfulness accounted for a significant amount of variance in believing in fake news (over and above traditional reasoning measures i.e., the CRT), sharing news content on the media, bullshit receptivity, and overclaiming accuracy. These results have implications for understanding individual differences in susceptibility to false beliefs and more generally, suggest that insight problem-solving has latent explanatory power outside of the realm of creativity studies proper and could prove a valuable tool in understanding consequential behaviors typically studied with other types of problem-solving and reasoning.

Reduced certainty preference after solving problems with insight than solving with analysis

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An 'Aha' experience when finding an insightful solution is often associated with a feeling of suddenness, pleasure and certainty. How does such an experience affect subsequent decision making and, in particular, risk preference? This is a rarely explored but important question because, in real life, solving a problem is often followed by courses of actions (such as implementing or advocating the solution), which involve risk/reward evaluation. In this study, online participants recruited from Amazon Mechanical Turk were asked to solve verbal Compound Remote Associate puzzles, report whether they solved with insight or analysis, and then make a risk choice: accept a fixed bonus (on average, \$0.25) or a bonus drawn randomly from a low and a high amount (e.g., \$0.05 vs \$0.55) with equal odds. The bonus amounts were individualized to each participant's choice point, through a trial run of baseline choices prior to the problem-solving task. As predicted, participants were more likely to make a risky choice (reduced certainty preference) after they solved problems with insight than after solving with analysis. Therefore, the manner in which people solve problems fosters a shift of risk preference from baseline. Further, this shift appears to be mediated by personality traits. Lastly, the current study validates the self-report of solution process with online subjects, with behavioral results consistent with those from lab settings.

Poster Session – 1, October 22nd, Thursday

Room – 3, Session – 1, Music

Dual-process contributions to creativity in jazz improvisations: An SPM-EEG study

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Conflicting theories identify creativity either with frontal-lobe mediated (Type-2) executive control processes or (Type-1) associative processes that are disinhibited when executive control is relaxed. Jazz improvisation is an ecologically valid test-case to distinguish between these views because relatively slow, deliberate, executive-control processes should not dominate during high-quality, real-time improvisation. Jazz guitarists ($n = 32$) improvised to novel chord sequences while 64-channel EEGs were recorded. Jazz experts rated each improvisation for creativity, technical proficiency and aesthetic appeal. Surface-Laplacian-transformed EEGs were analyzed in the scalp-frequency domain using SPM12. Significant clusters of high-frequency (beta- and gamma-band) activity were observed when higher-quality versus lower-quality improvisations were compared. Higher-quality improvisations were associated with predominantly posterior left-hemisphere activity; lower-quality improvisations were associated with right temporo-parietal and fronto-polar activity. However, after statistically controlling for experience (number of public performance), performance quality was a function of right-hemisphere, largely right-frontal, activity. These results support the notion that superior creative production is associated with hypofrontality and right-hemisphere activity thereby supporting a dual-process model of creativity in which experience influences the balance between executive and associative processes. This study also highlights the idea that the functional neuroanatomy of creative production depends on how creativity is defined, as the product or the cognitive processes.

Training-dependent changes of cortical network dynamics in musicians

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Creativity in musical improvisation has been associated with altered network dynamics, including heightened interactions between the executive control network (ECN) and default mode network (DMN). Previously, we have compared improvisational musicians, classical musicians, and minimally musically trained controls to determine how differential musical experience informs these network dynamics. Here, we present results from a longitudinal follow up to this work, with a particular focus on how resting state network dynamics change over the course of musical training. Our sample includes 11 improvisationally trained musicians and 9 non-improvisationally (classical) trained musicians. We used both seed-based connectivity and ROI-to-ROI connectivity to observe changes in connectivity within and between networks of interest. Improvisational musicians showed overall higher connections than classical musicians between ECN and DMN. In particular, a significant interaction between group and session was observed between right hemispheric ECN and dorsal DMN, with improvisational musicians showing an increase in connectivity over time whereas classical musicians showed decreased connectivity over time. In contrast, a significant interaction between group and session was observed between left ECN and posterior Salience network, with classical musicians showing increased functional connectivity over time. This converges with previous work to show that increased coupling between ECN and DMN connections support real-time creative behaviors such as musical improvisation. In contrast, classical musical training appears to develop connections between the ECN and salience networks.

The effects of musical improvisation instruction on visual and auditory statistical learning

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It is currently unknown whether music improvisation instruction results in far-transfer effects to other aspects of cognition. Our previous research showed enhanced performance related to executive function in the areas of inhibition and cognitive flexibility after 2 months of improvisation instruction with a large cohort of middle school band students (Norgaard et al., 2019). Here we probe if these enhancements may be related to underlying changes in statistical learning (SL). SL is the ability to implicitly extract the statistical regularities embedded within sequences of stimuli and use those regularities to predict upcoming stimuli or events. As improvisers create new sequences of notes, they must follow syntactic rules, also a central element of statistical learning that thus may enhance abilities in other domains where sequences are created in real time. Students participating in a university sponsored jazz instruction after-school program for adolescents (N = 11) participated in the study. Electroencephalography (EEG) data were collected during four computerized SL tasks assessing the learning of both adjacent and nonadjacent dependencies in visual and auditory input streams; learning was assessed both pre and post four months of jazz improvisation training. Participants also completed a music improvisation assessment at both time points. Pre-scores show a strong correlation between visual SL measures and improvisation achievement. Initial analysis of post scores shows a correlation between improvements over time in visual SL measures and improvisation achievement. Analysis of the auditory SL data will be available by the time of the proposed poster presentation.

Effects of music listening on Resting State Spectral Frequency measures and Independent Components of EEG

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Research evidences the ability of music listening to transiently improve performance on spatial abilities (Husain, Thompson, & Schellenberg, 2002), measures of general intelligence (Cockerton, Moore, & Norman, 1997), autobiographical memory (Irish, 2006), and creative cognition (Adaman & Blaney 1995; Eskine, 2018). However, the mechanism for cognitive improvements as a result of music listening are still contested. Recently Jung et al. (2013) has asserted that three networks neatly map onto the well-known theory of blind variation and selective retention (BVRT; Campbell, 1960); the Default Mode, Cognitive Control, and Salience Networks. Here we test this theory by looking for activation in these networks after participants listen to music that have previously been shown to increase creative cognition while controlling for musical experience (Eskine, 2018). Using 128-channel array we measured resting state EEG in 20 subjects before and after listening to the 2011 single “Can’t Hold Us” by Macklemore and Ryan Lewis featuring Ray Dalton. Findings indicate that activation is increased in the Default Mode and Salience Networks as indicated by increases in whole brain beta, and whole brain gamma. It was also found that delta and theta bands of the posterior independent component significantly differed between those with musical training compared to those without musical training. Here we find support for the idea that music might facilitate creative cognition by activating networks deemed important in the creative process.

Poster Session – 1, October 22nd, Thursday

Room – 3, Session – 2, Artistic Creativity

Creative paintings reveal gender differences in the allocation of spatial attention

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Background/Hypothesis: A critical feature of artistic creativity in paintings is the spatial location of the men and women who are being portrayed and their interactions. Prior studies using techniques such as line bisection have shown that healthy individuals have a leftward attentional visuospatial bias (pseudoneglect) and this bias is stronger in men than in women. Even in the absence of conscious awareness, creative artists may have knowledge of this gender dichotomy. We, therefore, wanted to learn if this gender dichotomy might also be observed in paintings of a man and woman, such that the artist would be more likely to position men to the right side of women. We also wanted to learn if men would be more likely to attend or look towards women when women were positioned on men’s left side than on their right side.

Methods and Results: Examination of 400 paintings showed no difference in the occurrence of men on the right versus men on the left side of women. However, more paintings showed men viewing/attending to the women on their left side, compared to when women are on their right side (82% vs. 64%).

Conclusions: These results suggest that creative artists have knowledge of gender and left-right spatial attentional asymmetries. Although we suspect that this knowledge is subconscious, future research will have to test this subconscious hypothesis. It would also be of interest to learn how this gender spatial arrangement influences the aesthetic quality of paintings.

Subtly and creatively revealing emotional valence in paintings

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Background: Creativity is dependent on the artist's awareness of nature and emotion. Prior studies have reported that patients with left frontal strokes often reveal depression with anxiety and right frontal lesions cause inappropriate indifference or euphoria. Our goal is to learn if artists have an implicit/explicit awareness of hemispheric asymmetries in the mediation of emotions and portray this left-right valence asymmetry in their art.

Methods: Activation of each hemisphere is associated with contralateral deviation of the eyes. To learn if artists implemented knowledge of hemispheric asymmetries, we examined 192 paintings to learn if in paintings that portray happy scenes the agent is more often looking right than left and in sad scenes more left than right.

Results: There were 38 paintings with a positive and 32 with a negative valence in which the eyes were visibly turned rightward or leftward. Of the 38 positive valence paintings, 28 had the agent looking rightward, and 10 had the agent looking leftward. Of the 32 negative valence paintings, 15 had the agent looking rightward, and 17 had the agent looking leftward.

Discussion: Studies suggest that the right hemisphere allocates attention to left and right hemispace, while the left hemisphere primarily allocates to attention the right. Since the left hemisphere appears to mediate positive emotions and the right negative emotions, these results are consistent with hemispheric valence attentional hypotheses. These results suggest that when creating these paintings, most creative artists, although perhaps not aware of these neuropsychological studies, are astute viewers of human behavior.

Becoming artists: Using creative writing to change the brain

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Identity formation is a critical part of adolescent development that requires creativity and openness to 'try on' different identities. Depression often manifests in rigid thinking, causing adolescents to get stuck in negative thoughts and self-view. Depression hijacks the ability to think creatively about oneself, takes away openness to new ideas, and forces a prematurely foreclosed identity as a 'depressed' person. Engagement in creative processes may be able to disrupt this negative thought loop by improving divergent thinking ability, which may open up pathways for healthy identity formation and a positive self-view. We are currently implementing a program in an adolescent mental health unit in which adolescents engage in creative writing exercises including poetry. The goals for this program are to help adolescents develop as artists, while also improving self-view. Adolescents are given feedback to promote their creative writing skills and encourage them as artists. Next steps are to incorporate resting-state fMRI before and after the creative arts intervention. Examination of neural changes related to creative thinking will focus on entropy of resting-state fMRI signals, which we propose reflects brain flexibility. We hypothesize that training with creative writing will improve brain flexibility, allowing adolescents to achieve insight. We will investigate brain entropy as a neural treatment target, setting the stage for an experimental therapeutics approach to further test the creative arts intervention. We hope to show that by promoting creative thinking, we will enhance brain flexibility and encourage adolescents to improve their self-view.

The cognitive appraisal of skilled performative movement

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Beyond its most basic survival purposes, human movement can also be performative or serve as a means of communication and expression, as in gesture, dance, and sign language. With training human beings can learn a highly skilled and specialized motor repertoire. Motor learning is thought to occur via an internal model that predicts the outcomes of our own and others' movements. Action execution, action observation, and the mental simulation of action (motor imagery) all draw upon the representation of this motor repertoire in the human brain. With learning, there tends to be a shift from the use of a visual imagery perspective to a kinesthetic perspective, possibly the result of plasticity that accompanies training. 'Breaking' (a dance sport that is played as a battle of movement concepts, often referred to as

breakdancing) was included among the 2018 Youth Olympic Games and is being considered for the 2024 Summer Olympic Games. With its inclusion comes the demand for a comprehensive standard of judging Breaking battle performance. Breaking involves learning a highly-skilled and specific motor repertoire that is often referred to as a movement vocabulary among breakers, who see the battle exchange as a sort of dialogue. Aims: This research investigates the difference in neural networks recruited by skilled breakers (10+ years), novices (< 3 years), and controls while evaluating battle performance for each of the 6 criteria (Technique, Variety, Performativity, Musicality, Creativity, and Personality) defined in the Olympic rulebook. The main purpose of this study is to determine how skill level and training affect the neural processes that are used to evaluate movement.

Dance expertise modulates emotion sensitivity: insights from face processing and embodied cognition using Somatosensory Evoked Potentials

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Dance expertise modulates neural and physiological responses to dance observation, enhancing visual and emotion sensitivity of familiar movements. This study investigates if the enhanced expert emotion sensitivity is domain-specific (i.e. emotion expressed on familiar dance movements) or general to other forms of emotional expression (i.e. facial expressions). We compare neural responses to facial expression (happy, fearful, neutral) in two groups (professional dancers/experts and non-dancers/controls). To explore activation in cortical regions related to embodied emotion (somatosensory/sensorimotor cortices), we measured Visual Evoked Potentials (VEP) and Somatosensory Evoked Potentials (SEP -by applying an irrelevant touch 105 ms after visual onset over the fingertip) while participants performed a visual emotion or gender task on emotional faces, as described in (Sel, Forster and Calvo- Merino, JoN, 2014). In line with previous work, results show a main effect of emotion over somatosensory cortex (80-100ms) over and above visually-driven carry-over effects and a main effect of emotion over the occipital lobe for the VEPs at P1, N170 and P2. Importantly, we find interactions between group and emotion from 40 to 160ms in the SEPs suggesting a differential embodied response to facial expression between experts and non-experts. Taken together, this data suggests an enhanced general emotion sensitivity in experts that is reflected beyond the observation of their motor acquired skill but onto general and everyday emotional expressions. These results point towards new venues for emotional sensitivity training based on engaging motor and artistic knowledge.

High scores on the Thought Impact Scale are associated with more frequent engagement in common creative and artistic activities among U.S. adults

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The Thought Impact Scale (TIS) is a newly validated 39-question questionnaire designed to measure a broad psychological trait reflecting a person's global amount of communication between consciousness and non-conscious mental functions in everyday life. High TIS scores were predicted to be associated with increased frequency of creative and artistic activities, and this was tested in one of the TIS validation studies. Five hundred U.S. adults (250 males and 250 females; mean age 49.4 years, range 18-88 years) completed a secure nationwide Internet survey including the TIS as well as the Creative and Artistic Activities Inventory (CAAI), which assesses the frequency in the past 12 months of 15 common creative/artistic activities (writing fiction, artistic drawing or painting, dancing or ballet, playing a musical instrument, writing poetry, etc.). Individuals with top quartile TIS scores were twice as likely as lowest-quartile TIS scorers to report on the CAAI to have engaged in one or more of the 15 creative/artistic activities at least monthly (86.8% of subjects vs. 42.4%; $p < .001$), and four times as likely to report having done so daily (38.0% vs. 9.9%; $p < .001$). The correlation of subjects' TIS scores with their overall amount of creative/artistic activities on the CAAI was $r = 0.48$ ($p < .001$). Our results suggest that the psychological trait measured by the TIS, which is likely indirectly indicative of the amount of neural communication

between brain regions, is a potent predictor of a person's propensity to engage spontaneously in common creative and artistic activities. A larger nationally representative population survey is now underway to confirm these findings.

Poster Session – 2, October 23rd, Friday

Room – 1, Session – 1, Domain Creativity

Increasing creative performance through basketball

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Studies concerning the laterality of brain activity have shown that it is possible to influence the performance on creativity tasks, namely by specifically increasing the level of activity in one of the brains hemispheres. In pre-activating the right hemisphere, e.g. through motor-tasks like squeezing a hand-gripper with the left hand, subsequent performance on creativity tasks was shown to be significantly increased, while doing the task with the right hand, meaning an increase in left hemispheric activity, tendentially lead to a decrease in creative performance. In this ongoing study the aim is to replicate these effects on creative performance in a slightly different context by implementing near-infrared spectroscopy (NIRS). As a motor-task for increasing the activation level of the left or right hemisphere, test-subjects (n = 40) are asked to dribble a basketball with the right or left hand, respectively. During dribbling the brain activity is monitored over the motor-cortex bilaterally using NIRS. By splitting the test-subjects into two groups (one dribbling with the left, the other with the right hand) and by conducting a pre-/posttest design for measuring creativity (verbal as well as figural divergent thinking tasks), effects of both left and right hemispheric activation on creative performance are examined. The implementation of NIRS, which is a novel approach to a study of this kind, could potentially broaden the gain of information of how manipulating the laterality of brain activity can influence creative performance.

Your brain on comedy: Neural activity associated with verbal improvisation in professional comedic improvisers

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Improvisation, the spontaneous generation of novel material occurs in many everyday activities, such as when we adapt to changing circumstances, innovate, or speak unscripted. While the last decade has seen increased research on the neural substrates of musical improvisation, in particular, other artistic domains of improvisation, such as comedic improvisation, remain relatively unexplored. Here, we examined the neural activity underlying verbal comedic improvisation. In collaboration with Speechless, Inc., an improvisation education center, experimental paradigms based on widely known improvisation warm-up games and exercises were adapted to be performed solo in a functional magnetic resonance imaging scanner. For these four paradigms (Three Things, Snap Clap Snap, Yes And, and Monologue), experimental improvisation tasks were contrasted against control tasks requiring pre-memorized, rote answers. 15 professional comedians participated in the experiment.

Across all paradigms, improvisation (in comparison to control tasks) was associated with deactivation in postparietal areas and variable involvement of the cerebellum. Moreover, the more

open-ended or unconstrained the paradigm, the more prefrontal deactivation was seen, particularly lateralized to the right hemisphere. Results suggest that spoken verbal improvisation is a unique biological process from the recitation of memorized text and that the neural activity underlying this improvisation varies according to the degree of improvisation required. Results have implications for better understanding verbal creativity and improvisation, a ubiquitous, commonplace occurrence in daily human social interactions.

Functional activity and connectivity during creative ideation in product design engineers

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Product Design Engineering (PDE) ideation, the generation of ideas for functional products to address a given problem, is a complex creative behavior with substantial technological and societal impact. While researchers have begun to examine the neural basis of PDE ideation, firm conclusions as to the cortical regions underlying this behavior have yet to be made. Furthermore, no study has investigated which neural regions, if any, functionally interact during ideation. In the study 30 professional product design engineers were tasked with generating novel and feasible ideas for products in response to design briefs while undergoing fMRI. Contrasts between ideation and 3 control tasks (rest, 2-back and mental rotation) showed consistent activations in the left PFC including the middle, superior and inferior frontal gyrus. Significant left parahippocampal gyrus activity was also shown during ideation when compared with 2-back and rotation. Finally, PPI analysis revealed higher functional connectivity between the middle and superior frontal gyrus during ideation as compared with rest. The results align with previous studies highlighting the role of the left PFC in ideation, suggesting that the generation of novel and feasible design ideas involves top-down executive processes such as inhibition and response monitoring. The observed left parahippocampal activations also indicate a role for episodic memory processing during ideation such as the retrieval of information from previously encountered design problems. Finally, this is the first study to examine functional connectivity in a PDE context, showing that key regions of the left PFC also interact to support ideation.

Cracking the joke: Reexamining humor's relationship with creative problem-solving

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While both humor and creativity have been the subject of extensive study, the relationship between the two has suffered from a shallow pool of research utilizing narrow definitions of both constructs. There is evidence for the role of humor ability in creative ideation and problem-solving (Kellner & Benedek, 2017), however, studies examining alternative definitions of humor (Yue & Hui, 2015) have found mixed results. This study aimed to better our understanding of the nuanced relationship between the two by incorporating multiple measures of humor and creativity. Specifically, 152 undergraduate students completed the two most prominent humor measures used in the literature: Humor Production Ability (a series of cognitive tasks requiring generation of funny responses; Nusbaum et al., 2016) and the Humor Styles Questionnaire (Martin et al., 2003). They also completed measures of divergent thinking ability (Alternate Uses Task) and creative problem solving (Remote Associates problems and verbal insight problems), as well as a general test of verbal ability. While we broadly replicate earlier findings regarding the relationship between the two humor measures and divergent thinking, our results suggest links between humor ability and styles not found in earlier studies (Edwards & Martin, 2010). In addition, associations between humor ability and styles and creative problem-solving are largely novel and

suggest a moderating factor of verbal ability, specifically in several interaction effects. The findings suggest a few possible explanations for the disparate results in existing literature and serve as the basis for a higher degree of specification for defining 'humor'.

Contribution of semantic memory and fluid reasoning to creativity problem solving in Chefs

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Divergent thinking tasks are widely used to measure creativity. They tap into associative thinking, cognitive-control processes, and their interaction. Neuroimaging studies have highlighted the contributions from rostral lateral prefrontal cortex (rLPFC), parietotemporal regions, and the default mode network in brain activity related to divergent thinking tasks.

The present functional magnetic resonance imaging (fMRI) study sought to establish whether regions involved in semantic knowledge (general and specific) and fluid reasoning were involved in solving general and domain-specific (e.g., professional culinary) creative problems. A total of 24 healthy adult chefs and matched controls performed two functional localizer tasks to identify areas responsible for semantic knowledge and fluid reasoning, as well as a general and a specific creative problem-solving fMRI tasks.

Results revealed that frontal areas, including the left inferior frontal gyrus, bilateral fusiform gyrus, and parietal cortex were more strongly recruited for domain-specific (culinary) than for domain-general problems in the experimental group (chefs) compared to the control group. These same areas were also recruited in the two functional localizer tasks. Furthermore, stronger functional coupling was found between these regions in chefs than in control participants. These findings suggest that specific semantic knowledge and fluid reasoning are critical aspects for creative problem solving.

Is creativity domain-specific or domain-general? An ALE meta-analysis across 5 domains

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One of the central questions about the cognition and neuroscience of creativity is the extent to which creativity depends on either domain-specific or domain-general mechanisms, or some combination of the two. One way to address this issue is to examine the profile of activated brain areas for creative tasks across domains. We carried out a series of activation likelihood estimation (ALE) meta-analyses of 55 neuroimaging studies of creativity across four domains of improvised production (piano improvisation, creative writing, creative drawing/design, creative verbalization) and one aspect of divergent thinking (the 'alternative uses' task). A total of 65 experiments were obtained from these studies, all of them contrasting a creative task to a matched, non-creative baseline task. Within individual domains, the results indicated a strong influence of domain-specific processes, as related to the presence of motor-planning and sensory-processing areas, suggesting that creativity may be an enhancement of sensorimotor circuits involved in non-creative processing. Across the five domains, there were clear indications of areas that were activated cross-modally, including the pre-SMA, the dorsal part of the IFG, and the frontal operculum. These areas were common across the motoric and divergent-thinking tasks, indicating that their functionality might relate to processes that are not limited to motor planning, but that also include domain-general aspects of cognitive control. The overall picture of creativity based on this analysis is one of domain-specific enhancement of sensorimotor functioning coupled with cross-modal processes related to motor planning and cognitive control.

Flexible semantic network structure supports creative metaphor ability

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Metaphor is one of the common ways to express creative language in everyday life, yet the cognitive basis of such figurative language production remains unclear. Previous studies have found that higher creative individuals performed faster and more accurately in comprehending novel metaphors, due to a more flexible and connected semantic memory network structure conducive to efficient combination of weakly connected concepts. The present study aimed to extend research on metaphor comprehension to the level of production, examining whether the ability to produce creative metaphors is related to variation in semantic network structure. Participants completed a creative metaphor production task and two verbal fluency tasks (animals and fruits/vegetables). They were divided into two equal groups (low- and high-metaphor producers; N = 71 per group) based on their creative metaphor production score. Next, the semantic networks of these two groups were estimated and analyzed based on their verbal fluency responses using a computational network science approach. Our results revealed that the semantic networks of high-metaphor producing individuals were more interconnected, flexible, and clustered than that of the low-metaphor producing individuals. Importantly, these results were consistent across the two semantic categories (i.e., animals and fruits/vegetables). The findings provide the first direct evidence that an interconnected and flexible semantic memory structure contributes to people's ability to produce figurative language, extending the growing literature on the role of semantic networks in creativity to the domain of metaphor production.

Poster Session – 2, October 23rd, Friday

Room – 1, Session – 2, Education & Social Context

Pedagogical influence on creativity: Preliminary evidence from resting-state fMRI data

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The rapid pace of changes faced by today's young people calls for pedagogical practices that equip them not only with knowledge but also with the ability to think flexibly and creatively. Some pedagogical practices can foster creativity skills in schoolchildren, such as Montessori education. However, few studies exist on the neural correlates of creativity in children, and no studies have examined its susceptibility to educational influences across age. Here, we recorded resting-state brain activity of 42 students (aged 5-12 years) using fMRI from high quality traditional or Montessori schools. In addition, students completed a standardized creativity task after fMRI scanning. Based on previous research on cognitive flexibility and creativity, three networks of interest were isolated through an independent component analysis; the default (DMN), salience (SN), and central executive (CEN) networks. Between-group inter- and intra- networks connectivity were investigated. While Montessori-schooled students scored higher on the creativity task, replicating previous studies, we found preliminary evidence of increased intra-DMN and inter-connectivity within the DMN and CEN in Montessori compared with traditionally-schooled students. The findings suggest that pedagogical experience influences the development of creativity and its neural correlates, with implications for neurodevelopment and education.

Fear, problem-solving, and socio-cognitive polarization during the early peak of the COVID-19 pandemic

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Previous research has demonstrated that stress and fear impair creative problem-solving and tend to make people socially and cognitively rigid. However, from an evolutionary perspective, shouldn't people be better problem-solvers when they are in danger? During the early peak of the COVID-19 pandemic (March and April, 2020), we had the opportunity to study creative problem-solving and socio-cognitive polarization (SCP; absolutism, xenophobia, and conservatism) in an ecological context of danger. Specifically, we measured participants' fear of COVID-19, their performance on Rebus puzzles, and their SCP in two populations affected by the pandemic: Italy and the U.S. Results revealed that fear of COVID-19 was related to worse problem solving-ability and enhanced SCP in both samples. Further, latent profile analyses of SCP scores yielded two statistically distinct SCP classes we interpreted as a high and low SCP groups, where the high SCP group had lower problem-solving accuracy compared with the low group. However, fear of COVID-19 did not moderate the relationship between SCP groups and problem-solving accuracy, suggesting fear impairs problem-solving independent of SCP. These results are an initial window into the relationship between people's creative problem-solving ability and SCP when in a context of danger.

The mobile technology crisis: Smartphone addiction is linked with lower divergent thinking scores

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Prior work has demonstrated that smartphone use is associated with increased creative expression, encouraging flow states and social creativity. However, this was true for active, but not passive smartphone use. From 1990 - 2008, about the same time as personal and mobile technologies have become more widely available, some reports suggest that creativity has been on the decline. The present study examined individual differences in creativity among students, and their proneness for being addicted to smartphones. Participants completed a divergent thinking test (The Torrance Test of Creative Thinking) and the Smartphone Addiction Proneness Scale. Results indicated that greater levels of smartphone addiction are associated with decreased fluency ($r = -.33, p < .01$) and decreased originality ($r = -.31, p < .01$) on the divergent thinking test. These results remained after controlling for perceived stress and individual differences in anxiety, suggesting that the effect is unique to smartphone addiction. Originality was also linked with better cognitive control, as assessed with an Oddball task, suggesting that higher levels of cognitive control may be the mechanism for reduced smartphone addiction in creative people. Future studies will need to replicate these findings, and examine the neural mechanisms involved in the link between creativity and smartphone addiction.

Imagination and social media use in young adults

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Social media is becoming a widespread phenomenon in today's society. Prior work has linked increased social media use to increased mind-wandering and negative mood, and to elevated depression and

anxiety. It is not clear, however, whether social media use is associated with the ability to imagine. The present study aimed to examine the relationships between imagination and active and passive media use in young adults. Seventy volunteer undergraduate students took part in an online study, in which they indicated frequency of their active media use (i.e. posting, commenting, or directly engaging with social media), and passive media use (i.e. browsing or not directly interacting with content online). They also gave their responses to the Four-Factor Imagination Scale (FFIS). Results indicated that passive media use was linked with increased frequency of imagination that was higher in negative affect, as well as with more goal-directed imagination. Active media use was not linked with any of the features of imagination. When all four features of imagination were entered simultaneously in a regression model as predictors of passive media use, higher frequency and increased goal-directed imagination remained significant predictors. These results demonstrate that people who spend more time engaging in imagination in more purposeful ways may use social media in a more passive manner. These findings provide insight for future research on the link between imagination and social media use.

The effect of social cognition style on creative potential

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Here, we examined the effects of social cognition style on creative potential. In the first and second experiments, we manipulated whether participants engaged in convergent social cognition via performance feedback (control condition), performance feedback and star-ratings of their performance (evaluation condition), or performance feedback and competition outcomes (competition condition). We measured participants' convergent creative potential with compound remote associative tests (study 1), and divergent creative potential with alternative uses tasks (study 2). We found that competition and evaluation boosted convergent but not divergent creative potential. In the third experiment, we manipulated whether participants experienced divergent social cognition via a training programme designed to reduce the use of stereotypes. We measured participants' divergent creative potential with alternative uses tasks. We found that less stereotypical thinking resulted in more divergent creative potential. These findings together suggest that the thinking style promoted by a particular type of social cognition can affect the corresponding creative potential. Future studies will investigate the impact of manipulating brain regions associated with convergent and divergent thinking on creative potential.

The relation between creativity and STEM learning among preschoolers

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Recent pushes for an integration of the arts into science, technology, engineering, and math (STEM) curriculum attempt to promote innovation and creativity in these ever-expanding job markets. The present study explores the relation between creativity and STEM learning among young children in digital and non-digital contexts. Thirty-one parent-child dyads consisting of one parent and one child aged four-and-a-half to five years old participated in a repeated measures experiment during which they played with magnetic tiles, similar to blocks, and then with a coding application on a tablet. Measures included levels of creativity during non-digital play, performance on the coding application, and parent report of children's STEM engagement. Considering these measures, four main findings emerge. Firstly, parent and child creativity were strongly correlated with one another and have no significant differences, suggesting that dyad creativity is built together. Additionally, there is some evidence that creativity and STEM skill performance are positively related, but this relation remains unclear. Consistent with previous research, our data also demonstrates that digital play can promote STEM learning. Finally, results suggest that STEM engagement at home can be a useful background for learning new STEM skills in another context. This study contributes to the development of STEM curriculum and its incorporation of creative activities in the preschool years.

Spontaneous and deliberate modes of creativity: Multitask eigenconnectivity analysis captures latent cognitive modes during creative thinking

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Although an interplay between deliberate goal-directed cognition and spontaneous thought generation is often implicated in dual-process theories of creativity, a data-driven validation is still lacking. Here, using a continuous multitask paradigm - with two creativity tasks, five cognitive tasks, and a resting-state scan - we sampled a hypothetical two-dimensional cognitive plane of deliberate and spontaneous thinking using fMRI. We then utilized a data-driven eigenconnectivity (EC) analysis on multitask whole-brain functional connectivity (FC) patterns to decompose multitask-FCs into representative low-dimensional connectivity embeddings. The first two latent components, revealed by the EC analysis, broadly mapped on the two cognitive modes of deliberate and spontaneous thinking. Further, in this two-dimensional cognitive space, we observed that creativity tasks occupied the space of higher deliberate and spontaneous thinking. This projected creative cognitive space was represented by higher integration of the default mode network (e.g., medial prefrontal frontal gyrus) and higher decoupling of the left-lateralized dorsal attention network. Moreover, individual differences reflected in the low-dimensional connectivity embeddings were related to differences in deliberate and spontaneous thinking abilities. Altogether, using a continuous multitask paradigm and data-driven analysis approach, we provide neural evidence for the classic theory of creativity regarding the contribution of both deliberate and spontaneous modes of cognition during creative thinking.

The impact of adding a fourth item to the traditional 3-item Remote Associates Test

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Introduction: The Remote Associates Test (RAT) is a classic laboratory measure of creative thinking. The 3-item trial has been widely used and validated but is limited for some applications (such as neuroimaging) due to low levels of performance. In the current work, we investigated whether adding a fourth clue word improved performance and subjective feelings of insight.

Methods: Across three experiments, 467 adults aged 18-30 completed 30, semi-randomly chosen, 3- & 4- item remote associate trials (within-subjects design). The 3- & 4-item trials were matched on overall Forward Associative Strength and on item level associations with previous work. Answer word frequencies were determined to not be related to accuracy, and stimuli were improved across experiments (to address stimuli with low performance). In Experiment 3, a rating of subjective feelings of insight (versus use of a strategy) followed successful trials.

Results: On average, participants performed significantly better on 4-item trials than on traditional 3-item trials (e.g., 53% vs 41% in Experiment 3). This performance gain occurred without changing the nature of the task (i.e., similar proportion of insight ratings). Interestingly, in all experiments, we observed significant interactions such that adding the fourth word improved performance on difficult trials and impaired performance on easy trials, when weighted against performance on the traditional 3-item versions ($r_s = -.34, -.50, -.50$).

Conclusions: The addition of a fourth item to the remote associates task improves performance on difficult items, without changing insight-based problem solving.

Applications of graph theory in creativity: A study of resting state functional connectivity and divergent thinking

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Recent investigations into the neuroscience of creativity have shown the various ways in which dynamic interactions between large-scale brain networks are involved in creative cognition. The present study applies graph theory techniques in resting state functional connectivity MRI (rs-fcMRI) data to explore how individual differences in network assembly are associated with creativity. To measure creative performance, a sample of healthy adults (N = 175) completed a divergent thinking task, in which they were asked to think of unusual uses for everyday objects. Computational semantic models were applied to calculate the semantic distance between objects and responses to obtain an automated measure of divergent thinking (DT) performance. All subjects underwent five-minute resting state scans, from which we computed voxel-wise connectivity matrices. We represented the number of significant (FDR<0.05) connections for each voxel by calculating weighted degree (WD) and performed linear regression analysis between WD and DT. Additionally, we performed a link-level analysis to identify specific connections associated with DT. All analyses were controlled for age, sex and visual-spatial intelligence. Weighted degree analysis revealed a negative association between DT and global connectivity to the visual cortex and right middle temporal gyrus. Link-level analyses showed higher local connectivity within visual regions was associated with lower DT, while projections to the left precuneus and right lateral visual pathway were positively associated with DT. These results demonstrate differential patterns of connectivity associated with creativity, assessed via semantic distance.

The role of creativity and fractality in visual pareidolia

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Pareidolia refers to the perception of recognizable forms in noisy or ambiguous stimuli. It has mostly been studied in the context of pathologies such as schizophrenia and dementia, but can also occur in general population without associated psychotic symptoms. It has been hypothesized that aberrant salience, an alteration of inhibitory processes, both promote the emergence of pareidolia and play a role in creative behavior. Ambiguous stimuli, such as visual noise, can be characterized by a fractal dimension, which is a measure of statistical complexity. In the present study, the effect of fractal dimension on pareidolic perception has been investigated by asking participants to perceive as many recognizable forms as possible in a set of fractal generative clouds. In addition, we further investigated, using questionnaires, whether creativity, aberrant salience and flow state are good predictors of pareidolic perception. Results show that pareidolic perceptions arise more often, more rapidly and are reported as more vivid in lower fractal dimension. We demonstrate that creative individuals are generally more inclined to experience pareidolia, with a specific dissociation around FD 1.3, and that high level of reported flow facilitate creative individuals to perceive meaningful objects in images of high fractal dimension. These results show that creative individuals perceive ambiguous stimuli differently and that fractal dimension is a promising visual feature to manipulate in order to investigate pareidolic perception. We suggest that pareidolia can be conceived as a compensatory perceptual mechanism that enables the brain to integrate ambiguous information.

Investigation of the neurophysiological mechanisms of internal attention in creative cognition

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Creative thinking involves imagination and thus commonly relies on an internal focus of attention. Internally directed cognition and externally directed cognition were found to differ in their neurophysiological signatures in fMRI, EEG, and eye-tracking research. This raises the question to what extent neurophysiological differences observed for creative thinking can be attributed to brain mechanisms supporting sustained internal attention. In two recent co-registration studies, we have concurrently measured brain activation (i.e., EEG alpha activity or fMRI BOLD response) and eye behavior in the context of varying levels of creative task demands and internal attention demands. The findings generally supported the robustness of previously reported creativity- and attention-related effects, showing that sustained internal attention is characterized amongst others by relatively higher posterior alpha power, reduced activation of visual networks, and increased pupil diameter. Covariation analyses of brain activation and eye behavior further indicate that attention-related brain activation changes are specifically associated with variation in pupil diameter. Together these findings shed further light on the involvement of specific brain mechanisms and eye behaviors in a common gating mechanism in support of internally directed cognition such as creative thinking.

Static and dynamic network re-configuration in creative brain networks

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In recent functional neuroimaging of creativity studies, the creative brain is recognized to involve spontaneous cognitive processes and has manifested complex networks within the creative brain regions. The emerging area of dynamic network neuroscience would help to understand these creative processes as well as the complex creative brain networks. However, the body of research in the area of dynamic network neuroscience involving dynamic re-configuration of creative cognition networks remains elusive. Here we used the approach of dynamic networks to examine the static and dynamic alterations in the network re-configuration of the creative brain. Nineteen healthy young adults were instructed to perform a convergent thinking creative task during functional magnetic resonance imaging (fMRI). This standard approach involved the use of sliding window method followed by a community detection algorithm on the blood-oxygen dependent (BOLD) time series signal of 32 region of interests involving 8 different major functional brain networks. The functional networks involved in creative cognition as per the literature such as the default mode network, salience network, cerebellar network, fronto-parietal network were of greater interest in the fMRI study. Furthermore, we characterized an important temporal network measure-‘flexibility’ to understand the dynamic re-configuration of the creative brain networks. Our results demonstrated the re-configuration of the static as well as dynamic large-scale creative networks during a creative cognition task and pushed forward our understanding of the network neuroscience of creative cognition.

Learning preferences as an index of individual differences in cognitive flexibility

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Recent findings suggest that when solving problems involving cognitive flexibility (CF), individuals who approach a learning task using exploration, outperform those who approach the task with exploitation. Based on these data, we hypothesized that CF is a function of individual differences in learning preference and task demands. In an initial behavioral study, healthy English speakers were administered three CF tasks that incorporated (i) shifting, (ii) divergent thinking, or (iii) both shifting and divergent thinking elements. Participants' response selection history on a reward-based learning task was used to determine each participant's learning style, either exploitation or exploration, and predict CF performance. As CF has been linked to prefrontal cortex (PFC) activation, in a second study we used a similar paradigm to examine whether modulation of PFC with noninvasive brain stimulation would produce measurable effects on CF that would be mitigated by individual learning preferences. While completing a CF task and a control task, participants underwent high-definition transcranial direct current stimulation (tDCS), a noninvasive brain stimulation approach involving small electric currents (1.5mA) through a 4x1 electrode montage over the left-lateral PFC. Participants received either excitatory, inhibitory, or sham stimulation. We show that different CF task components (i.e., whether the task involved divergent thinking) interact with participants learning preferences as measured by the independent learning task and that such effects are altered by modulation of PFC activity. We discuss how learning preferences might capture individual differences in CF.

Enhancing creativity by altering the frontoparietal control network functioning using transcranial direct current stimulation

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The left angular gyrus (AG), part of the frontal-temporal network, is implicated in creative thinking, including verbal creativity tasks such as novel metaphor generation. The current study tested the effects of tDCS over the left AG on two metaphor generation tasks. The study was a randomized, double-blind, sham-controlled, crossover study of anodal vs. cathodal stimulation by tDCS. Compared to sham, cathodal stimulation resulted in significantly increased novel metaphor generation, while anodal stimulation increased conventional metaphor generation. Higher motivation (BAS fun-seeking) was associated with greater metaphor creativity in the sham condition, and lower fun-seeking was associated with producing a greater quantity of conventional metaphors. Following active stimulation, motivation traits no longer contributed to creative metaphor generation. Thus, the beneficial effect of cathodal tDCS over the left AG in generation of novel metaphors is through restraining the control network. The current study gives a glimpse into the neural basis for creative thinking.

The effect of transcranial Random Noise Stimulation (tRNS) over the dorsolateral prefrontal cortex on divergent thinking, convergent thinking and insight problem solving

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Transcranial random noise stimulation (tRNS) increases performance in some perceptual and learning tasks. However, little is known about its effect on different aspects of creative cognition. We aimed to investigate the effect of tRNS on convergent thinking (CT), divergent thinking (DT) and insight problem solving (IPS) during dorsolateral prefrontal cortex (DLPFC) stimulation. Eighty-four participants were randomly assigned to anodal left/cathodal right DLPFC (L+R-) stimulation, cathodal left/anodal right DLPFC (L-R+) stimulation or sham stimulation (20 minutes). Current was set at 2 mA (100-500 Hz) with a 1mA direct current offset. Participants' creativity skills were assessed before and after tRNS with the Unusual Uses (verbal DT) and Picture Completion subtests (visual DT) from the Torrance Test of Creative Thinking, the Remote Associates Test (verbal CT), nine dot problem and matchstick arithmetic problems (IPS). There were no significant differences at baseline in any of the creativity scores. Bootstrapped analysis of variance showed that L+R- group had higher change scores than L-R+ and sham groups in verbal DT ($F = 5.09, p = .008$) and verbal CT ($F = 4.46, p = .015$). The L-R+ group performed significantly better than the L+R- and sham groups in both IPS tasks, including nine dot problem task ($\chi^2 = 15.30, p = .001$) and matchstick arithmetic problems ($\chi^2 = 10.71, p = .005$). Our results suggest that L+R- DLPFC may help verbal creative thinking, whereas the L-R+ seems to produce a 'releasing effect' on creativity.

tDCS modulates the interactions of brain networks related to creative thinking

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Creativity is commonly defined as the ability to generate knowledge or work that is novel and useful. Correspondingly, creative thinking consists of two processes: production of novel ideas, and evaluation or selection of those that are useful. Recent studies have revealed that the interactions within large-scale brain network (default mode, executive control and salience network) contribute to these processes of creative thinking. However, the effects of brain stimulation on the large-scale brain network during creative thinking has not been revealed. The present study examined the changes in effective connectivity of the large-scale brain network induced by transcranial direct current stimulation (tDCS). Sixteen healthy male participants underwent actual and sham stimulation (anode over the left dorsolateral prefrontal cortex, DLPFC; cathode over the right inferior parietal lobule, IPL) for 20 minutes on 2 separate days. Before and after the stimulation, electroencephalography (EEG) signals were acquired from 32 electrodes over the whole head during the Alternative Uses Task (AUT). The effective connectivity between all pairs of 11 regions of interests (ROIs) within large-scale brain network were computed using isolated effective coherence (iCoh) with eLORETA software. As a result, increased flow of higher frequency oscillations within a large-scale brain network and decreased flow within the default mode network were observed. Our results reveal that tDCS could change the interactions within large-scale brain network related to creative thinking.

Executive control network transcranial alternating stimulation (tACS) modulates visual analogical reasoning

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Previous research has linked the Executive Control Network (ECN) to analogical reasoning performance. Past theory and research have suggested that connectivity within the ECN may be important for analogy performance including its development. However, aside from studies of frontotemporal lobe

degeneration, the evidence linking brain networks to analogical reasoning performance has thus far been correlational. Here we applied transcranial alternating current stimulation (tACS) at theta frequency (6 Hz) to nodes in dorsolateral prefrontal cortex (DLPFC) and posterior parietal cortex (PPC) to investigate the causal role of ECN connectivity in both visual and verbal analogical reasoning. 94 participants (collected across two sites) participated in a between-subjects, double-blind design with three conditions: 1) 0-degree in phase 'synchronized' theta tACS (N = 32), 2) 180-degree out of phase 'desynchronized' theta tACS (N = 28), and 3) sham stimulation (N = 34). Contrary to previous evidence that 'synchronized' theta tACS to DLPFC and PPC enhances working memory, we found that 'desynchronized' stimulation led to enhanced visual analogical reasoning compared to both the sham and 'synchronized' stimulation conditions ($F = 4.31, p = .016, \eta^2 = .086$), even when controlling for baseline intelligence and vocabulary. We found no differences in performance on forward digit span (working memory) or the verbal analogy task between the three different stimulation conditions. These findings support a causal role of the ECN in visual analogical reasoning, and call into question whether 180-degree out of phase stimulation truly 'desynchronizes' cortical oscillations between brain regions.

Examining prefrontal cortex contributions to cognitive flexibility with noninvasive electric brain stimulation

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Cognitive neuroscience studies of cognitive flexibility typically employ divergent thinking tasks that prioritize bottom-up processes to generate novel responses. However, real-world creative problem solving is also guided by top-down thinking that puts an emphasis on the goal to be achieved. Here, we introduce the Alternative Objects Task (AOT) - a novel task that incorporates both bottom-up and top-down thought during problem solving. Guided by functional neuroimaging findings, we employed transcranial direct current stimulation (tDCS) over the left frontopolar cortex to investigate causally the impact of transient changes in activity in this region for problem solving performance on the AOT. Participants were presented with a series of goals and generated either a common or an uncommon object that could satisfy each, while undergoing either excitatory (anodal), inhibitory (cathodal), or sham 4 x 1 high-definition tDCS at 1.5 mA over left frontopolar cortex. Analyses of variance on the effect of tDCS on response fluency, reaction times, and semantic distance revealed significant interactions between task and stimulation type across measures and highlight how goal-orientation during cognitive flexibility may differentially prefrontal cortex contributions to creative thinking.

Poster Session – 2, October 23rd, Friday

Room – 3, Session – 1, Pharmacology & Altered States

Exploring brain white matter correlates of creativity in schizophrenia

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Background: The relationship between creativity and psychopathology has been a controversial research topic for decades. Specifically, it has been shown that people with schizophrenia have an impairment in creative performance. However, little is known about the brain correlates underlying this impairment. Therefore, the aim of this study was to analyze whole brain white matter (WM) correlates of several creativity dimensions in people with schizophrenia.

Methods: Fifty-five patients with schizophrenia underwent diffusion-weighted imaging on a 3T magnetic resonance imaging machine as well as a clinical and a creativity assessment, including verbal and figural creativity measures. Tract-based spatial statistic, implemented in FSL, was used to assess whole brain WM correlates with different creativity dimensions, controlling for sex, age, premorbid IQ, and medication.

Results: Mean fractional anisotropy in frontal, temporal, subcortical, brainstem, and interhemispheric regions correlated positively with figural originality. The most significant clusters included the right corticospinal tract (cerebral peduncle part) and the right body of the corpus callosum. Verbal creativity did not show any significant correlation.

Discussion: As a whole, these findings suggest that widespread WM integrity is involved in creative performance of patients with schizophrenia. Many of these areas have also been related to creativity in healthy people. In addition, some of these regions have shown to be particularly impaired in schizophrenia, suggesting that these WM alterations could be underlying the worse creative performance found in this pathology.

Polygenic risk score for bipolar disorder associates with divergent thinking and structures of the prefrontal cortex

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It has been hypothesized that a higher genetic risk of bipolar disorder (BD) is related to greater creativity. One previous study showed that a higher genetic risk of BD (polygenic risk score of bipolar disorder: BD-PRS) is related to being in artistic professions. Here we examined associations of BD-PRS with creativity measured by divergent thinking (CMDT) through psychological analyses and regional gray matter volume (rGMV)/ regional white matter volume (rWMV) through whole-brain voxel-by-voxel analyses in 1558 young typically developing adult students. After adjusting for confounding variables and multiple comparisons, greater BD-PRS was related to the greater total score of CMDT, and a significant relationship was found in fluency subscores. The greater BD-PRS was also associated with lower total mood disturbance. Neuroimaging analyses showed that the BD-PRS was associated with greater rGMV in the right inferior frontal gyrus, as well as greater rWMV in the left middle frontal gyrus. These findings suggest the relationship between genetic risk of BD and CMDT as well as prefrontal cortical structures among the young educated sample.

Experience with drugs modulates the belief that drug use impacts creativity: A focus on marijuana

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Since the late 1970's, large scale surveys indicated that the use of drugs like alcohol, marijuana, and cocaine in youth has generally declined. However, the medical and recreation legalization of marijuana in some areas, in addition to the potential clinical usefulness of psychedelics, raises the possibility that the use of certain drugs may increase. With this in mind, it is important to note that the effects of drugs on cognitive and behavioral outcomes are contingent upon the chemical itself, previous experience with

the drug, and expectations about the drug's effects. Although there are some exceptions, the general consensus is that drug use does not seem to enhance creativity. Nevertheless, people tend to believe that alcohol enhances creativity. Interestingly, it appears that the beneficial effects of alcohol on aspects of creativity may be largely due to expectancy effects. However, the extent to which people believe other types of drugs affect creativity and how their use of substances impact those beliefs remains to be determined. Results from a survey of 720 university students indicated that they believed that marijuana, more so than other types of drugs (e.g. alcohol, psychedelics, etc.), fostered creativity. As was the case for a variety of drugs, the more experience participants had with marijuana, the stronger their belief that the drug enhanced creativity. These results have implications for understanding the creative beliefs associated with the use of certain drugs. As indicated elsewhere, the expectation that the use of certain drugs is associated with enhanced creativity may in turn motivate individuals to use or continue to use the substances.

Psychedelic use and divergent thinking scores predict how we judge the self and others

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The brain states that occur for enhanced creative performance and during the use of psychedelics overlap, including increased functional connectivity, especially between the default mode network, executive control network and salience network. We propose that enhanced creative abilities and ego dissolution experiences via psychedelics can have a cognitive impact not only on creative task performance, but also on how one views the world and social groups more broadly. A key component of creative thinking and ego dissolution via psychedelics appears to be the reconceptualization of domain rules, situational constraints, and even the self. In this study we set out to examine the impact of psychedelic use and creative abilities on identity and creative problem solving (divergent thinking via AUT) on social and self-concepts. The research was conducted as an online survey (n = 117) with detailed questions on personality, creativity, and in-group and out-group beliefs previously shown to evoke defensiveness of an individual's worldview. Adjusted statistically for demographic differences, psychedelic use and AUT scores predicts less nationalism and outgroup hostility, and increased in-group compassion, consistent with our hypothesis. These results can be viewed as the persistence of reduced weight of high-level prior beliefs, as well as a persistent ambient level of self-transcendence which modulates self-identity to be more inclusive of the world at large.

The missing link: Exploring the link between altered states of consciousness and creative cognition

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This article addresses the controversy regarding the link between altered states of consciousness and creative cognition. While anecdotal evidence suggests enhanced creativity during altered states, the research on this topic is best described as inconclusive. I first examine two major hypotheses on the link between altered states and creative cognition. One account, known as hypofrontality, posits downregulation of prefrontal cortex activity as connecting altered states and creative cognition. The other puts forward internal attention and perceptual decoupling as the link. I argue that these hypotheses are insufficiently inclusive. Consequently, I propose a third account, the landscape flattening hypothesis, which extends and substantiates a recent account on the neural correlates of psychedelics, called anarchic brain (Carhart-Harris & Friston, 2019). My account suggests that creativity and altered states share a similar attractor landscape, characterized by flatter attractor basins, where basins represent the degree of cognitive stability of each brain network. Flattening provides the system with the mobility to flexibly move around the landscape and access a richer repertoire of novel associations

and ideas. Particularly, neuroimaging evidence suggests that flattening of two rival brain networks, the default mode and task positive networks, lends itself to creativity. This hypothesis combines neuroimaging evidence and the principles of dynamical systems theory to explain a broader range of phenomena. It reconciles major inconsistencies within the field, providing a more general explanation of creative cognition, altered states, and the link between the two.

Effects of methylphenidate on verbal creativity, verbal fluency, and convergent thinking tasks in adults with Attention-Deficit/Hyperactivity Disorder

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A common treatment for the symptoms of attention-deficit/hyperactivity disorder (ADHD) is methylphenidate (MPH), which functions as a norepinephrine-dopamine reuptake inhibitor. Both the dopamine and norepinephrine systems have been shown to impact aspects of creativity. For example, people with ADHD have been shown to perform better on some measures of creativity, and MPH has been shown to increase creativity in people without ADHD. However, it is not clear if MPH augments or impairs creativity in adults with ADHD. Seventeen participants diagnosed with ADHD, aged 18-40, participated in the study. Participants attended 2 sessions where they took the prescribed amount of MPH prior to the appointment for one session, and another session where they withheld their MPH. Participants were administered a battery of assessments in a counterbalanced fashion, including the Verbal Torrance Test (verbal creativity), convergent thinking tasks (compound remote associates, anagrams), and divergent thinking tasks (semantic and letter fluency). The number of words generated on the semantic fluency task as well as the solution latency for correctly solved problems were significantly increased for MPH compared to no MPH. Furthermore, MPH significantly increased originality scores on the Verbal Torrance Test, and a trend toward significance was found for the overall Verbal Torrance battery average score. In sum, results from this study suggest that MPH improves performance on semantic fluency but increases response latency on an anagrams task in adults with ADHD. Furthermore, MPH appears to enhance originality in the verbal domain in adults with ADHD.

Rostral anterior cingulate thickness predicts the emotional psilocybin experience

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Psilocybin is the psychoactive compound of mushrooms in the psilocybe species. Psilocybin directly affects many serotonin receptors, with affinity for the serotonin 2A receptor (5HT-2Ar). Effects of psilocybin and its active metabolite psilocin include cognitive, emotional, and perceptual changes, and have been shown to enhance both convergent and divergent thinking at different periods after administration. Though these effects are generally observed, variability exists in subjective psilocybin experiences that are not well understood. There is evidence to suggest that brain morphology metrics derived from MRI can predict response to psilocybin. Due to high expression of 5HT-2Ar in cingulate cortex, and associations with psilocybin, it is hypothesized that greater cingulate thickness may predict higher subjective ratings in sub-scales of the 5-Dimensional Altered State of Consciousness with high emotionality in healthy participants (N = 55) who received low dose (0.160 mg/kg) or high dose (0.215 mg/kg) oral psilocybin. Rostral anterior cingulate thickness predicted all four emotional sub-scales, whereas the caudal and posterior cingulate did not. Given the relationship between emotionality and creativity, this may help explain the neural mechanisms underlying the relationship between

psilocybin use and increased creativity. This highlights a need for future research on effects of psychedelic compounds on creativity and their neural mechanisms. How psychedelic compounds induce variability in subjective states has been a long-standing question in serotonergic research. These results extend the set and setting hypothesis of psychedelic experience to include brain structure metrics.

Poster Session – 2, October 23rd, Friday

Room – 3, Session – 2, Personality

Scientific studies do not support stronger visuospatial and creative abilities in dyslexia

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There is a long-held view that people with dyslexia, in contrast to having reading difficulties, have relatively stronger abilities in visuospatial cognition and creativity. While this idea is propagated through many media forms and some advocacy groups, a recent review revealed that empirical studies do not support the notion of exceptional visuospatial cognition in dyslexia (Gilger et al., 2016). Studies on enhanced creativity in dyslexia, however, have not yet been subjected to formal review. We performed two objective reviews of peer-reviewed studies comparing groups with and without dyslexia on (1) visuospatial and (2) creative abilities. We identified 34 studies on visuospatial cognition and 13 on creativity, with 4 overlapping. For each domain we determined how many studies had results that overall supported relatively better performance in those with dyslexia. We found that only 24% of studies on visuospatial cognition (similar to 17% reported by Gilger et al., 2016) showed an advantage in the groups with dyslexia, while 32% showed the opposite, and the majority, 44%, showed no significant between-group differences. Similarly, only 31% of studies on creativity showed an advantage in dyslexia, with 15% of the studies reporting the reverse, and the majority, 54%, reporting equal creative abilities. Results for both domains were similar for studies conducted in children, adolescents, and adults. Thus, empirical studies do not support the notion of exceptional visuospatial cognition nor creative abilities in dyslexia. This is important for understanding of the etiology of dyslexia and for educators and practitioners teaching those with dyslexia.

A personality network analysis of scientific and artistic creativity

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Personality plays a central role in distinguishing highly creative individuals in the arts and sciences. Although existing research has consistently supported a relationship between creative achievement and specific personality factors (e.g., openness to experience), such work has largely focused on univariate associations, potentially obscuring complex interactions among multiple personality factors. In addition, individuals in different creative domains, such as artists and scientists, exhibit distinct personality traits, but the mechanisms of these personality profiles have been unclear. Here, we apply a psychometric network approach to characterize the personality network structure of highly creative individuals in the arts and sciences. Using data from three samples (N=2,617)—including college students, a

representative adult sample, and the Big-C project of creative professionals—we aimed to identify essential characteristics of the creative personality. Replicating past work, we find that, compared to scientists and a control group of less creative people, the artists groups show reliably higher levels of open to experience. Psychometric network analysis further revealed that artists are characterized by more dispersed network components and a higher “out-degree” in openness, indicating higher connectivity of openness with other personality traits. Although the personality networks of all groups show robust small-worldness, both artists and scientists show more connectors compared with the control groups. Moreover, across all four samples, we found consistent evidence that the personality network structure of scientists is more resilient to simulated attacks than artists, potentially reflecting increased stability of the scientific personality.

Reframing anxiety: How domain anxieties affect performance on cognitive tasks framed as domain-specific

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Educationally relevant anxieties have been shown to impact performance in specific educational domains. For example, math anxiety is associated with underperformance in and avoidance of math and careers that involve math (Hembree, 1990; Dowker et al., 2016). Creativity anxiety (i.e., anxiety specific to creative thinking) has recently been shown to exist across diverse content domains, affecting creative thinking and performance in everything from music to science, and predicts individual differences in creative achievement (Daker, Cortes, Lyons, and Green, 2019). We hypothesized that the negative performance effects associated with domain anxieties could be ameliorated by reframing problems as being unrelated to the domain of an individual’s anxiety. To test this hypothesis, we paired administration of three cognitive measures that are not strongly tied to math or creativity with instructions indicating that the task was either math-related, creativity-related, or neutral. We predicted that individual differences in domain-specific anxiety would interact with instruction type such that individuals would perform worse when a task was described (framed) as relevant to their anxious domain and better when it was not. In addition to measuring task performance, we collected physiological measures of anxiety (autonomic arousal) using psychophysiology apparatus. Results have potential implications for education, as educators might effectively ameliorate domain anxieties by changing how a topic is presented or framed for students.

Relationships between behavioral correlates of openness to experience

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Openness to Experience is a broad dimension of personality with indicators extending from creative ability and moral reasoning to breadth in sensory processing. Although these aspects appear quite different, it has been suggested that they may be driven by the same underlying mechanism. One critical step toward examining this open question is determining the nature of the relationships between behavioral correlates of Openness. In this study (N = 100), we include measures previously associated with Openness across four domains: aesthetic, conceptual, attitudinal, and perceptual. Specifically, we employ a measure of divergent thinking, openness to aesthetic schema-violations, overinclusive thinking, openness toward opposing views and controversial topics, and two types of perceptual openness; visual irrelevance processing and mixed percept in a binocular rivalry task. By examining relationships between these correlates of Openness, we clarify which are likely to be driven by the same underlying mechanism and which are likely to be independent facets.

Creativity through functional MRI and the five-factor model of personality

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The present study will use both psychological and imaging data to explore the relationship between psychologically derived key terms relating to the openness factor of the FFM and their corresponding mechanisms within the brain. We will utilize the WU-Minn HCP Dataset, which includes data from 1,200 healthy adults. From HCP, we will study a subset of 415 participants whom have both imaging and FFM data accounted for, and whom are not related to other participants in the database. Using meta-analysis software Neurosynth to analyze large-scale data of functional MRI data, we will utilize the terms theorized by behavioral literature to study the neural correlates and their structures. For the purposes of this study, we will 'imagine', 'musical', and 'personality' as the facets for openness to experience. We will use DPABI: a toolbox for Data Processing & Analysis for Brain Imaging to extract the time courses from the corresponding regions of interest based on the coordinates of the facets analyzed through Neurosynth. Looking at several ROI's related to openness, creativity, musicality, and personality, we will correlate the individual ROI's and quantify the relationship using a Pearson correlation value. Then, comparing the Pearson correlations from each subject's individual imaging data, we will correlate each ROI value ROI to their FFM score of openness, analyzing the strength of functional connectivity through the time series of the ROI. Doing so will allow us to quantify a measure of connectivity strength of the ROI pairings which correlates functional connectivity with the five-factor-model of personality.

The cognitive neuroscience of the dark side of creativity: A proposal

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The neural underpinnings of creative thought have been investigated widely in past work. However, over the last decade, the emphasis has extended to understanding the dark sides of creativity; that is, acts that use the creative process to meet socially undesirable ends. Behavioral research in this domain has identified lying as a means to reach such goals, leading to the importance of examining deceptive creative thought through a neuroscientific lens. The neural basis of deception also differs based on whether help or harm is provided to the target in social situations, making it important to distinguish prosocial and antisocial motives of lying. Therefore, the principal aim of the project is to examine the neuroscientific underpinnings of dark creativity in tasks requiring the navigation of social relationships, through the EEG and fMRI methodologies. It is proposed to conduct two experiments where participants will respond to situations in creative or conventional ways, in a 2 (Type of situation: antisocial, general) x 2 (Type of instruction: creative, conventional) within-subjects design. An example of an antisocial situation is finding a way to not attend a close friend's wedding despite being in town; general situations involve finding a way to shift furniture to a new home. EEG data analysis will involve Task-Related Power (TRP) analyses within the alpha frequency band (8-12Hz) and fMRI data analysis will involve multiple comparisons to reveal similarities and differences in brain activation across conditions. The proposed project seeks to lend insights into broader conceptions of social cognition, moral cognition, and affective creativity.

Adopting an eccentric mindset enhances divergent thinking

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The current study investigated creativity as a flexible ability rather than a fixed trait. Dumas and Dunbar (2016) found that hypothetically taking on a stereotypically creative or uncreative occupation coupled with a modifier word (eccentric poet, rigid librarian, or control condition) modulates divergent thinking. This phenomenon is termed the Creative Stereotype Effect. We teased apart the effect of the modifier words by instructing participants to adopt a particular mindset (eccentric, simple, or control condition) with no reference to occupation. This experiment worked to determine if, in the absence of a

stereotypically creative or uncreative occupation, modifier words can modulate performance on a divergent thinking task. Specifically, we used an Alternate Uses Task in which participants were asked to generate as many uses as possible for a series of everyday objects. Compared to the simple mindset and control conditions, adopting an eccentric mindset significantly enhanced creative performance on the task. Using the eccentric modifier word, unattached to a stereotypically creative occupation, was sufficient to evoke the generation of more creative answers. Therefore, adopting a particular mindset holds power in modulating creativity. We propose that the bounds of creative ability are flexible and creative thinking can be encouraged through the use of selective modifiers.
