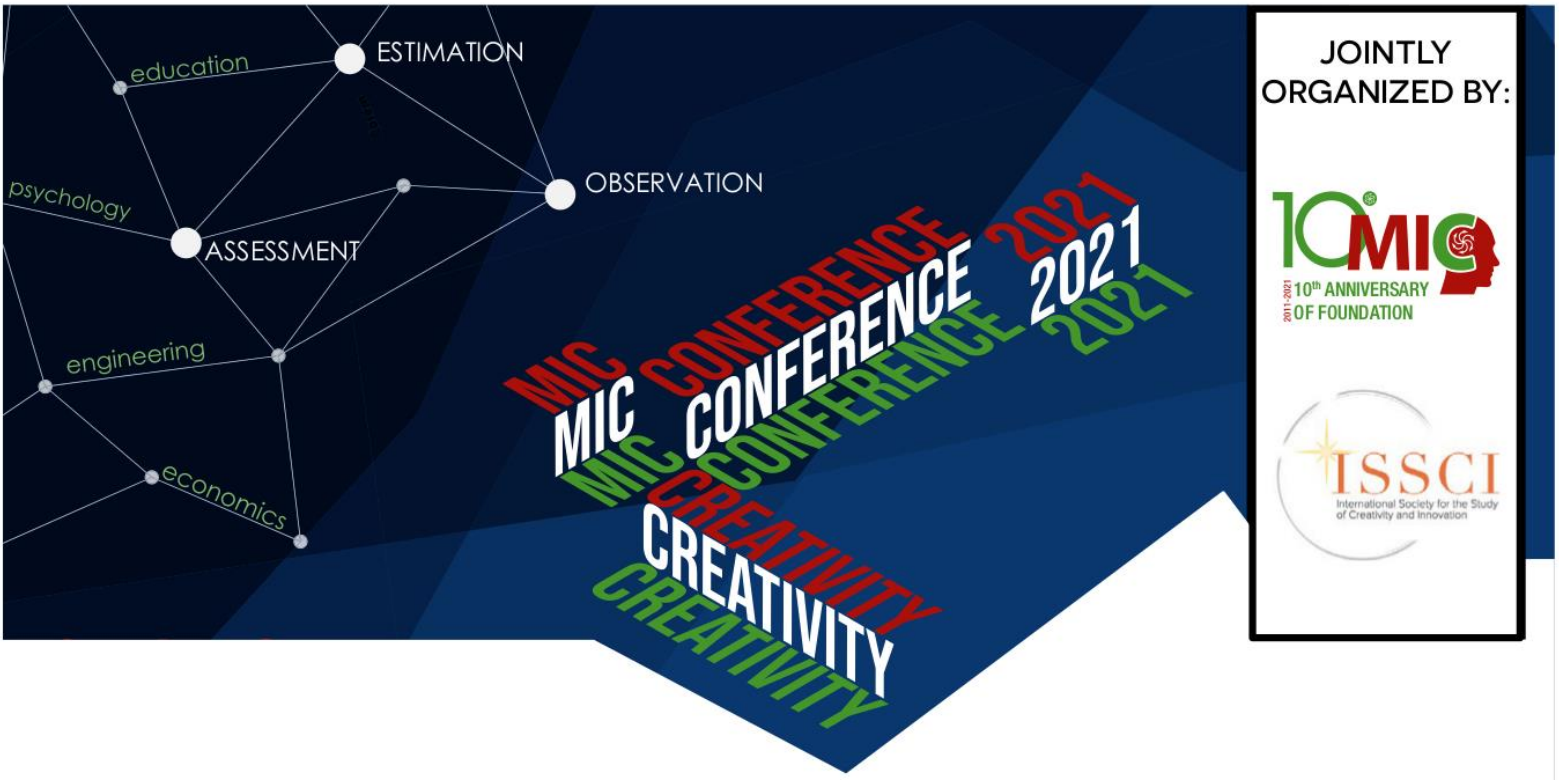


# MIC Conference 2021

# BOOK OF ABSTRACTS

Blended Edition

September 8 - September 10, 2021

Fondazione Guglielmo Marconi

SFNC
SOCIETY FOR THE NEUROSCIENCE OF CREATIVITY

ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

POSSIBILITY STUDIES NETWORK

# Wednesday, September 8, 2021

Note: all conference times are CEST (Central European Summer Time)

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| **9.00** *Connection check-in* | |
| **9.15 MIC Conference 2021 opening – Giovanni Emanuele Corazza**<br>*President of Fondazione Marconi and MIC Founder* | |
| **9.30 MIC Keynote Speech 1** | |
| **Boris Forthmann**<br>*University of Münster* | *The Devil is in the Details: On Divergent Thinking Assessment* |
| **10.00 Session 1** | **Creativity Training and Augmentation** |
| R. Marrone[1], S. Joksimovic[1], & V. Kovanovic[1]<br>*[1]U. of South Australia* | Creativity and Artificial Intelligence - a student perspective |
| J. von Thienen[1], C. Szymanski[1], T. Weinstein[1], & C. Meinel [1]<br>*[1]Hasso Plattner Institute, U. of Potsdam* | Neurodesign Cards: From Neuroscience Research to Creative Practice |
| C. Jaschek[1], K. Borchart [1], E. Krebs[1], J. von Thienen[1], & C. Meinel [1]<br>*[1]Hasso Plattner Institute, U. of Potsdam* | Improving Creative Team Performance and Togetherness in Remote Interaction via Motion-Based Games |
| A. Dumouilla[1], M. Botella[1], T. Lubart[1], & F. Zenasni [1]<br>*[1]LaPEA, U. de Paris* | Creation and evaluation of a creative serandipian training: a cohort study among French young people. |
| A. A. Karim[1], R. Khalil [2], & E. M. Khedr [3]<br>*[1]U. of Tübingen,*<br>*[2]Jacobs University Bremen,*<br>*[3]Assiut University* | Intra- and interindividual Connectivity: A neuropsychological method to improve creativity in teams |
| *11.00 Break* | |
| **11.15 Symposium 1 – Chair: S. Agnoli** | **The Creative Process: The role of Divergent and Convergent thinking** |
| I. de Vink[1]<br>*[1]Radboud University* | The creative mathematical thinking process: Divergent and convergent thinking in open mathematics tasks |
| R. Willemsen[1]<br>*[1]Radboud University* | Creative little scientists: The process of divergent and convergent thinking during scientific inquiry |
| K. van Broekhoven[1]<br>*[1]Radboud University* | Teachers' strategies in facilitating convergent collaborative creativity in higher education |
| **12.00 Session 2** | **Creativity dynamics across Domains** |

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| M. Botella[1], L. Robieux[2], F. Vindry[1], & B. Frantz[1]<br>*[1]LaPEA, U. de Paris,*<br>*[2]LPN, U. Paris* | Between art and design: the creative process of a stone carver |
| W. Ross[1], & M. Groves[2]<br>*[1]London Metropolitan University,*<br>*[2]U. of York* | Crafting the possible: Risk, uncertainty and knowing through doing |
| T. J. Wiltshire[1], & M. Fairhurst[2]<br>*[1]Tilburg University,*<br>*[2]Bundeswehr University Munich & Ludwig Maximilian University* | Collaborative Creativity, Coordination Dynamics, and Improvisation |
| E. Vass[1]<br>*[1]Western Sydney University* | Thinking from presence – co-creative musical encounters in the Kokas pedagogy |
| *12.45 Lunch* | |
| **14.00 Session 3** | **Creativity and Media** |
| M. Mercier[1], & T. Lubart[1]<br>*[1]U. de Paris* | Video Games and Creativity: the Moderating Role of Psychological Capital |
| I. Lebuda[1], A. Zielińska[1], & M. Karwowski[1]<br>*[1]U. of Wrocław* | Creativity and Media: On Whos and Whys of Talent Shows? |
| J. Frich[1], P. Dalsgaard[1], & M. Biskjaer[1]<br>*[1]Aarhus University* | Studying creativity in digitalised contexts |
| F. A. Roma[1]<br>*[1]U. Grenoble Alpes* | Collective creativity of multicultural virtual teams |
| S. Agnoli[1,2], S. Zenari[2], S. Mastria[1,2], G. E. Corazza[1,2,3]<br>*[1]U. of Bologna*<br>*[2]MIC*<br>*[3]U. de Paris & U. Gustave Eiffel, LaPEA* | How do you feel in virtual environments? The role of emotions and openness trait over creative performance |
| **15.00 Symposium 2 – Chair: C. Lattemann & R. Khalil** | **Cross-disciplinary perspectives on NeuroDesign** |
| J. von Thienen[1], & C. Meinel[1]<br>*[1]Hasso Plattner Institute, U. of Potsdam* | NeuroDesign – Synergies at the Intersection of Engineering, Neuroscience and Design Thinking Innovation |
| B. Godde[1], P. Gebbing[1], R. Khalil[1], C. Lattemann[1], & X. Yang[1]<br>*[1]Jacobs University Bremen* | NeuroDesign – a research field at the intersection of Neuroscience, Design Thinking and Business |
| J. Auernhammer[1]<br>*[1]Stanford University* | NeuroDesign Research – Investigating the Human Abilities of Designing: Opportunities and Challenges |

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| M. Shmailov[1]<br>*[1]Shenkar College of Engineering, Design and Art, Israel* | Neurodesign – Giving Shape and Voice to science: Crossing disciplinary boundaries to create new bodies of knowledge |
| *16.00 Break* | |
| **16.15 Mini Talks/Posters 1** | |
| M. M.Porto[1], & D. Fleith[2]<br>*[1]Universidad Autónoma de Madrid*<br>*[2]U. of Brasilia* | Creativity and acculturation in multicultural children and adolescents in Brazil |
| S. Hofreiter[1], & M. Tang[1]<br>*[1]Institute for Creativity & Innovation, University of Applied Management, Germany* | How do Creative Beliefs Influence Students' Intentions to Pursue a Creative Career: The Direct and Indirect Influences of Creative Mindsets, Creative Biases and Creative Self-Efficacy |
| E. Belova[1]<br>*[1]Psychological Institute of the Russian Academy of Education* | Motivation of children with high creative potential in preschool age |
| L. Esola[1]<br>*[1]Penn State University* | Cultivating Creativity: A Constructivist Methodology to Enhance the Creative Process in Young Adults |
| E. Shcheblanova[1]<br>*[1]Psychological Institute of the Russian Education* | Relationship Of Creativity To Multipotentiality And Leadership In High Ability School Children |
| N. Shumakova[1]<br>*[1]Psychological Institute of Russian Academy of Education* | Implicit theories of creativity including concepts of what is a "creative person" among intellectually gifted adolescents |
| **17.15 MIC Keynote Speech 2** | |
| **Jen Katz-Buonincontro**<br>*Drexel University* | *What does mixing phenomenological and behavioral data tell us about student creativity? Harnessing generative tensions* |
| *End 17.45* | |
| *Welcome Cocktail at Villa Griffone and Guided Visit to the Marconi Museum* | |

# *Thursday, September 9, 2021*

Note: all conference times are CEST (Central European Summer Time)

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| **9.00** *Connection check-in* | |
| **9.15 MIC Keynote Speech 3** | |
| **Vlad Glăveanu**<br>*Webster University* | *The birth of Possibility Studies:*<br>*From estimating to experiencing the possible* |
| **9.45 Session 4** | **Creativity across Emotions and Cultures** |
| L. Lin[1], A. Karim[1,2,3], B. Godde[1], & R. Khalil[1]<br>[1]*Jacobs University*<br>[2] *U. Clinic Tübingen*<br>[3] *SRH Mobile University* | Do emotional manipulation and encoding style moderate the effect of response inhibition on divergent thinking? |
| S. Russ[1]<br>[1]*Case Western Reserve University* | Affect in Ideation, Pretend Play, and Creativity: An Overlooked Connection |
| Z. Ivcevic[1]<br>[1]Yale University | Creativity and emotions: The role of measurement and analysis in detecting a complex relationship |
| V. Repeikova[1,2], T. Toivainen[3], M. Lihanov[1], K. van Broekhoven[4], & Y. Kovas[1,2,3]<br>[1]*Sirius University of Science and Technology*<br>[2]*National Research Tomsk State University*<br>[3]*Goldsmiths, U. of London*<br>[2]*Radboud University* | Sex Differences in Creative Performance, Creative Self-Efficacy & Self-rated Domain-specific Creativity among Russian adolescents with high achievements in Sciences, Arts & Sports |
| *10.45 Break* | |
| **11.00 Symposium 3 – Chair: W. Ross & V. Glăveanu** | **Estimating the possible: New methodologies for Possibility Studies** |
| A. Gaggioli[1,2], & A. Chirico[1]<br>[1]*Catholic University of the Sacred Heart, Italy*<br>[2]*Istituto Auxologico Italiano* | Assessing Transformative Experiences: Some methodological considerations |
| W. Ross[1]<br>[1]*London Metropolitan University* | Unfolding the possible: Knowing through doing and object movement |
| R. Poli[1]<br>[1]*University of Trento* | Future Indices |
| V. Glăveanu[1]<br>[1]*Webster University* | Wonder (in) research |
| **12.00 Session 5** | **Assessing Creative Cognition** |

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| S. Ceh[1], G. Hofer[1], & M. Benedek[1]<br>*[1] U. of Graz* | Assessing raters: what factors predict discernment in novice creativity raters? |
| M. Taranu[1], M. Andersen[1], & A. Roepstorff [1]<br>*[1]Aarhus University* | Dynamic processes in children's creativity |
| M. Romo[1], & V. Alfonso-Benlliure[1]<br>*[1]Universidad Autónoma de Madrid*<br>*[2]Universitat de València* | Assessment children's creativity with a problem finding task |
| M. Mangion[1], L. Baldacchino [2], & M. Briguglio [3]<br>*[1]U. of Leicester*<br>*[2]Warwick Business School*<br>*[3]Stirling University* | Measuring creativity through divergent thinking tests: The nuts and bolts of data analysis |
| A. D'Anselmo[1,2], S. Agnoli[1,2], M. Filardi[3,4], F. Pizza[1,5], S. Mastria[1,2], G. E. Corazza[1,2,6], G. Plazzi[5,7]<br>*[1]U. of Bologna*<br>*[2]MIC*<br>*[3]U. Aldo Moro Bari*<br>*[4]Department of Clinical Research in Neurology of the U. of Bari at "Pia Fondazione Card G. Panico" Hospital, Tricase*<br>*[5]IRCCS Istituto delle Scienze Neurologiche di Bologna*<br>*[6]U. de Paris and U. Gustave Eiffel*<br>*[7]U. of Modena and Reggio Emilia, Modena* | Pros and cons to be creative during lockdown: the effect of the creative potential on the psychological distress associated with the COVID-19 outbreak in narcolepsy type 1 patients |
| *13.00 Lunch* | |
| **14.00 MIC Keynote Speech 4** | |
| **Todd Lubart**<br>*Université de Paris* | *Creative People & Creative Robots: Back to the future* |
| **14.30 Session 6** | **Neuroscientific approaches to creativity** |
| C. Salvi[1]<br>*[1]University of Texas at Austin* | Oculometric signature of switch into awareness? Pupil dilation predicts 'Aha!' moments |
| N. D'Aleman Arango[1], S. Rahman[1], & C. Meinel[1]<br>*[1]Hasso Plattner Institute, U. of Potsdam* | Enhancing Creative Possibilities in Sonic Improvisation though Sonification and Biofeed-back |
| C. Rominger[1], C. M. Perchtold-Stefan[1], I. Papousek[1], A. R. Schwerdtfeger[1], & A. Fink[1]<br>*[1]University of Graz* | Creative metacognition is associated with decreased upper alpha power during idea generation |

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| S. Mastria[1,2], S. Agnoli[1,2], M. Vanucci[3], M. Zanon[4], S. Nigro[5,6], M. Filardi[7,5], & G. E. Corazza[1,2,8]<br>[1]*U. of Bologna*<br>[2]*MIC*<br>[3]*U. of Florence*<br>[4]*SISSA, Trieste*<br>[5]*Dep. of Clinical Research in Neurology of the U. of Bari at "Pia Fondazione Cardinale G. Panico", Tricase*<br>[6]*NANOTEC, National Research Council, Lecce*<br>[7]*Dep. of Basic Medicine, Neuroscience, and Sense Organs, U. of Bari*<br>[8]*U. de Paris & U. Gustave Eiffel, LaPEA* | The relationship between idea generation and trait mind wandering: A preliminary resting-state functional connectivity analysis |
| **15.20 Symposium 4 – Chair: J. von Thienen** | **Automated Creativity Measurement** |
| T. Maltenberger[1], I. Ilic[1], T. Weinstein[1], S. Ceh[2], & M. Benedek[2]<br>[1]*Hasso Plattner Institute, U. of Potsdam*<br>[2]*University of Graz* | Automated Analysis of Language Creativity |
| K. P. Borchart [1], J. von Thienen [1], & C. Meinel[1]<br>[1]*Hasso Plattner Institute, U. of Potsdam* | C-Tracer: Automatic Creativity Measurement for any Goal-Directed Behaviour that Leaves Digital Traces |
| H. McKee[1], J. von Thienen[1], S. Rahman[1,2], & C. Meinel[1]<br>[1]*Hasso Plattner Institute, U. of Potsdam*<br>[2]*NeuroCreate Ltd, London* | Comparing Different Forms of Automated Creativity Measurement in the Study of Individual and Collaborative Creative Writing |
| A. Halttunen[1], & S. Rahman[1,2]<br>[1]*NeuroCreate Ltd, London*<br>[2]*Hasso Plattner Institute, U. of Potsdam* | Computational Methods for Flow, Affect and Creativity on Ideation Tasks |
| *16.20 Break* | |
| **16.35 Mini Talks/Posters 2** | |
| M. E. Vanutelli[1], V. Cortinovis[2], & C. Lucchiari[1]<br>[1]*U. of Milan*<br>[2]*Arché Onlus, Società Cooperativa Sociale, Inzago* | Fear not: Creativity killed the Covid. Flexible thinking and emotions in intellectual disability |
| N. Göbel[1,2], M. Camenzind[1,2], A. K. Eberhard-Moscicka[1,2], H. Hegi[3], S. Knobel[3], P. Urwyler[3,4], T. | Creativity after stroke – a longitudinal study |

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| Nyffeler[1,4,5], T. Nef[4], & R. M. Müri[1,2,3]<br>*[1]Perception and Eye Movement Laboratory, Departments of Neurology and BioMedical Research, Inselspital, Bern U. Hospital, & U. of Bern*<br>*[2]Department of Neurology, Inselspital, U. Hospital Bern*<br>*[3]Gerontechnology and Rehabilitation Group, U. of Bern*<br>*[4]ARTORG Center for Biomedical Engineering Research, U. of Bern*<br>*[5]Neurocenter, Luzerner Kantonsspital* | |
| A. K. Eberhard-Moscicka[1,2], K. Chiffi[1], Y. Bühlmann[1], T. Nef[3,4], C. L. Bassetti[2], & R. M. Müri[1,2,3]<br>*[1]Perception and Eye Movement Laboratory, Departments of Neurology and BioMedical Research, Inselspital, Bern U. Hospital, & U. of Bern, Bern*<br>*[2] Department of Neurology, Inselspital, Bern U. Hospital, Bern*<br>*[3] Gerontechnology and Rehabilitation Group, U. of Bern*<br>*[4] ARTORG Center for Biomedical Engineering Research, U. of Bern* | Association between sleep macro- and micro-architecture and the measures of verbal and figural divergent and convergent thinking |
| A. N. Costa[1], M. B. Wallace,[1], B. J. Ferguson[1], M. A. Carey[1], C. Rzeppa[1], B. Kille[1], D. Drysdale[2], B. Sutton, B[1]. Schuler[1], E. Kwenda[1], R. Johnson[1], & D. Q. Beversdorf[1]<br>*[1]U. of Missouri*<br>*[2]A.T. Still University Kirksville College of Osteopathic Medicine* | Effects of Paced Breathing on Measures of Convergent and Divergent Thinking |
| M. Camenzind[1], M. Single[2,3], S. Gerber[2,3], F. W. Mast[4], T. Nef[2,3], R. M.Müri[1,2,5], & A. K. Eberhard-Moscicka[1,5]<br>*[1]Perception and Eye Movement Laboratory, Departments of Neurology and BioMedical Research, U. Hospital Inselspital, U. of Bern*<br>*[2]Gerontechnology and Rehabilitation Group, U. of Bern*<br>*[3]ARTORG Center for Biomedical Engineering Research, U. of Bern* | Aiming for more objectivity in creativity assessment–Applying word vectors to assess flexibility |

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| [4]*Department of Psychology, Center for Cognition, Learning, and Memory, U. of Bern*<br>[5]*Department of Neurology, Bern U. Hospital and U. of Bern* | |
| K. Chiffi[1], A. Eberhard-Moscicka[1], T. Nef[2], C. L. Bassetti[3], & R. M. Müri[1]<br>[1]*Perception and Eye Movement Laboratory, Departments of Neurology and BioMedical Research, U. Hospital Inselspital, U. of Bern*<br>[2]*ARTORG Center for Biomedical Engineering Research, U. of Bern*<br>[3]*Department of Neurology, Bern U. Hospital, & U. of Bern* | Napping improves verbal divergent thinking in healthy young subjects – Preliminary data |
| **17.35 MIC Keynote Speech 5** | |
| **Adam Green**<br>*Georgetown University*<br>*President, SfNC* | *Creativity Anxiety: New Insights into Anxiety that is Specific to Creative Thinking* |
| *End 18.05* | |
| *Social Dinner* | |

# *Friday, September 10, 2021*

Note: all conference times are CEST (Central European Summer Time)

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| **9.00** *Connection check-in* | |
| **9.15 MIC Keynote Speech 6** | |
| **Maciej Karwowski**<br>*University of Wroclaw* | *Exploring the Creative Self* |
| **9.45 Session 7** | **Design Thinking and Creativity** |
| A. Cattabriga[1], A. Licaj[1], E. Formia[1], & A. Sicklinger[1]<br>[1]*Advanced Design Unit, Department of Architecture, University of Bologna* | Designing the emergence of creativity in multidisciplinary contexts |
| O. I. Higuera-Martinez[1], L. Fernández Samacá[1],<br>[1]*U. Pedagógica y Tecnológica de Colombia* | Creativity in Engineering: Integrating creativity and PBL in a disciplinary course |
| C. Palestini[1],<br>[1]*Nato* | Philosophy by Design: Integrating philosophy and engineering in creative problem solving |
| S.C. Sauer[1], T. Krijnen[2], . M. Boënne[2], & J.J. Ebbers[3]<br>[1]*U. of Groningen*<br>[2]*Erasmus U. Rotterdam*<br>[3]*U. of Amsterdam* | Producing creatives: Organising and framing creative work in media broadcasting |
| Y. Zeng[1]<br>[1]*Concordia University* | Paths and barriers to design creativity: a theoretical analysis |
| *10.45 Break* | |
| **11.00 Session 8** | **Exploring Creativity in Educational Settings** |
| C. Cardinaletti[1]<br>[1]*Free U. of Bolzano* | Applying the 4 P's Model of Creativity to ethnographical data analysis: a mix method approach in educational research |
| C. Phelps[1], M. Brazzolotto[2], & T. Lubart[3]<br>[1]*Emporia State University*<br>[2]*TalentInclusivi, National School Network, Italy*<br>[3]*U. de Paris* | Perspectives of Creative Giftedness Through 50 Years of Bibliometric Analysis |
| L. Stepanek[1]<br>[1]*Masaryk U. Language Centre* | Authentic and Experiential: An Analysis of a Creativity-Focused Language Teacher Training |
| T. Toivainen[1], J. J. Marrid-Valero[2], R. Chapman[1], A. McMillan[4], B. R. Oliver[5], & Y. | A genetically informed study on Creative Expressiveness in childhood writing |

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| Kovas[1]<br>*[1]Goldsmiths U. of London*<br>*[2]U. of Alicante*<br>*[4]King's College, UK*<br>*[5]UCL Institute of Education, UK* | |
| **12.00 Mini Talks/Posters 3** | |
| S. Form[1]<br>*[1]U. of Applied Science Bingen* | Being polymathic about polymaths: A new approach to assess creative polymathy inspired by diversity measurement in ecology |
| K. Ginis[1], S. Stewart[1], & L. Kronborg[1]<br>*[1]Monash U.* | Artistic creativity, mental and physical illness in eminent female visual artists: A qualitative exploration |
| V. Kolzeev [1]<br>*[1]U. of London* | A movement-based theoretical framework for digital creator wellbeing support |
| S. Petrova[1]<br>*[1]Psychological Institute of the Russian Academy of Education* | The Interrelationship Between Creativity, School Achievement And Anxiety In High Ability Adolescents |
| N. Pichot[1]<br>*[1]Centre PsyCLE, Université Aix-Marseille* | A factorial study of variability in creative productions: towards a general factor of "Disruptivness" |
| L. Saguid[1], S. Kiefer[1], K. Scirpo[1], N. Johnson[1], S. Patel, A. Hinosa, N. Snograss, A. Kupfer, & K. Lucca<br>*[1]Arizona State University* | Investigating the relations between early creativity, confidence, curiosity, and persistence |
| K. Smith[1], J. Bhattacharya[1], & A. Pickering[1]<br>*[1]Goldsmiths U. of London* | The Creative Life: A Daily Diary Study of Creativity and Well-being in the Highly Creative |
| *13.15 Lunch* | |
| **14.15 Session 9** | **Creativity for Education, Organizations, and more** |
| D. Zbainos[1], & C. Sagia [1]<br>*[1] Harokopio University* | Transfer of creative ability across domains through dynamic assessment |
| M. McVeigh[1], & A. Valquaresma[2]<br>*[1]Griffith University*<br>*[2]University of Porto* | Understanding creative complexity in screenwriting: developing a transdisciplinary framework |
| I. J. Ness[1]<br>*[1]University of Bergen* | Creative Leadership in times of crises - A Norwegian case study in Higher Education |
| M. Porto[1], & M. Romo[1]<br>*[1]Universidad Autónoma de Madrid* | Family relationships of eminent women described in publications of the last 10 years |
| C. Scorolli[1], & G. Camillini[1]<br>*[1]University of Bologna* | Don't demand a bird to swim, join it in the sky! Teaching a foreign language to students with dyslexia |
| **15.15 MIC Keynote Speech 7** | |

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| **Roni Reiter-Palmon**<br>*University of Nebraska* | *Measuring creativity in organizations* |
| *15.45 Break* | |
| **16.00 SfNC Symposium – Chair: A. Green** | **Creativity Neuroscience** |
| R. Beaty[1]<br>[1]*Penn State University* | *Combining Latent Variable and Machine Learning Methods to Study How Creativity and Intelligence Overlap in the Brain* |
| M. Benedek[1]<br>[1]*University of Graz* | *How neuroscientific research informs models of creative cognition* |
| C. Di Bernardi Luft[1]<br>[1]*Queen Mary University of London* | *The role of alpha oscillations in creativity* |
| Y. Kenett[1]<br>[1]*Technion – Israel Institute of Technology* | *Neural dynamics during the generation and evaluation of creative and non-creative ideas* |
| D. Zabelina[1]<br>[1]*University of Arkansas* | *Machine learning classification of the creative brain* |
| **17.30 SfNC Panel – Moderator: G. E. Corazza** | R. Beaty, M. Benedek, C. Di Bernardi Luft, Y. Kenett, A. Green, R. Reiter-Palmon, M. Karwowski, J. Kaufman, and D. Zabelina |
| *Conference Closure 19.00* | |

# MIC Keynote speech I

## Wednesday, September 8, 2021

## 9:30 CEST

### The Devil is in the Details: On Divergent Thinking Assessment

Boris Forthmann

*University of Münster*

Divergent thinking tasks are commonly used to assess creative thinking andpsychometric issues inherently tied to this type of assessment have been debatedfor a century. Divergent thinking tasks require test-takers to generate an open-ended number of responses. Hence, a first level that affects assessment of divergentthinking is the level of responses (e.g., originality scores are derived for eachresponse). In a next step, evaluated responses are aggregated at the level of tasks(e.g., the average originality score across a test-taker's responses is derived for eachtask). Finally, task-scores are used to build a score for the full divergent thinking test(e.g., the average across all tasks). Psychometric issues (e.g., lack of measurementprecision) can emerge at each of these levels and from the interaction betweenlevels. Common divergent thinking assessment practices such as originality scoringbased on statistical rarity, human judgments, or semantic distance, but also methodsof aggregation (e.g., averaging, maximum scoring, or top-scoring) and prominentrelated issues such as the effect of fluency contamination fit well into this three-levelframework of assessment. Guided by this framework, I will present approaches fromthe past, related findings from recent research, and a future agenda for divergent thinking assessment.

# SESSION 1

# Creativity Training and Augmentation

# Creativity and Artificial Intelligence - a student perspective

Dr Rebecca Marrone, Dr Srecko Joksimovic and Dr Vitomir Kovanovic

*The Centre for Change and Complexity in Learning at The University of South Australia*

Creativity is a core 21st-century skill and is taught in education systems globally. Creativity is expected to separate us from machines, but is it? In isolation, machines can be more effective problem solvers than humans, and they can exhibit novelty. The challenge to being creative is exhibiting both novelty and effectiveness simultaneously.

As Artificial Intelligence (AI) is being implemented in classrooms around the world, a key question is proposed; how do students perceive AI and creativity? Semi-structured interviews were conducted with 12 secondary school-aged students after receiving training in both creativity and AI. Alongside the interview, students also completed a divergent thinking task based on the question 'what would happen if AI enters your classroom?'

Content Analysis of the interviews highlights student expectations of both creativity and AI vary. Students with higher self-reported understanding of AI reported more positive thoughts around integrating AI into their classrooms. Students with low understanding of AI tended to be fearful of AI. The majority of students indicated a thorough understanding of creativity and reported that AI could never match human creativity. Assessment of the divergent thinking task highlighted that students responded similarly. Implications of the results are presented as well as future recommendations to ensure both humans and machine can co-exist.

# Neurodesign Cards: From Neuroscience Research to Creative Practice

Julia von Thienen[1,2], Caroline Szymanski[1], Theresa Weinstein[1] and Christoph Meinel[1]

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While neuroscientific research has generated many insights on creativity, their use in creative practice is difficult. Findings are communicated in academic journals using technical jargon. Close personal exchange between neuroscientists and creative practitioners is not available for everyone. The goal of the Neurodesign Cards project is to build bridges between theory and practice, in a multistage endeavour of tool-building. Beginning in 2018, we listed neuroscientific content pertinent for a broad understanding of creativity. We invited experts per topic domain to deliver guest talks at our institute. In close coordination with the lecturers, we summarised each lecture input. We then developed a cards-based framework to communicate key content, and tried out card prototypes at events for design thinking practitioners, so that about 100 innovation facilitators have probed content from this tool so far. Based on feedback and trial experiences, the card framework has undergone considerable iteration. The final format foresees two types of cards. Each Theory Card explains a key finding from creativity research, such as “motion facilitates creativity”. One side of the card reviews studies on this behalf. The other side courts topic-related observations and actions, screening the four domains of creative people, processes, places and products. In addition, Action Cards suggest practical interventions. The cards are written by topic experts such as the invited lecturers, get edited for readability and consistency, and are then tested with innovation practitioners. We currently have a first set of cards ready for use, and more shall emerge in collaboration with interested neuroscientists.

# Improving Creative Team Performance and Togetherness in Remote Interaction via Motion-Based Game

Corinna Jaschek, Kim-Pascal Borchart, Eva Krebs, Julia von Thienen, Christoph Meinel

*Hasso Plattner Institute*

Remote interaction is becoming more and more frequent, used for work and private social gatherings. However, remote interaction has been found to be tiring, to cause "Zoom fatigue", and to limit creative collaboration. We have tested the impact of different warm-up interventions on creative team performance and feelings of togetherness online. To measure creative collaboration, we have developed the test Collabo-Use, which is adapted from the Alternative Uses Task, to be taken by two or more collaboration partners. The test can be taken online, which permits an automatic generation of scores. Based on research about motion patterns that impact creative performance and collaboration, we have created different warm-up interventions. They were delivered in an experiment via the online video game Mario Kart 8 on Nintendo Switch, where users drive virtual cars. In the study, teams of collaboration partners met online and experienced the following conditions in random order (i) driving synchronously throughout the course, (ii) driving a race against each other, (iii) driving races independently of each other, (iv) no particular movement, listening to an online talk about geology jointly. After each intervention, creative team performance was measured via the Collabo-Use. In line with hypotheses, we found that feelings of togetherness and objective measures of creative team collaboration decreased from condition (i) to (iv). These results feed into the development of serious games in order to improve feelings of togetherness and creative team collaboration in remote interaction.

*Keywords*: Creative Collaboration, Remote Interaction, Serious Games.

# Creation and evaluation of a creative serandipian training: a cohort study among French young people.

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The 21st century offers the opportunity for a new relationship to work and new management approaches for professional careers. Some contextual (e.g. artificial intelligence) and personal factors (e.g. meaning of work) will strongly impact the labor market and increase the emergence of shorter and multiple career cycles (Greenhaus & Callanan, 2012). As a result, individuals have more uncertain career choices to make and they have also to decide more quickly (Cappelli & Keller, 2013). Our experimental research (pre-post test design with a control group) shows that it is possible to enhance the capacity to generate, recognize and benefit from unexpected events in the construction of a professional career among French young people through a specific training (N= 147). We present the construction and the concrete impact of this creative serandipian training. To build this training, we mutualized two theoretical fields: happenstance learning theory (Krumboltz, 2009) and the multivariate approach of creativity (Lubart et al, 2015). The unexpected event is seen as a learning opportunity or a change of behavior, and catalyst for a new contribution in the creative process allowing the production of an original and adapted professional choice. Different areas of application and future research are discussed.

# Intra- and interindividual Connectivity: A neuropsychological method to improve creativity in teams

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Creativity is usually conceived of as the generation of ideas or problem solutions that are both novel and potentially useful (1).

In particular, if new teams are formed, e.g. in a company, they would benefit if (a) each team member can apply as many of his/her strengths as possible in the company and (b) if the team members can cooperate and combine as many of their strengths as possible. The discovery of such human resource potentials in a company is a crucial creative task. Yet, psychological methods to train and promote this capability remain elusive.

In this study we propose a method for promoting creativity in teams based on neuropsychological findings from creativity research (2,3).

In a role play, students were divided into two groups. Each group had the task of finding out how they could apply their strengths beneficially in a company (example here: A psychiatric clinic). Fluency and originality were measured as dependent variables of creativity. In the experimental group, the proposed method of intra- and interindividual connectivity analysis (IICA) was carried out, while the control group was supposed to solve the task using the common brainstorming method. The results show that IICA led to significantly higher fluency and originality rates compared to the control group. These preliminary data suggest that IICA can be a very promising method to promote creativity and cooperation potentials in a team. Future studies should validate this method in real companies and investigate the neurobiological foundations of our approach using neurophysiological methods and computational modelling.

*Keywords:* Improving Creativity, Business Psychology, Neuropsychology.

# SYMPOSIUM 1

## The Creative Process: The role of Divergent and Convergent thinking

# The creative mathematical thinking process: Divergent and convergent thinking in open mathematics tasks

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The value of creativity is increasingly recognized by those involved in mathematics education (Leikin & Sriraman, 2017). This increased interest fits well in the tradition of mathematicians like György Pólya and Jacques Hadamard, who both stressed more than 75 years ago that creativity is a driving force behind the discovery of new mathematical insights. But creativity is also important to those not involved in breaking new mathematical grounds, such as primary school children. Creative thinking helps them to integrate mathematical information and come up with different solutions or strategies to solve a problem (Hadamard, 1996; Mann, 2005). If we want to support the development of creative thinking skills in mathematics education, more insight into the creative thinking process is required. This study therefore aspired to illuminate the use of creative thinking, specifically divergent and convergent thinking, in solving different types of mathematics problems. 28 children from two groups (characterized by high vs. low mathematics achievement) were observed while doing mathematics tasks and asked about their creative problem solving process. Two types of open mathematics tasks were used: a problem-posing task and a multiple-solution task. Qualitative analysis showed that most children use more divergent than convergent thinking, but that children who generated multiple original ideas did so using both divergent and convergent thinking. Children with high mathematics achievement generated more creative ideas than children with low mathematics achievement.

# Creative little scientists: The process of divergent andconvergent thinking during scientific inquiry

Robin Willemsen

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Although educators around the world postulate that children can - and should - think creatively during scientific inquiry, the exact ways in which children can use creative modes of thought during scientific inquiry remains unclear. Therefore, the aim of this study was to elucidate how and when children use creative modes of thought during scientific inquiry. Thirty-two children from 5th grade completed a hands-on, individual, inquiry task. Herein, verbalizations of behavior and thought processes were elicited through a semi-structured dialogue between task administrator and child. Children were guided through the process of scientific inquiry and were given ample opportunities for creative thought. This discourse was recorded and subsequently analyzed in a qualitative manner to exemplify the usage of divergent and convergent thinking during scientific inquiry. Findings revealed that children used divergent and convergent thinking in different manners, and that the usage hereof differed across phases of scientific inquiry. Interestingly, neither the expression of divergent thinking, nor the expression of convergent thinking was necessarily followed by creative output. Instead, creative output followed after expressions of both divergent and convergent thinking. These findings illustrate that convergent thinking is necessary for creativity, but not necessarily creative. Herewith, the theoretical stance that the creative process encompasses an interplay between divergent and convergent thinking is supported.

# Teachers' strategies in facilitating convergentcollaborative creativity in higher education

Kim van Broekhoven

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Divergent thinking or ideation is seldom the final goal of a creative process. Rather, to successfully solve problems or actualize innovation, it requires one or a few good ideas that really work, and work better than previous ones. However, it seems that people do not select and implement creative ideas, but are more likely to go for ideas that are consistent with social norms, and easy to understand (e.g., Rietzschel, Nijstad, & Stroebe, 2010; Van Damme, Anseel, Duyck, & Rietzschel, 2019). This convergent process of selecting and implementing ideas is primarily a social-political process (Baer, 2012), where the environment plays a role. Research has found, for example, that extrinsic constraints in the environment, such as expected evaluation or implementation, draw people to feasible and easy to implement ideas, while turning a blind eye to original ideas (e.g., Yuan & Zhou, 2008). Little is known about factors that play a role in the selection and implementation of creative ideas, and it is likely that the tendency to select practical ideas becomes even stronger among people working together (i.e., convergent collaborative creativity). As such, group of students need to be guided in how to interact, but little is known how teachers can facilitate group interaction among students to foster the selection and implementation of creative ideas. Therefore, the aim of the present study is to investigate how teachers facilitate convergent collaborative creativity among students. In the presentation, existing research will be discussed on the role of the environment, such as extrinsic constraints, on the selection and implementation of creative ideas. Furthermore, a research proposal on teachers' strategies in facilitating convergent collaborative creativity will be discussed.

# SESSION 2

# Creativity dynamics across Domains

# Between art and design: the creative process of a stone carver

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Art and science are two opposite domains, with design between them. Therefore, there are similarities between domains, and specifics in each (Baer, 1999, 2010), particularly concerning the creative process (Glăveanu, et al., 2013) and the constraints involved. In this study, we explored in detail the unexplored domain of stone carving in terms of creative process and constraints. We hypothesized that stone carving would be situated between art and design fields.

In this study, we used the single case method (Gomm, et al., 2000) interviewing a stone carver for 1.5h about his creative process and the multivariate factors involved (Lubart et al., 2015). We conducted a discourse content analysis with three complementary software programs (IraMuTeQ, Tropes and NVivo).

A lexicometric synthesis is deepened by cognitive and grounded theory analyses. The results synthesizing the 3 analyzes brought out 3 main categories, as 3Cs of the 7Cs model of creativity (Lubart, 2019): creator, creating, and creations. Concerning the creator, this stone carver is situated between art, design and craft. Concerning the creating, his process fits the Conception-Realization-Socialisation model (Didier & Leuba, 2011). Concerning the creations, the interview identified the constraints inherent in the work of stone carving. We will present how these 3Cs are articulated in the creative process of this stone carver.

In conclusion, the interesting creative domain explored in this study and the original method used to situate it between art and design suggest that the purpose of the object would differentiate creative domains.

*Keywords:* Stone Carving, Process, Constraints.

# Crafting the possible: Risk, uncertainty and knowing throughdoing

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There have been several calls recently for a more dynamic method of assessing creativity which takes in account the situated nature of a materially engaged creative process. Such a research programme requires engaging with a complex unfolding of heteroscalar processes and assessing the entanglement of human and material agency. In this presentation, I shall present a focused ethnography which tracks the development of both a new product (two small wooden bowls) and a technique novel to the craftsperson. This case study draws on detailed video analysis triangulated with interview data to chart at a micro level the actualisation of the creative process as well as situating it in a broader cognitive and personal trajectory. The data led to a focus on the uncertainty and risk involved the craft process and a form of knowing through doing which contrasts with the notion of craftsmanship as being mundane, routine and preplanned. I finish with some reflections on the benefit of observational methods for understanding creative action.

*Keywords:* Craft, Knowing-through-doing, Uncertainty.

# Collaborative Creativity, Coordination Dynamics, and Improvisation

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Humans collaborate with a large number of people in order to create and accomplishincredible feats. We argue that rich coordination dynamics underpin our capacity forcollaborative creativity. These dynamics characterize the ways in which people are able tocovary their thoughts, actions, behavior etc. for functional purposes. We investigated thecoordination dynamics of improvisation as a special case of collaborative creativity from twoopenly available datasets: a movement-based mirror game (Noy et al., 2011) and jazz pianoimprovisation (Setzler & Goldstone, 2020). By focusing on improvisation, the tasks elicit theneed for real-time adaptation and mutual prediction based on information exchangebetween interacting individuals, with the creative 'product' being the behavioralperformance itself. For each dataset, we performed a transfer entropy analysis as well as anestimate of predication decay. The combination of these two methods allows us tounderstand the dynamics as information-driven coordination flow and to differentiateunidirectional influence from mutual influence as well as the predictability of signalsexhibited during collaborative creativity. We observed that for the mirror game, experts andnovices exhibited unidirectional and bidirectional influence on each other's movementslargely, independent of their improvisational experience level. Further, movementimprovisation signals generated by experts were generally more predictable than those ofnovices. In terms of the jazz improvisation, our results showed evidence of bidirectionalinfluence between the onset densities of coupledandone-way improvisational dyads and thepredictability of the signal did not vary systematically across these conditions. We discussthese findings in terms of differences between improvisational contexts, methodicalchallenges, and future directions.

*Keywords:* Collaborative Creativity, Coordination, Improvisation.

# Thinking from presence – co-creative musical encounters in the Kokas pedagogy

Eva Vass

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The present study examined the links between music, body perceptions and collective imagination in a Higher Education setting. It used a master's unit on the immersive music pedagogy of Klara Kokas as an explorative context. The cohort comprised of ten students with specialisations in violin, cello, accordion, folk music, folk singing, opera, and musicology. The study investigated how musically inspired movement catalysed participants' imaginative re-opening to self and the world with transformative potentials. This phenomenon is described as *thinking from presence*: a serendipitous inquiry process that is immersive, dialogic and inherently embodied.

The research built on a fusion of Bakhtinian dialogism and Natural Inclusion. Video recordings of nine 3-hour sessions, creative products (paintings, drawings) and students' self-reflective compositions formed the data. Building on a qualitative analytic design, the video recordings were used for the in-depth analysis of musically inspired movement. Constructivist narrative analysis of spoken and written reflections was used to study students' inner experiences as well as their outward-looking observations.

The analysis shows the intertwining of the visual, the auditory and the tactile in these learning experiences. The embodied encounters with music and others can be described as a form of inter-animation or polyphonic discourse. Musical knowledge evolved from such mutually co-creative relationships. However, the study also shows the complexity of this pedagogic undertaking. The paper unpacks the key challenges in implementing such serendipitous, experience-centred pedagogy, informing both research and practice.

*Keywords:* Embodied Dialogue, Collective Imagination, Thinking from Presence.

# SESSION 3

# Creativity and Media

# Video Games and Creativity: the Moderating Role of Psychological Capital

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Research on video games has often focused on their negative effects. They have been criticized for promoting violence or nurturing aggressivity. In counterpoint, studies have adopted the view that video games can help develop and nourish different skills, notably creativity. However, research on this topic is scarce, even more so for adult populations. In this paper, we provide a first look at the links between video games and creativity in the workplace. Furthermore, whereas theoretical explanations have been proposed regarding their relationship, no empirical efforts have been conducted to test these hypotheses. This paper focuses on one such candidate, Psychological Capital (PsyCap). PsyCap is a composite construct, defined as an individual's positive psychological state of development, characterized by four components: self-efficacy, optimism, hope and resiliency.

Using a cross-sectional study ($N$ = 370), we measured whether participants played video games, the amount of time players ($N$ = 171) dedicated to video games, Psychological Capital, and Creativity in the Workplace. PsyCap was measured using the French version of the PCQ, and Creativity in the Workplace was measured by means of a 13-item self-report scale. Before analyses, we extracted three groups to be compared from our sample: non-players, bottom-third players, and top-third players, following common practices in the video games literature. This allowed us to accurately account for non-players in statistical analyses, as opposed to regression analyses in which only players data would be analyzable.

Using ANOVAs, we found no effects of gaming frequency on our sample's creativity, whereas there were significant differences for PsyCap: players had a higher overall PsyCap than non-players. We conducted mediation analyses, with PsyCap as a mediator. Whereas we observed no direct effect of video games on creativity, we observed a full mediation of PsyCap, resulting in a significant total effect. Players had higher overall PsyCap than non-players, which in turn led players to be more creative in the workplace.

*Keywords:* Creativity, Psychological Capital, Video Games.

# Creativity and Media: On Whos and Whys of Talent Shows?

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Contemporary digital media made it possible to share our creativity to the extent that was hard to imagine a few decades ago. From YouTube channels to specialist services and TV talent shows – there are several opportunities to create and share different quality content. In a series of three surveys studies, we explored how viewers' creativity is associated with their practices and expectations regarding the well-known format of talent shows. We focused on three research questions. First, we examined whether and to what extent viewers' (adolescents in Studies 1-2 and adults in Study 3) creativity (abilities, activity, self-concept, and creative mindsets) and personality traits predict the willingness to watch such shows. As a second goal, explored in Studies 1. ($N$ = 1440) and 2 ($N$ = 1770), we examined what is perceived as critical for successes in Talent Shows – inborn talent or hard work. Finally, in Study 3 ($N$ = 882), we examined what viewers are mainly interested in while watching talent shows (success or field performers, judges' prices or critiques) and how their creativity and personality are associated with these preferences.

*Keywords:* Creativity, Media, Talent Shows.

# Studying creativity in digitalised contexts

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Amabile's acclaimed work 'Creativity in context' examines the influence of social context on foundational factors of creativity, such as motivation, personal skills and thinking styles. Since its publication, digitalisation has arguably been a dominant trend in creative work. Much creative work is now carried out using digital tools and creative collaboration is increasingly distributed and mediated via digital services. In other words, the context of creativity has changed, and we need approaches that help us examine creative work in this digitalised context.

Researchers in the field of Human-Computer Interaction (HCI) have been studying how humans realise a variety of activities by interacting with computers and software since the 1980s. However, while the topic of creativity has recently gained significant interest in this research community, focus is on building novel tools, and testing them in contrived settings.

We propose to build on insights from HCI to provide directions for creativity research in line with the three themes of the MIC conference. Firstly, we posit that we need to develop more focused approaches to **observing** creativity in digitalised contexts which includes the role and nature of digital tools. Secondly, that much could be gained from developing a heuristic for **assessing** digital creativity support tools based on existing creativity research. Thirdly, that better understanding of the affordances and constraints in digital creativity support tools may help us better **estimate** the impact that such tools may have on creative processes.

*Keywords:* Context, Digital tools, Human-Computer Interaction.

# Collective creativity of multicultural virtual teams

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The recent spread of COVID-19 and economic crisis resulted in forcing companies to start adopting virtual linking technologies, temporarily or permanently in a collection of geographically dispersed individuals, teams, organizational units, or entire organizations. In this paper the focus is to address what has not been explored and develop a creativity model for multicultural virtual teams (MVT). Where the emphasis is on finding how creativity emerges in these and what role do intercultural competence (IC) and socio-emotional processes play in fostering collective creativity. The model development is based on literature study of different creative concepts to identify the influencing constructs in MVTs and the analysis of an internal environment of these teams. The aim of this model is to better understand the processes that lead to collective creativity and test it empirically in business environments.

A systematic literature review approach was used for this paper. The review is based on 188 systematically selected publications published from 1939 to 2020 and retrieved from bibliographic databases and through a process of snowballing.

The author found several alternative conceptualizations for creativity at a team level, which highlighted different elements as core components for generating creative solutions. Based on this, author' findings suggest the literature has a fragmented view of what the creativity concept requires at a team level, and of which actors are relevant.

The study contributes to the current understanding of the concept of creativity at a team level and emphasises on finding how creativity emerges in these teams, coupled with what role do intercultural competence (IC) and socio-emotional processes play in fostering collective creativity.

*Keywords:* Creativity, Intercultural Competence, Socio-emotional Processes, Third Culture.

# How do you feel in virtual environments? The role of emotions and openness trait over creative performance

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In the Dynamic Creativity Framework creativity is defined as a context-embedded phenomenon requiring potential originality and effectiveness. This definition indicates that the environmental conditions embedding the creative process have fundamental impact on the process itself and its outcomes. In particular, Virtual environments (VEs) are emerging as everyday contexts for a large part of the world population, affecting behaviors and feelings. VEs have been demonstrated to affect creative performance in several ways, even if the psychological mechanisms at the basis of the different modifications in the creative behavior are far from being completely explained. The aim of this study was to explore the influence of different types of VEs on creative performance, with a specific focus on participants' emotional reactions and on their individual differences in the Openness personality trait. A total of 22 participants were exposed to four different types of environments: a real room environment (RE), a control virtual environment (CVE) resembling the physical characteristics of the RE, a positive virtual environment (PVE) and a negative virtual environment (NVE). Participants were free to explore each environment for two minutes, then they were asked to perform an Alternative Uses Task for five minutes, to measure divergent thinking performance. Openness and affective reactions in each environment were measured in all participants. Results showed that Openness was associated with higher originality of responses and that this effect was particularly significant in PVE. Importantly, the type of environment interacted significantly with participants' affective reactions in explaining their creative performance, revealing that an increase of ideas originality was associated with an increase of positive affect, emerging as a consequence of experiencing a PVE.

Affective reactions to VEs, in combination with individual differences in term of Openness, thus emerge as one of the possible explicatory mechanisms of the impact of virtual reality on creative performance.

*Keywords:* Virtual Environment, Divergent Thinking, Emotions, Openness.

# SYMPOSIUM 2

## Cross-disciplinary perspectives on NeuroDesign

# Cross-disciplinary perspectives on NeuroDesign

Christoph Lattemann, Ben Godde, Radwa Khalil, Pia Gebbing, Xingyue Yang, Christoph Meinel, Julia von Thienen, Jan Auernhammer, Maya Shmailov

*Jacobs University Bremen, Hasso Plattner Institut at the University of Potsdam, Stanford University, Shenkar College*

NeuroDesign is a novel, cross-disciplinary research stream that brings together neuroscience, psychology, design, engineering and creative thinking, with applications in fields such as education and innovation development. The new research field of NeuroDesign is currently fueled by different thematic streams. Recently, the Hasso-Plattner- Institute at the University of Potsdam (HPI) opened a NeuroDesign research and teaching program. The overarching aim of their curriculum is to advance synergies across digital engineering, neuroscience and design thinking (creativity, collaboration, innovation). NeuroDesignSciene at Stanford University highlights the intersection of psychology (including neuroscience) and design (including engineering). Scholars at Shenkar College of Engineering, Design and Art bring together neuroscientists and designers/artists for joint, innovative works. At Jacobs University Bremen, researchers combine neuroscience, innovation and creativity research, business and designerly approaches. This shows that all these institutions approach NeuroDesign from overlapping, and partially different angles or disciplines.

In this symposium, we bring together scholars from the aforementioned institutions, to explore prospects of NeuroDesign across disciplines, and potential novel agendas. Sharing multidisciplinary insights across the globe assists in advancing the development of NeuroDesign and its application. We outline and recap valuable inputs provided by neuroscientists, economists, creative engineers and artists from several countries, to create a common knowledge base through this symposium. We will highlight how various intersections of NeuroDesign open the gates for several prospects that enrich this research field. This may also help creativity scholars from various research traditions shape their expectations and questions for future NeuroDesign developments.

# NeuroDesign – Synergies at the Intersection of Engineering, Neuroscience and Design Thinking Innovation

Julia von Thienen[1], Christoph Meinel[1]

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NeuroDesign is a new academic work domain at the Hasso Plattner Institute of Potsdam University, established in 2018. We seek synergies across three domains: (i) engineering, (ii) neuroscience and (iii) design thinking:creativity collaboration innovation. The approach is to expand and combine basic knowledge and methods from the three fields, ultimately to foster worthwhile innovation. One example is an overarching theme pursued by several NeuroDesign groups at the institute: re-designing systems for online interaction, so that users don't get exhausted in long video-calls. Instead, people meeting online shall be enabled to experience deep personal connections, to use all human senses, and to show a great variety of natural behaviours. Neuroscientific insights as in the field of synchrony research help to advance innovative IT solutions towards these ends. Another key area of work is the automation of measurements of phenomena like creativity and collaboration, e.g. measuring creativity in e-mails, in video game play, or in any behaviour that leaves digital traces. These methodological developments permit new Big Data and personal analyses; they foster novel insights in creativity and collaboration research, and permit personal feedback on demand. Currently, our NeuroDesign education programme comprises seven different course formats with partially iterating content. For instance, the NeuroDesign Lecture in 2019 focused on the neuroscience of collaboration, in 2020 it was creativity and artificial intelligence and in 2021 it is the neuroscience of empathy. NeuroDesign at our institute and beyond is propelled forward by close collaborations across research groups and institutions.

# NeuroDesign – a research field at the intersection of Neuroscience, Design Thinking and Business

Ben Godde[1], Pia Gebbing[1], Radwa Khalil[1], Christoph Lattemann[1], Xingyue Yang Jacobs[1]

[1]*University Bremen, Germany*

We investigate design thinking and creative cognition in an interdisciplinary approach by combining perspectives from business and neuroscience.

Innovation management deals with the systematic development of innovations, as well as with innovation methods, processes, and mindsets in organizations. Entrepreneurs/intrapreneurs need to think creatively to develop innovative business ideas and turn them into profitable outcomes. Design thinking is an innovation approach that enables developing creative and innovative solutions to (complex) problems based on user needs. Creative thinking, as a basis of innovation management, is strongly linked to cognitive flexibility, one of the core executive functions (EFs). It supports advanced human behaviors such as reasoning and problem solving, which make up of higher order EFs and

are some of the most desired competences in innovation management. Decision making, a critical phase in problem solving, requires creativity to choose and verify possible solutions to the problem.

In this context, neuroscience has a long tradition in studying EFs, which play an essential role in creative cognition, reasoning and decision-making. The other two EFs are inhibition control and working memory. Inhibition control allows abondening prevalent ideas and solutions while working memory is required to keep targets in mind.

The inspiration from both research streams will gain insights for neuroscience and business to understand the existing research gaps and anchor them in scientifically validated concepts. We shed light on the development path for this interdisciplinary approach to open a novel agenda for creativity research in the intersection of design thinking, business and neuroscience.

# NeuroDesign Research – Investigating the Human Abilities of Designing: Opportunities and Challenges

Jan Auernhammer[1]

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Design Thinking is a widely utilized term in different fields, such as Engineering, Design, Management, and more recently Neuroscience (Brown, 2008; Dorst, 2011; Dym et al., 2005; Saggar et al., 2016). This interdisciplinary attention to a single construct provides opportunities to understand the human abilities, practices, and social dynamics involved in designing in new and meaningful ways.

At Stanford, we recently established a NeuroDesign Research Lab to investigate the neurocognitive, cognitive, and social processes involved in various design activities. The intersection between the human sciences and design practices, such as engineering design, provides the opportunities to investigate still unanswered research questions, such as the nature of insight and how to foster it (Kounios & Beeman, 2014; Mayer, 1995). In contrast to many other disciplines, designers actively and creatively manipulate materials and the environment to establish their mental schema as a tangible artifact. These practices allow investigating the psychological and neurocognitive processes of human creativity, invention, and innovation and at the same time provide practices to foster them.

Empirical research is required to go beyond the workshop-facilitation model of Design Thinking employed by many institutions and organizations that provide little actual design practice that result in outcomes that impacting the world in a positive manner. Too many idealized design methods and activities promise to solve open and complex problems with very little actual impact in our society. NeuroDesign Research provides the opportunity to establish a field that examines the human abilities and activities involved in complex problem finding and solving and develop practice to enable the creative potential in designers. However, for this to happen new approaches, such as neuroscience instruments and methods need to be developed to be able to investigate the thinking in design in real- world settings. These opportunities and challenges of NeuroDesign Research are discussed and explored in more detail in this talk.

# Neurodesign – Giving Shape and Voice to science: Crossing disciplinary boundaries to create new bodies of knowledge

Maya Shmailov

*Shenkar College of Engineering, Design and Art, Israel*

Neurodesign is a new academic domain that embodies collaborations and disciplina ry crossings between multiple disciplines of neuroscience, design, art, engineering and social sciences.

At Shenkar the field of neurodesign research was only recently established at the Master of Design Program directed by the author. The neurodesign program runs over a course of a year using a three-step teaching model. During the first step, graduate students from the program, comprised of designers and engineers, were exposed to a series of lectures on psychology, perception, creativity, application of neuroscience in design and vice versa, etc. During the second step a workshop was conducted to explore design and neuroscience concepts using methodologies of design thinking. Through the workshop process students chose a topic for further exploration which was fed into the third step. During this step, under remote guidance of experts on the topic chosen for the course project, students explored in depth the chosen topic, built a framework for the project, presented an initial design brief and proceeded to further develop their project.

By exploring the “outsiderness“ of the designers in the scientific domains, the cours e provides a glimpse in to the role designers play in promoting participation and un derstanding in science. Acquiring the role of outsiders, design students ask fundamentally scientific questions and further provoke new way of approaching research and of presenting the scientific research to the public. The yearlong course culminates in an exhibition allowing the general public to explore the projects and e stablishes a scientist-designer-public relationship.

# Mini talks/Posters 1

# Creativity and acculturation in multicultural children and adolescents in Brazil

Marina M. Porto[1], Denise Fleith[2]

*[1]Universidad Autónoma de Madrid, [2]University of Brasilia*

This study aimed at investigating the relationship between creativity and acculturation in multicultural children and adolescents. Twenty-two girls and 17 boys of 6 to 15 years old who had previously lived in at least two countries and were living then in Brazil participated in this research. The instruments were: Short Scale of Acculturation and Children's Figural Creativity Test. The first one measures the acculturation level by assessing three factors: Language, Media and Ethnic Social Relationship. The second instrument measures the creativity level including four factors: Enrichment of Ideas, Emotion, Creative Preparation and Cognitive Aspects. Descriptive and inferential analyses were conducted. It was noticed that participants with higher levels of acculturation were significantly more creative than those with lower levels. These multicultural youngsters presented above average results on the creativity test, driven by factors of Emotion and Cognitive Aspects.

Most of the sample had high levels of acculturation. The main acculturation strategies adopted were integration and assimilation, reflecting that the group absorbed foreign culture. In integration, this happens at the same time that the native culture is maintained, whereas in assimilation, original cultural heritage is neglected. We hypothesize that the emotional dimension, related to the confrontation of cultural antagonisms, and the cognitive dimension, derived from the expansion of the subject's information repertoire, could be mechanisms underlying the high levels of creativity of multicultural people. We suggest future longitudinal studies aiming to examine their creativity levels before, during and after the multicultural experience.

*Keywords:* Acculturation; Creativity; Multiculturalism

# How do Creative Beliefs Influence Students' Intentions to Pursue a Creative Career: The Direct and Indirect Influences of Creative Mindsets, Creative Biases and Creative Self-Efficacy

Hofreiter Sebastian[1], Min Tang[1]

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Creativity and its influences and outcomes in the workplace are a long-standing and often-studied research topic in psychological and social sciences. However, research on the factors that influence young peoples' intentions to pursue a creative career seems rare. Drawing on social cognitive theories, this study investigates how creative mindsets, creative biases and creative self-efficacy directly or indirectly affects students' intentions to take on a creative job. A total of 428 German students participated in the present study via an online survey. Results showed that a fixed creative mindset was negatively associated with students' intention to take on a creative job. This relationship was mediated through creative self-efficacy demonstrating that a stronger fixed mindset was associated with lower creative self-efficacy, which was associated with decreased intention to take on a creative job. In addition, the role of biased views towards creativity were also investigated. It was found that a fixed creative mindset was associated with a stronger Big-C creativity bias (the belief that only revolutionary creativity can be regarded as being creative), which was correlated negatively to creative self-efficacy that led to a decreased intention to take on a creative job. This study sheds light on the underlying psychological mechanism that influences students' intentions of pursuing a creative job or not. The results highlight the importance of the development of pro-creativity self-beliefs and have pedagogical implications for the assessment and fostering of creativity as well as the guidance for creative career choices in universities and educational institutions.

*Keywords:* Creative Mindsets, Creative Self-Efficacy, Creativity Biases, Creative Career Intentions.

# Motivation of children with high creative potential in preschool age

Elena Belova

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Motivation is an important factor in the development of giftedness. At the same time, it remains an insufficiently studied psychological variable that characterizes the phenomenon of creativity in modern children. This is especially true for preschool age, when the foundations of all mental functions and abilities are laid.

Purpose of the study: to investigate the features of motivation of preschoolers with high creative potential. The theoretical basis of the research: the concept of "Creative giftedness" (A.M.Matyushkin). In accordance with it, high creative potential can appear already in preschool age and forms the basis of creative giftedness as a prerequisite for the development of a creative personality.

Participants: 265 children of 6-7 years old from Moscow.

Methods: Torrance Tests of Creative Thinking; a technique of revealing the motivational preferences of preschoolers; observation; surveys of parents and educators; expert assessment of the children's creativity results (drawings, etc.).

Group I (N = 52) of children with high creative potential and an equal number of group II of peers, whose creative potential was at medium level and low, were singled out. The comparison of the two groups showed that the desire to learn new things among preschoolers in group I is more expressed than among their peers. Different variants of the ratio of motivational demonstrations are revealed. More than half of preschoolers, both from group I and from group II, were characterized by a balance of motivational demonstrations and their severity: they were equally eager to learn new things and play. At the same time, the willingness to be active and proactive in cognition was observed in less than a third of 6-7 years old children, regardless of the level of creative potential. Possible reasons for this are: excessive regulation of the child's life in the preschool period, overload of classes in preparation for school education, and the lack of time for free play.

The study showed that modern preschoolers, with an expressed desire of adults to start teaching a child (counting, reading, etc.) as early as possible, have less time for independent play, and, accordingly, opportunities for creative self-realization in play. Risks in the development of preschoolers with high creative potential have been

identified: most often, adults give priority to early purposeful learning and mastering school skills, as opposed to the development of creative play of an extraordinary child and the support of his/her desire for independent cognitive search. For the successful disclosure of the child's creative potential, it is necessary to take into account the age characteristics of motivation and the individual variability of its manifestations already at the stage of preschool age.

*Keywords:* Creative Potential, Motivation, Preschool Age

# Cultivating Creativity: A Constructivist Methodology to Enhance the Creative Process in Young Adults

Lindsay Esola

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The Apple Project is a series of teaching interventions designed and presented by the researcher to cohorts of preservice education majors. The study is based on the pedagogical assumption that educators can teach creative thinking in order to not only promote artistic gains among students, but also facilitate strong connections to long term memory through scaffolding and experiential learning methods.

Students had a baseline assessment of their current skill set by being asked to create a self portrait. This researcher showed 28 apple images to the students and then asked them to create 22 additional "anything apples" for a total of 50 different 5x5 artworks. The type of exercise is based on Dietrich's (2004) deliberate, spontaneous and flow definitions of creativity as well as Eagleman and Brandt's (2017) concepts of breaking, blending and bending.

The data collected from this case study was believed to demonstrate their artistic growth when their projects created before, during, and after scaffolded experiences were compared. The data was analyzed taking into account the serial order effect (Beaty, R., Silva, P., 2012), which is why they not only went on to create more Apple Artwork, they also were asked to create a self portrait to compare to earlier work.

Through qualitative evidence, it has been demonstrated that the novel technique proposed in this research is able to increase creativity. This was supported by scaffolding, class observations, the measured number of students that enhanced their artistic ability and student reflections. The outcome of the study is a practical application of a neuroeducational theory of Brain based learning. Because learning and memory are formed by a series of neuronal pathways that create networks, teachers can physically change the brain of their students.

Building upon the present rigorous study with proven creativity gain, it is proposed that in future work a student's creativity can be nurtured from an educational, psychological and neuroscience perspective. Work along these lines should lead to a strong educational curriculum to enhance creativity. Research in this area will benefit education, developmental psychology, neuroscience, and innovation levels in society.

*Keywords:* Constructivism, Creativity, Neuroeducation, Scaffolding

# Relationship Of Creativity To Multipotentiality And Leadership In High Ability School Children

Elena Shcheblanova

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Creativity is one of the important components of influential models of giftedness. To date many psychosocial aspects of giftedness and creativity development are growing understanding, but there is still much to learn. Our study aimed to investigate the interrelations between creativity and such psychosocial factors as adjustment problems and social interconnections in high ability secondary school children. A total of 184 eight- through eleventh-grade students of gymnasiums (83 boys and 101 girls; aged 14.7 to 17.6; M = 16.2: SD = 0.8), scored in the IQ-test range from 120 to 145, participated. We used the Amthauer Test of Intelligence Structure; The Verbal Tests of Creative Thinking "Unusual Uses"; the Checklist for Self-Assessment of Student Adjustment Problems; Peer Nomination Strategy to estimate the sociometric status among classmates; Grade Point Average of the major subjects. Similar to finding to other studies, the results revealed the low positive correlations between creativity and intelligence (mostly verbal) scores. Besides, the creativity were positively interconnected with the self-assessments on multipotentiality and aspiration to dominate, as well as to the intellectual leadership, according to classmates choice. The data demonstrated complexity and nonlinearity of these interrelations. Significantly differences between the parameters were observed in the subgroups with the highest and lowest creativity. Multipotentiality was more pronounced in highly creative adolescents as the problem arising from their multiple talents. The data obtained have implications for use in vocational guidance, counseling, and support of gifted students.

*Keywords:* Creativity, Giftedness, Leadership.

# Implicit theories of creativity including concepts of what is a “creative person” among intellectually gifted adolescents

Natalia Shumakova

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Implicit theories of creativity including concepts as to what is “a creative person” are important in the field of education since they can impact learning behavior and individual learning goals, motivation, creativity, and achievement (*Dweck*, 1999; *Runko*, 1990; *Sternberg*, 1985).However, only few studies have addressed these implicit theories and concepts among adolescents. This study compared these concepts among intellectually gifted adolescents in two age groups -- 13-14 year olds (n=73, mean age 13.5) versus 16-17 year olds (n=61, mean age 16.4). Do their concepts about who a “creative person” is differ or are they similar? The graphic technique “Bubbles” was used to collect data; participants in both age groups were asked to draw a person who they would consider to be creative, including clothes and the face; describe the attributes of such a person; indicate her or his gender and age. Participants also answered eight-items questionnaire about domains and personal characteristics of those they consider to be creative individuals (*Hopp & Händel*, 2016). The two groups of adolescents were found to considerably differ in terms of their concepts about creative persons. These differences pertained to the mean age, gender and attributes of a creative person. For younger adolescents, a creative person is unique, original, cheerful, resilient, and talented in artistic domains, though not necessarily hardworking; older adolescents considered such a person to be bright and original, dreamy, and at the same time, also hardworking and diligent.

*Keywords:* Creative Person, Gifted Adolescents, Implicit Theories.

# MIC Keynote Speech 2

## What does mixing phenomenological and behavioral data tell us about student creativity? Harnessing generative tensions

Jen Katz-Buonincontro

*Drexel University*

Though phenomenology and behaviorism have been pitted as incompatible or irreconcilable (Wann, 1964), many social scientists now embrace phenomenological (firsthand, narrative lived experience) and behavioral (measurable, observable) approaches to research. Mixed methods studies attempt to integrate these two epistemological frameworks but remain underutilized in the field of creativity. In this guest talk, Dr. Katz-Buonincontro will discuss the dialogic tensions arising from comparing such empirical data in various mixed methods creativity studies. She will describe her approach to harnessing these tensions as a springboard for designing new studies to dig deeper into barriers and supports to how students feel and act creatively.

# MIC Keynote Speech 3

## The birth of Possibility Studies:
## From estimating to experiencing the possible

Vlad P. Glăveanu

*Webster University Geneva, Switzerland*

This keynote offers an overview of a new, transdisciplinary field of study at a crucial moment in its development, that of assessing its own intrinsic possibilities. It is safe to assume that reflections on the possible as a key marker of human existence have always accompanied our exploration of self and world. Without falling into the trap of presentism, we should also note that the many crises we are faced with today – from environmental to political, from health to economic – confront us with a series of more or less insurmountable impossibilities. Taking the radical transformation of society into account, over the past decades, renewed calls for understanding our engagement with the possible have been formulated across the social sciences, humanities, and the arts. This is, after all, part of the reason why creativity is such a popular topic nowadays and, beyond it, why innovation, serendipity, awe, wonder, imagination, and anticipation, to name a few, are also experiencing a resurgence. In this unique socio-scientific context, it is high time to formalise Possibility Studies as an area of investigation, one that doesn't come to replace the exploration of any of the phenomena listed above but to deepen it. The possible is not simply added as a new concept – which it is not – but used as an open, unifying framework for all those theories and studies that deal with what lays beyond the here and now of immediate action and interaction. This talk will provide a brief history of conceptualising the possible, reflect on the main assumptions, principles, methodologies and forms of

practice specific for Possibility Studies, as well as argue that our attempts to estimate what is possible need to be matched by a critical and ethical reflection on the experience of possibility itself. The nature and value of this kind of experiencing are discussed and the field of Possibility Studies proposed, for the first time, not as an area that ‘could be’ but one that ‘is’ and, staying true to the topic itself, one that ‘is’ in and through ‘becoming’.

# SESSION 4

## Creativity across Emotions and Cultures

# Do emotional manipulation and encoding style moderate the effect of response inhibition on divergent thinking?

Lin Lin[1], Ahmed Karim[1,2,3], Ben Godde[1] and Radwa Khalil[1]

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Divergent thinking (DT), as a core component of creative behavior, depends on cognitive abilities (i.e., creative cognition) like inhibition control (IC) or flexibility. Response inhibition (RI) as one dimension of IC, which refers to self-control or behavioral inhibition involving suppressing prepotent responses, has been revealed to be associated with DT. Further emotional states as so-called creative drives influence creative thinking.

Moreover, it has revealed a relationship between IC and encoding style recently. Encoding style refers to individual differences in the perception of the balance between internal schemata and external information (hence, internal and external encoders). Together, DT could be affected by the interaction between RI, emotional states, and encoding styles. Therefore, we aimed at exploring whether both emotional states and encoding styles moderate the association between RI and DT. We induced two types of emotion (positive and negative) through respective feedback as an experimental manipulation during the Alternative Uses Task (AUT; a classical test for measuring DT) following the Go/No-Go Task (GNGT; one of the well-established paradigms for measuring RI). During the AUT and following feedback period, we assessed the emotional arousal through measuring skin conductance (SC) and heart rate variability (HRV). We also measured encoding style using the Encoding Style Questionnaire (ESQ). Forty-three young adults (age between 18 and 30 years) participated in the study. Data analysis is ongoing, and results will be reported at the conference.

*Keywords:* Divergent Thinking, Response Inhibition, Emotional States

# Affect in Ideation, Pretend Play, and Creativity: An Overlooked Connection

Sandra Russ

*Case Western Reserve University*

Affect has an important role in creative production. There are a number of affective processes that are recognized as being important in creativity: joy in the process of creation; intrinsic motivation; positive affect mood states; curiosity and enjoying tension involved in challenge.

Affect in ideation is another affective process important in creativity that has been overlooked in contemporary theory and research. Affect in ideation is also referred to as affect in fantasy, affect in mental representations, emotion-laden cognition, primary process thinking, and emotion-laden memories.

Pretend play behavior in children is an excellent venue in which to study affective ideation and creativity. Pretend play is a creative activity and affective expression can be measured. Examples of affect in ideation in play are scary monsters, yummy food, angry people, nurturing mothers, and exploding volcanoes. Research exploring the link between affective ideation , play, and creativity measures will be reviewed. For example, a number of studies have found associations between both positive and negative ideation in play and divergent thinking in children (See Russ, 2014 for review). Theoretically, access to a broad range of affective ideation should facilitate a broad search in creative problem solving. Children become comfortable with this type of ideation through the safe world of pretend play.

Questions that will be addressed are: In what domains is affective ideation important?; How does affect in ideation relate to actual mood states?; What are the implications of recent neuroimaging research and creativity for this affective process?

Suggestions for future research will be offered.

*Keywords:* Affect in Ideation; Pretend Play; Positive and Negative Ideation

# Creativity and emotions: The role of measurement and analysis in detecting a complex relationship

Zorana Ivcevic

*Yale Center for Emotional Intelligence, Yale University*

This paper examines the role of creativity measurement and methods of analysis in detecting a complex relationship between emotions and creativity. Creativity scholars have studied the role of emotions in creativity for a long time. We learned much, especially about how positive energized emotion states facilitate creative idea generation (Amabile, Barsade, Mueller, & Staw, 2005; Baas, De Dreu, & Nijstad, 2008). Yet, positive emotions do not tell a whole story about emotions and creativity. The influence of positive emotions is limited to short tasks or early stages in idea generation (Baas et al., 2008; Kaufmann & Vosburg, 2002). Studies outside of the laboratory (e.g., workplace, graduate studies) show a more complex relationship between emotion and creativity (Ivcevic, Li, & Levitats, 2021; To, Fisher, Ashkanasy, & Rowe, 2012). This paper presents a theoretical review and uses research examples to illustrate how seeming inconsistencies in findings about the role of emotions in predicting creativity are related to different measures of creativity (e.g., study of target groups, performance on creativity tests, social judgments of performance) and different measures of emotion-related constructs (e.g., in the moment assessments, retrospective reports of typical feelings). Furthermore, the paper argues that different analytical approaches (traditional variable-centered vs. person-centered analyses) influence our ability to detect complex relationships. For instance, although positive and negative emotions are negatively correlated, they can co-occur in the same individuals (Moeller, Ivcevic, White, & Brackett, 2018). Original data that examine such co-occurrences in the context of workplace show that creativity is related to both high positive and high negative emotions (and not only positive emotions). The paper concludes that understanding of the role of emotions in creativity requires an acknowledgement that creativity is not a unitary construct and should be discussed in relation to cognitive processes (such as idea generation and evaluation), behavior, and achievement. Research findings are more meaningful (and reliable) when instead of talking about creativity, we refer to different aspects of creativity. Understanding phenomenology of creativity in relation

to emotions (and other psychological and social constructs) will require use of multiple qualitative and quantitative methodologies.

# Sex Differences in Creative Performance, Creative Self-Efficacy & Self-rated Domain-specific Creativity among Russian adolescents with high achievements in Sciences, Arts & Sports

Vlada Repeikova[1,2], Teemu Toivainen[3], Maxim Lihanov[1], Kim van Broekhoven[4], Yulia Kovas [1, 2, 3].

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Studies have reported small sex differences in general creativity and larger effects in domain-specific measures of creativity. Inconsistent results may emerge due to diversity in test modalities, samples and methodologies.

The present study investigates sex differences employing 2 domain-general (Alternative Uses Test, AUT, Guilford, 1968; Creative Self-Efficacy, CSE, Beghetto, 2006) and 1 domain-specific (Kaufman's Domains of Creativity Scale, K-DOCS, Kaufman, 2012) instruments. Our sample included 1026 high-achieving Russian adolescents (544 females) from three areas of expertise: Sciences, Arts, or Sports.

Some sex differences emerged, with negligible to weak effects. Females on average produced more ideas in the AUT (np2 = .014) and had more variable responses than males. For originality, the variance was greater in males, but no average sex differences emerged. No sex differences emerged for creative self-efficacy (np2 = .005).

We also investigated sex differences in intra-individual strengths by subtracting the AUT (objective performance) from CSE (subjective self-perceptions). The results showed that males over- and females under-estimated their performance.

For self-reported creativity (K-DOCS), no sex differences were found in Self/Everyday, Scholarly and Performance domains. For Mechanical/Scientific creativity, males rated themselves higher (np2 = .060), whereas in Artistic creativity (np2 = .020) females rated themselves higher.

Some differences emerged across the 3 groups of expertise. For example, female Science and Arts students rated their artistic creativity higher than males; whereas this was not observed for Sports group.

We discuss different explanations for the observed results, including potential sex-bias in some creativity measures, as well as expertise and other characteristics of samples.

# SYMPOSIUM 3

## Estimating the possible: New methodologies for Possibility Studies

# Estimating the possible: New methodologies for Possibility Studies

by Wendy Ross[1], Vlad P. Glaveanu[2]

[1]*London Metropolitan University*

[2]*Webster University, Geneva*

The generation of novelty lies behind human progress. Creativity research is thereforeconcerned with how we make discoveries and changes which move us towards the futureand in so doing generate that future. Generating this form of novelty requires engaging withthose processes and concepts which are intangible and contingent. Easily reproducibleprocesses and phenomena will not explain the entirety of this experience and so different methodologies are required to fully understand how we engage with a possibility that weare also in the process of creating. The proposed symposium will look at novelmethodological approaches to understanding varied underexplored aspects of humanexperience.

The talks in this symposium explore the use of virtual reality to explore transformativeexperiences, inductive and qualitative experimental paradigms and the ways of measuringthe future. We will end with reflections on how the recursive relationship betweenresearching complex phenomena and using these complex phenomena to shift the methodsof research.

*Keywords:* Future Studies, Possibility, Serendipity, Wonder.

# Assessing Transformative Experiences: Some methodological considerations

Andrea Gaggioli[1, 2], Alice Chirico[1]

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Transformative experiences (TEs) are events that result in a shift in perspective, awareness, and worldview, leading to the construction of new meaning in life. Although anecdotal evidence of TEs has been provided by several disciplines, experience-induced life transitions are one of the least understood phenomena of psychological change, common definitions and methods of analysis are lacking. In this contribution, we will focus on the key methodological issues associated with the analysis and assessment of TEs. In the first place, TE has not been fully legitimated as a psychological construct. To allow for its operationalization, it is essential to improve our understanding of transformative change as a process, by focusing on its common antecedents as well as its proximal and long-term outcomes. Furthermore, we will argue that to study the impact of experience on personal transformation, multiple levels of analysis – i.e., physio-behavioral, neuropsychological, and psycho-social should be considered. Finally, we will examine the potential of advanced simulation technologies – such as virtual reality – for implementing experimental research on transformative experiences in controlled laboratory conditions, while ensuring ecological validity.

# Unfolding the possible: Knowing through doing and object movement.

Wendy Ross

*London Metropolitan University*

Creative cognition is in a funny position. The experiment in cognitive psychology has been conceived in the hypothetico-deductive framework. Hypotheses are formulated (even ideally preregistered) and outcome measures are decided in advance to reflect the underlying abstracted cognitive processes. The matrix of maybes of human behaviour is reduced to 1s and 0s on a spreadsheet. Yet creativity is necessarily complex, idiosyncratic and to some extent unpredictable. How to investigate this in the controlled environment of the laboratory is not immediately obvious.

In this presentation, I will draw on the cybernetic, forward looking ontology of Andrew Pickering to suggest that concepts such as serendipity, creativity and possibility invite us to move away from the traditional view of causes and effect to instead embrace idiosyncratic, emergent patterns in cognitive actions. I will introduce my suggestion for a prospective and inductive experimental paradigm which generates a perturbation and tracks participants' actions without relying on somewhat arbitrary measures of success to categorise those actions. This approach assumes the traditional order of cognition – knowledge leads to behaviour – is inverted in higher order processes such as creativity and rather, that performance and doing lead to knowledge. When performance is the focus rather than outcome then multiple pathways can be tracked through bodily gestures and object movements yielding a rich description of distributed creative cognition. I propose that this can lead to an iterative cycle of qualitative hypothesis-generating observations and quantitative investigation and in this way unfold the possible.

# Future Indices

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How can one improve the capacity of communities, organizations, and people to face future challenges? A possibility is to measure their awareness of possible, incoming changes. This paper describes the series of Future Indices (IF), an innovative tool that aims to measure the openness to the future of people, organizations and communities. The indices are meant to be easy and immediate to read (a number) and must allow comparisons between different realities. Following the logic of the HDI-Human Development Index, we will build a battery of indices, each one aimed at making different aspects of the theme visible. The indices follow the Anticipation Theory approach (Poli, 2017a, 2019a, 2019c) and are currently tested by -skopìa Srl.

In some respects, the IFs will be synthetic indices constructed from other indices. Some of the concepts underlining the IFs are widely discussed in the literature but are usually used without an actual prospect of the future. In other words, the component of anticipation is missing, the aspect that distinguishes the Ifs from other indices.

The IF battery includes three different indices, further subdivided into the community, organization and individual version. The three indices are: the Openness to the Future Index (OF), the Readiness for the Future Index (RF), and the Anticipation Index (AN). In my presentation I shall sketch the main features of each index.

# Wonder (in) research

Vlad P. Glăveanu

*Webster Univeristy, Geneva*

This talk will focus on two different yet interrelated issues: researching wonder and wondering in research. The former is a relatively new area of empirical investigation. Wonder as an experience has been a topic of philosophical reflection for millennia (at least since the time of Socrates), and yet, beside introspective and phenomenological tools, we have little at our disposal, methodologically, to study wonder. This can be partially explained by the fact that wonder itself is grounded in phenomena that seem to be antagonistic to how we imagine and practice research, at least in psychology: uncertainty and not knowing, questioning basic assumptions, defamiliarising the familiar. And this is where the latter issue comes to the fore: when and how do we welcome wondering within a research process? When 'room' is made for wonder in research it is typically at the start, as a kind of curiosity that activates researchers and helps them ask various questions. It is not only the case, though, that wonder is different than curiosity, but it's participation to any practice of discovery can only be transversal. A call will be made, in the end, to foster wondering in scientific observation, assessment and estimation as a means of infusing research practices with renewed possibilities.

# SESSION 5

## Assessing Creative Cognition

# Assessing raters: what factors predict discernment in novice creativity raters?

Simon Ceh[1], Gabriela Hofer[1], Mathias Benedek[1],

[1]*University of Graz*

Creativity research crucially relies on creativity evaluations by external raters, but what factors coin their ability to distinguish creative from uncreative responses (i.e., discernment)? In the present study, we investigated the potential impact of rater personality and rater creativity when evaluating others' responses. Specifically, 166 novice raters evaluated a pre-selected set of responses from the alternate uses task for creativity. We assessed each rater's creativity and personality and explored the role of task factors such as rating motivation and rating time. We found that creative potential and creative achievement independently predicted discernment. Among the Big-Five and dark triad personality traits, only openness to experience was related to higher discernment. Rating time, rating motivation, and rater leniency (i.e., the general tendency to appreciate creative responses) also impacted discernment. Finally, we seized the large rater sample to estimate to what extent the number of raters influenced inter-rater reliability. Taken together, this study has followed previous research [e.g., Benedek et. al., 2016; Silvia, 2008] in aiming to broaden our understanding of rater characteristics that influence creativity ratings: Researchers aiming for discerning raters should seek creative and open ones.

*Keywords:* Divergent Thinking; Rater Characteristics; Discernment

# Dynamic processes in children's creativity

Mihaela Taranu[1], Marc Andersen[1], Andreas Roepstorff,[1]

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It is acknowledged that iterative processes play an important role in creative thinking. The aim of this work is to elucidate whether children's creative products benefit as well from an iterative process and whether individual differences in divergent thinking abilities (*the creative potential*) predict the creative outputs of the children (*the creative product*).

These questions were addressed in a group of 27 children aged 10-12. Children completed a *LEGO building task* and an *Alternative Uses Task (AUT)*. In the LEGO building task, children had to build five creative modes of transportations (builds) over five consecutive iterations. Six independent LEGO expert raters evaluated the builds using a Consensual Assessment Technique (Amabile, 1996). Results showed that children's outputs became more novel as a function of iteration and less like a mode of transportation, but not more/less creative. The rating of how much the builds resembled typical modes of transportation were marginally predicted by the divergent thinking abilities (as measured by the AUT).

These results emphasize the importance of iterative processes for children's creativity, suggesting that a single assessment of creative products will miss to capture the dynamic nature of creativity and potentially offer an inaccurate account of children's creative potential.

*Keywords:* Children's Creativity, Dynamic Processes

# Assessment children's creativity with a problem finding task

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This paper introduces a research about children's creativity assessment. It was developed in different stages and was based on the Problem Finding model (as defined by Getzels and Csikszentmihalyi, 1976).

From an applied point of view, the objective of the research was to find a way to assess children's creativity beyond divergent thinking tests. These tests have been proved to have a limited predictive validity and do not attend the creative thinking process.

We consider that an instrument to evaluate creativity in elementary school children (from 6 to 12 years old) must be culture-free, figurative and not conditioned by a greater or lesser command of literacy. Those are the main characteristics of the TCI (Test de Creatividad Infantil- Childhood Creativity Test). This test captures the problem finding process and is administered in two phases. The first, formulating the problem, requires the child to create a model, using stickers representing objects/characters appropriate for this age range. The second phase, problem-solving, consists of creating a drawing from the model rendered in phase one. The final score of the test integrates both, variables related to the creative process and the final creative product.

After the test's validation, several researches have been undertaken around issues such as creativity development trajectories in Elementary Education, the fourth grade crisis, gender differences or intercultural differences with samples from different countries. This paper summarizes the main conclusions

*Keywords:* Children Creativity, Assessment, Problem Finding.

# Measuring creativity through divergent thinking tests: The nuts and bolts of data analysis

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The study of creativity has been receiving increased interest over the last few decades. Different aspects of creativity have been explored in a wide array of contexts through the use of a plethora of instruments. The measurement of creativity, however, remains a bone of contention for many, due to the different interpretations and connotations associated with the aspect of 'measuring' per se, as well as 'how' and 'what' to measure. Among the instruments used to measure creativity are tests of divergent thinking (DT), including the widely used 'Alternative Uses Test' (AUT) (Guilford, 1967), in which participants are asked to list as many possible uses for common items. Administering the AUT is straightforward, but limited information is available on how to analyse the data collected. Guilford (1967) provides some instructions on how to score fluency and originality, however, little guidance is offered on how to score other facets of creativity including relevance, flexibility and elaboration. Our paper addresses this gap in the literature by detailing the nuts and bolts of scoring and analysing AUT data, based on our experience conducting a study among students aged 11 to 16 years, observed over two waves of data collection (402 students in wave 1 and 257 students in wave 2). We offer tips on how to make this labour-intensive task less arduous while enhancing reliability and validity. In so doing, we hope to facilitate the data analysis process for future researchers who employ the AUT (and perhaps other DT tests) to measure creativity.

*Keywords:* Alternative Uses Test (AUT), scoring, analysis

# Pros and cons to be creative during lockdown: the effect of the creative potential on the psychological distress associated with the COVID-19 outbreak in narcolepsy type 1 patients.

Anita D'Anselmo[1,2], Sergio Agnoli[2,3], Marco Filardi[4,5], Fabio Pizza[1,6], Serena Mastria[2,3], Giovanni Emanuele Corazza[2,3,7], Giuseppe Plazzi[6,8]

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The national lockdown imposed in several countries to counteract the coronavirus disease 2019 (COVID- 19) pandemic led to an unprecedented situation with serious effects on mental health of the general population and of subjects affected by heterogeneous diseases. Considering the positive association between narcoleptic symptoms and creativity, we aimed at exploring the psychological distress associated with COVID- 19 restrictions and its relationship with depressive symptoms and creativity in patients with narcolepsy type 1 (NT1). A total of 52 patients with NT1 and 50 healthy controls, who completed a previous study on creativity, were contacted during the first lockdown period to complete an online survey evaluating psychological distress related to the COVID- 19 outbreak, sleep quality, narcolepsy and depressive symptoms, and creative abilities. The patients with NT1 showed an improvement in subjective sleepiness while controls reported worsening of sleep quality during the lockdown. Depression and NT1 symptom severity proved

significant predictors of COVID- 19- related distress. Creative performance, namely generative fluency, turned out to be a favourable moderator in the relationship between depression and patients' distress, reducing the detrimental effect of depression on the patients' wellbeing. On the contrary, creative originality proved to be a disadvantageous moderator in the relationship between NT1 symptom severity and the distress associated with this traumatic event indicating a higher vulnerability to developing COVID- 19- related distress, particularly evident in patients displaying higher originality. Overall, these results highlight a crucial role of creativity in patients with NT1, suggesting that creative potential could be used as a protective factor against the development of distress associated with the lockdown.

# MIC Keynote Speech 4

## Creative People & Creative Robots: Back to the future

Todd Lubart

*Université de Paris, France*

Since more than a century, robots with créative ability were imagined. Current work on social robots will be examined. Implications for the future of creativity will be developed.

# SESSION 6

## Neuroscientific approaches to creativity

# Oculometric signature of switch into awareness? Pupil dilation predicts ‘Aha!’ moments.

Carola Salvi

*Department of Psychiatry, University of Texas at Austin, USA.*

Insightful ideas are a powerful expression of creativity. For the Gestalt theorists, restructuring is an essential component of insight problem solving, contributing to the 'Aha!' moment and similar to the perceptual switch experienced when reinterpreting ambiguous figures. Because these perceptual and conceptual 'representational changes' rely on similar processes, they should present similar behavioral responses. Previous research showed that pupil diameter increases during the perceptual switch of ambiguous figures, indexing norepinephrine functioning mediated by the locus coeruleus. In this study, we investigated pupil diameter fluctuation by asking 38 participants to solve 120 Compound Remote Associate problems. Results show that pupil diameter increased significantly about 500 msec prior to the solution, only in trials for which subjects report having an insight. The pupil dilation seen when people have an ‘Aha!’ moment suggests the involvement of norepinephrine, via the locus coeruleus, in insight problem solving. This finding further corroborates the idea that insight is characterized by a ‘representational change’ and an off-on discontinuous process that rises in awareness in association with the ‘Aha!’ feeling.

# Enhancing Creative Possibilities in Sonic Improvisation though Sonification and Biofeedback

Nicolas D'Aleman Arango[1], Dr. Shama Rahman[1], Prof. Dr. Christoph Meinel[1]

[1]*Hasso Plattner Institute, University of Potsdam, Germany*

Our project explores creativity processed as a series of musical interconnections, of feedback loops that happen during musical performance and sonic improvisation. In general creativity brings about innovative outcomes, which likewise unveil novel creative possibilities in subsequent endeavours. We propose a conceptual and artistic framework, in which various types of sonification algorithms for EEG-measured brain activity can be probed to enhance creative possibilities in music-making. The musical improvisation act iBoS (input Brain, output Sound, with Dr. Shama Rahman on Sitar and Nico Daleman on electronics) merges synthesised sounds controlled by brainwaves with traditional acoustic instruments such as the Sitar. We use a brain-controlled musical interface (BCMI) based on the Muse2 headband to provide sonified feedback in real time that is incorporated into the musical performance. We have created a pilot study where different sonification algorithms are presented to a single performer with advanced musical expertise. The participant reacts in real time to the sonified readings of their brainwaves, which influence the level of complexity of electronic accompaniment, inciting more challenging musical gestures and thus creating a bio-feedback loop. The inclusion of a "human-in-the-loop" that controls sonification algorithms in real-time adds a layer of unpredicted agency to the process. The sonification accompainments are presented so that they avoid pre-established paradigms of music such as western classical and jazz, and challenges the performer to think about musical creativity as free improvisation, generative music, noise and sound art.

# Creative metacognition is associated with decreased upper alpha power during idea generation.

Christian Rominger[1], Corinna M. Perchtold-Stefan[1], Ilona Papousek[1], Andreas R. Schwerdtfeger[1], Andreas Fink[1]

[1]*University of Graz*

To know whether one's own creative ideas are bad or good is a fundamental creativity-relevant skill. However, available behavioral literature indicates that people differ in these metacognitive skills. To the best of our knowledge, no neuroscientific study investigated creative metacognition until now. In this study, the EEG of 77 participants was evaluated, while they worked on 16 randomly presented items of an alternate uses (AU) task. They were instructed to produce a one original use of an object. After pressing an idea button, participants verbalized and rated the originality of their idea. Objective originality was assessed by three independent judges. The subjective ratings of a participant were correlated with the corresponding objective originality ratings. The resulting Pearson correlation served as a measure of participant's metacognitive skill. We found that people with higher metacognitive abilities showed stronger upper alpha power decreases during creative ideation in contrast to people with lower metacognitive skills (p=.024). This constitutes a novel finding, since creativity research generally indicates that higher levels of originality are associated with increased upper alpha power. The observed activation pattern seems to suggest that less internal attention, less working memory load, and increased sensory processing might be associated with metacognitive performance during a creative ideation task. These processes may reflect relevant cognitive functions necessary for the evaluation of the creative value of an idea. The present research represents a first attempt to study brain mechanisms underlying creative metacognition and shows that metacognition is a distinct, creativity-relevant ability.

*Keywords:* Creative metacognition, creative ideation performance, EEG

# The relationship between idea generation and trait mind wandering: A preliminary resting-state functional connectivity analysis

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Past research on creative cognition has demonstrated that getting lost in one's own thoughts, such as memories or prospective thoughts, drifting away from an ongoing task, conceptualized into the construct of mind wandering (MW), improves creative performance, as measured by classic divergent thinking tasks. The contribution of network connectivity in the creativity-MW relation is currently relatively unexplored and represents a great challenge in the field of cognitive neuroscience. The aim of the present work is therefore to characterize at the network level the association between divergent thinking and MW, exploring whether trait MW can be considered one of the possible mechanisms explaining the ability to exploit imaginative and associative processing underlying the spreading activation conducive to higher creative performance. For this reason, we performed a resting state functional connectivity analysis to investigate how individual differences in functional resting-state networks are associated with diverse indexes (originality, uncommonness, fluency, and flexibility) of divergent-creative performance as a function of trait MW. A sample of healthy adults (n = 80) completed an Alternative Uses Task, in which they were asked to think of unusual uses for everyday objects. Before this task, resting-state EEG

activity was recorded for 3 min while participants had their eyes-open. MW was analyzed in light of a recent approach suggesting a differentiation between deliberate and spontaneous MW. Preliminary results obtained will be presented and their implications discussed.

*Keywords:* Resting-State Connectivity, Creativity, Divergent Thinking, Trait Mind-Wandering

# SYMPOSIUM 4

## Automated Creativity Measurement

# Automated Analysis of Language Creativity

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Creativity is one of the most profound and pervasive drivers for progress in every human endeavor. The two main components of successful creative products are novelty and effectiveness. Linguistic expressions - from spoken phrases to written novels - are products whose creativity can be evaluated through novelty measures (e.g., sophisticated grammar or extraordinary vocabulary) and effectiveness metrics (e.g., alliterations or rhymes). However, manually assessing language creativity is time-consuming and comes with drawbacks such as inconsistent ratings and subjective biases. Therefore, we propose a tool that automatically rates a sentence's language creativity using four distinct scores. First, the novelty score rewards unique vocabulary by determining the word frequency of each of the sentence's words based on an extensive news corpus. Moreover, it evaluates the originality of the word combinations through a Google web search. Second, the similarity score compares the sentence's vocabulary against the other sentences' vocabulary in the data set to compare a participant's creative performance to that of its peer group. Finally, the rhythmic and phonetic scores reward phonetic features. More precisely, the rhythmic score analyzes if the endings of word groups rhyme while the phonetic score searches for similar recurring sounds between all of the sentence's words. Our tool allows for configuring each score's weighting. We defined the rhythmic and phonetic scores' points as bonus points. We evaluate our creativity tool with a data set produced by N=20 participants in a study on creative thinking.

# C-Tracer: Automatic Creativity Measurement for any Goal-Directed Behaviour that Leaves Digital Traces

Kim-Pascal Borchart[1], Dr. Julia von Thienen[1] & Prof. Dr. Christoph Meinel[1]

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Traditionally, creativity assessments require judgements by human experts. The evaluation process is often time-intensive and resulting scores are partly subjective. C-Tracer is a novel data-agnostic software able to deliver automatic creativity scoring for many different types of activity data. The software calculates creativity scores for any digital data that reflects human actions across time directed towards some goal. Examples for successful C-Tracer applications are generating creativity scores for player behaviour in a video game, or for an online test of collaborative divergent thinking (where teams take the CollabUse Test, a task similar to the Alternative Uses Test, re-designed to assess creativity in teams). The scoring approach of C-Tracer builds on the standard definition of creativity regarding products: A product is creative when it is novel and effective. C-Tracer takes activity data as input and analyzes action sequences resulting in goal achievement. Each sequence of actions is compared to all other successful sequences, to estimate how unique/novel the individual sequence (or behavioural strategy) is. Creativity scores obtained by C-Tracer correlate strongly and significantly with standard creativity scores from the Alternative Uses Test. This approach of automated data analysis informed by the definition of creative products opens up novel possibilities for assessment. The approach renders possible large-scale population evaluations, immediate personal measurements, and finding creativity traces in previously impenetrable data sets too large for humans to analyze.

# Comparing Different Forms of Automated Creativity Measurement in the Study of Individual and Collaborative Creative Writing

Holly McKee[1], Dr. Julia von Thienen[1], Dr. Shama Rahman[1,2] & Prof. Dr. Christoph Meinel[1]

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Many naturally occurring forms of expression are considered creative. In these behaviour domains, people are praised for outstanding creative approaches and criticised for mundane styles. However, quantifying creativity in naturally occurring behaviour is challenging, and scores assigned to people or products tend to depend substantially on the personal opinions of experts. In creative writing, especially, there is an emphasis on originality, narrative craft and unique word choice. Yet, asking just how creative a single piece of writing is in quantitative terms is a bold question. Here we report the results of a study that compares several automated measurement approaches to assess naturally occurring creative behaviour. N=22 experienced creative writers undergo a series of creative writing exercises, where they write alone, write online in two-person-teams, in undisrupted conditions and under experimentally-induced cognitive load. The order of writing exercises is randomized across participants. To quantify the creativity of resulting texts, this study uses (i) linguistic metrics by Maltenberger, Ilic and colleagues, (ii) the software Linguistic Inquiry and Word Count by Pennebaker and colleagues, next to (iii) C-Tracer by Borchart et al. In addition, EEG-activity of study participants is measured during the writing exercises for an automatic quantification of Flow states, participants provide self-ratings of their Flow and work quality across conditions, and experts rate the creativity of texts. Overall, this study finds that different available approaches for automated data analysis can readily be combined, to provide pictures of creative processes and products more detailed and systematic than traditional expert ratings.

# Computational Methods for Flow, Affect and Creativity on Ideation Tasks

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Previous research has found encouraging links between creativity, affect and Flow. We propose novel ways for automating the measuring of creativity during ideation tasks using computational methods. The digital creativity tool *FlowCreate Innovator* provides a standardized environment for undertaking creative ideation tasks. The tool takes in user input in words and generates suggestions derived from an underlying proprietary semantic knowledge graph trained on data from 183 million sources ranging from culture and trends to technology and science. The user can interact with the suggestions using AI-digitised creativity and design-thinking tools. We have developed a creativity score determined by novelty and valence. Novelty is measured by AI-based hypernym and thematic analysis, and similarity contexts with word frequency tools. Valence is measured through multiple sentiment analysis methods (e.g. intensity and frequency of positive and negative emotions). In-depth analyses are done with real-time interactive capacities of the Innovator. Scores attributed to the selections made by the user and the AI-suggestions are compared, ultimately resulting in an automated real-time creativity score which is relative to the suggestions and standardised across ideation sessions. We retrieve EEG data from the user and pass it through a convolutional neural network classifier, which determines the frequency and duration of Flow states. This is calculated real-time and combined with the creativity score, allowing a thorough evaluation of the creative ideation process. These automated computational methods can be used to explore and research correlations between Flow state, affect and creativity on a larger scale.

# Mini talks/Posters 2

# Fear not: Creativity killed the Covid. Flexible thinking andemotions in intellectual disability

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In a historical moment like the present one, characterized by a continuous flow ofinformation and emotions, it becomes even more important to use flexible cognitivestrategies that allow us to deal with change in a functional and adaptive way. An area ofparticular attention related to the pandemic concerns the emotional domain, which is oftenchallenged due to quarantine and social isolation. This issue becomes even more critical forfrail people, for example in the case of disability, for whom the deprivation of this area isproblematic at a high level.In collaboration with a social cooperative in the Milan area, after the first quarantine, weproposed a training program for users with intellectual disabilities (ID). We implemented acreative pathway aimed at supporting participants in understanding and regulating theiremotions to prevent them to be overwhelmed during this difficult period. Therefore, wedesigned a weekly creative training that lasted 5 weeks and covered different emotionaltopics and experiences. Eight users, 3 women, and 6 men took part in the training. Theywere divided into two sub-groups and were aged between 22 and 51 years.The results of the pre- and post-training assessments showed significant differences inemotional awareness and understanding. Also, our data revealed an impact on fearmanagement, suggesting that the extension of similar programs could be useful foreveryone facing negative emotions that strongly characterize the present context.

*Keywords:* Covid-19, Creativity, Emotional Awareness, Intellectual Disability

# Creativity after stroke – a longitudinal study

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In neurological diseases, patients may develop compulsive de novo artistic creativity. This has been reported in rare single case studies. Compensatory functional enhancement or disinhibition due to a reversal of inhibition of the linked areas have been suggested as possible mechanisms behind this paradoxical facilitation.

To investigate this phenomenon, a longitudinal study with cerebral stroke patients (SP) and healthy controls (HC) is being conducted. In case of paradoxical facilitation, high creativity scores post-stroke with a decrease over time are to be expected. In case of plasticity and repair processes low creativity scores would be expected post-stroke with a subsequent increase over time. To test this, we examined creativity three times in SP 1-, 3-, and 6-months post-stroke, and in HC with an interval of one week.

Here, we report preliminary data of 30 SP (age: $M$=60.93, $SD$=12.16, 10 females, 15 left-hemispheric, 15 right-hemispheric) and 30 HC (age: $M$=55.83, $SD$=18.17, 15 females). The level (intercept) of fluency in the Alternative Uses Task (AUT, 3 items in each trial, randomized) was found to be significantly different between HC, left-hemispheric SP, and right-hemispheric SP ($F$-value=3.41, $p$=0.04). But the course of fluency over time (slope) did not differ between groups ($F$-value=0.239, $p$=0.79) and the slope over all subjects was close to zero ($M$=0.06, $SD$=2.62). While this relative stability of fluency over time in HC is according to our expectations and previous literature, this is not the case for SP. However, further analysis of other tasks and variables, such as verbal fluency, originality and flexibility shall follow.

# Association between sleep macro- and micro-architecture and the measures of verbal and figural divergent and convergent thinking

Aleksandra K. Eberhard-Moscicka[1,2], Kathrin Chiffi[1], Yasmine Bühlmann[1], Tobias Nef[3,4], Claudio L. Bassetti[2], and René M. Müri[1,2,3]

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Sleep has been linked to multiple important functions including learning and memory consolidation. To date, only few studies investigated the association between sleep and creative behavior. While there is an indication that different aspects of creativity correlate with distinct sleep stages, to our knowledge no study to date investigated the association between the performance in verbal and figural divergent (DT) and convergent thinking (CT) and sleep macro- as well as micro-architecture.

Forty healthy adults (age range 18-40, 21 females) participated in two sessions separated by one week. Whereas the first session included verbal and non-verbal intelligence and sleep disorder screening, the second session assessed verbal and figural DT and CT, as well as resting-state and over-night 256-channel EEG. Participants' sleep behavior was tracked between the sessions by means of an actigraphy device and a daily filled out sleep questionnaire.

On a macro-architecture level, an increase in the falling asleep stage was associated with increased fluency in verbal DT. While an increase in light sleep was positively correlated to verbal creative problem solving in CT, an increase in deep sleep was associated with higher scores in figural DT. Moreover, an increase in REM sleep was associated with a better performance in figural CT. On a micro-architecture level, higher originality in figural DT was correlated with lower slow wave power. While the current findings confirm the link between creativity and sleep, they emphasize that different aspects of creativity are distinctly associated with sleep macro- and micro-architecture.

*Keywords:* Macro- and Micro-Architecture of Sleep, Verbal and Figural Divergent and Convergent Thinking, Hd-EEG

# Effects of Paced Breathing on Measures of Convergent and Divergent Thinking

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Background: The ability of the autonomic nervous system stress response to impair aspectsof cognitive flexibility is known. However, the effect of paced breathing as a means ofsympathetic modulation to improve these cognitive impairments requires investigation, as isthe potential effect of sex-specific differences.

Methods: To better elucidate the effects of paced breathing in cognitive tasks, twoexperiments employed a paced breathing protocol in a total of 52 healthy men and womenand measures performance on convergent and divergent cognitive tasks and physiologicalmeasures (e.g., blood pressure, heart rate, perceived stress). Convergent thinking tasksrequired associative problem-solving while divergent thinking tasks required generation ofmultiple 'creative' responses. Participants attended two experimental session consisting ofeither paced breathing or normal breathing followed by cognitive assessments, withexperiment 2 utilizing more challenging tasks.

Results: Experiment 1 found that in females, but not males, paced breathing significantlyreduced systolic and diastolic blood pressure, but did not impact any other physiological orcognitive measure. Experiment 2 found that paced breathing significantly reducedperceived stress immediately after the breathing protocol in both males and females, but didnot significantly affect any other physiological or cognitive measures.Conclusion: These findings support the hypothesis that paced breathing may differentiallyimpact sympathetic activity in males and females. The lack of improvement in cognitiveperformance suggests against the clinical efficacy of a single trial of paced breathing toimprove cognitive flexibility, despite the effects on sympathetic activity in females.

*Keywords:* Creativity, Problem Solving, Stress

# Aiming for more objectivity in creativity assessment–Applying word vectors toassess flexibility

Magdalena Camenzind[1], Michael Single[2,3], Stephan Gerber[2,3], Fred W. Mast[4], Tobias Nef[2,3], René M.Müri[1,2,5] and Aleksandra K. Eberhard-Moscicka[1,5]

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Divergent thinking (DT), as a compound of creativity, refers to an ability to producemultiple solutions to a given problem. A possible means to measure DT is theAssociative Fluency Task (AFT) where participants are instructedto produceassociations to a prompt word. The output of such DT tasks is typically assessed bythe number of produced ideas (i.e., fluency), their originality as well as their semanticproximity (i.e., flexibility). Whereas there are objective means to assess fluency andoriginality, flexibility is often subjectively rated, hence influenced by inter-individualvariations in the perception of semantic distances.In this study, semantic distances between words were first quantified by applying wordvectors of the German language that were trained using a predefined set ofparameters. In the next step, these word vectors were adapted for the purpose ofcreativity assessment by composing a more diverse text corpus for the training and byaccounting for homonymsand synonyms to circumvent context ambiguities.The generated word vectors were applied on the AFT data of 50 healthy subjects.Compared to the pre-trained vectors, the adapted vectors indicated higher correlationsnot only to the human ratings, but alsoto the ratings extracted from GermaNet, asemantic network for the German language. Given these preliminary results, thedeveloped measure has a great potential to assess the output of DT tasks moreobjectively

# Napping improves verbal divergent thinking in healthy youngsubjects – Preliminary data

Kathrin Chiffi[1], Aleksandra Eberhard-Moscicka[1], Tobias Nef[2], Claudio L. Bassetti[3], René M. Müri[1]

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Sleep has been shown to be involved in several cognitive processes and may underlyphysiological brain maturation. It has also been indicated that appetitive napping not onlyimproves subjective well-being such as mood but can also boost cognitive behavior such aslogical reasoning, reaction time or symbol recognition. To this end, this study assesseswhether a short nap can influence a complex cognitive behavior such as creativity.

To investigate the effect of a 60-minute nap on creativity performance, we plan to measure40 healthy young subjects. While on a baseline day, the subjects perform the first creativityassessment, after a washout-period of one week they are subject to a second creativityassessment following either a quiet rest or a nap during which a 256-channel EEG isrecorded. Here we report preliminary data of 25 subjects (mean age=23.68, 15 females, 11in the nap and 14 in the quiet rest group).

Preliminary results indicated an increase in fluency in the nap compared to the quiet restgroup in verbal (p=.031) but not in figural divergent thinking (p>.963). While there was anindication of an overall improvement in figural convergent thinking (p=.002) for bothgroups, there was no such effect for verbal convergent thinking (p>.390). This study shallprovide insight into creativity research as it evaluates a potential impact of a nap as anintervention to boost creativity performance.

*Keywords:* Healthy subjects, Nap, Verbal divergent thinking

# MIC Keynote Speech 5

## Creativity Anxiety: New Insights into Anxiety that is Specific to Creative Thinking

Adam Green

*Georgetown University*

As creativity emerges as the human ability least achievable by artificial intelligence, the already historically high value placed on human creative thinking will continue to grow. Factors that keep people from realizing their creative potential are thus likely to have substantial impacts on achievement and opportunity now and in the future. We have recently proposed that anxiety about creative thinking may be a previously overlooked limiting factor for achievement. Across multiple studies, we have tested the viability of creativity-specific anxiety as a construct, begun to identify its neural characteristics, and tested its effects on educational outcomes and career interests. We first created and validated a new measure, the Creativity Anxiety Scale (CAS). Applying the CAS, we found evidence of creativity anxiety across diverse content domains, from science to the arts. Creativity Anxiety predicted individual differences in creative achievement and attitudes toward creativity and, notably, was especially pronounced in women. At the neural level, we applied connectome-based predictive modeling to identify a data-driven "creativity anxiety connectome," and showed that this enabled us to successfully predict individuals' Creativity Anxiety from their neural connectivity profile. Most recently, we have begun to identify real-world implications of Creativity Anxiety on science classroom performance and students' interests in pursuing creative careers. Establishing creativity anxiety as a novel construct, and the CAS as a valid measurement instrument, opens a new avenue of research that promises to deepen basic understanding of creative cognition and inform

development of interventions to enable greater achievement of creative potential, and greater inclusion in the highest levels of science and other creatively-demanding fields.

# MIC Keynote Speech 6

## Exploring the Creative Self

Maciej Karwowski

*University of Wrocław, Poland*

Creative self-beliefs refer to *a constellation of beliefs that shape one's creative self and play a role in helping to determine a person's engagement and performance in creative endeavors*. In this keynote I provide a conceptual overview of creative self-beliefs and discuss how to clarify, develop, and contribute to this line of inquiry. Special attention is given to the theoretical model of Creative Behavior as Agentic Action (CBAA). According to this model, transforming creative potential into creative behavior results from a decision informed by one's creative confidence and perceived value of creativity. Results that confirm the CBAA assumptions are discussed, along with implications for subsequent theory development and research. Finally, I will discuss some recent research project devoted to developing creative self-beliefs.

*Keywords*: Creative Self-Beliefs; Creative Self-Efficacy; Creative Agency; Creative Personal Identity

# SESSION 7

# Design Thinking and Creativity

# Designing the emergence of creativity in multidisciplinary contexts

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Disciplines nowadays operate in more complex areas. This leads to a reflection on structure, role and relationships of contemporary disciplines. Disciplinary action (and more specifically the project), is undergoing a transformation at the point of limits and boundaries, passing from a linear to a non-linear vision, and from vertical to horizontal. Today disciplines redistribute themselves, together with the others, around the problem, too complex to be solved by a single point of view.

Design practices have long recognized these approaches of multidisciplinary connections among apparently distant fields. See for example one of its most recent evolutions in the field of Data Visualization where the Designer together with specialists in Data Science cooperates, enriching themselves with new skills and knowledge.

The same approach is taken in other contexts such as the design of systemic processes, medical services and devices, or urban development.

Several interpretations about the role of creativity in multidisciplinary collaboration contexts have been developed so far. According to Oxman in his famous article *Age of Entanglement*, each of the modalities of human creativity (Science, Engineering, Design and Art), is part of a cycle where intellectual energy is created at the transition moment from one to another.

The contribution aims to provide an overview, through multidisciplinary case studies, of the relationships between the modalities of creativity in Science, Engineering, Design and Art, where creativity is understood not as a uniquely codified element but as an "activating implicit flow".

*Keywords:* Creativity, Design, Design for Health.

# Creativity in Engineering: Integrating creativity and PBL in a disciplinary course.

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In engineering education, it is common to use projects to enhance learning and encourage different skills in students, such as creativity. Usually, teachers conceive the project as an activity used only for final evaluation purposes but not to orient all the course learning as Project-Based Learning (PBL) approaches intend. This paper intends to relate the creative process, the five Ps model of creativity (Person, Process, Product, Press, and Phases), and the aligned model proposed by (Kolmos et al., 2009) that considers seven elements. This presentation discusses some critical issues that engineering teachers must face to promote creativity in a disciplinary course using project-based learning, which implies a mandatory alignment to the creative process phases. The paper presentation will revolve around promoting learning and strengthening creative thinking through a project by involving workshops that use different creativity techniques to encourage idea generation and divergent and convergent thinking and phases in the creative process. These are the aspects involved in the generation of novel and useful engineering products. We must consider that when developing a project following the phases of the creative process, the teacher is the designer of the tools and spaces necessary to achieve harmonization in the phases of the creative process in the elements of the PBL alignment. The presentation will take as a study case a PBL intervention will cover a disciplinary course of an electronic engineering program, where students are motivated to solve contextual problems.

*Keywords:* Engineering Education, PBL, engineering design

# Philosophy by Design: Integrating philosophy and engineering in creative problem solving

Claudio Palestini

*Nato*

Nowadays, emerging technologies have the potential to transform and disrupt life patterns, businesses, economy, security and consequently the world geo-politics.

From 5G to space, from unmanned systems to Artificial Intelligence, from quantum to bio-engineering, innovation is at the core of business and governmental strategies. But are the scientists, innovators and engineers behind these technologies aware of and ready to handle the impact that any design choice is making to the world's future?

"What you code affects the world now. Gone are the days when programmers could ignore the social context of what they code, when we could say, 'The users will just figure it all out.' Today, programs, apps, and algorithms affect society. Facebook's choices influence democracy. How driverless cars will choose to avoid accidents will affect human lives" recently wrote Bruce Schneier, one of the most renowned security technologist. Indeed, never in the history, technology and innovation have been so much at the core of human matters, such to disrupt life at its basic assumptions.

Taking inspiration by some of the most pressing modern challenges, the paper calls for a tighter integration of philosophical and engineering matters: wicked problems are the classic playground for creative problem solving, however the ideated solutions should now be assessed not only for their engineering functionality but also for the philosophically imbued contribution to ethical, social, legal and policy aspects.

This will demand the development of new leaders, capable to put engineering skills within a social, ethical, political and philosophical context.

This paper advocates for a broader engagement of engineering and philosophical practices as a critical part of modern engineering processes, in which the philosophical aspects are taken into account early at the design phase as non-functional requirements. This will be assessed with practical examples in the field of quantum technology, AI, space and autonomy.

*Keywords:* Philosophy, Engineering, Wicked Problems.

# Producing creatives: Organising and framing creative work in media broadcasting

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Media broadcasting and production companies employ so-called "creatives". These creatives are media content creating experts who, on the basis of a brief or assignment, are professional ideators; they devise new ideas for advertising campaigns, television formats, or online media productions, often within a very tight timeframe. Their creative work may be inspired by individual character traits as well as professional skills, but is also carefully governed within larger organisational contexts that are part of the creative industries.

This study presents qualitative research insights into creative processes and practices of professional media creatives, and focuses on how organisational creativity is produced within one large media broadcasting company in the Netherlands. Special attention is paid to how the creatives' work is framed as both "genius" and "ordinary", the outcome of an expertly protected almost childlike naiveté, and based on a collective trust in and maintenance of a steady stream of what are considered to be serendipitous ideas. The analysis, based on 22 semi-structured interviews with media creation experts, draws out how creative media practices are organised within this particular media broadcasting company, with a particular focus on how creatives make use of sources such as digital (big) data analytics to inform their search for creative ideas and decision-making processes. The goal of the research project is to unearth how media broadcasters' increasing turn to digital data changes how creativity is organised, managed, and produced within the creative industries in the Netherlands.

# Paths and barriers to design creativity: a theoretical analysis

Yong Zeng

*Concordia University*

This paper aims to discuss the paths and barriers to design creativity, based on a designcreativity theory. The theory is founded on two postulates: 1) a design reasoning processfollows the recursive logic implying a nonlinear design dynamics; 2) designer's creativity isrelated to mental stress in an inverse U-shaped curve. The mental stress is defined by thedesign workload, which is dynamic, and designer's knowledge, skills, and affect. As such,the effect of mental stress on design creativity is analyzed, which leads to four kinds ofbarriers and three paths to design creativity. A case study is used to demonstrate the paths,barriers, and mechanism.

*Keywords:* barrier, design creativity, mental stress

# SESSION 8

# Exploring Creativity in Educational Settings

# Applying the 4 P's Model of Creativity to ethnographical data analysis: a mix method approach in educational research.

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This contribution investigates how an innovative approach in qualitative research methodology in social science could help to grasp the *complexity of creativity* (Glăveanu et al., 2019) as a transformative practice in educational processes. Through the lens of philosophy of science and phenomenology, this paper analyzes the main qualitative research methods in social science and the main models proposed by scientific studies on creativity. The aim of this study is to find out the most suitable academic equipment to understand the *slippery* concept of creativity applied to the empirical case study of my doctoral research: "SOU. The school of architecture for children" (Favara – Sicily).

Rather than the findings of the research itself, the emphasis lies here on the process of acquiring knowledge in the field of methodology, highlighting limits and challenges of the various choices.

The theoretical framework was built upon the need to deal with various kinds of knowledge (Mortari, 2019), as called for by transdisciplinary (Montuori & Donnelly, 2016) / interdisciplinary (Corazza & Agnoli, 2016) approaches.

Following the lead of transversal thinkers such as Bateson and Morin, this study aims to achieve a balance between constructivist paradigm in social science and systemic views in the field of creative studies. The study shows how an interpretive matrix research could analyze ethnographic data through the lens of the 4 P's Model of Creativity proposed by Mel Rhodes (1961).

*Keywords:* 4 P's Model of Creativity, Educational Processes, Methodology.

# Perspectives of Creative Giftedness Through 50 Years of Bibliometric Analysis

Connie Phelps

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Post-Sputnik America experienced a surge of educational and psychological advancements in primary and secondary schools. Federal and state governments adopted expressions ofhigh ability and talent development including creative giftedness to identify potentially gifted children and adolescents. Schools modified regular education instruction with evidence-based practices guided through collaborative grant-supported research. Beginning with the publication of the 1971 Marland Report, this study conducted bibliometric keyword research in national and international academic journals in the field of gifted education to determine how perspectives toward creative giftedness evolved during a 50-year timeframe. Analysis of more than 50,000 “creativity” keyword incidences from more than 7000articles in 16 journals reflected the increasingly important role of creativity to identify high potential, qualify students for academic advancement, and support development of their giftedness and talents. During this time frame, creativity evolved from elusive definition toward multivariate complexity with subdisciplines including recent serendipity studies. Frequency of the creativity keyword steadily increased in publications, ranging from brief mention to 100s of incidents in creativity research based articles. Creativity themed issues emerged, and specialized journals emphasizing creativity studies appeared. Although American and European journals consistently published creativity research, newer journals in Australia, Korean, and Turkey expanded research in creative giftedness, attracting international researchers to their editorial boards and writers. Educators and psychologists acknowledge the inadequacy of single score identification measures. Schools and communities value contributions from creatively gifted persons to solve problems, invent solutions, and reimagine the future. Societies pursue creative giftedness integrally expressed through 21st century skills.

# Authentic and Experiential: An Analysis of a Creativity-Focused Language Teacher Training

Libor Stepanek

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Dynamic changes in societies of the last decades have affected the ways we think, learn and teach considerably. The educational sector has become closely connected to research. Relying on theories and research findings from disciplines such as linguistics, psychology or neurology, language teaching has experienced major shifts, such as in the role of teacher from an expert authority to a facilitator and guide, or in the focus of skills, from acquisition of knowledge and hard skills to enhancement of soft skills, with creativity being among the prominent ones.

This presentation offers an interpretation of results of qualitative action research which was carried out on Creative Approach to Language Teaching (CALT) teacher trainings. The paper describes the training structure, which consists of four main elements, namely (1) framing creative theories for language teaching, (2) developing creative materials, (3) fostering creativity in language learners and (4) reflecting teachers´ own creative barriers and skills. It focuses on the last element and addresses strategies that expose teachers to authentic creative experiences. They offer teachers an opportunity to discover and explore creative areas of language teaching that they have perhaps not had the chance to familiarise with or focus on before. This presentation is designed to share effective ways of implementation of creative activities and strategies in teacher trainings with the aim to meaningfully improve a non-creativity-focused subject matter, namely teaching of languages.

# A genetically informed study on Creative Expressiveness in childhood writing

Teemu Toivainen[1], Juan J Madrid-Valero[2], Robert Chapman[3], Andrew McMillan[4], Bonamy R. Oliver[5] & Yulia Kovas[1]

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Twin studies provide information on influences that account for differences between individuals in creativity by estimating proportions of variance due to genetic, shared environmental and nonshared environmental influences. Nine previous twin studies have reported diverse aetiology estimations of creativity, which is partly due to the diversity of the creativity measures and samples. For most measures, the proportion of genetic influences on creativity varied from moderate to substantial (.30 to .77). The remaining variance was mostly explained by nonshared environmental influences (which also includes error variance in the model). The role of shared environment was negligible for most measures. Two multivariate studies showed that the associations of creativity with personality and intelligence were largely explained by shared genetic factors. The present study is the first adequately powered genetically informative analysis of childhood creativity. The study utilized data from 1,306 twins, a subsample from a longitudinal, representative twin sample in the UK. Creativity was operationalised as a *Creative Expressiveness* score, using the Consensual Assessment Technique on stories written by 9-year-olds. The stories were originally designed to assess children's written language. The variance in *Creative Expressiveness* was explained by genetic (35%), shared environmental (20%), and non-shared environmental (45%) influences. The phenotypic correlations with other study variables (Intelligence, writing motivation and academic achievement) were mainly mediated genetically. The results from the genetic analyses are important indications on the role of environments in the development of creativity.

# Mini talks/Posters 3

# Being polymathic about polymaths: A new approach to assesscreative polymathy inspired by diversity measurement inecology

Sven Form

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Recently, Araki et al. wrote creative polymathy has not yet been operationalized, but theyalso defined three criteria for it: breadth, depth and integration. Breadth is the diversity ofknowledge in different domains. Depth concerns expertise within a domain. Integrationrefers to integrating ideas, methods, styles, etc. of distinct domains. If polymathy isconsidered a quantitative rather than a qualitative trait, these criteria can be assessed bydrawing upon the measurement of diversity, which is an established practice in ecology. Inthis field, different diversity indices are available for different purposes. By transferring thispractice across disciplinary boundaries, we can develop indices for polymathy. Theunderlying rationale is to apply the same framework of metrics but “feed” it with numbersof other countable entities. For polymathy, numbers can be taken from individual scores ofany creativity test, which measures different domains. More precisely, the number ofdomains may serve as index for breadth. The number of points within a given domain mayassess expertise for this domain and, thus, depth. Finally, the so-called Simpson index isuseful to describe whether points accumulate in a single domain or are similarly distributedacross domains. Thus, it can serve as a proxy for integration. These polymathy indices werevalidated in a secondary analysis (including necessary condition analysis) by comparingthem to personality traits recently suggested for polymathy. Results indicate the presentapproach enables new insights into creative polymathy, e.g. openness might not be merelyassociated with polymathy, but might be a necessary condition.

*Keywords:* Assessment, Creative Polymathy, Diversity.

# Relationships between artistic creativity, psychopathology and physical illness

Katrina Ginis[1], Dr Sandra Stewart[1], Leonie Kronborg[1]

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Artistic creativity has long been associated with physical and psychological suffering within the collective psyche as well as being the subject of empirical research in the sphere of psychology. Indeed, the stereotype of the anguished 'artistic genius' is ubiquitous and there is evidence to suggest that artists may have heightened susceptibility to psychopathology and experience it at an increased incidence.

The present qualitative study utilize in depth semi-structured interviews, in accordance with the methodology of Interpretive Phenomenological Analysis, to explore the relationship between artistic creativity and physical and mental health amongst 10 eminent Australian female visual artists. It revealed complex reciprocally influential interactions whereby physical and mental health impacted creativity and vice versa. Physical and psychological dysfunction could either serve to diminish or stimulate creativity due to interactions between biological predispositions, personal vulnerabilities and environmental variables as well as degree of severity. It was also revealed that immersive creative engagement could have therapeutic, healing and cathartic effects and facilitate post-traumatic growth. However, the stressors and demands of professional creative practice could also have a significantly detrimental impact upon artists physically and psychologically.

These findings contribute to existing understandings regarding the intricacy of the relationship between creativity, physical and psychological health. They highlight the need to challenge romantic societal mythologies regarding creativity and suffering and explore these issues in a nuanced manner to best assist those in creative industries.

*Keywords:* Artists, Creativity, Psychopathology.

# A movement-based theoretical framework for digital creator wellbeing support

Vlad Kolzeev

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Our understanding of the creative process has been greatly expanded by recent theoretical work. Creativity is now seen as a dynamic (Corazza, 2019), socially-mediated (Glaveanu, 2012), highly movement-dependent (Glaveanu, 2020) and potentially emotionally taxing (Ivcevic and Hoffmann, 2019) activity. Digital tools that support creators are, however, yet to catch up with these theoretical developments.

This work attempts to bridge concepts from modern creativity theory such as "mobility", "affordance" and "dynamic estimation" with the Reinforcement Sensitivity Theory of personality (Corr, 2008). This is done in order to explore the manifestations of activity from the approach and avoidance neurological systems within the creative process. This theoretical position is being developed as the framework for a digital creativity support tool with a focus on the emotional wellbeing of the creator.

Practically, the main argument is that a significant part of the emotional experience within the creative process arises as the result of progress (or lack thereof) and issues associated with the utilisation of affordances of objects. From this perspective, an experience such as creative block would be seen as an approach issue which is dynamically formed by the interaction between the creator and their environment.

An empirical study inspired by the Creative Process Report Diary (Botella et al., 2017) will be conducted with professional digital creators to investigate successful resolution strategies employed during emotionally challenging episodes and stages. Recruiting individuals whose work is fully mediated by the use of a computer enables the data collection system to be directly integrated into the creator's primary workspace. Using a digital tool will also allow for automatic event-contingent prompting, something that has not yet been implemented in CRD research. The interface used for the CRD study will then be expanded into a tool that will provide process-specific support functionality.

*Keywords:* Digital Support, Creative Movement, Reinforcement Sensitivity Theory

# The Interrelationship Between Creativity, SchoolAchievement And Anxiety In High Ability Adolescents

Svetlana Petrova

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The Torrance Tests of Creative Thinking remain one of the most important criteria foridentifying of giftedness and talents in Russian children, but the question on the relations ofverbal and nonverbal creativity to school achievement and personal characteristics areinsufficiently studied, especially with regard to gifted secondary school children. Our studyaimed to investigate the psychological features of the gifted adolescents with the differentlevels of verbal and figural creativity. 200 students of Moscow gymnasium (100 aged10.2-11.7 and 100 aged 15.2-17.1, male and female equally) took part in the study. We used:The Tests of Cognitive Abilities for the gifted students; the Torrance Tests of Verbal andFigural Creative Thinking; the Test of Self-Assessment on the student learning abilities; theQuestionnaire on School Anxiety; Grade Point Average of the major subjects. The dataobtained demonstrate that the relations between verbal and figural creativity are mostlynon-linear, age specific, and especially evident when comparing the students with high andlow levels of these abilities. The different relations of verbal and nonverbal creativity withacademic achievements of the adolescents are revealed. The Torrance Tests of CreativeThinking can provide the teachers with additional information about psychological featuresof the intellectually gifted school children to understand of their strengths and weaknessesand to promote the development of their giftedness.

*Keywords:* Creativity, Giftedness, Schoolchildren.

# A factorial study of variability in creative productions: towards a general factor of "Disruptivness"

Nicolas Pichot

*Centre PsyCLE*

In recent years, there have been many debates about the criteria to be used to define the 'creativity' of a production. The 'standard' definition of creativity puts forward two criteria: novelty (i.e., originality, innovative character) and value (i.e., effectiveness, appropriateness). In other words, according to this definition, the most creative productions would be those that are the most original and the most effective in solving the problem at hand. The supposed importance of the criterion of novelty in the characterization of the creativity of a production is justified by numerous empirical arguments. On the other hand, the value criterion is mostly justified by arguments based on logic. Moreover, there is no consensus on the standard definition of creativity, with some researchers proposing to add or remove criteria. Another way to explore this definitional issue would be to use psychometric arguments. In this presentation, we use a classical psychometric approach in order to address the question of defining creative production on the basis of empirical data. Through an analysis of articles that have used the psychometric approach to determine the supposed criteria of creativity of a production, we designed a 12-item scale to evaluate creative productions. This scale was used by 2 expert judges to score 383 proposed solutions to a creative problem in the design domain (aiming to find ideas/solutions to improve corporate well-being). Confirmatory factor analyses testing different theoretical models revealed that differences between productions, concerning their creativity, followed a hierarchical structure, with one general factor and three facets (i.e., novelty, value, and fit to constraints). Novelty appeared negatively correlated with value and fit to constraints, while the latter two appeared positively correlated (i.e., leading to a g-factor for disruptiveness). In other words, productions were distinguished from each other primarily along an axis ranging from novelty/lack of value/lack of constraint fit at one pole, to common/valuable/constraint fit at the opposite pole. These results can be considered as inconsistent with definitions proposed in the literature. In addition, they reveal a 'disruptive' axis underlying the differences between productions. These results will be discussed with

regard to the various limitations of the study as well as in order to suggest new perspectives concerning the measurement of the creative character of a production and the differences between individuals performing tasks that require creativity.

*Keywords:* Creativity Definition, Creativity Measurement, Factorial Analysis, Psycho metric.

# Investigating the relations between early creativity, confidence, curiosity, and persistence

Lezxandra Saguid[1], Sarah Kiefer[1], Kalie Scirpo[1], Nicole Johnson[1], Sonia Patel[1], Anna Hinosa[1], Natalie Snograss[1], Anne Kupfer[1], Kelsey Lucca[1]

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Creativity aids our ability to be open-minded, innovative and break boundaries. Optimizing creativity early in development will pave the way for more targeted interventions to promote it. However, we lack fundamental knowledge of what creativity is and how it interacts with other cognitive constructs. Here, we test the inter-relatedness of creativity with other constructs to better understand creativity as a psychological phenomenon during childhood.

As creatives are known for flexible and original thinking, we predict that highly creative children will be more likely to explore new environments than exploit known environments. Because exploration requires effort, we predict that highly persistent and confident children will explore more, and in turn be more creative.

Creativity was measured using the Embedded-Figure Drawing task; the Unusual-Instances task; Pretend-Person Drawing task; the Unique-Instances Task. Self-esteem was measured with the Purdue Self-Concept Scale and the Lifespan Self-Esteem Scale. Persistence and exploration were measured in a virtual search game developed by our lab.

Pilot testing (N =8, Mean age = 68 mos) revealed high levels of individual variability across tasks: Embedded-Figure Drawing Task (M = 4.14; SD = 1.95; range = 1-6); Unusual-Instances Task (M = 3; SD = 1.73; range = 1-6); Unique-Instances Task (M = 4.5; SD = 1.20; range = 3-6); Pretend-Person Drawing (M = 3.29; SD = 1.89; range = 1-6). Data collection for all tasks is underway, and full results from **approximately** 45 children will be presented in September.

We are currently collecting pilot data. Once piloting is complete, we will run a regression analysis on the full data set to determine the relations between creativity and related constructs. Specifically, we will predict children's creativity scores using their age and scores from the following experimental tasks: persistence and exploration in a virtual search task, vocabulary size as measured by the Peabody Picture Vocabulary Task, executive functioning as measured by The Dimensional

Change Card Sort (DCCS), and self-esteem as measured by Purdue Self-Esteem Scale and the Lifetime Self-Esteem Scale. Findings from these results will shed light on the ways in which creativity connects with other related constructs in the earliest stages of development.

*Keywords:* Creativity, Persistence, Curiosity.

# The Creative Life: A Daily Diary Study of Creativity and Well-being in the Highly Creative

Kaile Smith[1], Joydeep Bhattacharya[1]

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Participating in creative activities is associated with increased positive emotions and enhanced subjective well-being in general populations. However, these relationships are less understood in the daily lives of highly creative individuals who are actively engaged in both professional creative behaviours and everyday creative experiences. To address this, we recruited a sample of creative adults (N= 291; creative professionals, students studying creative disciplines, and hobbyists engaged in 20+ hours of creative activities per week) to participate in a two-week diary study, rating and cataloguing their creative behaviours, positive and negative emotions, flourishing, flow and feelings of inspiration – all recorded daily. Hierarchical linear regression analyses will examine the creativity–well-being relationship, the moderating roles of personality and creative self-concept, and assess the independent contributions of creativity, flow and inspiration towards daily positive emotions. Preliminary results show the following trends: creative adults are the most creative and most inspired on days with positive emotions, and work-related creativity is less affected by negative emotions than everyday creativity. The positive affect–creativity link appears to be stronger in this cohort of creative individuals as opposed to previously reported relationships observed in wider populations. Participants higher on creative self-concept are more creative overall, and this trait appears to moderate the relationship between negative affect and creativity. Overall, the outcomes of this study will provide novel insights into the link between the specific nature of daily creative activities and the unique contributions of inspiration and flow on subjective well-being in highly creative individuals.

# SESSION 9

## Creativity for Education, Organizations, and more

# Transfer of creative ability across domains through dynamic assessment

Dimitrios Zbainos[1], Charis Sagia[1]

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Cognitive transfer relates to how previous learning influences current and future learning and how past or current learning is applied or adapted to similar or novel situations. Dynamic Assessment (DA) refers to an assessment situation that encompasses mediation such as instruction and feedback within the testing situation, where the focus is mostly on the processes rather than the products of learning. Transfer in DA holds that introducing assessment tasks that follow the same principles as earlier ones but are more difficult, complex, or of a different domain can offer insights into whether learners have internalized previously offered mediation. The present study attempted to investigate whether creative skills mediated through DA in the graphic domain were transferred to the verbal and mathematical domains. The sample consisted of 71 primary school children (11 and 12 years old). All participants were pre-tested with the Evaluation of Creative Potential (EPoC) test in graphic, verbal and mathematical domains. Afterward, they were divided into three groups as follows:

1. Experimental no transfer: Received mediation between the two tests with prompts for creativity development in the graphic domain.
2. Experimental transfer: Received the same mediation plus additional prompts for transfer.
3. Control: Did not receive any mediation (prompts or feedback).

Finally, they were post-tested with an equivalent version of EPoC in the graphic, verbal and mathematical domains.

The results demonstrated that the effect of mediation in the graphic domain was significantly higher on both experimental groups than the control in verbal creativity, while the effect of the same mediation on mathematical creativity was significant only for the experimental transfer group that received transfer prompts.

In conclusion, transfer of creative skills across creativity domains seems to be spontaneous in relatively closely related domains while it needs to be prompted to happen in more distant domains.

*Keywords:* Creativity Tranfer, Dynamic Assessment, Primary Children.

# Understanding creative complexity in screenwriting: developing a transdisciplinary framework

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In recent years, the academic study of the intricacies of the screenwriting process has underlined its potential to enlighten the complexity of the creative experience. Due to the fact that myriad elements and agents that must be aligned to develop an engaging and coherent story for the screen, screenwriting balances, in a unique way, cognitive, conative, emotional, and environmental dimensions of creativity. In this sense, it can foster a nuanced and more complex understanding of the self, the other and the world, significantly shaping one's sense of creative self-efficacy (CSE). Furthermore, it may open a plurality of perspectives that unfold new developmental possibilities and reinforce artistic creativity.

Grounded in an innovative and interdisciplinary meta-cognitive domain-specific framework, neuroscientific, sociocultural and constructivist standpoints were combined in a 4-week intensive creative screenwriting course for a group of students in an Australian university film school. Departing from a multivariate approach to creativity each week was anchored in a different dimension of creativity, specifically: cognition (*e.g.*, divergent thinking), conation (*e.g.* motivation), emotion (*e.g.*, self-regulation) and environment (*e.g.*, social context) which were balanced with script development techniques to increase the students' level of creativity.

Thus, we intend to discuss the preliminary findings of an embedded quasi-experimental study aimed at exploring if this specific approach to the screenwriting creative process can promote CSE and artistic creativity, fostering a structural psychological change that underpins creativity development. One hundred screenwriting students are expected to participate in this study. An experimental group of 25 students will participate in the 4-week framework-based course. Both groups will be pre and post-tested regarding their CSE (resorting to the Karwowski's Short Scale of the Creative Self) and their artistic creativity (using Amabile's Consensual Assessment Technique to assess the creativity of a screen wright).

Besides sharing the primary outcomes of the study, the authors hope to discuss their collaborative research experience, exploring potential implications regarding the development of creative complexity in the first stages of the screenwriting process.

**Keywords:** Screenwriting, Creative Self-Efficacy, Meta-Cognitive Domain-Specific Framework.

# Creative Leadership in times of crises - A Norwegian casestudy in Higher Education

Ingunn Johanne Ness

*University of Berge*

This presentation builds on a qualitative study in Higher Education in Norway on howuniversity leaders were leading in times of crises during the COVID-19 pandemic. At thesame time as any crisis will be experienced as troubling (Beghetto, 2021), there is also alarge creative and innovative potential involved. In this study, we set out to explore howuniversity leaders were leading in the time of crisis, in order to gain a deeper understandingof how to lead in such changing times. We used a sociocultural approach by bringing in thesociocultural situatedness of mediated co-construction on the intermental plane (Wertsch,1991, p. 48) in order to understand how leaders made sense, stimulated action andorganized when the university faced a crisis. The unit of analyses was on the leaders´expressed experiences in interviews. We found that the leaders were leading through acombination of leadership strategies from different leadership theories. We identifiedleadership strategies from traditional education leadership theories as distributedleadership and pedagogical leadership but also strategies from innovation- and changeleadership, digital leadership and ambidextrous leadership. Taken together, we found thatthis particular combined leadership strategy, can be placed under the umbrella of CreativeLeadership which is about enabling and supporting creative thinking in others throughpsychological, material and social support. The aim of the study is to contribute withknowledge on how to lead for innovation in times of crises.

*Keywords:* Creative Leadership, Sociocultural, Innovation.

# Family relationships of eminent women described inpublications of the last 10 years

Marina Porto[1], Manuela Romo[1]

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Family relationships are researched as a factor that influences the development of creativityof eminent people, especially women, who historically have a stigmatized family role. Thisstudy aimed at investigating family characteristics of eminent women described in scientificarticles which were published with biographical approaches in the last 10 years. We havecarried out a search in databases in the areas of Education, Gender, Psychology and SocialSciences. After applying the eligibility criteria, we identified 18 articles. Among the mainresults, we identified reports about the support of a family member in 10 publications (55%), in six of them (33%) it refers specifically to other women (mother, aunt,grandmother). Meanwhile, six other articles (33%) highlighted discouraging by familymembers. In 11 articles (61%) there were references to life as a couple. Partners whoexercised the same profession were mentioned in seven (39%) articles, five of them (28%) pointed out an underestimation of the female result based on the work of their husbands. Ingeneral, biographical texts presented little information about family relationships. Femalechallenges often start early in their microsystem. Some families interpose barriers to theirfull development; however, these challenges strengthen personal characteristics such asresilience, persistence, and independence, which favor creativity

*Keywords:* Creativity, Family, Women.

# Don't demand a bird to swim, join it in the sky!
# Teaching a foreign language to students with dyslexia

Scorolli Claudia[1], Camillini Giorgia[2]

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Italian students with dyslexia face remarkable difficulties in learning English. Conventional school programs typically bring to scarce outcomes. Nowadays scientists and teachers agree on the idea that distinctive personality traits and motivational factors should be exploited as a basic resource for integration. Nonetheless, there is still confusion when it comes to translating theoretical knowledge into practical directions. The attempt of this work is to integrate well-established theories on Language Teaching Accessibility with Embodied Cognition to implement inclusive practices.

The case study refers to a 13-year-old student diagnosed with dyslexia. While traditional interventions focus on the learner's specific challenges, our approach is founded on his creative processes in conjunction with his specific interests and learning context. Thus, the experimental work has been concentrated on the development of a *methodological tool* which is effective in stimulating his internal motivation to use a new language, i.e., English, as a means of exploring a theme that is core to his bodily, affective, and social Self. The learning tool was identified in a Blog, that is a multimedia container allowing for the organization of audio-visual and linguistic materials. Through this approach the novel language should gradually emerge in its potential to extend bodily and contextual boundaries. Although language proficiency was not central to the intervention, the multisensory access to the content, along with the simultaneous use of non-linguistic and linguistic materials, led to a more spontaneous and confident use of English - improving reading and writing skills. The individual work -permanently available and updatable- was shared with the class group to enhance the student's sense-of-agency and self-efficacy.

**Keywords**: Dyslexia, Language Teaching, Embodied Cognition.

# MIC Keynote Speech 7

## Measuring creativity in organizations

Roni Reiter-Palmon

*University of Nebraska*

The last two decades have seen a significant increase in the interest and study of creativity in the workplace. In order to facilitate creativity in organizations, it is important that we understand the factors that contribute to or inhibit creative performance within the context of the workplace. Our research on creativity in organizations relies on accurate and effective measurement of creativity as a criterion. However, measuring creativity, especially in the context of organizations, is not straight forward. Further, the context of the workplace presents unique concerns regarding the measurement of creativity In this presentation, I will discuss various ways in which creativity has been measured in studies evaluating creativity in the workplace, their strengths and weaknesses, and how these approaches may differ from measuring creativity in other context.

# SfNC SYMPOSIUM

## Creativity Neuroscience

# Combining Latent Variable and Machine Learning Methods to Study How Creativity and Intelligence Overlap in the Brain

Roger E. Beaty

*Department of Psychology, Penn State University*

The relationship between intelligence and creativity has been historically controversial, partly due to prior limitations in the measurement and modeling of these cognitive abilities. Recently, however, increasing evidence from latent variable studies is providing a more consistent view on the association between intelligence and creativity, pointing to a considerable overlap between the two. In this talk, I will take a CHC perspective to conceptualizing the roles of lower-order intelligence facets and higher-order g to creative thinking ability. I will also present data from recent work examining how intelligence and creativity may overlap in the brain, focusing on network neuroscience and machine learning approaches to modeling patterns of functional brain connectivity that predict both cognitive abilities. I will conclude with future directions to further understand the mechanisms underlying the intelligence-creativity relationship.

## How neuroscientific research informs models of creative cognition

Mathias Benedek

*University of Graz*

The advent of neuroimaging methods has vastly extended the possibilities to study creativity. Over the last few decades, neuroscience research has generated exciting insights into the creative brain at work and thus contributed to a more complete understanding of human brain functioning. Importantly, relevant work has not just contributed to unveiling the neurophysiological basis of creativity, but it has also served as a powerful, complemental approach to rigorously study relevant processes and mechanisms in creative cognition. In this presentation, I will give a few examples of (partly unexpected) neuroscientific findings that have challenged and advanced how we think about creativity. They include insights in the relevance of episodic versus semantic memory, internal attention, and modality-specific processes in creative thought. Together, these findings highlight how different methodological approaches can mutually inform each other and thereby broadly contribute to our understanding of creative cognition.

# The role of alpha oscillations in creativity

Caroline Di Bernardi Luft

*Queen Mary University of London, London*

Oscillatory brain activity in the alpha frequency band (8-12Hz) is one of the most consistent electrophysiological correlates of creative thinking in the literature. However, there is substantial variability regarding the characteristics of the alpha oscillations observed (e.g. topography, baseline, creative task, correlation with behaviour) and the explanations of the underlying neurophysiological processes involved. In this talk, I will present a series of experiments aimed at unravelling the functional meaning of alpha oscillations on creativity, including EEG and brain stimulation studies. I will discuss whether alpha oscillatory activity may represent different creative processes depending on whether they occur in task-relevant vs. task-irrelevant areas in the brain. I will also present evidence demonstrating how alpha oscillations are crucially dependent on the intention to be creative. I will argue for a neuroimaging approach which breaks down creativity to each of its fundamental constituent processes to develop a more detailed understanding of how we generate new ideas in different creative contexts.

# Neural dynamics during the generation and evaluation of creative and non-creative ideas

Yoed N. Kenett

*Technion – Israel Institute of Technology*

What are the neural dynamics that drive creative thinking? Recent studies have provided much insight into the neural mechanisms of creative thought. Specifically, the interaction between the executive control, default mode, and salience brain networks has been shown to be an important marker of individual differences in creative ability. How different brain regions within these systems might be recruited dynamically during the two key components of the creative process, generation and evaluation of ideas, remains far from being understood. We applied state-of-the-art network neuroscience methodologies to examine the neural dynamics related to generation and evaluation of creative and non-creative ideas in a novel within-subject design. Participants completed two functional magnetic resonance imaging sessions, taking place a week a part. In the first imaging session, participants generated either creative (alternative uses) or non-creative (common characteristics) responses to common objects. In the second imaging session, participants evaluated their own creative and non-creative responses to the same objects. Network neuroscience methods were applied to directly examine and compare neural dynamic reconfiguration, integration, and recruitment during these four conditions. We found that generating creative ideas led to significantly higher neural reconfiguration than generating non-creative ideas, whereas evaluating creative and non-creative ideas led to similar levels of neural integration. Furthermore, we found that these differences were attributed to different neural dynamic patterns of activity across the executive control, default mode, and salience networks. This study is the first to show within-subject differences in the neural dynamics related to generating and evaluating creative and non-creative ideas.

# Machine learning classification of the creative brain.

Darya L. Zabelina

*University of Arkansas*

Prior research has shown that greater EEG alpha power (8–13 Hz) is characteristic of more creative individuals, and more creative task conditions. The present work investigated the potential for machine learning to classify more and less creative brain states. Participants completed an Alternate Uses Task, in which they thought of Normal or Uncommon (more creative) uses for everyday objects (e.g., brick). We hypothesized that alpha power would be greater for Uncommon (vs. Common) uses, and that a machine learning (ML) approach would enable the reliable classification data from the two conditions. Further, we expected that ML would be successful at classifying more (vs. less) creative individuals. As expected, alpha power was significantly greater for the Uncommon than for the Normal condition. Using spectrally weighted common spatial patterns to extract EEG features, and quadratic discriminant analysis, we found that classification accuracy for the two conditions varied widely among individuals, with a mean of 63.9%. For more vs. less creative individuals, 82.3% classification accuracy was attained. These findings indicate the potential for broader adoption of machine learning in creativity research.

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