4 NEURODEVELOPMENT

UK Research and Innovation

2023 Conference

10 November 2023

9.30am - 5pm

Full Programme

(Including Abstracts, Speaker Biographies and Event Details)

Engineering and Physical Sciences Research Council

Medical Research Council

If you can no longer attend inperson, please let us know asap so that the slot can be given to someone else.

Email: r4n@kcl.ac.uk Website: www.respect4neurodevelopment.com

4 NEURODEVELOPMENT

UK Research and Innovation

Programme

9.30	**Registration and Coffee**
10.00	**Welcome and Introduction to Respect 4 Neurodevelopment,** Prof Eva Loth, King's College London

Session 1: Keynote

10.10	**Prof Steve Williams, King's College London** UNITY – **U**ltralow field **N**euroimaging **I**n **T**he **Y**oung
10.50	**Six rapid fire poster presentations** Eleonora Tilkin-Franssens (KULeuven), Lucy Dowdall (Cambridge / Durham Universities), Ross Vanderwert (Cardiff University), Eloise Funnell (King's College London), Maheen Saddiqui (Birkbeck, University of London) Dianna Ilyka (Cambridge University)
11.15	**Coffee Break & Poster Viewing**

Session 2: The 4 Pillars of Respect Neurodevelopment

11.45	**Responsible Neurotechnology**, Prof Eva Loth, King's College London Síofra Heraty, Birkbeck, University of London
11.55	**Reliable Neurotechnology,** Prof Ilias Tachtsidis, University College London
12.05	**Scalable Neurotechnology,** Dr Tomoki Arichi, King's College London
12.15	**Personalised Neurotechnology,** Prof Emily Jones, Birkbeck, University of London
12.25	Discussion (20 mins)

Session 3: Buffet Lunch & Parallel Open Door Surgery

Lunch will be served in multiple locations.

12.45 Optional drop in & join open discussions around the four working groups on Responsible, Reliable, Scalable and Personalisation of neurotechnology.
(in person only -see room plans on the day)

Session 4: Pump-prime feasibility study awards 2023

1.30 **Developing low-cost wearables to track early home environments in neurodivergent children**
Prof Sam Wass, University of the East of London

Comfortable Conformal Coils for Children
Dr Tobias Wood, King's College London

Combining wearable diffuse optical tomography and immersive virtual reality to reliably study neurodevelopmental conditions
Dr Chiara Bulgarelli, Birkbeck

Immersive Virtual Reality for MRI scanning of awake young children with neurodevelopmental conditions
Prof Jo Hajnal, King's College London

Discussion Panel

Session 5: Perspectives across the network

2.20	**Ethical Considerations for Responsible Child-specific Neurotechnologies** Prof Paul Appelbaum, Columbia University
2.35	**Participatory Research perspective** Heta Pukki, European Council of Autistic People
2.50	**Early Career Researcher Network** Dr Rianne Haartsen, Sanjana Gandhi, King's College London
3.05	**Industry perspective** Jorit Dekker, Noldus Information Technology, The Netherlands
3.20	**Coffee & Poster Viewing Time**

Session 6: Scientific Advisory Board Recommendations

4.00	**Feedback on Posters Presentations & Prizes**
4.10	**Recommendations from the Scientific Advisory Board & Participatory Research Committee** SAB: Prof Jan Buitelaar, Prof Bill Fifer, Prof Paul Appelbaum, Prof Sue Leekam, Prof Clare Elwell, Prof Mark Johnson, Matthew Goodwin. PRC: Mary Doherty, Síofra Heraty, Sarah Douglas, Heta Pukki.
5.00	**Closing remarks** Prof Eva Loth
5.10 onwards	**Drinks Reception in the Foyer**

Thank you for coming along to our first annual event.

Keynote Speaker

Prof Steve Williams,

King's College London

UNITY – Ultralow field Neuroimaging In The Young

Abstract

Neuroimaging can provide objective, sensitive and predictive measures of brain health and development but tools such as magnetic resonance (MR) imaging are expensive and require substantial infrastructure and skilled personnel that exclude them from most low and middle-income countries (LMICs). Emerging systems that operate at lower magnetic fields (< 100mT) reduce this infrastructural and administrative burden, but the use of low-field MRI in LMICs and global health interventions remains untested. The UNITY project is a new global partnership between private philanthropy, industry, and academia to advance the state-of-the-art in low-field MRI and its application in global health studies. I will describe the UNITY project, including its goals and methods which will provide a basis for defining, measuring, and addressing poor neurodevelopmental burden and putative treatments. Preliminary results from four continents and regions (North America, Europe, Sub-Saharan Africa, and Southeast Asia) will be presented.

Biography

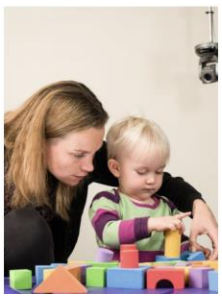
Steve Williams is the founder and Head of Department of Neuroimaging in the School of Neuroscience at the Institute of Psychiatry, Psychology and Neuroscience, King's College London. He graduated with the first ever PhD in Magnetic Resonance Imaging (MRI) from the University of Cambridge and then moved to London to champion the application of imaging in a broad range of neurological and psychiatric disorders. In 2014 he was elected a Fellow to the Academy of Medical Sciences and has spent the past decade focusing on improving access and application of MRI for some of our most challenging patient cohorts and environments. He has longstanding collaborations with the pharmaceutical and health technology sectors and is the PI of a recent Bill & Melinda Gates Foundation grant entitled UNITY – Ultralow field Neuroimaging In The Young.

The Four Pillars of R4N

Professor Eva Loth

Eva Loth is a Professor of Cognitive Neuroscience at, at the Institute of Psychiatry, Psychology and Neuroscience (IoPPN), King's College London (KCL) and the Principal Investigator of RESPECT 4 Neurodevelopment. She is also the Deputy Director of AIMS-2-TRIALS, which is a large-scale European consortium aimed at developing precision healthcare for autism. Her work combines developmental, cognitive and neuroimaging approaches to better understand the relationships between social, emotional, motivational and cognitive processes in 'typical development' and neurodevelopmental conditions. Eva is the lead on the P

Professor Emily Jones



Emily Jones is a Professor at the Centre for Brain and Cognitive Development, Birkbeck, University of London. Her research interests centre on understanding the cognitive and neural mechanisms that drive variability in developmental trajectories. In this context, she runs a number of prospective longitudinal studies of neurodevelopment from infancy and directs electrophysiological and eyetracking acquisition across several large-scale European and Global Health studies of children and adults with neurodevelopmental conditions. Emily is the lead on the Personalised theme working group.

Dr Tomoki Arichi

Tom Arichi is a Clinical Scientist and Clinical Senior Lecturer and Reader in Perinatal Imaging in the School of Biomedical Engineering and Imaging Sciences, King's College London whose research focuses on developing and applying advanced novel neuroimaging methods (particularly MRI and EEG) to understand early human brain development in health and disease. He is also a Consultant in Paediatric Neurodisability at the Evelina London Children's Hospital. Tom is the lead on the Scalability theme working group.

Professor Ilias Tachtsidis

Ilias Tachtsidis is a Professor of Biomedical Engineering at the department of Medical Physics and Biomedical Engineering at University College London. He is a senior member of the Biomedical Optics Research Laboratory and leads the MultiModal Spectroscopy group and the MetaboLight team. His work is cross-disciplinary integrating engineering, physics, neuroscience and clinical medicine; with the research focus to engineer the next generation of optical near-infrared systems to image the brain.

Pump Prime Studies Awarded

Developing low-cost wearables to track early home environments in neurodivergent children

Prof Sam Wass, University of the East of London

Professor Sam Wass is a child psychologist and neuroscientist with specific expertise in understanding how child concentration and stress factors influence early attention and learning in infancy. He runs his own baby development lab https://uelbabydev.com/ and is very active in the public engagement of science. In addition, Sam is active in the public communication of science. He appears as a press spokesperson for public organisations including the Department of Education and Public Health England, and for commercial organisations including Lego, Disney+ and many others. Sam also runs training for practitioners working in Early Years.

Comfortable Conformal Coils for Children

Dr Tobias Wood, King's College London

Tobias Wood is a physicist who has spent his career bouncing around the electromagnetic spectrum. He first worked in the space industry designing microwave telecommunications satellites, then completed a PhD in optical imaging using a broad spectrum laser for cancer diagnosis, before swapping to MRI where he has worked at 7, 9.4 and 3 Tesla. Here he has spent 10 happy years imaging brains with quantitative methods, and more recently silent ZTE imaging.

Combining wearable diffuse optical tomography and immersive virtual reality to reliably study neurodevelopmental conditions

Dr Chiara Bulgarelli, Birkbeck, University of London

Chiara Bulgarelli is a Leverhulme Trust Early Career Research Fellow at the Centre for Brain and Cognitive Development. She is currently using cutting edge technologies, like immersive virtual-reality and wearable functional near-infrared spectroscopy (fNIRS), to investigate the development of empathy in toddlers. In the next future she hopes to validate this set-up for the study of atypical social skills development.

Immersive Virtual Reality for MRI scanning of awake young children with neurodevelopmental conditions

Prof Jo Hajnal, King's College London

Jo Hajnal is a Professor of Imaging Science and has pioneered major developments in the field of medical imaging, in particular the development of novel approaches to Magnetic Resonance (MR) imaging, including the development of fundamental pulse sequences such as FLAIR. He is also a pioneer in the development of medical image analysis techniques such as image registration and image segmentation; his work has won many international awards and is highly cited. His research has led to the formation of IXICO and influenced technologies and products for clinical trials and patient-specific diagnostics, especially for neurodegenerative diseases such as Alzheimer's.

Prof Paul Appelbaum, MD

Columbia University

RESPECT4Neurodevelopment Scientific Advisor

Ethical Considerations for Child-Specific Neurotechnologies

Abstract

This presentation will draw on the results of a recent study of genomic testing in autism to suggest lessons that might apply in general to the use of neurotechnologies in children. The study was a mixed-methods evaluation of the impact on parents of receipt of a genetic diagnosis for their child with autism. This study was conducted in collaboration with SPARK, the largest genetic study of autism to date. We surveyed parents both before and after they were notified of their child's genetic results and conducted interviews with a diverse selection of parents whose children had received a genetic diagnosis. In general, the impact of the genetic results on parents was modest. However, there were discernable effects on parental perceptions of responsibility for their child's condition, optimism about their child's future prospects, and tolerance of their child's behavior. How can these findings be extrapolated to the use of neurotechnologies in childhood more broadly? The data suggest several possibilities. First, variation identified via laboratory testing concretizes a child's limitations for the parents, puncturing what are often states of denial. This can make them more tolerant but also less hopeful. Second, these concretized results, insofar as they have etiologic significance, can reduce parental self-blame and thus may be widely shared with expectation of reducing blame from others. Finally, many of the impacts of data from new technologies may derive from a misunderstanding of their implications, suggesting the importance of exploring with recipients their comprehension of the results and correcting misperceptions.

Biography

Paul Appelbaum is the Elizabeth K. Dollard Professor of Psychiatry, Medicine, and Law, and Director, Center for Law, Ethics, and Psychiatry, Department of Psychiatry, Vagelos College of Physicians and Surgeons, Columbia University. He directs Columbia's Center for Research on Ethical, Legal, & Social Implications of Psychiatric, Neurologic, & Behavioral Genetics. The author of many articles and books on law and ethics in clinical practice and research, much of his recent research has focused on the ethical and psychosocial impact of advances in genetics. Dr. Appelbaum is a Past President of the American Psychiatric Association and the American Academy of Psychiatry and the Law, now chairs the APA's DSM Steering Committee, and is a member (and former chair) of the Standing Committee on Ethics of the World Psychiatric Association. He has been elected to the National Academy of Medicine. Dr. Appelbaum is a graduate of Columbia College, received his M.D. from Harvard Medical School, and completed his psychiatry residency at the Massachusetts Mental Health Center/Harvard Medical School.

Heta Pukki

European Council of Autistic People

Participatory Research autistic-led organisations' perspective

Abstract:

As the feasibility study grantees consider their participatory approaches and their collaboration with end users, it is good to be aware of the long history and existing good practice in such matters. The primary message of the representatives of autistic-led organisations from around the world, expressed last year in an open letter and article, was that it is simply necessary to apply what has been learned before. Trying to re-invent participatory and collaborative practices from the beginning would be wasteful and bound to repeat mistakes that can be easily avoided.

On the basis of personal, lived experience, it can be frustrating to engage with organisations networks and communities of researchers as an individual, with no opportunity to discuss with one's own community and colleagues in the NGO world. This can feel like shutting out the people supposedly being represented through the involvement of the individual. While it is not possible to present the view of any autistic-led organisation, the speaker will present the idea of involving neurodivergent groups and organisations, instead of involving people on the basis of their individual lived experience only. The potential benefits of this approach will be discussed briefly.

Biography

Heta Pukki is autistic and partially sighted, as well as mother, family member or close friend of several autistic and otherwise neurologically different people, some of them disabled and some not. Her background is in biology and special education with a focus on autistic adults. She has been involved in developing peer support, advocacy, networks and organisations for autistic people for the past 25 years, in her home country Finland and internationally, in a variety of volunteer and professional roles involving NGO work, project coordination, training and translation of professional literature. She is currently President of the umbrella organisation European Council of Autistic People, which connects 25 autistic-led groups and organisations in Europe, with the aim of helping them to identify shared goals and advocate for their members.

Jorit Dekker

Industry perspective
Noldus Information Technology BV,
Wageningen, The Netherlands
Jorit.Dekker@Noldus.com

Multimodal approaches to the study of human behavior: integrating eye tracking, facial expression analysis and psychophysiology in one solution

Abstract

The field of human behavior research is evolving. Digital video technology, eye trackers and tools for measurement of facial expression and physiology have become more powerful, widely available and affordable. This has stimulated a move from single-modality studies to multimodal experiments in which different types of measurements are combined. At the same time, we see a shift from single subjects to groups, social networks and collaboration. Behavioral researchers go to great length to organize multimodal experiments, but existing solutions fall short in integration, scalability, and data accessibility. A typical multimodal study includes multiple computers with applications from different vendors, making it a challenge for the researcher to connect all devices properly, synchronize the data streams, and aggregate the data for integrated analysis. Real-time monitoring of the quality of measurements and visualization of multiple data streams, especially when data is collected from multiple subjects at once, is another challenge.

We will present a new integrated multimodal platform, named NoldusHub, that aims to provide a solution for all these challenges. We look forward to presenting the current solution and its growth path for the coming years,and hearing the feedback of the audience.

Biography

Jorit Dekker received his M.Sc. in behavioral biology from Wageningen University, the Netherlands. He has been working for Noldus Information Technology since 2004 as channel manager and trainer of solutions for a variety of research fields. He has extensive experience in setting up software and hardware tools for neuroscience & psychology research and in training users across the world to work with these tools.

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The Birthday Party game: an interactive, online tool to assess memory development in early childhood.

Arezoo Alford, Rachael Elward
Centre for Brain and Cognitive Development, Department of Psychological Sciences, Birkbeck, University of London

Abstract

Background: We present a novel game to assess memory in young children. According to the dual-process model of declarative memory, memory is supported by two processes: Familiarity and recollection. Familiarity (which supports performance on recognition tests) develops in infancy, while recollection (commonly measured with associative memory tests) is thought to have a protracted course of post-natal development. The Birthday Party Game assesses both of these memory abilities and can be utilised remotely. In line with previous findings, we hypothesised that associative memory alone would significantly improve with age.

Method: The Birthday Party Game was designed using the Gorilla Experiment Builder. Participants help four colourful characters to get ready for a birthday party, and in doing so, form 16 character-item associations. Later, children's are asked to 1) recall the associations (associative memory test) and 2) recognise the items from similar lures (recognition test). Fifty-four children aged 3-6 years played the game in their own homes with parental supervision. Parents were asked to indicate if the child was attending to the game.

Results: Associative memory abilities improved with age (β=.31, t=2.17, p=.036) but recognition did not. These results were consistent with the idea that recollection as a protracted course of post-natal development.

Conclusion: Online experiments, delivered remotely, may be a valid alternative to lab-based cognitive assessment of young children's memory development. These experiments could be cheaper, easier to conduct and greatly increase rates of recruitment. The game is being used to assess performance memory in young children with memory difficulties.

Sleep onset problems in infancy associates with later increased sensory sensitivity and Autism Spectrum Disorder symptomatology

Jannath Begum Ali[1], Greg Pasco[2], Tony Charman[2], Mark H. Johnson[1,3] & Emily J.H. Jones[1] and the BASIS-STAARS Team

[1]Centre for Brain and Cognitive Development, Department of Psychological Sciences, Birkbeck, University of London
[2]Psychology Department, Institute of Psychiatry, Psychology and Neuroscience, King's College London
[3]Department of Psychology, University of Cambridge

Abstract

Background: Sleep problems have been implicated in neurodevelopmental disorders, such as Autism Spectrum Disorder (ASD). Previous research found that infants with a family history of ASD, and those that go on to have an ASD diagnosis, demonstrate reduced levels of night sleep with reduced night sleep in infancy (Begum Ali, Gosse et al., 2023). Further, sleep disturbances in ASD cohorts have been associated with increased sensory atypicalities (Holway et al., 2013; De Laet et al., 2022).

Methods: We collected parent-report questionnaires (Infant Behaviour Questionnaire Revised) from a sample of 247 infants; 170 infants with an elevated likelihood of ASD and 77 infants with a typical likelihood of ASD. We assessed sleep using the Infant Sleep Onset Problem score (ISOP) at 4, 6-10 and 12-15 months of age. To examine sensory behaviours, we used the Perceptual Sensitivity subscale (PSS) from the IBQ-R (4-15 months) and the Early Childhood Behaviour Questionnaire (24-months).

Results: Sleep Onset Problems did not vary by ASD likelihood [$F(1,314)=.25$, $p=.62$)] or ASD Outcome at 3 years [$F(1,403)=1.31$, $p=.25$]. To investigate the relationship between sleep and sensory behaviours, we used a cross-lagged structural equation model. Increased Sleep Onset Problems at 12-15 months associated with increased Perceptual Sensitivity at 2 years ($\beta=.14$, $p=.03$) and increased ASD symptomatology (Social Responsiveness Scale scores: $\beta=.2$, $p=.004$) at 3 years; Figure 1.

Conclusions: increased levels of sleep problems in infancy associate with increased sensory sensitivity and ASD symptomatology in toddlerhood. We find no group differences in the sleep measure used.

Parent attitudes towards data sharing in developmental science

Jannath Begum Ali*[1], Rebecca Holman*[1], Amy Goodwin[2], Siofra Heraty[1] & Emily J.H. Jones[1]

*Joint first authors

[1]Centre for Brain and Cognitive Development, Department of Psychological Sciences, Birkbeck, University of London

[2]Department of Forensic and Neurodevelopmental Sciences, Institute of Psychiatry, Psychology and Neuroscience, King's College London

Abstract

Introduction: data sharing in developmental science is receiving increasing recognition and prioritisation, supported by funder and publisher mandates for open data access. Data sharing can accelerate the pace of discovery, link researchers with high quality analytic expertise to researchers with large datasets and democratise the research landscape. However, there are also significant privacy and security concerns, in addition to conceptual and ethical considerations. These are particularly acute for developmental science as infants cannot consent for themselves. It is essential that we adequately represent the views of stakeholder communities in our decision-making processes.

Methods: we conducted a comprehensive survey of the opinions of 195 parents on data sharing in developmental science. Results: parents were generally supportive of curated, but not open, data sharing. In addition to individual privacy and security concerns, more altruistic considerations around the purpose of research were critical. Parents overwhelmingly supported nuanced consenting models in which preferences for particular types of data sharing could be changed over time. This model is different to that implemented for the vast majority of developmental science research and is contrary to many funder or publisher mandates.

Conclusions: the field should look to create shared repositories that implement features such as dynamic consent and mechanisms for curated sharing that allow consideration of the scientific questions addressed. Better communication and outreach is required to build trust in data sharing and advanced analytic methods will be required to understand the impact of selective sharing on reproducibility and representativeness of research datasets.

Metastable microstates still in development in the newborn brain

Juliette Champaud^[1,2], Mohammed Rupawala[1], Neelum Mistry[1], Tomoki Arichi*[2], Lorenzo Fabrizi*[2]

[1] Department of Neuroscience, Physiology & Pharmacology, University College London, UK
Centre for the Developing Brain, School of Biomedical Engineering and Imaging Sciences, King's College London, UK. ^ Presenting author, * Final authors
Correspondence: juliette.champaud.17@ucl.ac.uk

Abstract

Introduction

Evidence suggests that neural activity underlying complex behavioural and cognitive functions involves brain networks transiently activating on a spatial and temporal scale. We can model these metastable brain dynamics using neural microstates: electrical topographies derived from spatio-temporal patterning of electroencephalography (EEG). Around 75% of adult resting brain activity is explained by four microstates whose temporal characteristics are altered in neurodivergent cases such as autism. However, it remains unclear whether the typical spatial and temporal properties of microstates are present at birth, during the brain's rapid development.

Methods

We tested whether neonatal brain activity can also be described by distinct microstates and compared them to those in adults. Microstates were inferred from 150-second 20-channel EEG recordings from 36 neonates (37.14-42.86 postmenstrual weeks), and 46 adults (18-27 years old) using an adapted agglomerative hierarchical clustering algorithm. Microstate spatial and temporal characteristics were then compared across groups.

Results

Both neonates and adults exhibited six similar microstates (spatial correlation r=0.85-0.96) which accounted for 59% and 61% of the EEG signal, respectively. However, microstates in neonates lasted significantly longer (131.6 milliseconds on average) and occurred less frequently (1 occurrence per second on average) compared to adults (27.2 milliseconds and 6 occurrences per second on average).

Conclusion

Our findings indicate the presence of a well-established brain organisation at birth and suggest that neonatal brain networks are capable of transient activation, albeit at a slower pace compared to adults. This difference in timing may impact the flexibility and efficiency of information processing in neonates, as seen impacted in neurodivergent individuals. Microstates are therefore a promising tool for studying neurodevelopmental conditions in the future.

Can a baby sleep through anything? The effect of sensory input and sensory sensitivity on infant nap.

Anna De Laet[1],Morgan Whitworth[1], Hope Fincham[1], Fabiola Ruiz Castro[1], Alpar Lazar[1], Rachael Bedford[2], Teodora Gliga[1]

[1.] University of East Anglia

[2.] University of Bath

Email address: A.De-Laet@uea.ac.uk

Abstract

Introduction

Research shows that infants at elevated likelihood for autism process sensory information differently and that they have difficulties gating sensory stimuli. Many people with autism also indicate that they have sleep difficulties including waking up frequently at night and struggling to fall asleep, starting early in development. One theory describes sleep problems in autism to originate from atypical sensory processing, one of the core symptoms of autism. Indeed, a link between hypersensitivity and sleep problems has been described in previous literature using subjective measures of sleep, both in autism and in typical populations. We conducted a study to firstly look at the effect of sensory stimulation on an infant's nap using objective measures of sleep and secondly to investigate the role of sensory sensitivity.

Methods

EEG recordings of 8-11-month-olds were collected during a nap with auditory stimulation and a control nap without stimulation. So far, data of 29 infants (8 at elevated likelihood for autism) has been collected and analysed, of which 17 completed both visit. Mixed effects models were used to compare baseline and stimulation naps as well as the effect of sensory sensitivity. The latter was measured using the Sensory Profile 2, a parental report.

Results

The results so far show that auditory stimulation significantly decreases nap duration (Est = 11.56, p = .041), but does not significantly impact sleep stage distribution (Est = . 01, p= 0.66) or sleep spindle density Est =-.28, p = .10). Sensory sensitivity does not significantly influence nap duration, nor does it affect nap duration from baseline to stimulation (Sensitivity: Est =. 996, p = .89; SensitivityxCondition: Est = 7.29, p= 0.589).

Title: Developing and Testing Inclusive Wearable Enhancement Technologies

Lucy Dowdall[1,3],Dani Clode[1,2], Lucy Dowdall[1,2], Edmund da Silva[1,2], Klara Selen[1], Dorothy Cowie[3], Giulia Dominijanni[1,4], Tamar R. Makin[1,2]

[1] MRC Cognition and Brain Sciences Unit, University of Cambridge, Cambridge, UK
[2] Institute of Cognitive Neuroscience, University College London, London, UK
[3]Department of Psychology, Durham University, Durham, UK
[4]Bertarelli Foundation Chair in Translational Neural Engineering, Neuro-X Institute, Ecole Polytechnique Fédérale de Lausanne, Lausanne, Switzerland
Email: lucy.dowdall@mrc-cbu.cam.ac.uk

Abstract

Augmentation technology is a rapidly expanding field, and it is crucial developments are supported by thorough design testing to ensure diversity and inclusion are taken into consideration.

We conducted large-scale testing to validate the use of the Third Thumb (Dani Clode Design), a supernumerary robotic finger, worn on the hand and controlled by the feet. We successfully collected first-exposure data from 596 participants (aged 3-97) who carried out one of two tasks aimed at different motor skills (individuation or collaboration) with the Third Thumb.

Overall, 98% of participants were able to carry out a motor task with the Third Thumb within the first minute of usage, demonstrating how robotic augmentation can be used by a diverse range of users. Furthermore, we found gender, having a hobby, and even handedness did not impact Third Thumb performance. However, one variable that did affect performance was age. Younger children (aged £ 11 years) generally performed poorer than older children (12-16 years). Therefore, it appears motor performance with an augmentation device follows the developmental trajectory of motor control. Interestingly, even older children struggled more than young adults (aged 17-33 years). As motor control is already well established in older children, this could be attributed to attention or other cognitive factors.

We now plan to expand to more thorough testing of the Third Thumb in children, and particularly those with upper limb differences. This will allow more careful consideration of how we can adapt our technologies to be accessible to people of all bodies.

Involving young children and families to shape the future of a virtual reality MRI world

Molly Eddison[1], Jessica Cader[2], Tomoki Arichi[2], Kun Qian[2], Jo Hajnal[2]

[1]Centre for the Developing Brain, School of Biomedical Engineering and Imaging Sciences, *King's College London.* [2]*King's College London.*
molly.o.eddison@kcl.ac.uk

Jessica Cader *King's College London,* Tomoki Arichi, *King's College London*, Kun Qian *King's College London*, Jo Hajnal *King's College London.*

Abstract

Introduction: Magnetic resonance imaging (MRI) can non-invasively provide detailed images of the human brain and body, but typically requires subjects to remain still during scanning. Children pose a particular challenge as they struggle to stay still or may get anxious, and thus anaesthesia is often used for clinical purposes. We have developed a novel MRI-compatible virtual-reality (VR) system to enhance the scanning experience and reduce anxiety.

Aims: We conducted 3 Public Patient Involvement (PPI) workshops to identify VR content priorities for children under 5 and understand barriers to technology engagement.

Methods: Six children aged 3-4 participated in 2-hour PPI workshops. Sessions included 30 minutes of free play with the VR headset followed by guided parent discussion. Active feedback was gathered via parental forms and researcher reflections.

Results: Children had varying engagement times with the VR system (5-30 minutes). Success depended on inclusion of familiar characters and preparation with a social story. Challenges included lying supine and a lack of positive audio reinforcement. Parents stressed the need to feel included during their child's use of the device to reduce anxiety and highlighted that the varied children's temperaments may require different approaches.

Conclusions: The workshops underscored the importance of tailoring VR content, developing a *'lying down'* protocol and a research passport which will help to provide tailored support. Future work will focus specifically on supporting neurodiverse individuals who often find the MR environment difficult to tolerate. These tools will enhance researchers' understanding of children's preferences to optimise system design and guide use.

Smart technology ecological momentary assessment in populations at risk of cognitive differences: A systematic review and meta-analysis of completion rates.

Kate Fifield[a], Kanyakorn Veerakanjana[b], Dr John Hodsoll[c], Dr Jonna Kuntsi[b], Dr Charlotte Tye[a], Dr Sara Simblett[a]

[a] Department of Psychology, Institute of Psychiatry, Psychology & Neuroscience (IoPPN), King's College London,
[b] Social Genetic and Developmental, IoPPN , King's College London,
[c] Department of Biostatistics and Health Informatics, IoPPN, King's College London,

Kate.fifield@kcl.ac.uk

Abstract

Background: Smart Ecological Momentary Assessment (EMA) is used to gather self-report 'in the moment' experiences, thoughts, and behaviours using smartphones. This novel assessment may help overcome difficulties individuals with cognitive differences face with self-reporting their feelings and subjective experiences in retrospect. Aim: To quantify and analyse moderators of smart EMA completion rates in populations at risk of cognitive differences.

Methods: A meta-analysis was conducted on smart EMA studies in populations with neurological, neurodevelopmental and neurogenetic conditions. Completion rates and potential moderator characteristics were analysed using meta-regression, dividing the cohort into those with confirmed Cognitive Impairment (CI) and/or Intellectual Disability (ID), and those at risk but without neuropsychological evidence of impairment.

Results: Burden, total number of assessments, number of assessments per day, incentives and the use of other devices were significant moderators in the full cohort. Amount of training was a significant moderator in the confirmed CI/ID group ($Q[1] = 4.3$, $p = .039$). There were no differences in completion rates ($Q[1] = 2.5$, $p = .115$) or dropout rates ($U = 186$, $p = .097$) between the two groups. There were significant methodological issues in the reporting of completion rates and associations with completion and dropout rates.

Conclusion: Smart EMA is feasible in populations with cognitive differences and with the right support, individuals with CI/ID should not be excluded from smart EMA studies. Future research should focus on the feasibility within populations with cognitive differences to ensure that smart EMA becomes a more inclusive and effective tool.

Enhancing Knowledge Co-production Between Neurodivergent Young People and Academic Researchers to Enrich Experimental Neuroscience.

Eloise Funnell[1], Maciej Matejko[2], Dorian Poulton[2], Luke Harvey-Nguyen[2], Tiegan Boyens[2], Isabel Jackson[2], Georgia Pavlopoulou[3,4], Steve Lukito[1] and the RE-STAR Participatory Research Team*

[1]Department of Child and Adolescent Psychiatry; Institute of Psychiatry, Psychology and Neuroscience; King's College London, [2]Independent Researcher (RE-STAR Youth Researcher Panel [Y-RP] members), [3]Group for Research in Relationships in Neurodiversity (GRRAND), Clinical, Educational & Health Psychology, Division of Psychology & Language Sciences, Faculty of Brain Sciences, University College London, UK. [4]Anna Freud National Centre for Children and Families, London, UK.
*The RE-STAR Participatory Research Team is: Maciej Matejko, Dorian Poulton, Luke Harvey-Nguyen, Tiegan Boyens, Isabel Jackson (independent youth researchers), Edmund Sonuga-Barke, Susie Chandler, Eloise Funnell and Steve Lukito (King's College London); Georgia Pavlopoulou (Anna Freud Centre and UCL), Sylvan Baker & Lauren Low (Royal Central School of Speech and Drama).

Abstract

Introduction:

Basic experimental science traditionally lacks a participatory research element. Within the RE-STAR (Regulating Emotion – Strengthening Adolescence Resilience) research programme, we establish new ground by conducting participatory research using a basic experimental methodology. We explore how environment influences both the research experience of neurodivergent young people and quality of collected electroencephalography (EEG) data. We describe our progress in the first phase of the project, which aimed to produce an ethically approved research protocol for the study.

Methods:

Weekly sessions were carried out with two academic researchers and five members of RE-STAR youth researcher panel (Y-RP) (collectively known as the Participatory Research Team) to plan an EEG experimental study. Reflective journaling and live reflective sessions were organised to support and evaluate the impact of our work. Themes were harvested qualitatively from these reflections.

Results:

Between 1st May to 31st August 2023, we completed two workshops on quantitative research and seven sessions on designing an EEG experiment. We received provisional ethics approval for the study protocol on 21st September 2023. Reflective sessions and journalling produced themes of the value of participatory research for generating new knowledge and research direction, challenges associated with the different base knowledge between co-researchers, the enjoyment that our co-researchers gained in the process, and the power dynamics between academic and Y-RP researchers.

Conclusion:

Co-production research has enriched the development of our basic neuroscience study. Y-RP members will be involved more fully as co-researchers through their participation in the data collection, analysis, and dissemination phase of the study.

The Role of Alexithymia in Explaining the Relationship between Autistic Traits and Cardiac Autonomic Activity during Social Cognition.

Sanjana Gandhi[1], James Findon[1], Bethany F. Oakley[1], Martina Carboni[2]

[1]King's College London, [2]Martina Carboni, South London and Maudsley Hospital
Sanjana.1.gandhi@kcl.ac.uk

Abstract:

Alexithymia, prevalent in autistic adults, is characterized by difficulty recognizing and expressing emotions. This trait, known as the "alexithymia hypothesis," may explain variances in emotional challenges in autism spectrum disorder (ASD). Respiratory sinus arrhythmia (RSA), reflecting autonomic adaptability impacting emotional processing, has shown inconsistent results in ASD, potentially due to co-occurring alexithymia. Previous studies have examined RSA at rest, without assessing reaction to emotional stimuli. This is important because differences may only emerge during condition-relevant stimuli.

Objectives: Examining the mediating role of alexithymia in the relationship between autistic traits and cardiac autonomic activity at rest and in response to emotional stimuli.

Methods: Participants from a general population (N = 42; 12 males, 30 females, M = 25.54(5.99)) were measured on Autistic traits using the AQ and alexithymia using the TAS20. Physiological data (ECG and respiratory effort) were collected using a Biopac system at rest (5 minutes) and during the RMET. RSA reactivity was computed as RMET RSA values minus baseline RSA.

Results: Autistic traits were significantly positively associated with alexithymia ($r(42) = 0.558$; $p<0.001$), RSA baseline ($r(42) = 0.333$; $p = 0.032$) and reactivity ($r(42) = -0.462$; $p <0.001$). Crucially, alexithymia fully mediated the relationship between autistic traits and RSA reactivity ($B = -0.015$, $p = 0.076$) but not baseline RSA ($B = 0.018$, $p = 0.162$).

Conclusions: These findings extend the alexithymia hypothesis to cardiac autonomic reactivity to emotional stimuli. Future work exploring this should control for the mediating effects of alexithymia. Targeting alexithymia may enhance autonomic reactivity, improving emotion processing in autism.

Exploring VR as an assistive tool to develop daily living skills and help alleviate stress in children and young people with Autism

Annelies Gibson, Daniel J. Finnegan
Cardiff University

Gibsona3@cardiff.ac.uk

Abstract

Daily living skills (DLS) are the routines that every person undertakes regularly e.g., self-care, mealtimes, shopping, education and routine appointments, however, these are often difficult for children and young people with autism as their brains function and process information differently than a neurotypical person. DLS are essential for people to live independently, to increase their self-esteem and to improve their quality of life. Among these skills, there are instances where a change in an established routine can occur, or an unfamiliar situation can arise. For example, within education the main teacher may be off sick unexpectedly and a supply teacher could be taking the class instead or the supermarket they usually go to has decided to change the layout of the aisles and add seasonal decorations. For the autistic individual, this can lead to an increase in anxiety and potential sensory overload resulting in meltdowns -- the fear of the unknown can be particularly distressing. In recent years, studies have shown that the use of Virtual Reality can help to relieve symptoms of stress and anxiety, particularly when repeatedly exposed to the environment that triggers these fears and anxieties.

By exposing them to controlled environments in a virtual world repeatedly over time that are safe, this project aims to develop technological interventions that can help to alleviate some of this stress and prepare them for when they face these situations in the real world.

Sleep EEG slow waves and fNIRS functional connectivity in napping infants

L.K. Gossé*[a], P. Pinti[a], F. Wiesemann[b], C.E. Elwell[c] and E.J.H. Jones[a]

[a]*Birkbeck, University of London, Department of Psychological Sciences, London, UK*
[b]*Procter & Gamble, Research & Development, Schwalbach am Taunus, Germany*
[c]*UCL, Department of Medical Physics and Biomedical Engineering, London, UK*

*l.gosse@bbk.ac.uk

Introduction: A key role for sleep is to facilitate memory formation. The sleeping brain achieves this via so-called slow waves (high amplitude oscillations <4.5Hz) that travel across the brain during NREM sleep that are measured using electroencephalography (EEG). Slow waves appear to also foster functional connectivity (FC) in adults (Aedo-Jury,2020). FC predicts later cognitive development in infants (Cao&Huang,2017). Here we investigate how EEG sleep slow waves co-modulate with fNIRS-measured functional connectivity as measured by NIRS-EEG.

Methods: N=34 5-to-9-months-old infants participated in the sleep study at Birkbeck Babylab, London, UK. A wearable NIRS-EEG headgear (20-channel EEG (Enobio,ES)/44-channel NIRS (Artinis,NL)) was used. Data quality checks/preprocessing/analyses were performed using Matlab 2022b. fNIRS data was segmented into 120s epochs and channel-by-channel correlational analyses were performed to obtain epoch-by-epoch connectivity matrices. Average power in slow wave (0.5-4Hz)/sleep spindle (11-16Hz) bands was extracted. EEG characteristics for every epoch were then linked to fNIRS FC.

Results: Preliminary results of individual participants show differences in connectivity depending on nap length and length of slow wave periods. Further analyses will include group-wise analyses of common connectivity patterns and their association with slow waves.

Conclusion: Results show preliminary evidence that studying slow waves in association with FC during a nap could provide information on how sleep impacts development. Slow waves could indeed modulate functional connectivity showing a cascading impact on development. In the long run this study has implications for sleep interventions as e.g., slow waves can be modulated by auditory stimulation.

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Longitudinal association of habitual sleep fragmentation and awake theta power in infants at elevated likelihood for ASD/ADHD

Louisa K. Gossé*[a], Eleanor K. Braithwaite[a], Jannath Begum Ali[a], Greg Pasco[b], Tony Charman[b], Mark H. Johnson[a,c], Emily J.H. Jones[a] and the STAARS Team[f]

a Centre for Brain and Cognitive Development, Department of Psychological Sciences, Birkbeck, University of London
b Psychology Department, Institute of Psychiatry, Psychology & Neuroscience, King's College London
c Department of Psychology, University of Cambridge
*l.gosse@bbk.ac.uk

Abstract

Introduction: Lower frequency theta band oscillations have been proposed as a potential unifying marker for general information processing in development but is also relevant in the context of sleep in that higher sleep propensity (i.e., sleep pressure) is associated with increased theta power. In infants with typical likelihood of ASD/ADHD sleep fragmentation predicted awake theta power. Waking theta power may constitute a proxy measure of sleep propensity with higher sleep propensity affecting an infant's ability to learn and process information during the day. Research has shown that sleep could be a target for ameliorating symptoms of neurodevelopmental disorders.

Methods: Using structural equation models we examined how parent-reported sleep fragmentation is related to ADHD/ASD outcome scores and theta modulation as marker of development across the first three years of life (age points tested: 5, 10, 14, 24 and 36 months) in a cohort of N=166 infants at elevated and typical likelihood of ADHD and/or ASD.

Results: Infants with elevated likelihood of ASD showed less night sleep compared to the other groups [F(1,133)=10.08, p=.002, hp2=.07]. ASD elevated likelihood predicted night waking sleep slope (b=.328, p=.039) but not frontal theta power slope.

Conclusion: The preliminary results indicate that lower parent-reported night sleep could be a target for further understanding sleep in ASD and that perhaps sleep fragmentation impacts ASD symptomatology directly rather than via its impact on theta band oscillations. SEM modelling of the longitudinal data can help disentangle effects of stability and change within the association of sleep and early brain development.

Time travel in the classroom: exploring the potential of VR as a pedagogical tool in History lessons

Emerald Grimshaw[1], Anna Matejko[1], Robert Kentridge[1] & Dorothy Cowie[1]

[1]Durham University
Email: emerald.grimshaw@durham.ac.uk

Abstract:

Previous research has found that teaching in an immersive VR environment can produce beneficial learning outcomes[1] and positive shifts in attitude towards the topic of the VR experience[2 3]. My research explores how the unique technological features of VR, such as its multisensory capabilities, make it useful as a pedagogical tool. This study explores how the inclusion of a dynamic soundscape in a virtual educational experience influences learning outcomes and engagement. Participants (N = 49, 7- to 9-year-olds) had a 10-minute immersive virtual experience on the Silk Road, set 2,000 years ago, in which they interacted with the world by clicking objects with a hand-held controller. They were randomly assigned to a sound or no sound condition. Learning was measured with an MCQ quiz; engagement with an adapted Museum Experience Scale[4]; presence using the SUS presence scale[5]; and embodiment with an established child-friendly questionnaire[6]. There was no significant difference between the quiz scores for the sound (M = 9.04) and no sound (M = 8.52) conditions, $t(47) = .830$, $p = .205$, but the difference between the presence scores in the sound (M = 4.39) and no sound (M = 3.81) condition was approaching significance, $t(47) = 1.584$, $p = .060$. Engagement scores in both groups were high (M = 4.9 / 6) and were significantly positively correlated with embodiment ($r = 0.637$, $p < .001$) and presence ($r = 0.539$, $p < .001$). These preliminary analyses suggest a benefit of embodiment, but not soundscapes, for virtual learning experiences.

Different brain styles: Increased alpha-band EEG connectivity in autistic group compared to non-autistic group

Rianne Haartsen[f], Luke Mason [a,c], Pilar Garces [b], Philip Bomatter [b], Joerg Hipp [b], Tony Charman [c,d], Jan K. Buitelaar [e], Eva Loth [a], Mark H. Johnson [f,g], Declan Murphy [a], Emily J.H. Jones [g], & the EU-AIMS LEAP team [a]

[a] Department of Forensic and Neurodevelopmental Science, King's College London, United Kingdom; [b] Roche Pharma Research and Early Development, Roche Innovation Center Basel, F. Hoffmann-La Roche Ltd, Basel, Switzerland; [c] Department of Psychology, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, United Kingdom; [d] South London and Maudsley NHS Foundation Trust, Bethlem Royal Hospital, Kent, United Kingdom; [e] Radboud University Medical Centre, Donders Institute for Brain, Cognition and Behaviour, Department of Cognitive Neuroscience, Nijmegen, the Netherlands; [f] Centre for Brain and Cognitive Development, Birkbeck College, University of London, United Kingdom; [g] Department of Psychology, University of Cambridge, Cambridge, United Kingdom
r.haartsen@bbk

Abstract

Understanding variability in developmental trajectories of brain development and responses has the potential to help develop precision support for children with neurodevelopmental conditions and their families. Findings from infant studies suggest neural responses such as electroencephalography (EEG) power and connectivity while watching dynamic videos are associated with later outcomes: Increased fronto-central alpha connectivity during infancy was related to later restricted and repetitive behaviours during toddlerhood. Theta power and connectivity are increased during videos with singing women (social) compared to spinning toys (non-social) in infants with and without a family history of autism. Infant theta power variability has further been associated with later communication skills during toddlerhood. These findings suggest specific neural measures may be related to different phenotypic profiles of autism during early development. The current study aimed to examine whether associations between theta/alpha oscillations and different phenotypic profiles also exist between childhood and adulthood or whether these associations change with developmental levels.

In the EEG task, participants viewed dynamic videos of women singing nursery rhymes (social) and spinning toys (non-social). Each video was 60sec long and they were presented 3 times in total. EEG was recorded with 59-channels. EEG data for the social and non-social dynamic videos of 539 participants have been preprocessed with the in-house BOND automated pipeline. Findings of the planned analyses will be presented at the meeting.

Bridge-building between AIMS-2-TRIALS researchers and A-Reps: a pilot paper writing exercise

Síofra Heraty

(Department of Psychological Sciences, Birkbeck, University of London)
s.heraty@bbk.ac.uk

(co)authors: Alexandra Lautarescu1, David Belton2, Alison Boyle2, Pietro Cirrincione2, Mary Doherty2,3, Sarah Douglas2, Jan Roderik Derk Plas2, Katrien Van Den Bosch2, Pierre Violland2, Jerneja Tercon[2,4], Amber Ruigrok5,6, Declan G.M. Murphy7,8,9, Thomas Bourgeron10, Christopher Chatham11, Eva Loth7, Bethany Oakley7, Grainne M. McAlonan7,8,9, Tony Charman1, Nicolaas Puts7,9,, Louise Gallagher12,13, Emily J.H. Jones14

[1]Department of Psychology, Institute of Psychiatry, Psychology, and Neuroscience (IoPPN), King's College London (KCL), [2]AIMS-2-Trials A-Reps, University of Cambridge, [3]Department of Neuroscience, Brighton & Sussex Medical School, Brighton, [4]Department of Developmental Pediatrics and Early Intervention, Community Health Centre Domzale, Slovenia, [5]Division of Psychology and Mental Health, School of Health Sciences, Faculty of Biology, Medicine and Health, University of Manchester, [6]Autism Research Centre, Department of Psychiatry, University of Cambridge, [7]Department of Forensic and Neurodevelopmental Sciences, (IoPPN), KCL, [8]South London and Maudsley NHS Foundation Trust (SLaM), [9]Sackler Institute for Translational Neurodevelopment, (IoPPN), KCL, [10]Human Genetics and Cognitive Functions, Institut Pasteur, Université Paris Cité, Paris, France, [11]F. Hoffmann-La Roche Ltd., Switzerland, [12]Department of Psychiatry, School of Medicine, Trinity College Dublin, [13]Child and Youth Mental Health Collaborative, Hospital for Sick Children, Centre for Addiction and Mental Health, Department of Psychiatry, University of Toronto, [14]Centre for Brain and Cognitive Development, Birkbeck, University of London.

Abstract

Increasing tension between some autistic people and the biomedical research community is an ethical issue, and foreshadows a paradigm shift in the field. As a group of autistic and non-autistic researchers and A-Reps, we decided the time was right to collaborate on a paper describing our hopes for future biomedical autism research, and how to achieve them.

Methods

We used different methods to gather opinions on key issues for researchers and A-Reps. We used Delphi principles to gather researcher opinions. A-Reps contributed to the writing process in accordance with their needs and preferences. The perspectives gathered from each group were synthesised iteratively. To ensure our message reached the intended audience, we focussed on writing this piece for submission to a biomedical research journal.

Results

We reflect on the experience of writing collaboratively as a mixed-neurotype group, and also outline the key messages from the resulting paper. Our paper proposes a neurodiversity-affirmative biomedical research culture, incorporating autistic perspectives on autism and the use of participatory research principles. We also identified some barriers in current research culture to working more collaboratively with the autistic community. Our Commentary was published in Cell.

Conclusion

We successfully brought together a variety of diverse perspectives, which required in-depth discussion and compromise. We hope that this piece can serve as an example of how biomedical autism researchers can work ethically and collaboratively with the lived experience community, a topic highly relevant for neurotechnology research.

Farm2: an assessment of cognitive and motor skills for children and young adults with neurodevelopmental differences

Charlotte (Carly) Hood, Dr Kate Baker

(Medical Research Council Cognition and Brain Sciences Unit, University of Cambridge)

Email address of presenting author: carly.hood@mrc-cbu.cam.ac.uk

Abstract

Introduction Traditional neuropsychological assessments have strict administration procedures that are challenging for individuals with Neurodevelopmental Disorders. FarmApp, a tablet-based, gamified assessment of cognition was designed to address such challenges. The original version assessed stimulus response accuracy and speed, short-term memory and long-term memory based on three tasks that adapt to individual performance. Though FarmApp is a valid and useful tool (Brkic et al, Child Neuropsychology 2022), several limitations were identified. Here we present the updated version, Farm2.

Method An iterative design approach was utilised. The design process was informed by researchers who collected its feasibility and validity data. The software of the second version was developed in partnership with Ounce Technology.

Results Farm2 maintains the original three cognitive tasks and adaptive structure. We have added a new fine motor task. Animated demonstrations for every task and a central narrative were added to increase user engagement. The app has adjustable parameters including task inclusion, task order, grid-size and feedback style. Additionally, it has the capability to include a life-style data questionnaire. It is compatible across both iOS and Android devices and has security features that permit use by external research groups.

Conclusion Farm2 has been updated to address limitations of the original version. This includes a new fine motor task to better isolate cognitive processes and the capability to include a questionnaire. With the addition of these features, it is possible that links between genes, environment, cognition, and behaviour can be evaluated. Farm2 will be made openly accessible in early 2024.

Taking neuroimaging into the home: Brain and behaviour associations in neonates

Ilyka, D[a], Blanco, B.[a], Carnevali, L.[b], Rozhko, M. [a], Weiss, S.M. [a], Clackson, K.[a], Greenhalgh, I.[a], Johnson, M.H. [a] and Lloyd-Fox, S.[a]

[a] *Department of Psychology, University of Cambridge, Cambridge, UK,*
[b] *Department of Developmental Psychology and Socialization, University of Padova, Padova, Italy*
Corresponding author: di257@cam.ac.uk

Abstract

Introduction: The Perinatal Imaging Project in partnership with families (PIPKIN) study investigates the impact of family context on infants' cognitive and brain development longitudinally. In this study, we explored the feasibility of employing High-Density Diffuse Optical Tomography (HD-DOT) in a home setting to measure cortical responses to social and non-social auditory stimuli in neonates within the first month of life. Furthermore, we examined how these responses relate to neonates' behavioural measure of alertness, defined as their ability to stay awake and respond to stimuli.

Methods: We used an HD-DOT system (LUMO, Gowerlabs), consisting of 12 tiles covering bilateral frontal and temporal regions, to measure neonates' cortical responses to social auditory (vocal) sounds, including laughter and crying, as well as non-social auditory (non-vocal) sounds like a rattle or running water, interspersed with periods of silence as a baseline. During data collection, all neonates remained in their natural sleep state within the comfort of their homes supported by the experimenter. In this study, we present the initial results obtained during the first wave of data collection from 19 neonates with an average age of 5.84 days, 20 neonates with an average age of 14.05 days, and 19 infants with an average age of 33.11 days. Additionally, we assessed the neonates' "alertness" using the Neonatal Behavioral Assessment Scale (NBAS) during the same session.

Results and Discussion: Preliminary findings demonstrated that HD-DOT is feasible for high-quality data collection in a home setting, with the potential for studying neonates' cortical responses to auditory stimuli. The descriptive two-dimensional channel maps suggested developmental changes in how infants process social and non-social auditory stimuli within the first month of life. Furthermore, these responses appeared to be linked to the infants' alertness measure during the same session, providing preliminary support for the presence of early-life brain-behaviour associations.

A translational approach to cortical mechanisms of novelty detection in the developing brain

Amy Lawson, Samuel Cooke, Emily Jones
King's College London / Birkbeck, University of London
Amy.lawson@kcl.ac.uk

Abstract

Electroencephalogram (EEG) is an affordable and non-invasive measure of cortical activity in human subjects, including infants, which is frequently used to measure neural differences arising in neurodevelopmental disorders. While several EEG phenomena have been used as key measures to assess differences in cortical function for purposes of diagnoses, stratification, or assessment of response to treatments in psychiatry and neurology, there is rarely an understanding of the underlying cortical processes that give rise to each aspect of the EEG signal. Novelty detection can be observed through familiar / novel paradigms, as well as phenomenology such as mismatch negativity (MMN), which is expressed as an increase in the magnitude of cortical event-related potentials (ERPs) occurring in response to an unexpected or 'oddball' stimulus embedded in a sequence of familiar, expected stimuli with otherwise equivalent features. Habituation and MMN are often found to be dysregulated in neurodevelopmental disorders such as autism spectrum disorder and schizophrenia.

Here we present work using pre-clinical electrophysiology combined with genetic tools to assess the role of two major types of neocortical inhibitory neuron in visual MMN and other accompanying EEG measures. Specifically, we have used optogenetics and chemo-genetics to inactivate or activate parvalbumin-expressing (PV+) neurons or somatostatin-expressing (SOM+) neurons within primary visual cortex (V1) during orientation-specific, visual MMN, providing insight into the specific inhibitory circuit components that are critical for MMN. We also present plans of future work to translate these findings using EEG data collecting from typically developing infants, and infants with neurodevelopmental disorders.

Neural Underpinnings of Preschoolers' Collaborative Interactions

V. L. Mousley[a], C. Soderberg[a], D. Mareschal[a], & P. Pinti[a]

[a] *Centre for Brain and Cognitive Development, Birkbeck, University of London, UK*

Corresponding author e-mail address: v.mousley@bbk.ac.uk

Abstract

Introduction: Social interactions are crucial for children's early learning but are also methodologically difficult to study. Artefacts from movement and physiology can compromise data quality, and best practices for using wearable technologies with children are generally lacking. We use wearable functional near-infrared spectroscopy (fNIRS) to measure the alignment of neural activity between preschoolers and their mothers during naturalistic collaborative problem-solving.

Methods: Data was collected from *N*=59 dyads of mothers and their four- to six-year-old children at the Birkbeck ToddlerLab. Mothers and children arranged Tangram puzzles into templates (e.g., house, cat) in cooperative and individual conditions [1]. Both wore a Brite MKII system (Artinis Medical Systems BV) and a head-mounted Pupil Core eye-tracker (Pupil Labs GmbH, Berlin, Germany).

Data Pre-Processing & Analysis: Data was pre-processed with Homer2 [2, 3]. Raw intensity signals were visually inspected to identify channels for exclusion (e.g., low signal-to-noise ratio) and converted into changes in optical density. Motion artefacts were wavelet corrected, and a band-pass filter was applied [1]. Signals from short-separation channels were regressed out from the long-separation channels to minimise the impact of physiological fluctuations on estimation of brain activity. Neural synchrony was calculated with wavelet transform coherence between each channel and averaged across conditions [5] (Fig 1).

Results & Conclusions: Initial results suggest stronger synchrony during collaborative compared to individual problem-solving. Physiological noise was more prominent in oxyhaemoglobin than deoxyhaemoglobin. Further, we found typically developing preschoolers tolerated the wearable devices well. Future research may consider adapting these methods for use with atypically developing populations.

Acknowledgements & References: This research is funded by the Leverhulme Trust. [1] Nguyen et al. (2020), *Cortex.* [2] Huppert et al. (2009), *Applied Optics*. [3] Pinti et al. (2019), *Frontiers in Human Neuroscience.* [4] Scholkmann & Wolf (2013), *Journal of Biomedical Optics*. [5] Hirsch et al. (2017), *NeuroImage*.

Beyond the visual supremacy: Multimodal Joint Attention Skills in children with Multisensory Impairments (MSI)

Núñez, M.[1*], Guevara, I.[1] Sarriá, E.[2]

[1] Faculty of Psychology, Universidad Autónoma de Madrid (UAM), Spain.
*maria.nunnezb@uam.es
[2] Faculty of Psychology, Universidad Nacional de Educación a Distancia (UNED), Spain

Abstract

Introduction

Skills in Joint Attention (JA) are traditionally defined through visual behaviours (e.g., gaze-following, gaze-shifting) as expressed in distal interactions. This challenges both the study and our understanding of JA in children with Multisensory Impairments (MSI) whose distal senses are affected from birth. We undertook this challenge by analysing at P/C proximal and distal interactions with a new method that allows to identify dynamic elements of JA across a range of sensory modalities.

Method

We recorded free-play mother/child interactions of nine children with congenital MSI and looked for the behaviours that children use to share attention through every sensory modality. First, we identified JA sequences in each interaction by following a new coding system that includes both interactive definitory elements and temporal constraints. Then, in each sequence we coded children's specific JA skills by adapting the typical "visual behaviours" (e.g., gaze shifting) to those structurally and functionally similar produced through other sensory modalities (e.g., tactile attention shifting).

Results

A total of 287 JA sequences were identified and 9 different JA skills were coded. Every child followed attention, shifted their attentional focus, produced gestures and showed positive affect. JA skills were produced through every sensory modality; most (66%) JA interactions were multimodal. Children with moderate MSIs often used visual and auditory channels, while children with profound MSIs produced tactile adaptations of the standard JA behaviours.

Conclusion

Overall, findings indicate that: (1) JA is present in the communicative interactions of children with MSI and (2) standard, definitory JA skills can be identified in their communicative repertoire.

Understanding the role of anxiety in the early development of Autism Spectrum Conditions' sensory and social traits

Ottavia Ollari, Emily J. H. Jones and BASIS team

(Centre for Brain and Cognitive Development, Birkbeck College, University of London)
o.ollari@bbk.ac.uk

Abstract

Autism Spectrum Conditions (ASC) are characterised by differences in social communication differences and the presence of focused interests, repetitive behaviours and alterations in sensory experiences. Autistic people report anxiety to be a priority in their everyday life, and it is estimated that about 60% meet diagnostic criteria for a clinical anxiety disorder. However, it remains unclear whether early manifestations of anxiety precede or follow the emergence of core autism symptoms. The current study adopted a prospective longitudinal design in 143 infants with and without a family history to test the relation between early brain measures of social and sensory processing and social and sensory functioning, early temperamental fear, and ASC traits at 3 years of age. We found that temperamental fear at 5 and 8 months predicted dimensional measures of social and sensory skills respectively at 36 months. Further, early neural correlates of social and sensory processing (N290 latency and MMN amplitude) at 8-10 months also predicted social and sensory profiles at 36 months respectively; but there were no associations between neural responses and early fear. Our results suggest that differences in sensory and social processing and differences in temperamental fear both emerge in early infancy, potentially representing additive components of an ASC developmental substructure. Such insights will improve our understanding of hierarchical effects in the manifestation of ASC-like behavioural traits and better target evidence-based interventions.

Reduced social responsiveness in infancy as an early behavioural marker of later developmental outcomes in typically developing infants and infants at risk for autism spectrum disorder

Süheyla Özen, Jolie Keemink and David Kelly

University of Kent, Canterbury, England, UK
Presenting author: Süheyla Özen (so389@kent.ac.uk)

Introduction: Research on autism in infants with a familial history, typically an older sibling, has shown that reliable predictors of autism in the first year of life remain elusive. Keemink et al. (2021) used a gaze-contingent paradigm with typically developing (TD), and infant sibling (IS) groups in which engaging in eye contact with on-screen actors would trigger the stimulus to produce a facial expression. Findings of this study demonstrated that infant sibling group showed reduced behavioural responsiveness to facial expressions. We are currently conducting follow-up work with infants tested by Keemink et al. to assess whether reduced social responsiveness is related to later developmental outcomes.

Method: We followed up 45 TD infants (21– 56 months) and 10 IS (42 – 60 months). A parent-child free-play task and developmental assessments, including the Repetitive Behaviour Questionnaire-2 (RBQ-2), Language Use Inventory (LUI), and Ages and Stages Questionnaires-3 (ASQ-3), were conducted.

Results: Infants in the IS group with low responsiveness exhibited significantly less social vocalization in free-play tasks compared to low-scoring TD infants ($p < 0.006$). Infants who responded less during the eye-tracking task had lower developmental assessment scores in ASQ-3 ($F(1,49) = 4.183$, $p = 0.046$, $\eta p2 = 0.079$). A significant association between imitation behaviour in infancy and the ASQ-3 developmental assessment score ($F(1,49) = 4.084$, $p = 0.049$, $\eta_p^2 = 0.077$) was also found.

Conclusion: Reduced social responsiveness in infant siblings may be precursor of later developmental delays, potentially aiding in the early detection of autism.

References

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NeuroCave Tailoring Neuroscience to Developmental Differences

Giulia Serino[1], Siofra Heraty[1,2], Silvia Dalvit-Menabe[3], Samuel Powell[4], Nicholas Everdell[4], Nadine Aburumman[5], Tony Charman[6], Essi Viding[7], Antonia Hamilton[8], Paola Pinti[1], & Chiara Bulgarelli[1]

[1]Centre for Brain and Cognitive Development, Department of Psychological Sciences, Birkbeck, University of London, London, UK; [2]Child and Family Centre, Meath Primary Care Services, Our Lady's Hospital, Navan, Co. Meath, Ireland; [3]BabyBrains Limited, 33 Eastgate Street, ST16 3EL Stafford, UK; [4]Gowerlabs Limited; [5]Department of Computer Science, Brunel University; [6]King's College London; [7]Clinical, Educational, and Health Psychology Research Department, University College London; [8]Institute of Cognitive Neuroscience, University College London.

Presenting Author email address: a.serino@bbk.ac.uk

Abstract

Introduction: Neurodevelopmental conditions, such as autism and ADHD, have traditionally been studied in controlled laboratory settings. While this approach provided insights into cognitive mechanisms and their neural correlates, it limited our understanding of the intricate neuro-dynamics in real-world contexts. By optimizing diffuse optical tomography (DOT) and Virtual Reality (VR) setups for neurodivergent children, this project aims to lay the foundation for studying atypical development biomarkers in ecological contexts. We will embrace a parent and child-centred approach, promoting collaboration among families, researchers, and Gowerlabs, our partner DOT company.

Methods: We will recruit 60 neurodiverse 3-to-6-year-olds. We will administer a questionnaire to children's caregivers to identify challenges related to the VR/DOT testing setup. We will assess children's executive function with a Go/NoGo task in the ToddlerLab Cave, a child-friendly Virtual Environment, while measuring their frontal cortex activation with the new LUMO DOT system by Gowerlabs Ltd. By dialoguing with the parents and our partner DOT company, we will adjust the testing set-up (i.e., using a headband instead of a cap), and we will reassess the same children.

Expected Results: We expect a high inclusion-rate, good compliance, and data quality, as the testing environment will be tailored to the children's needs.

Conclusion: By leveraging cutting-edge methods and a parent-centric approach, this project seeks to democratise science by placing children's needs at the forefront. The aim is to increase children's compliance to assessment with neurotechnologies and obtain more reliable and valid data, ultimately contributing to a collective body of knowledge that benefits all stakeholders.

Using multi-modal neuroimaging to characterise social brain specialisation in infants

M.F. Siddiqui[a], P. Pinti[a], S. Brigadoi, S. Lloyd-Fox[b], C.E. Elwell[c], M.H. Johnson[b], I. Tachtsidis[c], E.J.H. Jones[a]

[a] *Centre for Brain and Cognitive Development, Birkbeck College, London, UK*
[b] *Department of Psychology, University of Cambridge, UK*
[c] *Department of Medical Physics and Biomedical Engineering, UCL, London, UK*
[d] *Department of Development and Psychology, University of Padova, Padova, Italy*
Corresponding author email address: Dr. Maheen Siddiqui; m.siddiqui@bbk.ac.uk

Abstract: Broadband near-infrared spectroscopy (bNIRS) is a novel technique that provides measures of cerebral energy metabolism, through measurement of the oxidation status of mitochondrial enzyme cytochrome-c-oxidase (oxCCO), alongside haemodynamic measures that are obtained by conventional fNIRS. bNIRS provides the opportunity to investigate neurovascular coupling (NVC) mechanisms and their role in cortical specialization. Here, we present an integrated platform (combining bNIRS and EEG) to explore these mechanisms in infancy.

Methods: Social and non-social visual and auditory stimuli were used in 42 4-to-7-month-old typically developing infants. bNIRS measurements were made using an in-house system developed at UCL. Infants wore custom-built headgear with 9 channels over the right hemisphere (source/detector separation was 2.5 cm). $\Delta[HbO_2]$, Δ[HHb] and Δ[oxCCO] were calculated using changes in attenuation of light at 120 wavelengths between 780-900nm using the UCLn algorithm. EEG data was collected using the wireless Enobio system (Neuroelectrics, Spain) and 32 electrodes were positioned according to the international 10/20 system (see Figure 1). The root mean square (RMS) power was calculated for each experimental trial and averaged across trials. We used a GLM analysis to gather information on how the task-evoked neuronal activity predicts the hemodynamic activity. The resulting beta values were entered into one sample t-tests vs 0 to localize the brain regions with significant correlations between HbO_2, HHb and oxCCO and EEG in response to the task.

Results: Data from 14 infants were included. Figure 1 shows the group level activation maps (for the social condition, for beta and gamma frequency bands), showing the channels where a statistically significant relation was observed for different frequency bands. HbO_2 and HHb show strong correlation between temporo-parietal NIRS channels and EEG channels while oxCCO shows more spatially specific correlations.

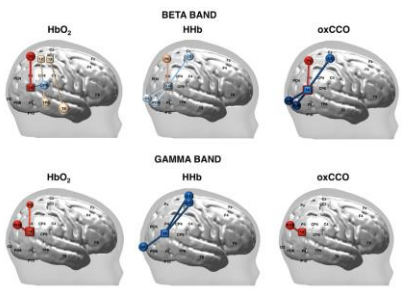
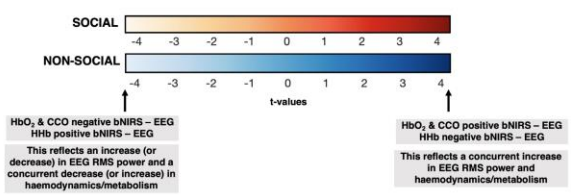


Figure 1: FDR-corrected significant connections between bNIRS channels (squares) and EEG electrodes (circles) for the beta and gamma bands for the social condition (red colour bar) and the non-social condition (blue colour bar) for HbO2, HHb, and oxCCO.



Neuro-metabolite alterations in Autism Spectrum Condition: a meta-analysis.

Alice R. Thomson[1,2], Duanghathai Pasanta[1], Tomoki Arichi[2,3], and Nicolaas A. Puts[1,2]

[1] Department of Forensic and Neurodevelopmental Sciences, King's College London.
[2] MRC Centre for Neurodevelopmental Disorders, King's College London.
[3]Centre for the Developing Brain, King's College London, London.
Email: alice.r.thomson@kcl.ac.uk

Abstract:

Introduction:

Evidence suggests that a common neurobiological endpoint of autism aetiologies may be an imbalance between excitation/inhibition (E/I) in brain circuits. This is predominantly determined by glutamate and gamma-aminobutyric acid (GABA), the adult human brain's principal excitatory and inhibitory neurotransmitters respectively. *^{1}H-Magnetic Resonance Spectroscopy (MRS)* is a non-invasive technique that can be used to quantify the concentrations of metabolites, including Glutamate and GABA, in the brain in vivo. This is highly valuable for validating the E/I imbalance hypothesis in humans. MRS findings in the context of autism are however inconsistent and conflicting. We performed a *meta-analysis* of MRS studies observing GABA and/or Glutamate, as well as metabolites involved in energy metabolism (glutamine, creatine), and neural integrity (e.g. N-acetyl aspartate (NAA), Choline) in autistic cohorts and neurotypical controls.

Methods:

Data were extracted and grouped by metabolite, brain region and several demographic and methodological factors before calculation of standardised effect sizes. The quality of each study was assessed.

Results & Conclusions:

Overall, we provide strong evidence of disruptions to regional brain E/I balance and neural integrity in autism. We find significantly lower concentrations of GABA and NAA in autism compared to controls (Figure 1). Further analysis suggested that GABA and NAA alterations are specific to limbic brain regions involved in brain processes relevant to autism phenotypes (e.g., thalamus, ACC; Figure 2). We also highlight several demographic and methodological factors (including sex and medication usage) that influenced study outcome (Figure 3), emphasising the importance of transparent reporting to ensure repeatability MRS findings.

MRI support kit: Autistic led and co-creative research and design

Eleonora Tilkin-Franssens (KULeuven) – eleonora.tilkin-franssens@kuleuven.be

Co-authors: Dr. Judit Ciarrusta Monzon (Universitat Pompeu Fabra), Dr. Jennifer Cooke (King's College London), and Alyson Law (King's College London)
This research project takes place within the Intellectual Disabilities & Autism (IDA) Working Group, led by Dr. Jennifer Cooke, and is part of AIMS-2-TRIALS.

Introduction

Many autistic people report difficult and traumatic experiences undergoing MRI procedures. This barrier can lead to reduced data. Recent work by Stogiannos et al. (2022) highlighted the need for custom guidelines to improve MRI practice with respect to autism.

Method

Anxiety and sensory needs were the biggest barriers highlighted to MRI scanning by autistic people and/or their parents in the IDA working group.
We collected and implemented informal feedback on the first design of the MRI support kit from researchers, radiographers, and autistic representatives from different European countries.
The overall feedback was positive, with professionals expressing interest in implementing this resource.

We plan to pilot the use of the MRI support kit in research studies.
This is currently pending ethical approval for use in the Longitudinal European Autism Project (LEAP) at King's College London.
Data about the utility, helpfulness, and clarity of the resource will be gathered by asking participants to complete a questionnaire before and after their MRI scan.
We will assess participants' perspectives of the MRI support kit and make necessary adaptations before formal implementation in future research studies.

Conclusion

This project addresses unmet needs that will be beneficial to the autistic community and promotes equity in MRI environments.
By co-producing, we are representing the best interests of the community and delivering work that will have maximum impact to autistic wellbeing.
We hope that this work will improve the MRI experience for neurodivergent people and empower researchers & clinicians to accommodate neurodivergent needs into their practices.

The developing homunculus: neuroplasticity in children with and without upper limb differences

Raffaele Tucciarelli[1,2], Laura Bird[3], Maggie Szymanska[1], Mathew Kollamkulam[2], Harshal Sonar[4], Jamie Paik[4], Dani Clode[1], Tessa Dekker[5], Dorothy Cowie[3], Tamar R. Makin[1,2]

[1]MRC Cognition &Brain Sciences Unit, Cambridge, England, United Kingdom; [2]Institute of Cognitive Neuroscience, University College London, London, UK; [3]Durham University, Department of Psychology, Durham, UK; [4]EPFL, Lausanne, Switzerland; [5]UCL Institute of Ophthalmology, University College London

Raffaele Tucciarelli - Raffaele.Tucciarelli@mrc-cbu.cam.ac.uk

Abstract

Congenital hand loss leads to neural adaptations in primary somatosensory cortex (S1) that are not yet fully understood. Recent research in adults indicates that the S1 territory corresponding to the missing hand becomes responsive when using various body parts. It has been suggested that this remapping is facilitated by compensatory strategies – body parts which are used to substitute the missing hand function would harness the freed-up hand resources. However, this theory hasn't been empirically validated. Within this theoretical framework, a key prediction is that the sensory representation of the body in one-handers is shaped by the compensatory use of multiple body parts during childhood. Alternatively, these neural adaptations might be present from an early age (i.e., at the onset of development). This study employs fMRI to measure somatosensory activity across different body parts (from forehead to foot) and compensatory behaviours in one- and two-handed children (5-8 years old), and one- and two-handed adults (18-65 years old). Preliminary results reveal somatosensory remapping of the residual arm representation in the deprived hand area. Further analysis involving representation similarity analysis (RSA) will follow to elucidate on differences related to developmental period (children versus adult), limb difference (one or two hands), and links with compensatory behaviour. This approach not only maps the somatosensory homunculus, which is rarely investigated in children, but also explores the broader impact of limb loss on the developing homunculus. The findings hold significance in advancing our understanding of neural plasticity in response to congenital limb differences.

Autism Subgrouping: Unraveling Complexity with functional magnetic resonance imaging (fMRI) & Explainable Artificial Intelligence (XAI)

Topic: Autism subgrouping using machine learning

Ioannis Valasakis[1,4], Stefan Holiga[2], Juergen Dukart[3], Grainne McAlonan[1], Maria Deprez[4], Dafnis Batalle[1,4]

[1] Department of Forensic and Neurodevelopmental Science, Institute of Psychiatry, Psychology & Neuroscience, King's College London, London, London, [2]Roche Pharma Research and Early Development, Basel, Base, [3]Institute of Neuroscience and Medicine: Brain and Behavior (INM-7), Research Center Jülich, Jülich, NRW, [4]Centre for the Developing Brain, School of Biomedical Engineering & Imaging Sciences, King's College London, London, United Kingdom

Email: ioannis.valasakis@kcl.ac.uk

Abstract:

In this study, we used functional MRI (fMRI), machine learning, and XAI methods to classify autistic participants into subgroups and identify relationships between functional connectivity patterns and potential autism subgroups.

We processed fMRI data from 1450 selected participants in Autism Brain Imaging Data Exchange (ABIDE) I/II datasets[2] using fMRIprep[3], calculated voxelwise degree centrality (DC) maps and employed a DenseNet-121[4] convolutional neural network to classify autistic versus non-autistic participants. We used SmoothGrad[5] to generate individual saliency maps indicating the brain areas used by the classifier, identifying potential biomarkers for classification. Using a non-parametric permutation test[6], we studied the voxelwise correlation of demographic and behavioural phenotypes with saliency maps of correctly classified autistic participants. Finally, we used UMAP[7] non-linear dimensionality reduction and k-means[8] clustering to categorise autistic participants into four data-informed subcategories.

Our method achieved a classification accuracy of 70.16% with a ROC-AUC of 0.72. The saliency maps of correctly classified autistic participants correlated with age, ADI[9] social, and ADI verbal but not sex and IQ. We identified four subgroups showing distinct behavioural and demographic characteristics, such as age and ADI scores (Figure 1).

Our results contribute to a better understanding of the neurobiological basis of autism subgroups, potentially informing personalised support. Our ongoing work includes refining the interpretability of results and validating the findings using AIMS-2-TRIALS. Our goal is to contribute to a more comprehensive understanding of autism.

Disrupted sensory-motor integration in children with Developmental Coordination Disorder

Ross E. Vanderwert,[a,b,*] Jennifer Keating,[a] Sarah A. Gerson, [a] Catherine R.G. Jones, [a] Catherine Purcell [c]

[a]Cardiff University Centre for Human Developmental Science, School of Psychology, Cardiff University
[b]Cardiff University Brain Research Imaging Centre, School of Psychology, Cardiff University
[c]School of Healthcare Sciences, Cardiff University
[*]Presenting Author

Abstract

There is emerging evidence that the Mirror Mechanism (MM) might contribute to the motor impairments characteristic of Developmental Coordination Disorder (DCD). This study aimed to identify whether the MM is disrupted in DCD during action observation or action execution, or whether both processes are affected.

Electroencephalography (EEG) was used to measure mu power (a measure of MM) in 8-12-year-old children either with (n=23) or without (n=24) a diagnosis of DCD. EEG was recorded during six conditions: observation (1) gross and (2) fine motor; execution (3) gross and (4) fine motor; (5) non-biological movement (kaleidoscope); and (6) resting. To address whether potential deficits in these systems were unique to DCD or related to co-occurring traits of other neurodevelopmental disorders, parents reported on their child's attention and social communication skills.

We were interested in mu desynchronization (mu power for non-biological movement – mu power for observation/execution). As expected, the non-DCD group showed desynchronization for observation conditions and increased desynchronisation for execution conditions. However, the DCD group showed low mu power across *all* conditions, including non-biological movement. There were no differences in resting mu power. There were significant correlations between children's attention and motor skills and MM activity.

Results suggest that the MM activates differently in children with DCD. Due to low mu power observed for non-biological movement for the DCD group, the MM may be more generalised in DCD and reflects disrupted communication between the dorsal visual stream and MM.

The entropy of resting-state neural dynamics is a marker of general cognitive ability in childhood

Natalia Zdorovtsova, Edward Young2, Danyal Akarca[1], Alexander Anwyl-Irvine[1], The RED Team[1], The CALM Team[1], Duncan E. Astle[1]

1(MRC Cognition and Brain Sciences Unit, University of Cambridge)
2(Engineering Department, University of Cambridge),

Email address of presenting author: Natalia.Zdorovtsova@mrc-cbu.cam.ac.uk

Abstract

Introduction

Resting-state network activity has been associated with the emergence of individual differences across childhood development. However, due to the limitations of time-averaged representations of neural activity, little is known about how cognitive and behavioural variability relates to the rapid spatiotemporal dynamics of these networks. Magnetoencephalography (MEG), which records neural activity at a millisecond timescale, can be combined with Hidden Markov Modelling to track the spatial and temporal characteristics of transient neural states.

Methods

We inferred a Hidden Markov Model from resting-state MEG data collected from (n = 46) children aged 8-13, who were also assessed on their cognitive ability and across multiple parent-report measures of behaviour.

Results

We found that entropy-related properties of participants' resting-state time-courses were positively associated with cognitive ability. Additionally, cognitive ability was positively correlated with the probability of transitioning into HMM states involving fronto-parietal and somatomotor activation, and negatively associated with a state distinguished by default-mode network suppression.

Conclusion

There is increasing evidence that the function of resting-state brain networks contributes to individual differences in cognition and behaviour across development. However, the relationship between dynamic, transient patterns of switching between resting-state networks and neurodevelopmental diversity is largely unknown. Here, we show that cognitive ability in childhood is related to the complexity of resting-state brain dynamics.

Screen Usage and Irritability in Children: Altered Brain Reward Systems in a Longitudinal Analysis

Lanting Zhang[1,2],Nellia Bellaert[3], Wan-Ling Tseng[2]
[1]University College London
Email: lanting.zhang.21@ucl.ac.uk

Abstract

Irritability is common in childhood and has been linked to various future psychopathologies. Irritable children are easily frustrated presumably due to aberrant reward processing. Digital media use might contribute to irritability by affecting emotion regulation and reward sensitivity. This project investigates screen time in different types of media activity alongside irritability, at baseline and through longitudinal follow-up over three years, using data from the Adolescent Brain and Cognitive Development study (N = 11,748, baseline Mean age = 9.5 years). A subset of the sample had quality neuroimaging data (N = 3,761) in a monetary incentive reward task to measure neural activity during reward processing at two-year follow up. We conducted a multiple mediation analysis, using pre-selected regions of interest (ROIs) and neural coactivation networks associated with reward anticipation and reward feedback as mediators. The results did not provide evidence to support a direct, longitudinal association between screen time and irritability or indirect association via reward-related brain function. However, excessive screen time was related to increased anticipatory reward activations in the bilateral precentral gyrus, insula and thalamus, regions implicated in processing reward-related information and exercising cognitive control. Different types of media activities were associated with distinct neural patterns of reward anticipation. Limited activation was found in reward feedback across different media types. In summary, this study offers initial longitudinal evidence regarding the link between different forms of screen use and reward-related neural activation patterns, but without any impact on irritability.