Table of Contents

NUALA BRADY PROJECT 1

Exploring the role of the superior temporal sulcus in biological motion perception

Assoc Prof Nuala Brady (UCD), Prof Klaus Kessler (UCD)

Will this project require Garda vetting? No

Project details: We are remarkably good at perceiving bodies in motion as demonstrated by the pioneering work of Johansson (1973), who showed that we can readily identify actions from sparse 'point-light displays' (PLDs) in which an actor's movement are conveyed solely by the kinematics of lights placed on the major joints of the body (shoulders, hips, knees, elbows etc). Such sensitivity reflects the importance of body perception to social cognition. PLDs have been used in conjunction with repetitive transcranial magnetic stimulation

(rTMS) to pinpoint the role of the posterior superior temporal sulcus (pSTS) (Grossman et al., 2005) and, very recently, the role of the cerebellum (Ferrari et al., 2022) in biological motion perception. While these studies have used a discrimination task (in which participants decide where a PLD stimulus, which walks 'on the spot' is a real or scrambled PLD) the current study will use a more naturalistic task developed in the UCD Perception Lab (Murphy, Brady et al, 2009) whereby the PLD walkers will walk to the right or left across a screen and participants will be asked to decide the direction of motion. Such movements are particularly important given proposals that the cerebellum is involved in predicting motion sequencing (Van Overwalle et al. 2020). The current project will investigate the role of the STS in processing these stimuli using TMS. Students interested in biological motion perception are recommended to read the review paper by Blake & Shiffrar (2007) for an excellent introduction.

Recommended reading:

Johansson, G. (1973). Visual perception of biological motion and a model for its analysis. *Perception & psychophysics*, *14*(2), 201-211.

Grossman, E. D., Battelli, L., & Pascual-Leone, A. (2005). Repetitive TMS over posterior STS disrupts perception of biological motion. *Vision research*, *45*(22), 2847-2853.

Ferrari, C., Ciricugno, A., Battelli, L., Grossman, E. D., & Cattaneo, Z. (2022). Distinct cerebellar regions for body motion discrimination. *Social cognitive and affective neuroscience*, *17*(1), 72-80.

Murphy, P., Brady, N., Fitzgerald, M., & Troje, N. F. (2009). No evidence for impaired perception of biological motion in adults with autistic spectrum disorders. *Neuropsychologia*, *47*(14), 3225-3235.

Van Overwalle, F., Manto, M., Cattaneo, Z., Clausi, S., Ferrari, C., Gabrieli, J. D., ... & Leggio, M. (2020). Consensus paper: cerebellum and social cognition. *The Cerebellum*, *19*(6), 833-868.

Blake, R., & Shiffrar, M. (2007). Perception of human motion. *Annual review of psychology*, *58*, 47.

NUALA BRADY PROJECT 2

Action Perception, Motor Representation & Memory: Canonical moments in action perception

Assoc Prof Nuala Brady (UCD), Dr Patricia Gough (UCD) & Dr David McGovern (DCU)

Will this project require Garda vetting? No

Project details: The study of visual object recognition shows that images of objects photographed from certain viewpoints are judged to be a 'better likeness' to those objects and confer an advantage in memory (Palmer, Rosch & Chase, 1981; Gomez, Shutter & Rouder, 2008). Our recent research (Brady, Gough, Allan, McManus, McGovern, 2021: ECVP abstract) extends this notion to the representation of perceived actions. Across two psychophysical studies, participants viewed 50 short videos of actions (e.g., a dancer performing, a sports player kicking a ball, a child reaching for a toy) and chose which of 12 still images 'best represented' the portrayed action. The data show remarkable agreement across the two methods with participants' choices revealing 'action peaks'. This idea that 'canonical moments' might inform our representation of perceived actions receives support from recent ideas on how human motor cortex may be organized. The current project extends this research to explore whether such 'action peaks' confer an advantage in memory.

Recommended reading:

- Palmer, S. E.. Rosch, E.& Chase. P. (1981). Canonical perspective and the perception of objects. In Long, J, & Baddeley, A. (Eds). Attention and performance IX (pp. 135-151). Hillsdale. N.J.: Erlbaum
- Graziano, M. (2006). The organization of behavioral repertoire in motor cortex. Annu. Rev. Neurosci., 29, 105-134.
- Gomez, P., Shutter, J., & Rouder, J. N. (2008). Memory for objects in canonical and noncanonical viewpoints. Psychonomic bulletin & review, 15(5), 940-944
- Baker, C. L., Saxe, R., & Tenenbaum, J. B. (2009). Action understanding as inverse planning. *Cognition*, *113*(3), 329-349

NUALA BRADY PROJECT 3

Developing handedness: Spontaneous manual actions across infancy

Assoc. Prof. Nuala Brady (UCD), Dr Áine Ní Choisdealbha (UCD/University of Washington)

Will this project require Garda vetting? Yes

Project details: Humans typically do not use their hands in equal proportion, but exhibit a preference for using one over the other. Handedness is not evenly split in the population, with right-handedness being more common. Despite being such a universal phenomenon, the questions of how and when hand preference develops are still open. Some suggest that hand preference exists prenatally (Hepper, 2013); others find that it unfolds for different actions at different times across infancy and toddlerhood (Jacobsohn et al., 2014).

In general, studies examining the emergence of hand preference have used laboratory tasks to elicit reaching, grasping and manipulation actions from infants. In this citizen science-motivated project, you will study naturalistic manual behaviours in infants' own home environments. Seeking a cross-sectional sample of infants up to 18 months, you will collect video recordings of infants playing and eating from parents. There is also the potential to re-use existing data hosted on sites like databrary.org. You will analyse these using a combination of automated motion-tracking software (OpenPose) and visual behavioural coding. Using this dataset, you will answer questions such as when the ratio of right-to-left-handed actions changes from chance levels, and when infants reliably begin to reach across their bodies to grasp an object.

Recommended reading

- Jacobsohn, L., Rodrigues, P., Vasconcelos, O., Corbetta, D., & Barreiros, J. (2014). Lateral manual asymmetries: A longitudinal study from birth to 24 months. *Developmental Psychobiology*, *56*(1), 58-72.

- Fagard, J. (2013). Early development of hand preference and language lateralization: Are they linked, and if so, how? *Developmental Psychobiology*, 55(6),

JESSICA BRAMHAM PROJECT 1

Psychosocial costs of adult ADHD in Ireland
Prof Jessica Bramham (UCD)

Will this project require Garda vetting? No

Services for adults with ADHD in Ireland have been very limited to date and are only now being rolled out. ADHD is a neurodevelopmental condition and undiagnosed individuals can incur numerous personal and societal costs in different functional domains including education, occupational, relationships, health, criminal justice. This project will attempt to map out these costs by surveying adults with ADHD in partnership with ADHD-Ireland and the HSE National Clinical Programme for Adults with ADHD. This research aims to have impact and provide evidence for development of services in the HSE.

This would be a suitable project for someone who is interested in clinical psychology or neuropsychology.

Useful weblinks:
https://www.hse.ie/eng/about/who/cspd/ncps/mental-health/adhd/

https://adhdireland.ie

MÉADHBH BROSNAN PROJECT 1

Neurophysiological markers of resilient cognitive ageing

Will this project require Garda vetting? No

Older adults differ vastly in the extent to which their cognitive functions, such as memory, attention, and decision making remain healthy. Highlighting sources of interindividual variability in this resilience to cognitive ageing, particularly in the face of neuropathology such as Alzheimer's Disease, will enhance the development of targeted neurorehabilitation interventions to prevent and redress cognitive decline. The aim of this MSc project is to explore aspects of brain function that support resilience to cognitive decline in older adults.

This will be an analysis only project using an existing dataset of ~80 older adults who have been assessed on MEG (during a retro-cue working memory task[1,2]), a wide range of neuropsychological and mental health tests, and MRI. In addition to a wide breadth of baseline neurocognitive measures, neuropsychological function has been assessed longitudinally in these older adults, which will enable us to explore the utility of different brain-based measures for predicting vulnerability to future cognitive decline. The overarching goal of this work is to isolate distinct neurophysiological signatures (using MEG and EEG, e.g.[3]) that can be developed as biomarkers of cognitive decline and as objective phenotypes to monitor the success of novel intervention approaches (e.g.[4]).

Recommended Reading

1. Griffin, I. C. & Nobre, A. C. Orienting Attention to Locations in Internal Representations. *Journal of Cognitive Neuroscience* **15,** 1176–1194 (2006).

2. Mok, R. M., Myers, N. E., Wallis, G. & Nobre, A. C. Behavioral and Neural Markers of Flexible Attention over Working Memory in Aging. *Cerebral Cortex* **26,** 1831–1842 (2016).

3. Brosnan, M. B. *et al.* Evidence accumulation during perceptual decisions in humans varies as a function of dorsal frontoparietal organization. *Nature Human Behaviour* **269,** 1–12 (2020).

4. Brosnan, M. B. *et al.* Plasticity of the Right-Lateralized Cognitive Reserve Network in Ageing. *Cerebral Cortex* **28,** 1749–1759 (2017).

TOM BURKE PROJECT 1

Traits of Schizophrenia in the General Population and their relationship to objective and subjective social cognition outcomes

TOM BURKE PROJECT 2

Interpersonal Impression management, empathy, and inferring mental states

Both Projects 1 & 2 (with Professor Alan Carr, UCD)relate to clinical and neuropsychological measurement of social cognition (emotion recognition, mentalising, empathy) and symptoms of mental health conditions i.e., schizophrenia. The aims of these projects are to investigate the relationship between clinical variables which relate to both personality and cognitive outcomes. These projects are in collaboration with the Galway Neuroscience Centre.

TOM BURKE PROJECT 3

Self-reported cognitive and affective empathy, and the tendency to relate emotionally to film.

TOM BURKE PROJECT 4

Mental state attribution coding of film and the role of social cognitive ability

Both Projects 3 & 4 (with Dr Brendan Rooney) relate to outcomes on assessment of social cognition (cognitive and affective theory of mind and empathy) and a person's ability/tendency to infer theory of mind from film

MICHELLE DOWNES PROJECT 1

Parental knowledge of infant cognitive development

This project is within developmental cognitive neuroscience, developmental neuropsychology, early child development, and educational neuroscience research themes.

Recent research has emphasised that the promotion of parental knowledge about cognitive development is important for the fostering of positive caregiving behaviour that stimulates cognitive development in the early years (Leung & Suskind, 2020). However, despite the emerging research that demonstrates the impact of parental knowledge on child interaction

and child development, there remains many research gaps including how and where parents find information on parenting with a recent study showing that educational level is more strongly correlated with formal resources such as books targeted at caregivers (McCatharn, Herbert, Wei, & Rowe, 2021).
Parents will be invited to explore their knowledge of early brain development and learning in their infants when infants are under 6 months old with a specific emphasis on themes including infant opportunities for exploration and media.

It is anticipated that this will lead to long-term follow-up research.

Recommended Reading

Christy Y.Y. Leung, Dana L. Suskind, What Parents Know Matters: Parental Knowledge at Birth Predicts Caregiving Behaviors at 9 Months,
The Journal of Pediatrics, Volume 221,
2020,

Ciara Green Project 1

Can misinformation affect behaviour?

Will this project require Garda vetting? No

This project will investigate whether exposure to misinformation, either in the form of online fake news or in more personalised form, can substantially affect behaviour. The project will involve a large online survey, followed by an in-person lab assessment of a subset of participants. Participants will be asked to complete a behavioural task in the lab, and we will assess whether exposure to the misinformation affected their subsequent behavioural choices.

Recommended reading:

- Greene, C.M. & Murphy, G. (2021). Quantifying the effects of fake news on behaviour: Evidence from a study of COVID-19 misinformation. *Journal of Experimental Psychology: Applied,* 27(4), 773-784. https://doi.org/10.1037/xap0000371.
- Murphy, G. Loftus, E.F., Grady, R.H.., Levine, L.J. & Greene, C.M. (2020). Fool Me Twice: How effective is debriefing in false memory studies? *Memory*, 28(7), 938-949. https://doi.org/10.1080/09658211.2020.1803917
- Bernstein, D. M., & Loftus, E. F. (2009). The consequences of false memories for food preferences and choices. *Perspectives on Psychological Science*, *4*(2), 135-139.https://doi.org/10.1111%2Fj.1745-6924.2009.01113.x

SARAH COONEY PROJECT 1

Body Representation: What is the relationship between interoceptive accuracy and the maintenance of the body schema?

Dr Sarah Cooney (UCD), Assoc. Professor Nuala Brady (UCD)

Will this project require Garda vetting? No

The self is an integrated part of our conscious life and our body is central to our sense of self (Zahavi, 2003). Body representation is a continuously updating system of multisensory interactions that give structure and the impression of consistency and coherence to the experience of the body and is modified and updated across the entire adult life span . Our experience of our bodies is mediated by a host of sensory and perceptual information — such a somatosensory and visual information, signals originating from inside the body that tell us about our physiological state (interoceptive information), and the position of our limbs in space (proprioceptive information). Recent research has shown that interoceptive awareness plays a pivotal role in some aspects of body representation (Naraindas & Cooney, BRNet 2022, Psychonomics 2022). Indeed, interoception is often significantly reduced in people with Anorexia and various neurological and psychiatric conditions compared to healthy controls (Pollatos et al., 2008).

Participants will complete behavioural tasks that index the *body schema* - a spatial representation of the body driven by motor planning (Dijkerman and de Haan, 2007, de Vignemont, 2010). Experimental methods that measure the body schema often use motor imagery tasks. Performance in these tasks relies on the ability to represent a third person schematic of the body in *the mind's eye* and emulate the observed posture by mentally adopting the same posture. This project asks, what is the relationship between interoceptive accuracy and the body schema?

This project would suit a student with a strong interest in cognitive neuroscience, experimental psychology, perception and cognition.

Recommended Reading:

O'Dowd, A., Cooney, S. M., & Newell, F. N. (2022). Self-reported vividness of tactile imagery for object properties and body regions: An exploratory study. *Consciousness and Cognition*, *103*, 103376.

Chen, W. G., Schloesser, D., Arensdorf, A. M., Simmons, J. M., Cui, C., Valentino, R., ... & Langevin, H. M. (2021). The emerging science of interoception: sensing, integrating, interpreting, and regulating signals within the self. *Trends in neurosciences*, *44*(1), 3-16.

Raimo, S., Boccia, M., Di Vita, A., Cropano, M., Guariglia, C., Grossi, D., & Palermo, L. (2021). The body across adulthood: On the relation between interoception and body representations. *Frontiers in Neuroscience*, *15*, 586684.

PATRICIA GOUGH PROJECT 1

Mu rhythm suppression and Language – an EEG study.

Dr Patricia Gough (UCD), Prof Klaus Kessler (UCD)

The mu rhythm (8-13Hz) has been recorded over central areas of the scalp using EEG and this rhythm has been shown to desynchronise when participants perform an action, view an action, or read action-related sentences. Results such as these suggest that event-related desynchronisation (ERD) of the mu rhythm can be associated with activation of motor cortex. Further it has been suggested that this may reflect mirror neuron activity, as the effect is seen for both execution and observation, and action-related language (involving verbs).
Embodiment theories of language predict that motor-related language should be expected to activate the motor system. This has been shown using different techniques and, as seen above, it appears that sentences built around action verbs lead to ERD of the mu rhythm. However, this language related work relies on sentence stimuli which could mean that effects seen are due to imagery following sentence processing and are not automatic in nature.
Embodiment theory also predicts that graspable objects, and nouns referring to these, should also activate the motor system (due to canonical rather than mirror neuron activity). There is little work looking at ERD with nouns, and work that exists involves associating action with an object within the same experiment.

The current experiment will present participants with individual words on each trial while recording EEG. There will be two factors: Word type (Verb, Noun) and Motor (motor-related, non motor-related), resulting in four conditions, with an additional basline. Effects of these conditions (versus baseline) on mu rhythm will be examined.

Recommended Reading:

Bechtold, L., Ghio, M., Lange, J., & Bellebaum, C. (2018). Event-related desynchronization of mu and beta oscillations during the processing of novel tool names. *Brain and Language*, *177*, 44-55.

Bowman, L. C., Bakermans-Kranenburg, M. J., Yoo, K. H., Cannon, E. N., Vanderwert, R. E., Ferrari, P. F., van IJzendoorn, M. H., & Fox, N. A. (2017). The mu-rhythm can mirror: Insights from experimental design, and looking past the controversy. *Cortex; a journal devoted to the study of the nervous system and behavior*, *96*, 121–125. https://doi.org/10.1016/j.cortex.2017.03.025

Marino, B. F., Gough, P. M., Gallese, V., Riggio, L., & Buccino, G. (2013). How the motor system handles nouns: a behavioral study. *Psychological research*, *77*(1), 64-73.

Gough, P.M., Riggio,L., Chersi, F., Sato, M., Fogassi, L., and Buccino, G. (2012). Nouns referring to tools and natural objects differentially modulate the motor system. *Neuropsychologia* 50, 19-25.

Patricia Gough Project 2

Controlling for age of acquisition in measures of embodiment of language – A TMS study

Embodiment of language refers to the idea that our representation of language relies on cortical areas involved in the representation of a word's referent i.e. the experience of what a word refers to is relevant for how the brain processes a word itself. For example, words referring to actions, or objects on which a person can act, would be expected to activate motor areas, words that refer to items with visual experience would be expected to activate visual areas etc. An individual word may activate several sensory and motor regions of the brain.

Much work in the area of language embodiment, including the current project, focuses on motor-related language and the roll of the motor system. Two of the possible methods to test for embodiment effects are reaction times (RTs), and Transcranial Magnetic Stimulation (TMS) to primary motor cortex (M1) with measurement of Motor Evoked Potentials (MEPs) at a given muscle (e.g. a hand muscle).

While researchers interested in the embodiment of language are careful to balance word stimuli in terms of frequency, far fewer researchers take into consideration the possible effect of age of acquisition (AoA). Current (unpublished) work, using RTs as a measure of embodiment, suggests that the AoA of words can have large effects on embodiment measures, with early acquired words appearing to drive the overall effect. Although RTs are an acceptable measure of embodiment effects, this method relies on the participant being very focused and motivated to respond as quickly as they can. The current project aims to use the stimuli created for the previously run RT study and to use TMS and motor-evoked potentials (MEPs) to measure motor excitability, and hence potential embodiment effects. The effect of the factors of frequency, age of acquisition, motor-relatedness, and their interaction, on MEPs measured at word presentation will be analysed.

You will be fully supervised in the use of TMS. This project would suit someone keen to learn to use TMS. The use of TMS in the measurement of MEPs is one of the simpler types of TMS protocols and is a good introduction to the technique.

Recommended Reading

Gough, P. M., Campione, G. C., & Buccino, G. (2013). Fine tuned modulation of the motor system by adjectives expressing positive and negative properties. *Brain and language*, *125*(1), 54-59.

Marino, B. F., Gough, P. M., Gallese, V., Riggio, L., & Buccino, G. (2013). How the motor system handles nouns: a behavioral study. *Psychological research*, *77*(1), 64-73.

Gough, P.M., Riggio,L., Chersi, F., Sato, M., Fogassi, L., and Buccino, G. (2012). Nouns referring to tools and natural objects differentially modulate the motor system. *Neuropsychologia* 50, 19-25.

Walsh, V., & Cowey, A. (2000). Transcranial magnetic stimulation and cognitive neuroscience. *Nature Reviews Neuroscience*, *1*(1), 73-80.

Pitcher, D., Parkin, B., & Walsh, V. (2021). Transcranial magnetic stimulation and the understanding of behavior. *Annual Review of Psychology*, *72*, 97-121.

KLAUS KESSLER PROJECT 1

Perspective Taking: the causal roles of left vs right temporoparietal junction probed by TMS

Klaus Kessler, Nuala Brady, Hongfang Wang

High-level visuospatial perspective taking (VPT) is a crucial social ability that relies on a mechanism of embodied mental self-rotation (literally putting yourself into another's shoes). VPT has been linked to theta brain oscillations across a distributed cortical network, in which the right temporo-parietal junction (TPJ) seems to be a crucial network hub. Previous research was primarily based on Magnetoencephalography (MEG) recordings, supported by non-invasive brain stimulation, i.e. transcranial magnetic (TMS) and electric (TES) stimulation. The current project aims to deepen our understanding of the crucial role of the right TPJ in contrast to the left TPJ, by targeting each brain area separately with TMS. The

results of the project will further our understanding of fundamental mechanisms of how the human mind is implemented in the brain.

This project offers the opportunity to engage with the School's new TMS system and learn about data collection and analysis. This prospect should be most attractive to students who aspire to undertake a research career in cognitive neuroscience, incl. related clinical applications.

Recommended Reading:

Wang, H., Callaghan, E., Gooding-Williams, G., McAllister, C., & Kessler, K. (2016). Rhythm makes the world go round: An MEG-TMS study on the role of right TPJ theta oscillations in embodied perspective taking. *Cortex*, *75*, 68-81.

Seymour, R. A., Wang, H., Rippon, G., & Kessler, K. (2018). Oscillatory networks of high-level mental alignment: A perspective-taking MEG study. *NeuroImage*, *177*, 98-107.

Gooding-Williams, G., Wang, H., & Kessler, K. (2017). THETA-rhythm makes the world go round: dissociative effects of TMS Theta versus alpha entrainment of right pTPJ on embodied perspective transformations. *Brain topography*, *30*(5), 561-564.

Martin, A. K., Kessler, K., Cooke, S., Huang, J., & Meinzer, M. (2020). The right temporoparietal junctiocausally associated with embodied perspective-taking. *Journal of Neuroscience*, *40*(15), 3089-3095.

KLAUS KESSLER PROJECT 2

Contrasting oscillatory neural underpinnings of Perspective Taking vs mental Object Rotation using EEG

Prof Klaus Kessler (UCD), Dr Hongfang Wang (Aston University)

High-level visuospatial perspective taking is a crucial social ability that relies on a mechanism of embodied mental self-rotation (literally putting yourself into another's shoes). This mental rotation of the self (Self-Rot) has been shown to be different from mental rotation of objects (Obj-Rot). But little is known about the neurological differences between the two mental processes. Self-Rot has been linked to theta brain oscillations across a distributed cortical network, in which the right temporo-parietal junction (TPJ) seems to be a crucial network hub. Previous research was primarily based on Magnetoencephalography (MEG) recordings, supported by non-invasive brain stimulation. The current project aims to deepen our

understanding of the differences between Self-Rot and Obj-Rot using Electroencephalography (EEG). We aim to replicate the fundamental role of theta oscillations in Self-Rot, potentially in contrast to Obj-Rot. Even if theta is also underpinning Obj-Rot, we predict a different topography for the two processes, i.e. with right TPJ being specifically involved in Self-Rot but not Obj-Rot. The results of the project will further our understanding of fundamental mechanisms of the human mind and brain.

This project offers the opportunity to engage with the School's new high-density (128 electrodes) EEG system and learn about data collection, preprocessing and analysis. This prospect should be most attractive to students who aspire to undertake a research career in cognitive neuroscience, incl. related clinical applications.

Recommended Reading:

Kessler, K., & Thomson, L. A. (2010). The embodied nature of spatial perspective taking: embodied transformation versus sensorimotor interference. *Cognition*, *114*(1), 72-88.

Seymour, R. A., Wang, H., Rippon, G., & Kessler, K. (2018). Oscillatory networks of high-level mental alignment: A perspective-taking MEG study. *NeuroImage*, *177*, 98-107.

Wang, H., Callaghan, E., Gooding-Williams, G., McAllister, C., & Kessler, K. (2016). Rhythm makes the world go round: An MEG-TMS study on the role of right TPJ theta oscillations in embodied perspective taking. *Cortex*, *75*, 68-81.

Martin, A. K., Kessler, K., Cooke, S., Huang, J., & Meinzer, M. (2020). The right temporoparietal junction is causally associated with embodied perspective-taking. *Journal of Neuroscience*, *40*(15), 3089-3095.

FIADHNAIT O'KEEFFE PROJECT 1

Clinical Neuropsychology: Body image and sexual well being in people with Multiple Sclerosis

Assoc Prof Fiadhnait O'Keeffe (St Vincent's University Hospital/UCD), Dr Sarah Cooney (UCD)

Will this project require Garda vetting . No ?

Project details: This project would suit students with a keen interest in clinical psychology and neurological conditions. Participants with MS attending SVUH MS Clinics will be given scales measuring Intimacy and Sexuality, Body appreciation and Body image concerns.

Recommended reading:

Young, C. A., Tennant, A., & TONiC Study Group. (2017). Sexual functioning in multiple sclerosis: relationships with depression, fatigue and physical function. *Multiple Sclerosis Journal*, *23*(9), 1268-1275.

Foley, F. W., Zemon, V., Campagnolo, D., Marrie, R. A., Cutter, G., Tyry, T., ... & Schairer, L. (2013). The Multiple Sclerosis Intimacy and Sexuality Questionnaire—re-validation and development of a 15-item version with a large US sample. *Multiple Sclerosis Journal*, *19*(9), 1197-1203.

FLAVIA SANTOS PROJECT 1

How does Maths Anxiety relate to Number-Space Associations?

Will this project require Garda vetting? Yes, if collecting data face-to-face and with children or adolescents. No, if the sample has undergraduate students.

Project details: Some children have difficulties learning mathematics associated with negative feelings, thoughts, and physiological responses toward mathematics, which is known as Maths Anxiety (Cipora et al 2022). We are interested in how children perceive the number order because this measure is a marker of mathematical reasoning and school outcomes. The proposed study will involve running a newly designed multi-directional number line task (Leonard, Santos 2021) developed in our Lab, The UCD Music and Math Cognition Lab and behavioural scales. The relationship between spatial and numerical cognition has been well established (Sokolowski, Hawes and Lyons, 2019). There is flexibility regarding the sample, the study could be carried out with children, adolescents, or young adults (undergraduates) and will compare task performance with levels of mathematical and spatial anxiety. Children with Dyscalculia (i.e., maths learning disorder) would be of particular interest to be examined in this paradigm. Ultimately, this study will aim to understand how the developing brain processes both spatial and emotional components of mathematics. Outcomes can be considered in designing interventions for both mathematics education in typical development and developmental conditions such as Dyscalculia, Dyslexia and ADHD.

Recommended Reading:

Cipora, K., Santos, F.H., Kucian, K. and Dowker, A. (2022), Mathematics anxiety—where are we and where shall we go? Ann. N.Y. Acad. Sci. https://doi.org/10.1111/nyas.14770

Sokolowski HM, Hawes Z, Lyons IM. What explains sex differences in math anxiety? A closer look at the role of spatial processing. Cognition. 2019 Jan;182:193-212. doi: 10.1016/j.cognition.2018.10.005. Epub 2018 Oct 18. PMID: 30343180.

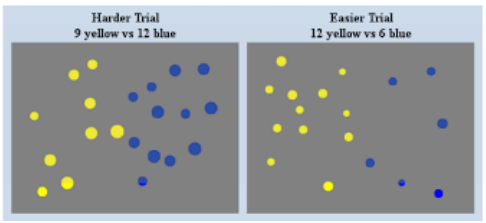
Siegler RS, Opfer JE. The development of numerical estimation: evidence for multiple representations of numerical quantity. Psychol Sci. 2003 May;14(3):237-43. doi: 10.1111/1467-9280.02438. PMID: 12741747.

FLAVIA SANTOS PROJECT 2

The effect of tRNS (transcranial random noise stimulation) in Non-symbolic Magnitude Comparison

Dr Flavia Santos (UCD), Professor Klaus Kessler (UCD)

Project details: The ability to nonverbally approximate numbers plays a role in quantitative reasoning throughout the human life span and supports mathematical intuitions. In the nonsymbolic magnitude comparison task, participants are shown two dot arrays and asked to choose the larger, without counting. Magnitude comparison depends on the integrity of IPS (intraparietal sulcus), however, attentional resources and decision is guided by the DLPC (dorsolateral prefrontal cortex). In this study, we will test whether a single session of tNRS on DLPC (F3 and F4) or IPS (P3 and P4) can improve performance in a nonsymbolic magnitude comparison task. We also will investigate the potential mechanism. We expect a dissociation: A single session of tNRS in DLPC would improve reaction time but not accuracy on the dots discrimination task, while a single session of tNRS on IPS would improve accuracy but not reaction time in the discrimination task. The study design is 2 x 2 x 2 (two groups, two-time points and two conditions). Time-points: behavioural assessment will be carried out during pre- and post- tNRS sessions. Participants will be undergraduate students divided into two groups of tNRS sessions: N=12 (DLPC) and N=12 (IPS). Conditions: experimental vs placebo (sham). In the experimental condition, participants will have an active tNRS session in and in the sham condition, the same participants will take part in a mock tNRS session on the same day.



Recommended Reading:

Halberda J, Feigenson L. Developmental change in the acuity of the "number sense": The approximate number system in 3-, 4-, 5-, and 6-year-olds and adults. *Developmental Psychology.* 2008;44:1457–1465. doi: 10.1037/a0012682.

Lazzaro, G., Fucà, E., Caciolo, C., Battisti, A., Costanzo, F., Varuzza, C., Vicari, S., & Menghini, D. (2022). Understanding the Effects of Transcranial Electrical Stimulation in

Numerical Cognition: A Systematic Review for Clinical Translation. *Journal of clinical medicine*, *11*(8), 2082. https://doi.org/10.3390/jcm11082082