

[](http://riogroup.weebly.com/) **RIO group** [](https://twitter.com/_RIOgroup_)

**2019 Annual Research in Imagery and Observation Group Meeting**

**25-26 April 2019**

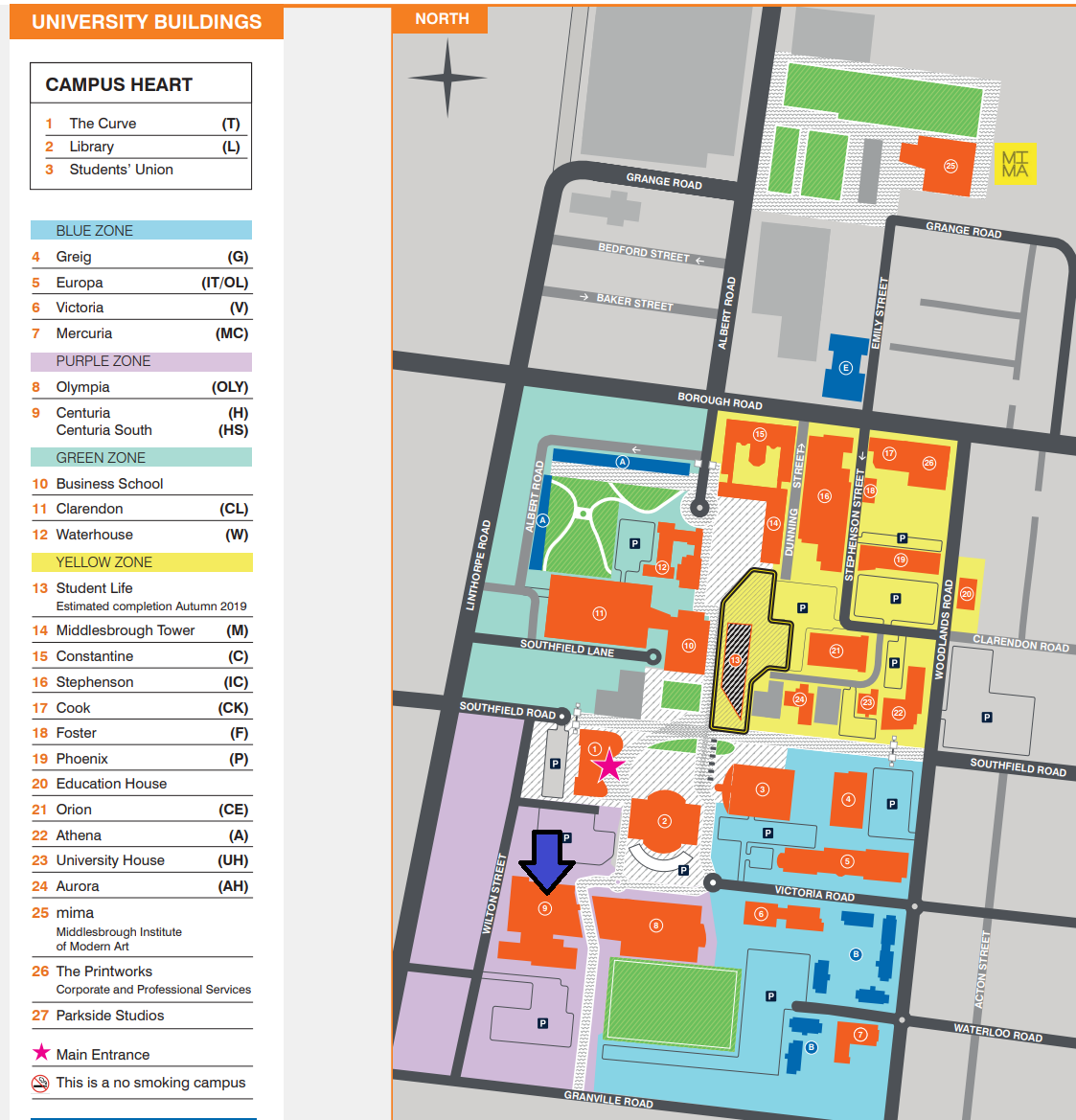
**Teesside University, Middlesbrough, UK**



**Welcome**

Welcome to this year’s RIO group meeting! The RIO group organisers Daniel Eaves, Cornelia Frank, David Wright, and Adam Bruton are looking forward to seeing all group members for the 2019 RIO group meeting in the North East of England. The meeting will take place 25-26 April at Teesside University hosted by Daniel Eaves as local organiser. This year’s programme looks excellent again, with contributions from various locations across Europe and beyond. With this programme, we look forward to building on the success of recent meetings.





We would like to thank the School of Health and Social Care at Teesside University for providing us with financial support and a venue to host the 2019 Annual RIO Group Meeting. We would also like to thank tobii pro for their attendance and subsequent sponsorship of the meeting. Representatives of tobii pro will be demonstrating their eye-tracking equipment to delegates during the first day of the meeting and we urge those interested to discuss products with them during the day.

**Venue and Travel Information**  
The meeting will be held in the Centuria Building (building 9),

Teesside University,

Middlesbrough,

Tees Valley,

TS1 3BX

United Kingdom.

A [campus map](https://www.tees.ac.uk/docs/docrepo/about/CampusMap.pdf) and [travel information](http://www.tees.ac.uk/sections/about/visiting/travel.cfm)

can be found online.

**Research in Imagery and Observation**

**2019 Conference Schedule**

**Thursday 25th April**

|  |  |
| --- | --- |
| **08.30 – 09.00** | **Registration** (Foyer in front of lecture theatre, Centuria Building) |
| **09.00 – 09.20** | **Welcome and Introduction** (Lecture Theatre H0.01, Centuria Building) |
| **09.20 – 10.40** | **Oral Session 1: Motor imagery: Motor learning and rehabilitation** (Lecture Theatre H0.01, Centuria Building) |
| 09.20 | **Jack P. Solomon**, Sarah N. Kraeutner, Shaun G. Boe  Dalhousie University  **Investigating the role of the supplementary motor area in motor imagery based skill acquisition** |
| 09.40 | **Sarah N. Kraeutner**, Jennifer L. McArthur, Alexandra Stratas, Shaun G. Boe  Dalhousie University  **Exploring the evolution of skill acquisition via motor imagery** |
| 10.00 | **Theresa Gaughan,** Taylor Prentice, Shaun G. Boe  Dalhousie University  **Exploring the optimal dosage of motor imagery for upper-limb rehabilitation post-stroke** |
| 10.20 | **Jack A. Binks,** Paul Van Schaik, Christopher Wilson, Matthew Scott, Jonathan Emerson, Daniel L. Eaves  Teesside University  **Motor imagery during action observation enhances motor re-learning in stroke** |
| **10.40 – 11.40** | **Coffee Break and Poster Session: Imagery and Observation across Domains** (Foyer in front of lecture hall, Centuria Building)  *Complementary Tea/Coffee Available*  **Paul D.E. Baniqued**, E. Stanyer, F. Mushtaq, M. Awais, A. Alazmani, A. Jackson, M. Mon-Williams, R. Holt  University of Leeds  **Motor imagery and brain-computer interfaces for hand rehabilitation after stroke: A systematic review**  **Judith Bek1**, Aline Arakaki1, Matthew Sullivan2, Ellen Poliakoff1  1University of Manchester, 2 Manchester Metropolitan University  **The role of action representation in dance for people with Parkinson’s**  **Jayesha Chudasama**, Gorana Pobric, Shaheen Hamdy, Cheryl Capek  University of Manchester  **Using action observation, imagination and imitation to learn meaningful associations between nonsense actions and abstract symbols**  **Samantha Chye1**, Ceri E. Diss1, David A. Shearer2, Adam M. Bruton1  1University of Roehampton, 2University of South Wales  **The effects of combined action observation and motor imagery on self-efficacy and learning in Brazilian jiu-jitsu athletes**  **Zoe Franklin,** David Wright, Paul Holmes  Manchester Metropolitan University  Using action congruent language facilitates the motor response during action observation: A combined TMS and eye tracking study  **Ryan Kenny,** Arash Abdolazimi, Jonathan Emmerson, Matt Scott, Paul Chesterton, Daniel L. Eaves  Teesside University  **Acute treatments effects for motor imagery during action observation on postural control during quiet standing**  **JungWoo Lee**, Sarah Kraeutner, Devan Pancura, and Shaun Boe  Dalhousie University  **Duration of motor imagery performance impacts cortical excitability**  **Cormac McLoughlin-Gavin1,** David Shearer2, Adam Bruton1  1University of Roehampton, 2University of South Wales  **Comparing simulation-based methods as pre-performance interventions for semi-professional cricket batsmen**  **Ellen Poliakoff1,** Judith Bek1, Chesney Craig2, Zoe Franklin2, Matthew Sullivan2, Emma Gowen1, Stefan Vogt3, Trevor Crawford3, Paul Holmes2  1University of Manchester, 2Manchester Metropolitan University, 3Lancaster University  **Action Imagery and Observation in Neurorehabilitation for Parkinson’s Disease (ACTION-PD): A pilot RCT of a home-based intervention to improve functional actions**  **Gabriel David Valadez Roque1,** Alvaro Florencio Torres Chávez2  1Instituto Nacional de Rehabilitación, 2 Universidad Nacional Autónoma de México  **Effects of action observation plus motor imagery on the recovery of paretic hand in stroke patients**  **Matthew Scott,** Jonathan Emerson, Adam Gilmartin, Daniel Eaves  Teesside University  **Motor imagery during action observation modulates automatic imitation in aging individuals**  **Hayley Shepherd,** Judith Bek, Emma Gowen, Ellen Poliakoff  University of Manchester  **How do people with Parkinson’s watch other people’s actions?**  David Wright1, Gavin Buckingham2, **Greg Wood1**  1Manchester Metropolitan University, 2University of Exeter  **Corticospinal excitability markers of embodiment with a prosthesis: A pilot study**  **Andrei Zarie,** L. O’Hare, P.M.J. Pollux  University of Lincoln  **Emotional body expressions modulate steady-state visually evoked potentials** |
| **11.40 – 13.20** | **Oral Session 2:** **Combined Action Observation and Motor Imagery: Theoretical issues and behavioural effects** (Lecture Theatre H0.01, Centuria Building) |
| 11.40 | **Adam M. Bruton1**, Zoe C. Franklin2, Paul S. Holmes2, Daniel L. Eaves3 & David L. Wright2  1University of Roehampton, 2Manchester Metropolitan University, 3Teesside University  **Corticospinal excitability and eye gaze markers of different combined action observation and motor imagery states** |
| 12.00 | **Jonathan Emerson,** Paul van Schaik, Matthew Scott & Daniel Eaves  Teesside University  **fNIRS and behavioural correlates of motor imagery during action observation in people with depression and agency misattribution** |
| 12.20 | **Matthew Scott,** Jonathan Emerson, John Dixon, Martin Tayler & Daniel L. Eaves  Teesside University  **The effect of motor imagery during action observation on imitation of familiar rhythmical actions in children with and without developmental coordination disorder** |
| 12.40 | **Eoghan McNeill,** Niall Ramsbottom, Adam J Toth, Mark J Campbell  University of Limerick  **The combined effect of action observation and motor imagery (AO+MI) on golf putting performance** |
| 13.00 | **Cornelia Frank1,** Felix Hülsmann1, Thomas Waltemate1, David Wright2, Daniel L. Eaves3, Adam Bruton4, Mario Botsch1, Thomas Schack1  1Bielefeld University, 2Manchester Metropolitan University, 3Teesside University, 4University of Roehampton  **AO+MI in virtual reality: Practicing at a level that one has not yet achieved** |
| **13.20 – 14.00** | **Lunch Break (Cafeteria)**  *Hot Food and Sandwiches Available for Purchase* |
| **14.00 – 15.00** | **Invited Talk 1** (Lecture Theatre H0.01, Centuria Building)  **Richard Ramsey**  Bangor University  **Cognitive and brain mechanisms of social perception and interaction** |
| **15.00 – 16.00** | **Coffee Break and Poster Session: Imagery and Observation across Domains** (Foyer in front of lecture hall, Centuria Building)  *Complementary Tea/Coffee Available*  *For posters, see first Coffee Break and Poster Session of 2019 RIO Meeting* |
| **16.00 – 17.00** | **Research in Imagery and Observation – Fostering Collaboration/Networking Session** |
| **17.00 – 17.15** | **Annual Group Meeting Photo** (Entrance Hall, Centuria Building) |
| **17.15 – 17.45** | **Tobii Pro Demonstration** (Lecture Theatre H0.01, Centuria Building) |
| **18.30** | **Meet for Drinks** – The Dickens Pub, 4 Southfield Rd, Middlesbrough TS1 3BZ |
| **19.30** | **Conference Dinner** – ‘The Oven’ restaurant 206-209 Linthorpe Rd, Middlesbrough TS1 3QW |

**Research in Imagery and Observation**

**2019 Conference Schedule**

**Friday 26th April**

|  |  |
| --- | --- |
| **09.15 – 09.30** | **Welcome and Introduction** (Lecture Theatre H0.01, Centuria Building) |
| **09.30 – 10.50** | **Oral Session 3: Visual Attention and Action Observation** (Lecture Theatre H0.01, Centuria Building) |
| 09.30 | **Maaike W.H.H. Esselaar,** Zoe Franklin , David Wright, Dave Smith, Paul Holmes  Manchester Metropolitan University  **The effect of personality type on attentional bias and its manipulation in patients with chronic back pain** |
| 09.50 | **Daniel T. Smith1,** Neil Archibald2, Dr Soazig Casteau1  1Durham University, 2 South Tees NHS Hospitals Trust  **The role of the oculomotor system in spatial working memory** |
| 10.10 | **Soazig Casteau,** Jacob Hathaway, Amanda Ellison, Daniel T. Smith  Durham University  **Do the eye-movement system and the hand-movement system contribute independently to attentional orienting: a TMS study** |
| 10.30 | **Shiau-Chuen Chiou,** Thomas Schack  Bielefeld University  **Is temporal information integrated with spatial information during action observation? Effects of visual attention on the processing of whole-body movement sequences** |
| 10.50 | **Judith Bek1,** Emma Gowen1, Stefan Vogt2, Trevor Crawford2, Ellen Poliakoff1  1University of Manchester, 2Lancaster University  **Imitation of biological movement in Parkinson’s disease: a kinematic and eye-tracking study** |
| **11.10 – 11.50** | **Coffee Break and Poster Session: Imagery and Observation across Domains** (Foyer in front of lecture hall, Centuria Building)  *Complementary Tea/Coffee Available*  *For posters, see first Coffee Break and Poster Session of 2019 RIO Meeting* |
| **11.50 – 12.50** | **Invited Talk 2** (Lecture Theatre H0.01, Centuria Building)  **Robert Hardwick**  KU Leuven  **Neural correlates of action: Comparing meta-analyses of imagery, observation, and execution** |
| **12.50 – 13.30** | **Lunch Break (Cafeteria)**  *Hot Food and Sandwiches Available for Purchase* |
| **13.30 – 14.00** | **Discussion Session** (Lecture Theatre H0.01, Centuria Building)  **Stefan Vogt and Daniel L. Eaves: Future Directions for Research in Imagery and Observation?** |
| **14.00** | **Conference End** (*optional* social activity) |

**Abstracts for Invited Speakers**

|  |
| --- |
| **Invited Talk 1**  **Richard Ramsey,** Bangor University  **Cognitive and brain mechanisms of social perception and interaction**  The ability to perceive and interact with others occurs in an effortless manner, but is underpinned by complex cognitive and neural processes. In this talk, I review recent evidence from behavioural and brain imaging studies that uncover deeper insight into social cognition and brain function. Using examples from action learning, imitation, person perception and theory of mind paradigms, I highlight the importance of considering distributed and connected brain circuits when aiming to understand how we perceive and interact with others in a social world. Looking forward, I suggest that if we want to make greater progress in psychology and neuroscience, we have to fully embrace recent Open Science initiatives that advocate scientific best-practice, in order to enable a more cumulative science to develop. |

**Invited Talk 2**

**Robert Hardwick**, KU Leuven

**Neural correlates of action: Comparing meta-analyses of imagery, observation, and execution**

Several established models have proposed that the mental simulation of action through motor Imagery and/or action observation shares common neural substrates with movement execution. Recently, we examined this theory by producing a quantitative synthesis of the brain regions consistently recruited by these tasks as shown in current neuroimaging literature. We compared the brain regions consistently associated with motor imagery (303 experiments, 4,902 participants), action observation (595 experiments, 11,032 participants), and control tasks involving movement execution (142 experiments, 2,302 participants). Motor imagery and action observation recruited generally similar premotor-parietal cortical networks. However, while motor imagery and movement execution both consistently recruited subcortical and cerebellar regions, action observation did not. These data provide a quantitative summary of the similarities in the brain networks underlying motor imagery, action observation, and movement execution, but also highlight key differences in their recruitment of the primary motor cortex, parietal cortex, and subcortical structures. These results question theories of 'functional equivalence' between mentally simulated and physically executed actions, and highlight that alternative models are required to improve our understanding of action simulation.

**Abstracts for Oral Presentations**

|  |
| --- |
| **Jack P. Solomon**, Sarah N. Kraeutner, Shaun G. Boe  Dalhousie University  **Investigating the role of the supplementary motor area in motor imagery based skill acquisition**  Inhibition of the inferior parietal lobe (IPL) impairs motor imagery (MI)-based learning of an implicit sequence task, whereas inhibition of the primary motor cortex does not. Collectively with other research, this suggests the IPL is an important substrate in MI-based motor learning. To better understand the role of the IPL in MI-based learning, it is important to investigate other brain regions involved in motor execution (ME) and learning, as well as MI. One such region is the supplementary motor area (SMA), which has been implicated in implicit motor learning and with sequential motor tasks when learning via ME, but whose role in MI-based motor learning is not precisely known. This study sought to determine if inhibition of the SMA via repetitive transcranial magnetic stimulation (rTMS) affects MI-based implicit motor learning. Participants (n=60) will be randomly assigned to one of four groups that receive either real (rTMS) or sham stimulation and who complete the task via ME or MI. Immediately following stimulation, participants complete an implicit sequence task where they respond to auditory cues by imagining/actually pressing a corresponding key. A repeated (implicit) sequence is embedded within random sequences. Following training reaction times (RTs) to the repeated and random sequences are determined via actual performance. Learning is assessed by calculating RT differences between repeated and random sequence RTs. We anticipate rTMS to the SMA will impair learning in the ME, but not MI, group, with no impairment to learning observed in the sham stimulation groups. |
| **Sarah N. Kraeutner**, Jennifer L. McArthur, Alexandra Stratas, Shaun G. Boe  Dalhousie University  **Exploring the evolution of skill acquisition via motor imagery**  Despite evidence supporting the effectiveness of motor imagery (MI) for skill acquisition, we lack knowledge related to the mechanism underlying it. Here, we examined the evolution of skill acquisition via MI by 1) directly comparing howdifferences between MI and physical practice (PP) manifest after equivalent training, and 2) examining the effect of MI-based training applied either prior to, or after PP-based training.Participants (*N* = 24) engaged in ten days of training of a dart-throwing task, involving either five days of PP followed by five days of MI (PP-MI), or MI followed by PP (MI-PP). Performance-related outcomes and brain activity (functional magnetic resonance imaging; fMRI) were obtained at three time points (pre-, mid-, and post-training). Comparing an equal amount of training (after day five) demonstrated that MI led to smaller improvements in performance relative to PP (evidenced via effect sizes). fMRI between-group analyses at this time point revealed additional activation for the PP group (PP > MI), localized to regions including primary motor cortex, supplementary motor area, and cerebellum. Overall (after day ten), greater performance was observed when MI preceded PP. Further, no between-group differences in brain activation were observed post-training. Findings indicate that an equal dose of MI is inferior to PP in driving skill acquisition. Yet, MI is most effective in the early stage of skill acquisition and as a primer to PP. Ultimately, this work provides new information related to the mechanism of how skill acquisition occurs via MI. |
| **Theresa Gaughan,** Taylor Prentice, Shaun G. Boe  Dalhousie University  **Exploring the optimal dosage of motor imagery for upper-limb rehabilitation post-stroke**  Despite the use of motor imagery (MI) in post-stroke rehabilitation, there is a lack of consensus for optimal dosage of MI-based therapy. Specifically, disparity within the literature exists that is linked to heterogenous dosage regimens, and systematic reviews have been unable to provide clear dosage guidelines due to a limited number of studies and small sample sizes. By analyzing a large body of literature, optimal MI dosage may be determined and used to generate a standardized prescription in research and clinical practice. The present study, an exploratory scoping review, aimed to investigate the relationship between dosage of MI therapy and motor recovery of the upper limb post-stroke. We anticipate the relationship between MI dosage and upper limb motor recovery will be mediated by practice dosage, treatment regimen, or the outcome measure used. Studies included adult (>18 years) survivors of ischemic or hemorrhagic stroke with chronic (>3 months post-stroke) upper limb impairment in the form of hemiparesis. A literature search will be conducted in Medline, CINAHL, and EMBASE using comprehensive subject headings and keywords relating to two major concepts: MI and stroke. Papers will be selected for inclusion using a three-phase article review process. Dose response curves comparing the change scores for each outcome measure used across studies to the total dosage of MI. Data will be graphically summarized to identify trends between dose and treatment response. Findings will inform on optimal parameters of MI training for stroke rehabilitation. |
| **Jack A. Binks,** Paul Van Schaik, Christopher Wilson, Matthew Scott, Jonathan Emerson, Daniel L. Eaves  Teesside University  **Motor imagery during action observation enhances motor re-learning in stroke**  While stroke is a leading cause of motor deficiency, physical therapy aims to reduce these movement inequalities. When physical therapy is not possible or appropriate, both action observation (AO) training and motor imagery (MI) therapy are recommended. Here we compare these two mental practice techniques against a novel combination of action observation and motor imagery (AO+MI) therapy in post-stroke patients. The within-subjects design involved participants (*n* = 10) mentally practicing three variations of a complex bilateral cup-stacking action under the three different instruction conditions in a counterbalanced order. Once a week, over five consecutive weeks, participants performed 16 trials under each instruction condition. Each trial displayed a first-person perspective visual of a cup-stacking action performed by an experienced model. For AO participants watched each video and responded to an occasional colour cue. For MI participants imagined the effort and sensation of performing the action; cued by still-images showing the sequence of the target action. For combined AO+MI participants observed a video of the target action while they imagined performing the same action in real-time. At three time points (baseline; six-week post-test; two-week retention test) participants physically executed the three practiced sequences, plus a fourth unpracticed sequence (control condition) as quickly and accurately as possible. Movement execution times significantly reduced over time in all instruction conditions. Execution was also significantly faster at retention in the combined AO+MI condition compared to both AO and the control. Combined AO+MI is therefore a potentially more effective adjunct in chronic stroke rehabilitation. |

|  |
| --- |
| **Adam M. Bruton1**, Zoe C. Franklin2, Paul S. Holmes2, Daniel L. Eaves3, David J. Wright2  1University of Roehampton, 2Manchester Metropolitan University, 3Teesside University  **Corticospinal excitability and eye gaze markers of different combined action observation and motor imagery states**  Existing research investigating combined action observation and motor imagery (AO+MI) has largely focused on observing and imagining the same movement. Based on the dual-action simulation hypothesis (see Eaves, Riach, Holmes, & Wright, 2016), representations of observed and imagined actions can be maintained concurrently and either merge or compete based on their relevance towards ongoing action plans. Single-pulse transcranial magnetic stimulation (TMS) and eye-tracking were used to explore this hypothesis using three different AO+MI states (*congruent*, *coordinative*, and *conflicting*) for an index finger abduction-adduction movement. The amplitude of motor evoked potential responses following TMS to the left primary motor cortex were recorded from the first dorsal interosseous (FDI) and abductor digiti minimi (ADM) muscles of the right-hand. When controlling for the influence of relevant eye movements, corticospinal excitability was facilitated relative to controls in the concurrently observed and imaged muscles for both *congruent* and *coordinative* AO+MI conditions. Specifically, when controlling for fixations on the index finger, results indicated that *congruent* and *coordinative* AO+MI conditions facilitated corticospinal excitability in the FDI muscle compared to control and *conflicting* AO+MI conditions. Additionally, when controlling for fixations on the little finger, results indicated that *coordinative* AO+MI facilitated corticospinal excitability in the ADM muscle relative to all other conditions. Eye-movement metrics and social validation data from post-experiment interviews were used to provide insight into the mechanisms underlying these effects. The findings provide compelling support for the dual-action simulation hypothesis, by indicating for the first time that it is possible to co-represent observed and imaged actions simultaneously. |
| **Jonathan Emerson,** Paul van Schaik, Matthew Scott, Daniel Eaves  Teesside University  **fNIRS and behavioural correlates of motor imagery during action observation in people with depression and agency misattribution**  Combined action observation and motor imagery (AO+MI) instructions can increase automatic imitation effects in healthy adults. Across two studies we assessed if depression and agency misattribution influence these automatic imitation effects along with the neurophysiological correlates. On each trial participants viewed an action picture: rhythmical face-washing or paint-brushing in either the horizontal or vertical plane. Before executing this action, participants saw a rhythmical distractor action video, with a subtle speed manipulation across trials (fast vs. slow). The instructed and distractor actions either matched or differed both in action type and plane of motion. Automatic imitation was quantified across trials as an imitation bias in movement execution speeds in response to the distractor speed manipulations. The instruction conditions were manipulated across four blocks of sixteen trials in a counterbalanced order. Participants engaged in distractor action observation (AO), observed while imagined the same action (AO+MI), purely imagined the action (MI), or intentionally imitated the distractor speed. In Study One the imitation bias was significantly greater in healthy adults (*n* = 14) both for AO+MI and intentional imitation compared to AO or MI instructions. fNIRS recordings showed AO+MI produced significantly greater activation of medial BA10 compared to AO, MI and intentional imitation, lateralized to the left hemisphere. Study Two aimed to replicate this effect in healthy adults (*n* = 11) compared to participants with either depression (*n* = 10) or depression and agency misattribution (*n* = 11). While all data is collected, the analysis is ongoing for both the kinematic and fNIRS data. |
| **Matthew Scott,** Jonathan Emerson, John Dixon, Martin Tayler, Daniel L. Eaves  Teesside University  **The effect of motor imagery during action observation on imitation of familiar rhythmical actions in children with and without developmental coordination disorder**  Our previous research in children both with and without movement difficulties showed enhanced automatic imitation effects following motor imagery during action observation (AO+MI). Using a similar paradigm, we further investigated the effects of AO+MI on intentional imitation in children aged 7-12 years old. On each trial participants intentionally imitated a target action that was either a habitually slow (face washing or paint brushing) or habitually fast rhythmical action (tooth brushing or window wiping) in either the horizontal or vertical plane. Prior to execution, participants saw an image of the target action before observing a 4 second video of the same action. Within each habitual speed, movement cycle times were covertly manipulated across trials (fast vs. slow). The task instructions were manipulated across 3 blocks of 16 trials. First participants observed with the intent to imitate the target action (intentional imitation). The subsequent two blocks were delivered in a counterbalanced order across participants. In the motor imagery condition (MI), participants first observed the target action video. They then imagined performing for 4 seconds before they physically copied this action. Participants also undertook combined action observation and motor imagery (AO+MI) before imitating the target action. Preliminary data (*n* = 9) indicates more accurate copying for combined AO+MI instructions (135%) compared to both the intentional imitation (129%) and MI instructions (125%). Data collection and analysis is ongoing. |
| **Eoghan McNeill,** Niall Ramsbottom, Adam J Toth, Mark J Campbell  University of Limerick  **The combined effect of action observation and motor imagery (AO+MI) on golf putting performance**  Motor imagery (MI) and action observation (AO) are motor simulation interventions that have been repeatedly shown to enhance motor skill performance. Traditionally, MI and AO have been examined independently of one another; however recent experimental evidence suggests added benefit when MI and AO are used concurrently (AOMI) to augment motor learning and performance (Romano-Smith et al., 2018; Scott et al., 2017). Given the promising initial experimental findings related to AOMI, the purpose of the current study was to determine the effect of an AOMI intervention on golf putting performance. Golf putting is a suitable, widely used (Frank et al., 2018; Kim et al., 2017) exemplar motor skill. Forty-four right-handed male golfers were assigned to one of two experimental groups as part of a pre-test versus post-test design. Both groups completed 20 putts to a target from a distance of 15 feet. Following either a period of AOMI (Intervention Group; N=22) or passive reading (Control Group; N=22), participants completed 20 more putts. Putting performance was measured using mean radial error (MRE) from the target and kinematic variables measured using a SAM PuttLab device, this kinematic data is yet to be analysed. A one-way ANCOVA with baseline performance as a covariate compared the post-performance MRE between the AOMI intervention and control groups. Differences were reported between groups for MRE with findings approaching statistical significance [F(1)=3.872, *p*=.056]. Moreover, a moderate positive effect was demonstrated for AOMI’s effect on performance (*d*=.614). Findings are discussed in the context of both current literature and future research. |
| **Cornelia Frank1,** Felix Hülsmann1, Thomas Waltemate1, David Wright2, Daniel L. Eaves3, Adam Bruton4, Mario Botsch1, Thomas Schack1  1Bielefeld University, 2Manchester Metropolitan University, 3Teesside University, 4University of Roehampton  **AO+MI in virtual reality: Practicing at a level that one has not yet achieved**  Combining motor imagery during action observation (AO+MI) can be effective in improving motor performance (for a review, see Eaves, Riach, Holmes, & Wright, 2016). Modeling future states of action (Law, Post, & McCullagh, 2017) during AO+MI, however, has not yet been addressed. Using an immersive, state-of-the-art, low-latency cave automatic virtual environment (Waltemate, Hülsmann, Pfeiffer, Kopp, & Botsch, 2015), we compared AO+MI of one’s current state of performance to AO+MI of one’s future state of performance. After having performed 3D scans and having created ready-to-animate virtual humans of each participant, we assigned novice participants to one of two groups: a self-appearance/current performance level group (Me-Current) and a self-appearance/future performance level group (Me-Future). During acquisition, participants simultaneously imagined whilst observing an avatar of themselves either performing one of their previously executed squats or performing a squat of an expert model. We measured movement quality, mental representation structure, and self-efficacy of the squat. Preliminary findings revealed an advantage of the Me-Future group as compared to the Me-Current group in motor (i.e. movement quality), cognitive (i.e. mental representation structure) as well as motivational (i.e. self-efficacy) variables. These findings indicate that simultaneous imagery whilst observing future states of action may help establish both cognitive and motivational prerequisites that enable better motor performance. To this end, virtual reality is a promising tool to create environments for imagery and observation research that exceed real-world opportunities. |

|  |
| --- |
| **Maaike W.H.H. Esselaar,** Zoe Franklin , David Wright, Dave Smith, Paul Holmes  Manchester Metropolitan University  **The effect of personality type on attentional bias and its manipulation in patients with chronic back pain**  One in three people living in the UK are affected by back pain. Over the last decade research into psychological factors that influence the experience of back pain suggests that the differences in pain experience can be found in the attentional bias towards threat stimuli. Attentional bias refers to the preference of an individual’s attention towards stimuli (or parts of a stimulus) that is related to their current state. Individuals with chronic pain have an attentional bias directed towards pain related information in comparison to non-symptomatic controls. Theories of attention and pain hypothesise that manipulation of an individual’s attentional bias may lead to positive clinical outcomes. Currently, attentional bias manipulation methods (ABM) have resulted in mixed results. These mixed results may be due to the assumption that chronic pain patients are a homogenous group. Recent research found that different personality types (divided by anxiousness and defensiveness) have different attentional biases towards pain. The aim of this PhD project is to enhance the understanding of the attentional biases of different personality types on attentional bias and develop a new ABM method. Three experiments are proposed to 1) determine if there is a difference in attentional bias between the different personality types with chronic back pain and non-symptomatic controls. 2) ascertain the muscular and cognitive differences during action observation and action performance between different personality types with chronic back pain and non-symptomatic controls and 3) develop and test a new ABM intervention. Using new methods such as eye-tracking and virtual reality to gain new insights. |
| **Daniel T. Smith1,** Neil Archibald2, Soazig Casteau1  1Durham University, 2 South Tees NHS Hospitals Trust  **The role of the oculomotor system in spatial working memory**  The neural and cognitive mechanisms of spatial working memory are tightly coupled with the systems that control eye-movements but the precise nature of this coupling is not well understood. In particular, there are very few neuropsychological studies that explicitly examine how deficits of oculomotor control affect visuospatial working memory. In this study we examined the link between spatial working memory and the oculomotor system in a sample of patients with Progressive Supranuclear Palsy (PSP), a degenerative neurological disease characterised by defective vertical eye-movements but relatively preserved horizontal eye-movements. Consistent with the idea that the oculomotor system plays a critical role in spatial working memory performance, people with PSP had significantly shorter spatial spans when stimuli were presented along the vertical axis compared to the horizontal axis. This effect was not observed in age matched controls, or in a control group of patients with Parkinson’s disease. We hypothesize that PSP disrupts a colliculo-parietal feedback loop that contributes to the maintenance of activation in a parietal priority map during the delay period. This result is the first direct neuropsychological evidence for an association between oculomotor function and spatial working memory and replicates our previous finding that experimentally restricting saccade programming disrupts spatial memory in healthy participants. These results are broadly consistent with idea that rehearsal in visuospatial working memory is mediated by an ‘oculomotor loop’, as proposed by [Baddeley (1986)](#_ENREF_5). We conclude that optimal spatial working memory performance depends on an intact oculomotor system. |
| **Soazig Casteau,** Jacob Hathaway, Amanda Ellison, Daniel T. Smith  Durham University  **Do the eye-movement system and the hand-movement system contribute independently to attentional orienting: a TMS study**  Saccadic eye-movements and arm-movements are preceded by a shift of attention. Previous studies reported that attentional resources are allocated independently for eye and hand movements, implying separate attentional mechanisms. It is well established that Frontal Eye Fields (FEF) have a central role in the deployment of spatial attention, more specifically in the coupling between eye-movements and attention. The question remains whether this brain region is also involved in the coupling between arm-movements and attention. Using MRI guided Transcranial Magnetic Stimulation (TMS), we stimulated FEF in order to 1) test for separate pre-motor attentional mechanisms for eye and arm movement, and 2) further describe the role of the FEF in attentional orienting. TMS over FEF increased saccade latency and delayed the onset of pointing movements. We also observed that TMS over FEF perturbed pre-saccadic perception, with a larger effect when the discrimination target appeared contralateral to the saccade endpoint. Interestingly, perceptual performance was less affected by TMS in the pointing condition. This suggests that, as previously reported, attentional resources for eye and arm movements are allocated independently. |
| **Shiau-Chuen Chiou,** Thomas Schack  Bielefeld University  **Is temporal information integrated with spatial information during action observation? Effects of visual attention on the processing of whole-body movement sequences**  Spatial and temporal information are two major components of human movements. Although the temporal information, such as rhythm, is physically conveyed through spatial information, i.e., trajectory, whether these two types of information are integrated during action observation or are processed separately as individual features remains unclear. In two experiments, we used a dual-task paradigm, in which participants performed a change detection task on whole-body movement sequences with different foci of attention: (a) temporal-only, (b) spatial-only and (c) both. Movement sequences, all without action semantics, could be different in either temporal (rhythm) or spatial (trajectory) domain in accordance with respective attention requirements. The results showed that, when the task difficulty was low, an additional spatial processing did not impair temporal processing; however, when the task difficulty was high, participants’ performance was significantly impaired when both temporal and spatial information were attended to as compared to only either of them was in focus. Furthermore, a comparable dual-task cost in temporal and spatial domains, respectively, indicated that there was no trade-off or prioritization between the processing of temporal and spatial information. In conclusion, although the temporal processing relies on a certain level of spatial processing during action observation, no further integration was observed in the current study. A mutual interference suggests that these two information streams are processed separately and compete for a common pool of cognitive resources. |
| **Judith Bek1,** Emma Gowen1, Stefan Vogt2, Trevor Crawford2, Ellen Poliakoff1  1University of Manchester, 2Lancaster University  **Imitation of biological movement in Parkinson’s disease: a kinematic and eye-tracking study**  Action observation (AO) and imitation have been found to facilitate movement in Parkinson’s disease (PD). However, simple visual cues can also elicit movement in PD, and action representation may be altered, with neuroimaging findings suggesting an increased reliance on visual processing. It is therefore unclear whether AO can exert a stronger influence on movement than simple visual cues. This study examined the effects of observing human movement, compared with a simple moving cue, on hand and eye movements in people with PD and healthy older adults. Participants with mild to moderate PD (*N*=22) and age-matched controls (*N*=23) observed and imitated videos of sequential movements with a high or low trajectory, depicted by either a human hand or a simple shape. Hand kinematics were recorded and modulation of movement amplitude provided a measure of imitation. Eye movements were also recorded to explore mechanisms during observation. Although the PD group made slower and smaller movements overall, both groups exhibited increased modulation of movement amplitude when observing the human hand than with the simple cue. Participants made smaller saccades and fixated the end point earlier when watching the hand, suggesting that it was attended to more closely. The results indicate that people with mild to moderate PD and healthy older adults observe and imitate stimuli with a human appearance more closely than simple moving cues. These findings suggest the importance of stimulus appearance for imitation, and support the use of action observation as a tool for rehabilitation of manual tasks in PD. |

**Abstracts for Poster Presentations**

**Paul D.E. Baniqued**, E. Stanyer, F. Mushtaq, M. Awais, A. Alazmani, A. Jackson, M. Mon-Williams, R. Holt

University of Leeds

**Motor Imagery and Brain-Computer Interfaces for Hand Rehabilitation After Stroke: A Systematic Review**

Background: Motor imagery-based brain-computer interfaces allow the control of robotic devices to aid stroke patients during upper limb therapy. Hand rehabilitation is a core component in regaining activities of daily living while hand motor imagery promotes neuroplasticity through patient-driven motor planning without execution. This systematic review examines recent developments in MI-BCI-robotic systems for hand rehabilitation to identify evidence-based clinical studies on stroke patients. Methods: Studies involving BCI-robotic systems for hand rehabilitation using various databases were selected. Search terms included brain-computer interface, brain-machine interface, electroencephalography, stroke, hand, rehabilitation or therapy, exoskeleton or orthosis, and robotic or device. Data fields include those related to study design, participant characteristics, technical specifications of the system, and clinical outcome measures. Results: 24 studies were identified as eligible for qualitative review. 7 studies are involved in testing the BCI-robot on stroke patients. Improvements in FMMA and ARAT scores have been observed for BCI-robot interventions as compared to controls. The degree of BCI-robot control for majority of the studies is limited to triggering the device to perform grasping or pinching movements using motor imagery. In terms of matching sensory feedback, most systems employ a combination of proprioceptive and visual response. Conclusion: The majority of studies on BCI-robotic systems for hand rehabilitation report systems at prototype or pre-clinical stages of development. Whilst there are several studies reporting significant improvements in the functional recovery of stroke patients, the lack of a standard protocol in assessing such clinical outcomes may undermine its argument as a viable therapy option post-stroke.

**Judith Bek1**, Aline Arakaki1, Matthew Sullivan2, Ellen Poliakoff1

1University of Manchester, 2 Manchester Metropolitan University

**The role of action representation in dance for people with Parkinson’s**

Dance involves action observation (AO), imitation and motor imagery (MI), and increases in cortical activity associated with the AO network have been found following physical and observational dance training, as well as changes in MI. Dance is an increasingly popular therapeutic activity for people with Parkinson’s disease (PD), with a range of motor and non-motor effects reported. Internal representation of action through AO, imitation and MI may contribute to these benefits; moreover, dance may develop skills in using AO and MI for everyday tasks. However, while dance classes for PD frequently draw on imagery and imitation, action representation in dance for PD is largely unexplored; only one study has measured the effects of dance on MI ability. We investigated the use of AO and MI within a dance class for people with PD. A 6-week pilot programme was co-developed by researchers, dance artists and people with PD, incorporating imagery and imitation. Quantitative (pre/post measures) and qualitative (focus group) data were collected to explore action representation. Eight participants with mild-to-moderate PD completed pre- and post-assessments. No change in explicit motor imagery was found, but there were trends for increased emotion recognition and embodiment of observed dance. Participants reported using imitation and imagery within classes, as well as applying MI to everyday tasks beyond the dance studio. These preliminary findings suggest that people with PD may benefit from action observation, imitation and imagery within dance classes, and that dance could equip individuals with skills in using MI to facilitate everyday movement.

**Jayesha Chudasama**, Gorana Pobric, Shaheen Hamdy, Cheryl Capek

University of Manchester

**Using action observation, imagination and imitation to learn meaningful associations between nonsense actions and abstract symbols**

The meanings of new gestures are often learned by forming associations with words. The present study examined whether adults can learn the meanings of new gestures and retain associations without using an already known vocabulary. A set of nonsense gestures conveyed manually, orally or via both hand and mouth, were paired with two-dimensional, abstract symbols. To elucidate how motor regions can facilitate learning, associations between gesture-symbol pairs were taught using three different strategies that involve different levels of movement: passive observation, motor imagery and overt imitation. A group of native English speakers were tested in this within-participants experiment. For each stimulus pair, the gesture was presented before a corresponding symbol. No explicit instructions for learning the pairs were given in the passive observation condition. In the imagery condition, participants were instructed to imagine themselves performing the action and in the imitation condition, participants explicitly performed the gesture. After learning, participants were shown each gesture and selected the corresponding symbol using a forced-choice recognition test. Preliminary results show that nonsense gesture and abstract symbol pairs can be learned to a high degree of accuracy. Imagining and overtly imitating gestures facilitates retention of associations between stimuli pairs better than when learned by passive observation alone. This supports research that shows learning meaningful actions is facilitated by motor imagery and enactment. To further understand the motor mechanisms involved, we are also recording motor-evoked potentials (MEPs) to examine the extent to which articulator-specific motor excitability is modulated by learning strategy.

**Samantha Chye1**, Ceri E. Diss1, David A. Shearer2, Adam M. Bruton1

1University of Roehampton, 2University of South Wales

**The effects of combined action observation and motor imagery on self-efficacy and learning in Brazilian jiu-jitsu athletes**

Neuroscientific literature has demonstrated that cortico-motor activity is increased when an individual simultaneously observes and imagines (AO+MI) a movement compared to independent simulation (AO or MI) for the same movement. Based on this increased activity, researchers have proposed AO+MI can lead to improved execution of a movement, as supported by recent findings demonstrating improved performance across various simple motor tasks. However, existing studies have yet to systematically explore the effects of AO+MI on motor learning for more complex movement sequences. Therefore, this doctoral programme will explore the effectiveness of different combinations of AO+MI on motor learning in Brazilian jiu-jitsu (BJJ), a sport where individuals are required to synchronize multiple movements across a sequence and couple these with the actions of an opponent:

|  |  |
| --- | --- |
| Study 1: | Exploring the influence of perspective of AO (first-person vs third-person) on the effectiveness of AO+MI for motor learning in novice BJJ athletes |
| Study 2: | Investigating if the observed agents (self vs other) influence the effectiveness of AO+MI for motor learning in moderately skilled BJJ athletes |
| Study 3: | Examine the influence of congruency (congruent vs coordinative) of the observed and imagined actions on the effectiveness of AO+MI for motor learning in highly skilled BJJ athletes |

Self-efficacy will be measured across the studies as a key psychological determinant of behavior change, and three-dimensional motion analysis will be used to compare movement kinematics between participants and more skilled performers across learning phases. The findings from each study will be used to inform the AO+MI intervention delivered in subsequent studies.

**Zoe Franklin,** David Wright, Paul Holmes

Manchester Metropolitan University

**Using action congruent language facilitates the motor response during action observation: A combined TMS and eye tracking study**

There is evidence that both action observation (AO) and the processing of action-related words are associated with increased activity in cortical motor regions of the brain. To date, however, research has predominantly examined the effects of both action observation and action verb processing on activity in the motor system independently. The aim of this experiment was to investigate whether the inclusion of auditory action verbs alongside AO stimuli would modulate corticospinal excitability and visual attention. Twenty participants took part in a combined transcranial magnetic stimulation (TMS) and eye tracking protocol. Single pulse TMS was delivered to the hand representation of the left motor cortex during observation of a static hand, AO of a hand squeezing a sponge, AO with an audio recording of the word ‘squeeze’ (AOAV), and AO with an audio recording of the word ‘green’ (AONV). Motor evoked potentials (MEPs) were recorded from the abductor pollicis brevis (APB) and abductor digiti minimi (ADM) muscles of the right hand. Eye tracking was monitored throughout all four conditions. Follow up interviews were conducted to discuss participants’ preferences for each condition and whether imagery was used. The AOAV condition resulted in increased MEPs compared to the other three conditions in the APB muscle. Furthermore, in this condition, participants’ made significantly more fixations on the sponge and reported that they felt as though they wanted to move their hand more. The inclusion of auditory action verbs alongside AO stimuli could have implications for the delivery of AO interventions for motor (re)learning.

**Ryan Kenny,** Arash Abdolazimi, Jonathan Emmerson, Matt Scott, Paul Chesterton, Daniel L. Eaves

Teesside University

**Acute treatments effects for motor imagery during action observation on postural control during quiet standing**

Previous research shows combined action observation and motor imagery (AO+MI) training can increase unperturbed and perturbed balance stability. While physical balance training often uses unstable conditions to promote balance adaptions, the acute effect of combined AO+MI training on quiet single-leg standing has not previously been studied in this context. In this repeated-measures study, we assessed balance in healthy young adults (*n* = 12; mean age = 22.83 ± 1.95yrs) during quiet single-leg standing (with eyes open) both before and after an acute (60 second) exposure to three separate instruction conditions. Action observation (AO) involved watching a model perform a single-leg stance. Motor imagery (MI) required mentally rehearsing (first person perspective) the kinaesthetic sensations of this stance. For combined AO+MI participants performed imagery during observation of the same action. Within each instruction condition the stability of the observed/imagined stance was manipulated across trials (stable vs. unstable). Postural sway was assessed using four measures: the anterior-posterior index (API), anterior-posterior index standard deviation (API-SD), medial-lateral index (MLI), and medial-lateral index standard deviation (MLI-SD). Separate ANCOVAs were used to control for the baseline values. In stable trials MLI significantly reduced for combined AO+MI compared to MI instructions. In the unstable trials, sway significantly increased in API, API-SD and MLI-SD for combined AO+MI compared to AO instructions. Acute exposure to combined AO+MI instructions therefore produced larger postural sway adaptations than either observing or imagining alone. Longitudinal studies can now examine if combined AO+MI yields beneficial adaptations following prolonged balance training under unstable conditions.

**JungWoo Lee**, Sarah Kraeutner, Devan Pancura, Shaun Boe

Dalhousie University

**Duration of motor imagery performance impacts cortical excitability**

Motor imagery (MI) is effective in facilitating motor skill learning and is often used as an adjunct to physical practice. Similar to physical practice, MI leads to an increase in corticospinal excitability (CE)– facilitating brain plasticity and, in turn, motor learning. However, prolonged MI performance is fatiguing, likely resulting in decreased CE over time, making MI-based motor skill learning ineffective. Yet, parameters surrounding practice duration, and more specifically how the length of MI impacts cortical excitability, are not well understood. This study will look at how different MI-block durations effect CE. Participants (N = 36)were randomised into one of three groups that differed only in MI-block duration (2, 4, or 6 min), and engaged in a single session of MI-based practice.CE was assessed using transcranial magnetic stimulation (TMS). TMS was applied to the hand representation of the primary motor cortex as participants performed MI-based practice of unilateral upper-limb tasks (e.g., squeezing a foam ball), eliciting a motor evoked potential, a measurement of CE. We expect to observe a relationship between MI-block length and CE. Specifically, we anticipate a greater decrease in CE with increased MI block length, such that the greatest reduction in CE will be observed in the 4- and 6-min block groups compared to the 2-min block group. Findings from this study will allow us to better understand the relationship between the length of MI training and CE. Ultimately, this work will expand our understanding of the optimal parameters for imagery-based practice to facilitate motor learning.

**Cormac McLoughlin-Gavin1,** David Shearer2, Adam Bruton1

1University of Roehampton, 2University of South Wales

**Comparing simulation-based methods as pre-performance interventions for semi-professional cricket batsmen**

Motor imagery (MI) and action observation (AO) have been shown to facilitate improved performance and enhanced self-efficacy beliefs in athletes. Recent findings suggest that combining these interventions (AO+MI) may improve performance compared to AO or MI in isolation. Self-efficacy is a possible mechanism for this change as the combined intervention has the capacity to provide an athlete with two of the strongest types of efficacy information (Bandura, 1997). Specifically, observation of another performer provides an athlete with vicarious experiences whilst imagery of one’s own successful performance serves to remind an athlete about his/her performance accomplishments. This study used an A-B-A single-case design across a 12-week period to examine the effectiveness of AO, MI and AO+MI interventions for improving the subjective performance and self-efficacy of amateur cricket batsmen during a competitive cricket season. Three participants completed the study in full. During all three phases (pre-intervention, intervention, post-intervention), self-efficacy was recorded immediately before the warm-up and subjective performance ratings were collected after the competitive fixture was complete. For the intervention phase, the respective simulation-based intervention was delivered upon arrival at the ground. Visual and statistical analyses revealed no effects for any of the interventions despite social validation questionnaire and interview data outlining perceived benefits for all batsmen. Several recommendations for future research are discussed, such as the use models closely matched to the observer, while strengths, limitations and potential confounding variables for this study are addressed in this applied context.

**Ellen Poliakoff1,** Judith Bek1, Chesney Craig2, Zoe Franklin2, Matthew Sullivan2, Emma Gowen1, Stefan Vogt3, Trevor Crawford3, Paul Holmes2

1University of Manchester, 2Manchester Metropolitan University, 3Lancaster University

**Action Imagery and Observation in Neurorehabilitation for Parkinson’s Disease (ACTION-PD): A pilot RCT of a home-based intervention to improve functional actions**

Parkinson’s disease can significantly affect manual dexterity, impacting on daily life. We conducted a pilot randomized controlled trial (RCT) of ACTION-PD, which allows individuals to train everyday hand actions at home, using a tablet-based app. The intervention was developed with patient and clinician input and combines action observation and motor imagery, which have been shown to improve movement amplitude in people with Parkinson’s disease, in laboratory settings. Participants with mild to moderate Parkinson’s disease were randomised to the intervention (N=6) or control (N=4) group. Training consisted of video-based observation, imagery and physical practice of five functional manual actions (e.g., fastening buttons), including three selected by the individual, with a target training time of 120 minutes per week for 6 weeks. Participants completed pre and post questionnaires and laboratory-based assessments, and the intervention group were also interviewed. Post-training interviews indicated that the training schedule was acceptable and the app was usable. Participants reported greater awareness of motor imagery, but wanted the option to select different actions for training (e.g., more or less challenging). Preliminary outcome data indicated an 11.3% improvement in self-reported dexterity (DextQ-24) in the intervention group, compared to a 9.8% decline in the control group. This study indicates that this home-based intervention is acceptable to participants and a RCT is feasible. Preliminary outcomes are also promising, with numerical improvements in self-reported dexterity (the primary outcome). Participants’ experiences indicate that the intervention would benefit from a greater choice of actions and feedback.

**Gabriel David Valadez Roque1,** Alvaro Florencio Torres Chávez2

1Instituto Nacional de Rehabilitación, 2 Universidad Nacional Autónoma de México

**Effects of action observation plus motor imagery on the recovery of paretic hand in stroke patients**

Since the first descriptions of Action Observation (AO) and Motor Imagery (MI) as functionally equivalent types of action representation, it has been suggested that both processes could be used for rehabilitation purposes in cases of hand hemiparesis related to brain injury. This study aims to investigate the effects of an AO plus MI (AO+MI) based intervention, complementary to physical rehabilitation for the recovery of force and movement of paretic hand in stroke patients. Six patients, four men and two women, mean age of 53.1 (±11.1) years, received AO+MI treatment that involved observation and imagination of daily living activities (take a spoon or lift a bottle), two times a week, during 6 weeks. Measurements of force (flexion, extension) and movement were carried out before and after the treatment. Repeated measures analysis and K related-samples tests were conducted. Results show significant increases in flexion force (χ2=8.27, p=0.016) and movement (χ2=9.47, p=0.009) but not in extension force (F2=0.58, p=0.578) after treatment. The results of Wilcoxon test for paired comparisons after Bonferroni correction were not significant, however the β error probability were between 36.6% and 41.6%. There is a tendency for recovery of flexion force and movement of the paretic hand in stroke patients after an AO+MI based intervention. Authors hypothesize that AO+MI could function as a ‘simulated’ feedback of (1) sensory consequences and (2) knowledge of results following movement, both absent processes due to paresis.

**Matthew Scott,** Jonathan Emerson, Adam Gilmartin, Daniel Eaves

Teesside University

**Motor imagery during action observation modulates automatic imitation in aging individuals**

In this study we assessed automatic imitation effects in older adults for different forms of combined action observation and motor imagery (AO+MI) instructions. On each trial participants (*n* = 11; mean age = 59.4 + 5.5 years) viewed a picture of the target action: rhythmical face-washing or paint-brushing in either the horizontal or vertical plane. Before executing this action, participants saw a rhythmical distractor action video, with a subtle speed manipulation across trials (fast vs. slow). The instructed and distractor actions either matched or differed both in action type and plane of motion. Automatic imitation was quantified across trials as an imitation bias in movement execution speeds in response to the distractor speed manipulations. The instruction conditions were manipulated across five blocks of 16 trials delivered in a counterbalanced order. Participants engaged in distractor action observation (AO), or observed while imagined performing either a synchronised or a static version of this action (synchronized AO+MI; static AO+MI). Participants also performed sychronised execution during AO, or intentionally imitated the distractor speed. While the main effect of distractor speed was significant overall, this effect was absent for incompatible AO trials. The imitation bias was significantly stronger for synchronised AO+MI compared to static AO+MI instructions. Pairwise comparisons revealed the bias for compatible AO+MI was significantly stronger than incompatible static AO+MI, and also both the compatible and incompatible AO trials. These findings suggest mirror system function is variable in older adults, but automatic imitation can be increased via synchronised AO+MI instructions.

**Hayley Shepherd,** Judith Bek, Emma Gowen, Ellen Poliakoff

University of Manchester

**How do people with Parkinson’s watch other people’s actions?**

Observing actions results in activation of the observer’s own motor system, termed motor resonance. Previous research has shown a link between motor resonance and eye movements during action observation in healthy individuals. They look ahead to the goal of the action as they would when performing the action themselves (prediction) (Flanagan & Johansson, 2003). We explored whether people with Parkinson’s produce comparable eye movements to healthy controls when observing naturalistic actions. Participants with mild-to-moderate Parkinson’s (N=16) and healthy aged matched controls (N=22), observed five videos (54-76s) depicting an actor performing everyday actions (e.g. watering a plant) whilst eye movements were recorded. To avoid over-analysing the data, an analysis protocol was developed using data from a separate healthy young sample (N=15). Interest areas were defined (actor’s body, action-relevant objects) and time-series analysis was used to identify timepoints where these were consistently fixated. These timepoints were then used to compare levels of predictive eye movements in the healthy older group and the Parkinson’s group. Relatively few predictive eye movements were made even in the young group, which may reflect the more complex stimuli. Results demonstrated that the Parkinson’s group displayed more predictive behavior than the healthy older group, which is suggestive of preserved motor resonance in Parkinson’s although we discuss possible limitations of our analysis technique. These findings have positive implications for the effectiveness of action observation therapies to train movements in Parkinson’s (Pelosin et al., 2010).

David Wright1, Gavin Buckingham2, **Greg Wood1**

1Manchester Metropolitan University, 2University of Exeter

**Corticospinal excitability markers of embodiment with a prosthesis: A pilot study**

The aim of this pilot study was to determine the efficacy of using transcranial magnetic stimulation (TMS) to provide an objective marker of embodiment with a myoelectric prosthetic hand. Six intact limb volunteers participated in this study. At pre-test, single-pulse TMS was delivered to the motor cortex whilst participants observed videos of a myoelectric prosthetic hand opening and closing. Electromyography (EMG) recorded the amplitudes of motor evoked potential (MEP) responses from two hand and two forearm muscles on the right arm. Participants were then assigned to one of two groups. Group 1 trained with a myoelectric prosthetic hand, controlled by user-initiated EMG activity in the forearm muscles. The training involved 370 repetitions of hand opening and closing actions or object pick-up actions with the prosthesis. Group 2 performed the same number of repetitions with their anatomic limb. The TMS procedure was repeated at post-test. Results are currently being analysed, but it is predicted that the observation of the prosthesis in use at the post-test will result in increased amplitude MEPs in the forearm muscles in the group who trained with the device. This may provide an objective marker of the control mechanisms of the prosthesis becoming embodied by the user.

**Andrei Zarie,** L. O’Hare, P.M.J. Pollux

University of Lincoln

**Emotional body expressions modulate steady-state visually evoked potentials**

Steady-state visually evoked potentials have been applied traditionally to low-level perception research, with some studies looking at higher level stimuli such as facial identity. However, only a few studies have recently looked at SSVEPs evoked by expressions of emotions, with exclusive focus on facial expressions. To our knowledge, the present study is the first one where evoking SSVEPs using body expressions of emotion was attempted. We presented stimuli consisting of four expressions of emotion (anger, fear, joy, sadness) and one neutral expression, from four different identities (2 female). The presentation method was a simple on/off contrast modulated flickering of the images at 3 Hz and 6 Hz for all the stimulus conditions. EEG recordings from 19 participants were included in the final analysis. Results show higher amplitude of anger compared to neutral expressions at the fundamental frequency of 3 Hz (electrodes P8 and PO8), with no difference at the 6 Hz fundamental harmonic. No differences between the emotion expressions were found in the 6 Hz condition. The location and lateralisation of the effect is in line with previous research on facial expressions. Theoretical interpretations of the anger-effect and implications of low-level visual differences between the body expressions, including methods that would overcome such limitations, are discussed.