Conference Abstracts

Thursday, 9th May, 13.30 – 15.00

Motor Imagery Ability: The relationship between motor imagery measures

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In the past decades different instruments have been developed that are being used to measure motor imagery ability. In the domain of sport science, and also increasingly in the rehabilitation domain, phenomenological self-report questionnaires like the VMIQ-2 (Roberts, Callow, Hardy, Markland, & Bringer, 2008), the MIQ-RS (Gregg, Hall, & Butler, 2007) and the KVIQ (Malouin, Richards, & Jackson, 2007) are used to measure motor imagery ability. Typically, these questionnaires are constructed to measure the vividness of motor imagery, often within three perspectives, external visual motor imagery, internal visual motor imagery and kinaesthetic motor imagery. It is unclear how performance on these phenomenological instruments relates to performance on perceptually driven motor decision task, such as the hand laterality judgment task (Parsons, 1987) that requires an implicit motor imagery judgment from the participant. In this presentation, results from experiments with stroke patients and healthy controls focusing on the question how these different measures of motor imagery ability relate to each other will be discussed in the light of Kosslyn's model of imagery (Kosslyn, 1980).

Motor Imagery, Anxiety and Imagery Perspective Training: An Exploratory Investigation

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Mental imagery is the cognitive simulation process by which we mentally represent perceptual information in the absence of appropriate sensory input. An imagery process that has attracted increasing attention from researchers is 'motor imagery' or the mental rehearsal of actions without engaging in the actual movements involved. Although considerable progress has been made in understanding motor imagery processes, relatively little is known about how they are affected by anxiety. This neglect is surprising because imagery processes play a crucial role in the experience of anxiety. To fill this gap in the

literature, the present paper reports two studies on imagery and anxiety. In Study 1, we compared the motor imagery performance of relatively anxious and less anxious students. Specifically, we tested the hypothesis that self-reported trait anxiety is inversely related to accuracy on chronometric measures of motor imagery. We also explored the relationship between anxiety and vividness of motor imagery. In Study 2, we evaluated the effects of imagery perspective (either first-person or third-person) training on students' anxiety about speaking in public. Here, we tested the hypothesis that first-person imagery perspective training reduces self-reported anxiety more than does third-person perspective training. Following analysis of our results, we discuss the theoretical and practical implications of our findings.

A quantitative meta-analysis of motor imagery

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Whole brain neuroimaging studies have improved our understanding of the brain structures that are active during motor imagery. These studies typically indicate that premotor areas are activated during the motor imagery (Decety, 1996). There are, however, conflicting results regarding the activation of the primary motor cortex (see for instance Dechent et al., 2004). The source of this discrepancy is likely to arise from subtle differences between studies such as the choice of baseline condition to which motor imagery is compared, and can be further exacerbated by the relatively low number of participants in each study. Meta-analytical approaches can pool the results of multiple studies. This offers the benefits of reducing study-specific noise (such the choice of baseline condition) and highlighting the commonalities among the investigated studies (i.e. brain activations relating to motor imagery). Meta-analyses also integrate the results of multiple studies, pooling results from hundreds of participants. Here we present data from a quantitative meta-analysis of motor imagery in the human brain. Results are compared to recent meta-analyses of action observation (Caspers et al., 2010) and motor learning (Hardwick et al., 2013) in order to highlight common and diverging neural activations underlying these processes.

Cortical plasticity for weakened motor inhibition during motor imagery after spinal cord injury

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Motor imagery (MI) involves almost the same central processing to that of actual motor command, but how motor inhibition occurs during MI remains debated (Guillot et al., 2012). Spinal cord injury (SCI) might result in weakened motor inhibition during MI (Alkadhi et al., 2005). Using magnetocephalography, we observed weakened primary motor cortex (M_1) inhibition during MI in a C6-C7 SCI participant, by comparison with a control participant. We extended this inhibitory network to frontal and parietal regions assumed to be involved in motor inhibition. Five SCI participants and five controls mentally and physically performed thumb abduction (impossible movement for SCI patients) and wrist extensions (preserved movement). We observed similar M1 activation during MI and attempted actual thumb abduction in SCI participants, while M1 activity was reduced during MI in controls. Granger functional connectivity analysis revealed that M_1 received neural input from inhibitory sites during both MI tasks in healthy controls. A similar inhibitory network was active during imagined wrist extension in SCI participants, but not during MI of thumb abduction. These findings support the hypothesis of selective weakening in motor command inhibition during MI after SCI. Motor inhibition during MI is maintained for motor skills involving spared effectors.

Thursday, 9th May, 15.30 – 17.00

BASES Expert Statement on the Use of Mental Imagery in Sport, Exercise and Rehabilitation Contexts: A Working Paper

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Mental imagery is one of the most commonly applied techniques in applied sport psychology (Morris et al., 2005). Since the emergence of robust research on the mental practice effect (Driskell et al., 1994), the application of mental imagery beyond its traditional role in performance enhancement has been recognised in sport (Cummings & Williams, 2012), rehabilitation contexts (Braun, 2006) and exercise environments (Thøgersen-Ntoumani et al., 2012). Furthermore, our understanding of the application of imagery has been illuminated by the accumulation of four strands of evidence. Firstly, an increasing awareness of the theoretical underpinnings of imagery and action has emerged (Jeannerod, 1994, 2001, 2006). More recently, advances in the measurement of motor imagery have suggested combining measures to account for the complexity of imagery (Collet et al., 2011). Thirdly, exploratory research using the strength-based approach has highlighted the meta-imagery abilities of elite performers (MacIntyre & Moran, 2010). And finally, research on the nature of dynamic motor imagery has led to new questions on the coupling of action and

motor imagery (Guillot et al., 2012). Practitioner advice for athlete, exerciser and patient samples needs to be grounded in the functional equivalence framework, specify agency and modality, and consider multiple processes including dynamic motor imagery and meta-imagery.

Measuring Imagery in the 21st Century: A study of object-spatial and motor imagery among sport participants

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A century ago researchers measured imagery based on assumptions that it was a unitary phenomena. In the past two decades evidence has emerged to suggest that imagery has distinctive processes including object, spatial and motor. These are measureable using a variety of approaches ranging. This study aims to explore imagery ability, imagery use and meta-imagery knowledge among sport participants at the University of Limerick. In this study imagery use, across the domains proposed by Hall et al. (1998) is measured in addition to several measures of imagery ability and meta-imagery. A comprehensive snapshot of the imagery abilities of sport participants is developed focusing on an individual differences approach. Both theoretical and methodological implications of the findings will be discussed.

Behind the curtain: The influence of mental practice on the development of mental representation structure in early skill acquisition

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Research has elicited distinct differences in mental representations between novices and experts. More recently, research on the development of mental representations in early skill acquisition has revealed functional adaptations in one's mental representation of a motor skill as a result of practice. However, it is not clear if and how mental practice adds to this adaptation process. Therefore, in the present study, we examined the effects of mental practice (i.e., imagery rehearsal) on the development of one's mental representation of a golf putt using the structural dimensional analysis of mental representation (SDA-M). Specifically, novices (*N*=52) were assigned to one of four groups (i.e., mental, physical, mental-physical combined, and no practice). Outcome performance and representation structure of the putt were recorded prior to and after an acquisition phase. Findings

revealed changes in mental representation structure along with performance improvements for each group. Interestingly, mental practice led to more elaborate representations compared to physical and no practice. Our findings suggest that practice leads to functional adaptations in the development of one's mental representation, and that mental practice adds to this development. From this, it is concluded that action-related knowledge in long-term memory and its modification play an important role in motor learning.

The Effects of Observation Content Familiarity upon Collective Efficacy Perceptions

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This study compared the influence of the content familiarity (own v unfamiliar sport) of an observation intervention upon individual collective efficacy perceptions. Participants were interactive team sports players (*N* = 36; basketball *n* = 18, non-basketball *n* = 18) from a UK university. Competitive video footage of the basketball teams was collected over an 8-week period. 7 x 90*sec* video clips of positive footage were produced for both basketball teams' *familiar* observation intervention. Non-basketball participants were randomly allocated either the 1st (*n* = 9) or 2nd basketball team intervention (*n* = 9) for their *unfamiliar* observation intervention. Participants recorded individual collective efficacy perceptions before and after viewing their respective intervention. A mixed 2x2 (*familiarity* x *pre/post intervention*) ANOVA revealed increased collective efficacy for both familiar and unfamiliar conditions post-intervention, with the largest increase for the familiar condition. The findings suggest that although observation of one's own team leads to the greatest increases in collective efficacy beliefs, observations of any group displaying positive group characteristics are likely to increase collective efficacy. Future research should consider observation as a means to examine the neurological basis of collective efficacy, comparing brain activity associated with positive footage of one's own group to that of unfamiliar group footage and neutral footage.

Friday, 9th May, 09.15 – 11.00

Using action observation bouts for improving dexterity in two case-patients with hemiparesis

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Research shows that the observation of action activates the mirror neuron system (i.e., the areas of the brain used to execute action), and that this activity can moderate subsequent

planning and execution of action performance. Here, we investigated whether action observation-execution priming could be adapted for clinical use. Clinically, it may be more efficient to present action observation bouts prior to a patient performing physiotherapy exercises (enhancing the therapy, and reducing clinician time). In the first part of the presentation, I will present evidence that action observation bouts activate the areas of the brain associated with action execution. In the second part of the presentation, I will present the findings from an experiment that tested a group of control participants, and two case-patients with hemiparesis, and compared performance before and after experimental versus control observation conditions. The results showed evidence of action (experimental) observation-execution priming relative to the control observation condition in both the control participants and the two patients. I will discuss the findings in relation to the clinical application of the effects.

Performance and Motor Cortex Excitability changes during the Observation of Cyclical Actions

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Athletes often follow one another closely in races. This behaviour is thought to provide a biomechanical advantage by reducing aerodynamic drag. However, in part this advantage may be due to increases in motor cortex excitability via the action observation network. To investigate this aim first, in a behavioural study under laboratory conditions, participants either watched a video of a model performing a 20 KM cycling time trial at a cadence set at their own average time trial performance (LEG condition), a video of arm cranking at the same cadence (ARM condition) or a blank screen control (CON condition). Across the conditions, mean power was significantly different in the LEG condition (198.2 watts ± 40.5) than the CON condition (173.0 watts ± 43.65) and the ARM condition (167.6 watts ± 44.4). However no significant differences were found in the average cadence (84.8 RPM ± 5.9, 84.8 RPM ± 6.2, 84.9 RPM ± 6.3 for the LEG, CON and ARM conditions respectively). In the next experiment, participants observed baseline blank screen (CON), 20km time trial cycling (LEG) and arm cranking at the same cadence (ARM) whilst TMS was applied to the primary motor cortex at a point where the most activation of vastus lateralis (VL) and biceps brachii (BB) muscles was found. Motor evoked potentials (MEPs) were recorded. Action observation was found to induce a significant change in indices of motor cortex excitability, specifically the peak-to-peak amplitude of the MEP. Neural transmission strength increased during the ARM condition in the BB by 113.5 ± 79.3 %, whereas it increased by only 7.5 ± 18.5 % during observation in the LEG condition in the BB. These data demonstrate that observation of a cyclical action can increase force production during cycling. Additionally, observation of arms performing a cyclical action can increase motor cortex excitability. This result may partly explain the benefits of following another person in a race.

Slow Walking Increases the Cognitive Control of Gait in Healthy Adults

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Observational interventions are frequently used to investigate the control of gait particularly a slow speeds in neurodegenerative populations. However, the mechanisms by which slow walking increases stride variability in healthy young adults are unclear. One suggestion is that an increase in stride time variability may represent reduced gait stability caused by the increased control of gait by cognitive processes. In this study we endeavoured to determine whether slow walking increases the contribution of cognitive processes in the control of gait. Sixteen healthy adults walked on a treadmill for two, three-minute stages at 1 $km.h^{-1}$ and 4$km.h^{-1}$ (in a counterbalanced order). Stride time (s) was recorded in the second minute of each stage during 30s of both walking with and then without a concurrent cognitive task (a mental arithmetic task). Coefficient of variation for stride time (CST) was calculated to determine stride variability. CST was higher at 1$km.h^{-1}$ than 4$km.h^{-1}$ (p <.001). CST was lower during the concurrent cognitive task at 1$km.h^{-1}$ but not at 4$km.h^{-1}$ (p<.01). The increased CST at 1$km.h^{-1}$ indicates a reduction in gait stability during slow walking. The change in CST during the concurrent cognitive task at 1$km.h^{-1}$ but not 4$km.h^{-1}$ indicates a greater contribution from cognitive processes during slow walking. In contrast to patient populations, healthy young adults increase gait stability during slow walking whilst performing a concurrent cognitive task, possibly due to a greater capacity to switch between cognitive and automatic gait processes. Implications for observation based interventions on gait control are discussed.

Active Vision during Action Execution, Observation and Imagery: Evidence for Shared Motor Representations

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The concept of shared motor representations between action execution and various covert states has been demonstrated repeatedly over the past two decades. Rarely, however, have researchers considered the congruence of physical, imaginary and observed movement markers in a single paradigm and never in a design comparing eye gaze metrics. In this study, participants performed a forward reach and point Fitts' Task on a digitizing tablet whilst wearing a Mobile Eye system. Gaze behaviour was compared between action execution, action observation, and guided and unguided movement imagery conditions. The data showed that fixation location was preserved across states. Fixation duration was only congruent between action execution and action observation conditions and both displayed an indirect Fitts' Law effect. The study demonstrates, for the first time, common spatial eye movement metrics across simulation states and some specific temporal congruence for action observation. Preliminary results from a follow up study examining the effects of age on the gaze metrics are also presented. Collectively, the findings of both studies suggest that action observation may an effective technique in supporting motor processes.

The Manchester Action Simulation Therapy (MAST) App for Upper Limb Stroke Rehabilitation

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In the UK, 150,000 people a year have a stroke, many with severe disability including upper limb dysfunction. After stroke, long-term rehabilitation is required to prevent further functional deterioration. Observation of upper-limb movements, linked to physiotherapy interventions, can facilitate rehabilitation compared to physical therapy alone. Delivery of movement observation has, however, been difficult for clinicians. Recent technological advances may address this concern to allow greater patient involvement, time spent in therapeutic activities, increased effectiveness of physiotherapy treatments and enhanced-recovery from stroke. We have developed a theoretically-rigorous interactive system for upper-limb rehabilitation for hospitalised and early discharge stroke patients at relatively low cost. The MAST development has been informed by research from movement imagery, action observation, and eye-gaze and has had extensive physical therapists, patient, carer and public involvement. In this paper we present the MAST design concepts and its predicted use as a practical and economically viable tool for clinicians making functional therapeutic treatment for stroke available as permanent resource.

Friday, 9th May, 13.30-15.00

Different but complementary roles of action and gaze in the action priming effect

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Research shows that action observation can prime subsequent action execution responses; an effect thought to be caused by the observed action being represented in the same brain areas as those used for action execution. In this study, we modified the observation conditions by manipulating the availability of either the agent's gaze and / or the agent's action ('Gaze only' *versus* 'Action only' *versus* 'Full'). In addition, we manipulated the congruency between the target of the agent's action and the observer's action (Object congruency) and the congruency in the spatial locations of the observed and the executed actions (Spatial congruency). We recorded the gaze patterns of the observers during the observation phase using eye-tracking measures, and we measured the prime effect after observation using motion tracker measurements. The results showed that the agent's gaze rather than action had the larger influence on the participants' eye movement behavior, but we found that the prime effect was more influenced by the agent's action than gaze. These results suggest that the prime effect was driven by the observed action of the agent and although the agent's eye-gaze influenced the participants eye-movements during

observation, any gaze cuing effects were overridden when kinematic information were available.

Motor imagery during action observation modulates automatic imitation effects

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Passively observing rhythmical actions biases subsequent movement cycle times (Eaves et al., 2012). This imitation bias was reduced when observed and executed actions differed in action type, plane of motion, or both. Here we examined possible interactions between observed and imagined actions. Participants saw a picture of an imperative action, followed by a rhythmical distractor, before executing the imperative rhythmical action. In Experiment 1, they imagined executing either a static or dynamic version of the imperative action during distractor observation, where dynamic imagery was synchronised with the distractor. Static imagery largely abolished the imitation bias, whereas dynamic imagery enhanced the bias across all compatibility conditions. In Experiment 2, we contrasted imagined with overt distractor synchronisation in different synchronisation conditions. Overall, the imitation bias was more pronounced following overt compared to imagined synchronisation, which might be due to temporary loss of synchronicity during motor imagery. Although the imitation bias was stronger for compatible than incompatible actions, this compatibility effect was relatively small in comparison to that in Eaves et al. (2012). Thus, dynamic imagery helped to make the incompatible compatible. Our results show that the content of motor imagery during observation of a task-irrelevant action can substantially modulate automatic imitation effects.

Veering in mental walks: An investigation of the role of force in the mental travel effect

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The aim is of this experiment is to provide an empirical answer to the following neglected question in motor imagery research. What is the role of force in the representation of simulated action? One way of exploring the role of force during motor imagery is to employ the mental travel paradigm (Moran et al., 2011). This paradigm has led to the discovery of the mental travel effect-a strong positive correlation is typically reported between the duration of simulated (imagined) and executed action (Guillot & Collet, 2005). Recent research has advocated that duration of a simulated movement be used on metric of image

quality (Collet et al. 2011). One theoretical question is the degree to which force is used to encode movements. Using a veering paradigm with a large scale sample of sport and exercise science students, participants will also imagine a 30m walk as well as executing it in a variety of conditions (weighted vs non-weighted conditions). We predict that greater force during action will lead to higher temporal equivalence than in the moderate or low force conditions. Both theoretical and methodological implications of the findings will be discussed.

An investigation of gender differences in mental rotation of animate and inanimate stimuli

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This study aimed to dispel common misconceptions surrounding gender differences and spatial ability, namely mental rotation ability. In 1974, Macoby and Jacklin first suggested that robust gender differences in spatial ability existed. Subsequent research indicated that this *male advantage* was specific to mental rotation tests. Debate in the intervening period has focused on the influences of changes in socialisation and education practices on cognitive gender differences (Halpern, 2011). Nevertheless evidence continues to accrue indicating differences in mean response times on mental rotation tasks favouring males. However, these studies typically use the original stimuli of the Shepard and Metzler (1971) study i.e., abstract block figures. Research using has expanded the range of stimuli to include a range of animate objects (e.g., hands and feet). Strategy differences have emerged which may account for gender differences. Thus this study explored gender differences in the mental rotation of animate compared to inanimate stimuli. It was hypothesized that the male advantage for mental rotation would not be significant for animate stimuli. Participants comprised sport and exercise students from the University of Limerick, with groups balanced for gender and distinguished based on the basis of their level of sports expertise. Both theoretical and methodological implications of the findings will be discussed.