

Memory malleability over time – Schedule overview

Workshop at the University of Kent, 10-11 January 2019.

Talks location: KLT4 in Keynes college (signposted from Keynes main entrance)

Posters, coffee and lunch: Keynes Atrium (just inside Keynes main entrance)

10 January

Time	Event/speaker	Title
1.15pm	Welcome and introduction	
1.30pm	Zara Bergström	Counterfactual imagination and memory malleability – mechanisms and forensic applications
2.15pm	Louis Renoult	Effects of repeated presentations on semantic and episodic memory
3 pm	Coffee break	
3.30pm	Catarina Ferreira	Testing the fast consolidation hypothesis of retrieval-mediated learning using pattern fMRI
4.15pm	Michael Anderson	A species-general retrieval-specific mechanism of adaptive forgetting
5pm	Data blitz session (three 10 minute talks)	
	Amy Atkinson	Memory for valuable information across short and long delays
	Rachael Elward	Strategic Retrieval in Developmental Amnesia
	Akul Satish	The efficacy of different strategies for modifying unpleasant memories of past immoral acts
5.30pm	Poster session	
6.30pm	break	
8pm	Conference dinner	Café Du Soleil

11 January

Time	Event/speaker	Title
9am	Matt Plummer	Recognition-induced updating of face memories is modulated by confidence
9.25am	Robin Hellerstedt	Neural mechanisms underlying recognition-induced updating of face memories
9.50am	Dace Apšvalka	Controlling unwanted memories: the medial septal pacemaker suppression hypothesis
10.15am	Coffee break	
10.45am	Maite Crespo-Garcia	Anterior Cingulate Cortex signals the need to control intrusive thoughts during motivated forgetting
11.10am	Mikael Johansson	Benefits and cost of memory reactivation in episodic memory
11.55am	Data blitz session (3 10 minute talks)	
	Ali Mair	Wearable camera-supported consolidation of recent event memories in dementia and MCI
	Louisa Salhi	Electrical brain activity associated with false memory-related increases to subsequent recognition
	TBC	TBC
12.20pm	Lunch	
1.30pm	Deborah Talmi	In for a pound, in for a penny: How the opportunity to gain reward influences the competition for memory resources
2.15pm	Amir-Homayoun Javadi	The modulatory effect of oscillatory reinstatement on memory
3pm	Concluding remarks	<i>(Note: Peggy St Jacques talk cancelled due to illness)</i>
3.15pm	Workshop close	

Talk abstracts (alphabetically ordered by author last name)

Prof Michael Anderson, MRC Cognition and Brain Sciences Unit, University of Cambridge.

A species-general retrieval-specific mechanism of adaptive forgetting.

Neurobiological research on memory has focused on the mechanisms underlying memory storage. Yet, the universal occurrence of forgetting throughout the animal kingdom suggests that it serves critical adaptive functions, driven by distinct mechanisms. Here we show the existence of a species-general active forgetting mechanism shared by rodents and humans that suppresses distracting past events to facilitate the use of memory in service of adaptive behavior. We found that when rats retrieved their prior experience with an object to guide new exploration, it significantly reduced their later recognition of other objects previously encountered in that environment. As in humans, this retrieval-induced forgetting was competition-dependent, cue-independent, long-lasting, and reliant on inhibitory control processes mediated by the prefrontal cortex: Silencing medial prefrontal cortex with muscimol selectively abolished the forgetting effect. cFOS imaging revealed that prefrontal control demands declined over repeated retrievals as competing memories were forgotten, revealing a key adaptive benefit of forgetting. Occurring in 88% of the 63 rats studied, this finding establishes an unusually robust model of how active forgetting harmonizes the mnemonic ecosystem with behavioral demands, and permits isolation of its circuit, cellular and molecular mechanisms.

Dr Dace Apšvalka, MRC Cognition and Brain Sciences Unit, University of Cambridge.

Controlling unwanted memories: the medial septal pacemaker suppression hypothesis

The ability to control unwanted thoughts and memories is essential to mental health and wellbeing. Prior research has found that stopping intrusive memories involves top-down control by the prefrontal cortex and subsequent inhibition of hippocampal retrieval processes. Moreover, the efficacy of this fronto-hippocampal inhibitory pathway depends on hippocampal GABA to enable memory suppression. Specifically, higher resting concentration of hippocampal GABA has predicted better mnemonic control. These findings raise questions about the mechanisms through which hippocampal GABA enables the suppression of unwanted memories. The prefrontal cortex itself does not have direct connections to the hippocampus. Therefore, the question is, what is acting on the GABAergic interneurons in the hippocampus during memory suppression? Based on animal research, we hypothesise that the medial-septal nucleus in the basal forebrain is critically involved in the memory inhibition process. Our preliminary results support the hypothesis. When stopping intrusive memories, activity in the medial-septal nucleus is suppressed, potentially causing hippocampal tonic inhibition and disabling the memory recall.

Amy Atkinson, University of Leeds (datablitz talk with accompanying poster)

Memory for valuable information across short and long delays

Prioritisation effects have been observed in working memory, whereby memory for an item is enhanced if participants are told that particular representation is more valuable than others presented within the same trial. However, to date, research has not examined whether prioritisation yields longer-term boosts or whether these effects are constrained to working memory. The current experiment examined this. Participants were shown series of everyday objects to remember for a brief period of time. During encoding, they were either told that all items were equally valuable (control condition), or that one item was more valuable than the rest (prioritisation condition). Memory for the objects was assessed after a few seconds (working memory) and as part of a surprise test after 10 minutes (long-term memory). Half of the images tested during the long-term memory phase had been assessed at working memory, whilst half had not. At

working memory, a significant prioritisation effect emerged, whereby accuracy was higher if the item was more valuable. At long-term memory, a large testing effect was observed, whereby items that had been assessed during working memory were remembered significantly better than items that had not been tested during this phase. The prioritisation effect at long-term memory was only significant if participants had been asked about the item previously. These findings reveal that an intermediate test can enhance memory for valuable information, which may have important implications for learning.

Dr Zara Bergström, University of Kent

Counterfactual imagination and memory malleability – mechanisms and forensic applications

A growing body of research indicates that people can reshape memories of past events by imagining alternative, counterfactual versions of what really happened. In three experiments, we examined whether imagining a false alibi for a mock crime would make suspects appear innocent in a concealed memory detection test, the autobiographical Implicit Association Test (aIAT), which aims to determine criminal guilt based on establishing which of two autobiographical events are true. Across experiments, we found that the aIAT accurately detected a mock crime as true for ‘guilty’ participants who had conducted the mock crime when they did not employ a false alibi. For guilty participants who imagined a false alibi, the aIAT was far less able to detect the mock crime as true. Surprisingly, this countermeasure was most effective at making guilty suspects appear innocent when used only once just before the aIAT, whereas extended and repeated imagination of the false alibi over a week-long period appeared to ironically strengthen the memory of the mock crime. Furthermore, the results suggest that imagining a false alibi impaired guilt detection because the alibi was erroneously detected as true, and not because it inhibited the mock crime memory. The findings suggest that if guilty suspects fabricate an alibi, this may create a false memory that appears to be true, which is problematic for real-life applications of forensic memory detection with uncooperative, lying suspects.

Dr Maite Crespo-Garcia, MRC Cognition and Brain Sciences Unit, University of Cambridge.

Anterior Cingulate Cortex Signals the Need to Control Intrusive Thoughts During Motivated Forgetting

How do people limit awareness of unwanted memories? Previous research has shown that excluding memories from awareness engages the right dorsolateral prefrontal cortex to suppress hippocampal activity underlying the retrieval process, and that such hippocampal suppression is especially pronounced when unwanted memories intrude into awareness. The mechanism triggering this reactive control has remained unclear, however. Here, we hypothesize that the dorsal anterior cingulate cortex (dACC) dynamically regulates mnemonic inhibition by detecting conflict created by intrusions of unwanted thoughts. To test this idea, we used simultaneous EEG-fMRI recording and investigated trial-by-trial relationships between the N2 (an ERP component that indexes cognitive conflict) and BOLD signals in the dACC and the hippocampus. We found that N2 source amplitude (localized within the dACC) was coupled with increased dACC’s fMRI activation, selectively during memory suppression. Critically, conflict-related N2 source amplitude predicted more pronounced down-regulation in the hippocampus. Taken together, these findings point to a role of the dACC in signalling the penetration of intruding thoughts into awareness and the need for greater inhibitory control to truncate the presence of unwanted memories in working memory.

Dr Rachael Elward, UCL (datablitz talk with accompanying poster)

Strategic Retrieval in Developmental Amnesia

Developmental amnesia (DA) is associated with early hippocampal damage and subsequent difficulty with recollection. We employed fMRI to assess whether patients with DA show evidence of ‘cortical reinstatement’, a neural correlate of recollection, despite their poor memory performance. In addition, we investigated whether reinstatement effects were strategically modulated in accordance with a retrieval goal. At study, 24 volunteers (including 5 patients) were presented with words overlaid on a scene or a scrambled image. At test, scene reinstatement effects were indexed by scene memory effects (greater activity for words that were previously paired with a scene than scrambled images) that overlapped with scene perception effects. DA patients demonstrated scene reinstatement effects in the parahippocampal cortex and the retrosplenial cortex equivalent to those of healthy controls. Behaviourally, however, patients with DA showed impaired scene memory performance. The data indicate that reinstatement can occur despite hippocampal damage and that reinstatement is insufficient to drive accurate memory judgements. Furthermore, scene reinstatement effects were diminished during a retrieval task in which scene information was not relevant for accurate responding, indicating that strategic mnemonic processes are operating normally in DA. Indeed, goal-directed scene reinstatement effects in occipital cortex were significantly larger in the amnesic patients than the controls. These data suggest that cortical reinstatement of trial specific context information is decoupled from the conscious experience of recollection.

Dr Catarina Ferreira, University of Birmingham

Testing the fast consolidation hypothesis of retrieval-mediated learning using pattern fMRI

It is well known that actively and repeatedly retrieving information produces more durable memories than repeatedly studying that same information. On a neural level, it is still unclear why retrieval has such beneficial effects on long-term retention. Attempting to fill this gap, we here tested some key predictions derived from a recent framework proposing that retrieval acts as a fast consolidation mechanism, stabilizing memories through online reactivation, similar to memory replay during offline (e.g. sleep) consolidation. In this fMRI study, participants encoded scene-object pairs, and repeatedly retrieved or restudied the objects over two different sessions, two days apart. We analysed univariate and multivariate changes in brain activity specific to retrieval but not restudy, and tested whether the predicted changes occur rapidly (i.e., within a session) or evolve slowly, across the two days. If retrieval rapidly creates consolidated, integrated neocortical memory traces, we expected to observe categorical (semantic) pattern changes within the first session, along with an increase in neocortical and decrease in hippocampal activity. Results showed that ventromedial prefrontal cortex activation increased across retrieval trials within one session, consistent with a fast consolidation account. Hippocampal activity decreased not within but across sessions, suggesting a slower mechanism. Moreover, Representational Similarity Analyses (RSA) showed that consecutive retrieval attempts strengthen both higher-level semantic and episode-specific information in parietal areas, again across but not within sessions. Our results suggest that retrieval does support the creation of an additional neocortical trace, which becomes increasingly relevant at long delays when hippocampus-dependent episodic details would otherwise have faded

Dr Robin Hellerstedt, University of Kent

Neural mechanisms underlying recognition-induced updating of face memories

Retrieval practice usually enhances later memory performance. However, retrieval can also induce memory biases, since episodic memory is prone to updating whereby errors made during recollection attempts are stored into long-term memory, biasing subsequent memories towards those errors. Previous studies of such ‘retrieval-induced updating’ have typically used cued recall tasks and it is unknown to what extent these

findings generalise to recognition tasks, such as face recognition. We combined EEG with a continuous measure of face recognition with an aim to investigate the neural mechanisms underlying recognition-induced updating. The participants first learned faces before engaging in an initial recognition test. In this test, the studied face was shown amongst four other distractor faces and the participants were asked to select the face that they recognised from the encoding phase. The same procedure was used in the subsequent final memory test. The behavioural results from the final test replicate our previous findings that participants are more likely to repeat errors made during the initial test if they were made with high confidence. The EEG data allow us to investigate the neural mechanisms during the first test that predict re-selections of the same face, and whether those mechanisms differ depending on whether the repeated selection is accurate or biased towards an error, and the role of confidence in such repeated responses.

Dr Amir-Homayoun Javadi, University of Kent

The modulatory effect of oscillatory reinstatement on memory

Consistent with the context-dependent memory literature, previous research suggests that when the same frequency of neural oscillations is reinstated between memory encoding and retrieval, engram reactivation is facilitated, and thus declarative memory recall is enhanced. In two studies we applied transcranial alternating current stimulation (tACS) to the left dorsolateral prefrontal cortex to induce oscillatory activity during encoding of some stimuli. We showed that having the same stimulation during retrieval and consolidation enhances memory performance. These findings support a novel theoretical proposal, which assumes an intrinsic neurobiological mechanism for coordinating frequency-specific oscillatory activity.

Professor Mikael Johansson, Lund University

Benefits and cost of memory reactivation in episodic memory

Memory plays a central role in cognition and is a ubiquitous part of everyday life. Retrieval cues in the present bring to mind past experiences by triggering the reactivation of stored memories, allowing us to revisit the past to inform current thinking and behaviour. While memory reactivations typically are supportive, they may also be counterproductive, as when they are irrelevant and interfere with our current goals. In this talk, I will present recent experimental work leveraging high time-resolution recordings of brain activity (electroencephalography, EEG) and multivariate pattern analysis (MVPA) methods to elucidate the temporal dynamics of memory reactivation during episodic memory retrieval. These studies show benefits when the processing engaged during encoding and retrieval overlaps. However, they also reveal a cost: the reinstatement of an encoding context during retrieval may impair memory for the target event if the context was shared and experienced across multiple past events. A similar problem arises when a retrieval cue for a specific memory becomes associated with additional memories. Resolution of interference between competing memories is then critical for goal-relevant remembering. I will show recent work where MVPA was used to track the neural reactivation of target and competitor memories during retrieval in an interference paradigm. The data give insight into the time course of retrieval competition and competition resolution. Overall, this talk will address questions concerning memory accessibility and memory control with a focus on the goal-relevance of episodic memory reactivation.

Dr Ali Mair, University of Hertfordshire (datablitz talk with accompanying poster)

Wearable camera-supported consolidation of recent event memories in dementia and MCI.

This study examined the effect of wearable-camera-supported memory consolidation in people with early-stage dementia and mild cognitive impairment. Seven people with dementia/MCI and five age-matched controls wore chest-mounted cameras to record a series of three events. The events were scripted

experimenter-led tours of local attractions, matched for the amount and type of information that was presented. Consolidation of event memory and the subjective sense of reliving was tracked across four days immediately following each event. On each occasion participants' event memory was tested in a free recall procedure immediately followed by externally-supported event review. There were three review conditions: written description, still images, and video clips, and each participant reviewed one event in each condition. However, only half of each event was reviewed, and half remained unseen, allowing us to distinguish between material that was and was not re-encountered during review. An additional free recall test and visual recognition test were administered one week following the final review session in each condition. Consolidation was measured as baseline (Day 1) recall subtracted from the number of details recalled on each day. Total recall was subdivided into factual information (presented verbally during the tour), memory for objects and locations that were physically encountered, and memory for hands-on activities and incidental occurrences that did not form part of the tour script. This allowed us to track changes in recall of different detail types following repeated retrieval attempts.

Matthew Plummer, University of Kent

Recognition-induced updating of face memories is modulated by confidence

Episodic memories are susceptible to updating, whereby errors made during a retrieval attempt can modify memories, as evident at a subsequent test. Existing evidence has demonstrated retrieval-induced updating as a result of recollection of complex episodic memories, however it is not known whether simple item memories can become updated by recognition. We investigated this issue in a novel repeated-recognition paradigm that we have developed to examine factors that modulate whether face memories are updated via retrieval. First, participants learned a number of target faces, before completing two recognition tests. During both tests, target faces were presented with perceptually similar, but distinct distractor faces. Participants were asked to select which face they recognised from the learning phase, as well as provide confidence judgements for their recognition decisions. Results showed that, when correct and incorrect recognition decisions during the initial test were made with high (vs low) confidence, participants were more likely to make the same recognition response in the subsequent test. These findings have demonstrated that face memories can be updated by recognition, and such updating is more likely following retrieval decisions made with high confidence even when those decisions are wrong.

Dr Louis Renault, University of East Anglia

Effects of repeated presentations on semantic and episodic memory

I will review behavioural, ERP and fMRI data on effects of repeated presentations on semantic processing and episodic memory encoding, and discuss how these effects can be modulated by context. A number of studies have reported that when stimulus are presented repeatedly in an experiment, their meaning is no longer processed or that semantic effects are decreased in magnitude. However, more recent evidence shows that the impact of repetition on semantic processing is task-dependent and that in explicit semantic task, meaning can still be processed over multiple presentations. In the domain of episodic memory, it has been demonstrated that encoding the same material repeatedly generally enhances memory performance. However, it is still controversial how task modulates such repetition effects and whether the distinctiveness of each encoding experience is a better predictor of subsequent recall than simple reactivations. I will present data compatible with Tulving's perspective (1972, 1983) that each event a person experiences is always unique, even if it just a repetition of the same item, and that the episodic system tracks individual levels of repetition. However, I will show that, similar to semantic memory, these repetition effects are task-dependent and that recollection and familiarity may be differentially impacted by repeated presentations.

Louisa Salhi, University of Kent (datablitz talk with accompanying poster)

Electrical brain activity associated with false memory-related increases to subsequent recognition.

Incidental encoding takes place in many situations, including during old/new recognition tasks where new “foil” items are encoded to different extents depending on modulatory processes occurring during retrieval attempts. Our recent findings suggest that one such modulator is false familiarity, since foil words that were falsely recognised as previously seen on a first test were subsequently more likely to be accurately recognised as previously seen on a final surprise test compared to other foil words that were correctly identified as new on the first test. This pattern may be due to false familiarity facilitating context encoding during the first test, or due to false familiarity “carrying over” across multiple tests (i.e. persistent false memories). In this EEG study, we investigated the neurocognitive mechanisms that underlie spontaneous false memory during an old/new task and how this relates to increased subsequent recognition. Source judgments during the subsequent old/new task also enabled us to examine if the false memories enhanced test context encoding or simply persisted without enhancing encoding. Initial behavioural findings replicate prior results by showing increased subsequent recognition for items that produced false familiarity on the first test. Source judgments indicated that this was mostly due to persistent false memories rather than familiarity facilitating encoding. EEG findings will provide more information on the neural mechanisms driving this effect, and how they relate to well-established markers of familiarity and recollection. The results will also be used to inform the theoretical debate regarding whether there are dissociable novelty and familiarity processes during recognition tasks.

Akul Satish, University of Kent (datablitz talk)

The efficacy of different strategies for modifying unpleasant memories of past immoral acts

Memories of our past immoral acts can haunt us, leading to unpleasant emotions such as guilt and shame. People use a variety of strategies to deal with these emotions. One such strategy is to avoid thoughts of the memory by thinking of something completely different (thought substitution). Another strategy is to imagine a better alternative outcome to the events (upward counter-factual thinking; CFT). In this study, we used a modified Think/No-Think (TNT) task to compare the efficacy of repeated thought substitution versus upward counterfactual thinking in alleviating unpleasant emotions associated with remembering autobiographical memories of immoral acts. On Day 1, participants described 20 different memories of their past morally wrong and morally right acts, and self-report emotional responses were measured for each memory. On the next day, participants first completed the TNT task, which involved repeatedly thinking of some memories and repeatedly attempting to not think of the other memories. Participants either used thought substitution or counterfactual thinking strategies during the no-think trials, and told us how they felt after each attempt of not-thinking (or thinking) of these memories using a button press during the TNT task, providing for an ‘online’ measure of emotion. Finally, participants completed a memory test, during which self-report emotional responses were measured for each memory, providing a measure of potential ‘off-line’ changes to the memories. Preliminary findings will be reported and discussed in light of theories of memory malleability and emotion regulation.

Dr Deborah Talmi, University of Manchester

In for a pound, in for a penny: How the opportunity to gain reward influences the competition for memory resources

When people encounter items that they believe will help them gain reward, they later remember them better than those that do not. While it is adaptive to preferentially remember experiences that will be useful later, it is unknown how the competition for memory resources is implemented in time, through the processes of encoding, consolidation, and retrieval. In two experiments we promised participants £1 for remembering

some pictures, but only 10 pence for remembering others. Their ability to describe the pictures was tested after one minute and after 24 hours. Memory at immediate test showed effects of list composition, suggesting local competition at encoding and/or retrieval. These results are consistent with our recently-proposed emotional Context Maintenance and Retrieval model, supporting it as a general account of motivated memory. In contrast, relative to this baseline, more valuable memories were not preferentially retained following delay, suggesting no detectable role of competition for consolidation.

Poster only abstracts (alphabetically ordered by presenting author last name)

Susan Absolon, University of Kent

Music impairs working memory performance of introverts

Students often listen to music as they say it helps them to revise for exams, and although investigating the effects of music on memory became popular following the ‘Mozart effect’ there is contradicting evidence as to its benefits. Factors that have been found to influence results include music genre and personality. Personality has been shown to effect cognitive task performance, with extraverts performing better than introverts on working memory tasks that include distractors such as office noise and music. This within participant study aimed to investigate how personality modulates the working memory task during three conditions of silence, music without lyrics, and music with lyrics. Country-rock music utilised for unfamiliarity so that words were not internally activated in the music without lyrics condition. Additionally EEG was used to record brain activity. Behaviour results showed a highly significant interaction effect between group (introvert/extravert) and condition (silence/music with lyrics/music without lyrics), with the introvert group performing better in the silent condition, and the extravert group performing better in the music without lyrics condition. EEG data is currently being analysed. Therefore, this research extends knowledge of the effect of music genre on working memory and supports previous findings that personality differences may affect how music impacts on memory.

Giulia Barsuola, MRC Cognition and Brain Sciences Unit, University of Cambridge

A novel Autobiographical Think/No-Think paradigm to elicit and control the involuntary recall of autobiographical intrusive negative memories: behavioural evidences

Introduction The flow of human thoughts is frequently plagued by unwanted cognitive activity, which has the unfortunate power to interfere with task performance, planning, social behaviour, and many other aspects of our lives, playing also a major role in psychopathology. Drawing on Benoit’s Imagine/No-Imagine study based on personally relevant future fears, we developed the Autobiographical Think/No-Think paradigm, a modified version of Anderson’s Think/No-Think task based on autobiographically grounded word pairs to study the intrusions of recurrent upsetting memories. This represents the first attempt to use intrusion ratings in an Autobiographical Think/No-Think study, enabling us to elicit the recall of autobiographical intrusive involuntary memories in a controlled way. *Materials & Methods* 40 participants were tested for this behavioural study. Unlike most studies, no standardised materials were used. Participants were instructed to generate a list of twenty-two upsetting intruding personal events happened in the past three years and to select two key words before completing the pre-TNT phase, the TNT phase, and the post-TNT phase. *Results & Conclusions* We predicted that memories would frequently intrude into awareness involuntarily initially, but that with repeated attempts to stop retrieval, intrusion frequency would decline. Our one-way ANOVA analysis confirmed that intrusions declined significantly from the first block to the fourth. These preliminary results indicate that participants gained increasing control over the

intrusions of unwanted memories. Post experimental questionnaires, phenomenological perspectives on intrusions, and Skin Conductance measurements will shortly be added to this study, providing novel and insightful views on this topic.

Chloe Brunskill, University of Kent

Aging-Related Changes to ERP Markers of Memory: Implications for Forensic Applications

We present an experiment that compared memory-related ERP effects in young (<30) and older (>65) participants. The project aimed to assess whether aging-related changes to EEG activity can impair the accuracy of forensic memory detection tests, which rely on EEG markers of memory as indications of criminal guilt. These tests are based on the logic that guilty suspects will hold incriminating knowledge about the crimes they have committed, and therefore should reveal their guilt with brain activity related to recognition when presented with information about their crimes. However, we predicted that these tests might not be as accurate in older adults, because of the well-known changes to memory-related brain activity that occurs with aging. We investigated both standard old/new recognition and P300-based forensic memory detection in these two groups, and found significantly reduced memory-related ERP effects in the old group in both tasks, despite highly similar behavioural performance. This pattern was consistent across both group level and individual level statistical analyses. The results suggest that ERP-based forensic memory detection is invalid in older populations, and also have broader implications for EEG research on aging and cognition.

Fadi Ifram, University of Kent

Physical exercise is as effective as transcranial direct current stimulation at enhancing long-term memory

It is well established that acute physical exercise is beneficial to declarative memory, especially when administered during consolidation. Also beneficial to declarative memory processes is the application of transcranial direct current stimulation (tDCS) over the dorsolateral prefrontal cortex (DLPFC) during encoding. However, to our knowledge, no study to date has compared the efficacy of physical exercise and tDCS on memory performance. We employed an old-new recognition paradigm, where we used images to test the beneficial effects of acute physical exercise and tDCS on declarative memory. Participants were assigned to the following conditions: physical exercise, anodal, and sham tDCS. During anodal stimulation, participants received tDCS over the left DLPFC for 15 min. During physical exercise, participants were administered an exercise protocol on a cycle ergometer that kept their heart rate between 60-70% of their maximum heart rate. The results show that tDCS and physical exercise comparably enhance declarative memory, as indicated by increased memory performance scores on the old-new recognition task. In conclusion, our results demonstrate that physical exercise is, at least, as good as tDCS at enhancing long-term memory performance.

Rachel Lambert, University of East Anglia

The Effect of Autobiographical Significance in Older and Younger Adults

Previous investigations in Autobiographically Significant Concepts (ASC) have shown that when general semantic concepts, such as famous names, become associated with a personal episodic memory, these concepts evolve and become more episodic in nature resulting in superior recognition memory. This study furthers previous research by investigating ASC in older and younger adults and examines the impact of type and time of memory, associated factual knowledge, familiarity, and emotional salience on the AS enhancement effect. Participants were 51 younger adults (18-35 years), and 48 older adults (65-85 years).

They completed a Dead or Alive semantic judgement task on a series of famous faces, followed by an old-new episodic recognition task. Unique to this study, a questionnaire was then administered to determine familiarity, factual knowledge and memory information associated with each of the presented stimuli. Results showed faster reaction times and higher accuracy for stimuli associated with a personal memory across both age groups. This AS enhancement effect was resilient when fact and familiarity were controlled for and was present irrespective of time or type of associated memory. This study provides insight into semantic-episodic interactions within older and younger adults, particularly demonstrating the influence of episodic memory when completing largely semantic guided-tasks.

Asma Maher, University of Kent

Listening to classical music during memorisation impairs memory performance of introverts but not extroverts

The effects of music on memory have been shown to evidence inconsistent results, depending on stimuli used, music genre, and whether music was played before, during or after encoding. These mixed results suggest that the relationship between music and memory may be moderated by individual differences such as personality. Studies that have investigated music and memory with regards to personality have shown that when music is played during encoding extroverts perform better than introverts on reading comprehension and visual memory tasks. The present study used a personality scale measure and four music conditions to investigate whether time of listening to music and personality modulate the effect of music on long term memory. Participants (N=44) memorised pictures together with their corresponding words whilst listening to five minutes of classical music either before, during or after encoding, or in silence. An old/new recognition test was completed following a 30-minute retention interval. Our results showed that introverts performed significantly worse when they listened to music during memorisation. This impairment was significantly difference to that of extroverts. Listening to music before or after memorisation had no effect on memory performance. Therefore, this research offers further support to previous findings, and suggests that personality differences may make a difference to long term memory when music is played during encoding.

Petra Marcotti, University of Sussex

Using 360° videos to study visual perspective in immersive memories

Shifting visual perspective during retrieval influences the phenomenology of subsequent memories for events. Instructing participants to shift from a dominant own eyes to an observer perspective changes the viewpoint from which memories are later remembered and reduces the vividness of the original event. To better understand how retrieving from different viewpoints alters some phenomenological properties of memories, we developed a novel paradigm using an immersive 360° video experience. Participants encoded interactive 360° videos of complex real-world events (e.g., making breakfast). One week later, they repeatedly retrieved some of the events cued by screenshots from the videos while maintaining the perspective shown or shifting to a novel perspective. Here, we also manipulated whether the photo-cue either matched or mismatched encoding. Across two studies, our results show that, despite not explicitly instructing participants to adopt an own eyes or observer vantage point, actively shifting to a novel viewpoint during retrieval differentially affected the visual perspective from which memories were remembered. In particular, shifting back to the original viewpoint at encoding produced higher own eyes ratings, whereas shifting to a novel viewpoint led to higher observer ratings. We also found that shifting to a novel perspective reduced the sense of reliving and the vividness of memories. Critically, these effects were due to actively shifting visual perspective during retrieval rather than the nature of the match or mismatch of the retrieval cue. Our findings demonstrate that memories created in immersive 360° videos are subject to similar phenomenological changes when shifting visual perspective as real-life memories, suggesting that 360° videos are a viable way to study immersive memories.

Laura Marsh, MRC Cognition & Brain Sciences unit, University of Cambridge

Positivity bias in past and future episodic thinking: relationship with anxiety, depression and retrieval induced forgetting.

Positivity biases in autobiographical memory and in episodic future thinking are considered important in mental wellbeing, and are reduced in both anxiety and depression. It has been proposed that the inhibitory processes underlying retrieval induced forgetting (RIF) may contribute these biases, via forgetting of negative material. In this study, we measured individual differences in RIF, and examined how this related to positivity biases in past and future thinking. We also examined whether this relationship was influenced by anxiety and depression levels, and ruminative tendencies. Reduced positivity in past and future thinking was associated with greater levels of anxiety, depression and rumination, and reduced ability to generate specific episodes. In general, greater levels of RIF significantly predicted more positive memory valence. However, for participants with high depression scores, greater levels of RIF were associated with more negative memory biases. These results indicate that RIF plays a role in healthy positivity biases, but that this relationship may depend on an existing positivity bias. We suggest that the habitual retrieval positive material can lead to RIF of associated negative items, but, in the context of repetitive negative recall in depression, the opposite may occur; positive alternatives are weakened or forgotten.

Alessandro Massazza, University College London

Intrusive Memories and Peritraumatic Phenomena Following Disaster

Cognitive theories of post-traumatic stress disorder (PTSD) hypothesize that the way in which memory is encoded during the trauma is key to the development of intrusive memories. Therefore, what happens during the trauma, i.e. peritraumatic phenomena such as dissociation and data-driven processing, might be key to the development of intrusive memories. However, little research has investigated naturalistically why certain moments of a trauma are encoded as intrusive memories while others are not in a population exposed to the same trauma. Severely exposed survivors of the 2016-2017 Central Italy Earthquakes (N = 104) were asked to identify an intrusive memory and a distressing, but non-intrusive, control memory. If participants did not report having experienced intrusive memories they were asked to identify the most distressing memory of the event. They were then asked to complete measures of the peritraumatic phenomena they experienced in the moments corresponding to each memory. During the same trauma, the moments that were encoded as intrusive memories were characterized by significantly higher ratings on all seven peritraumatic phenomena in comparison with the moments that had become non-intrusive memories. Peritraumatic phenomena are key variables in the development of intrusive memories. The current study is the first to confirm this naturalistically in a community sample exposed to real trauma with spontaneously occurring long-term intrusive memories. The findings can inform preventative and acute-phase intervention with trauma survivors by developing techniques to diminish peritraumatic phenomena and, in turn, the chances of developing intrusive memories.

Wesley Pyke, University of Kent

The effects of different protocols of physical exercise and rest on long-term memory

There are many studies looking at the effects of physical exercise on long-term memory. However, to date, no study has compared the effect of different intensities of physical exercise and different rest conditions on long-term memory. In three studies (N=59) we measured to what extent physical exercise (in its varying intensities) and wakeful rest (active-rest; in which participants were cognitively engaged while seated and passive-rest; no cognitive engagement) could influence long-term memory. Across all three studies, identical

procedures were carried out with an identical old/new recognition memory test in order to establish the most effective protocol for cognitive enhancement. In Study 1 the effects of continuous moderate intensity exercise, uninterrupted wakeful rest (passive) and rest with an engagement task (active) were explored. In Study 2 continuous moderate intensity exercise was compared with High-Intensity Interval Training (HIIT) and passive rest. Study 3 observed the effects of low, moderate and high-intensity continuous exercise. Results across the three studies suggest moderate intensity exercise to have the greatest positive impact on memory performance. Passive rest was more effective than active rest, however, less than HIIT. Potential reasons for the results obtained, future direction of study and implications of this research are discussed.

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Seeking the supramodal inhibitory control network in the brain: the role of the right DLPFC and the basal ganglia in memory and motor control.

Memory inhibition and motor inhibition can be seen as fundamentally similar processes involving the stopping of prepotent responses. Various studies have hinted at a supramodal inhibitory control network in the brain which is engaged in the suppression of both unwanted memories and actions. A recent meta-analysis study showed that there are indeed overlapping cortical and sub-cortical regions which get activated in both memory and motor control tasks (Guo et al, 2018). In this study, we chose to investigate the role of the potential key players in this control network namely the right dorsolateral prefrontal cortex (DLPFC) and the basal ganglia. 33 healthy young adults were recruited for the study, and they performed two sessions inside the 3T scanner- an inhibitory motor task and a version of the Think/No Think memory inhibition task. The univariate group level analysis revealed that the conjunction of regions of activation seen in both the right DLPFC and the basal ganglia for the two inhibitory tasks closely overlap with the regions previously identified in the meta-analysis. Further analysis (DCM) would help investigate if this network can then be artificially 'entrained' by non-invasive brain stimulation to see if memory and motor control can be enhanced especially in people having difficulties in controlling unwanted memories. The possibility of aiding better cognitive memory control training through motor control training, can also be investigated.

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Modulation of naturalistic maladaptive memories using behavioural and pharmacological reconsolidation-interfering strategies: A meta-analysis of clinical and sub-clinical studies

Consolidated memories can undergo enduring modification through retrieval-dependent treatments that modulate reconsolidation. This has been suggested to represent a potentially transformative clinical strategy for weakening or overwriting the maladaptive memories that underlie substance use and anxiety/trauma-related disorders. However, the ability to modulate naturalistic maladaptive memories may be limited by 'boundary conditions' imposed on reconsolidation by the nature of these memories. As such, the true potential of 'reconsolidation therapy' is currently unknown. *Methods:* Here, we report a meta-analysis of behavioural and pharmacological studies examining retrieval-dependent modulation of reward and threat memories in (sub)clinical substance use and anxiety/trauma respectively. Of 4936 publications assessed for eligibility, 8 studies of substance use, and 10 of anxiety (phobia) and trauma-related symptoms were included in the meta-analysis. *Results:* Overall, the findings were in the predicted direction, with the majority of effect sizes favouring the 'Retrieval + Treatment' condition. However, the magnitude of effects depended upon the nature of the treatment type, with pharmacological interventions ($g=0.59$; relative to behavioural strategies; $g=0.32$) showing a clearer beneficial effect in studies of phobia/trauma, and post-retrieval behavioural strategies a (significantly; $g=0.60$) larger effect in substance use studies when compared to pharmacological ($g=-0.09$). *Conclusions:* High levels of heterogeneity and small sample sizes limit the strength of conclusions that can be drawn at this stage of inquiry. We hope this review will provide an impetus to address these issues in future research.