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INTRODUCTION



Introduction to the special issue: the neuroscience of false memory

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Memory is not perfect, and memory errors occur in almost any retrieval scenario. While the most thought-of type of memory error may be forgetting, false memories are also a large part of memory inaccuracies (e.g., Brainerd & Reyna, 2005; Schacter & Dodson, 2001). A false memory (Roediger, 1996; Schacter, 2022) is a memory error that occurs when one remembers a past experience in a manner that is inconsistent with the way in which the event originally occurred. As such, a false memory may include incorrectly recalling details about a retrieved event, erroneously recombining details across two different events, or even retrieving a partial or full false memory for an event that never occurred before.

Errors in false memory can affect a wide array of everyday tasks. Examples include thinking you took your medication, when you did not; misremembering the name of someone you recently met; misremembering an appointment schedule or items in a grocery list. Errors resulting from misinformation related to a past event can have long ranging consequences, for example in the context of eyewitness testimony, education or decision-making. There are considerable individual differences in the propensity to false memory, which varies considerably with age in childhood (Ghetti & Fandakova, 2020) and old age (Dennis et al., 2014; Devitt & Schacter, 2016; Fandakova et al., 2020), as well as in Alzheimers's disease (e.g., El-Haj et al., 2020) or confabulation (e.g., Ciaramelli et al., 2006). False memories are generally thought to reflect the adaptive nature of the episodic memory system (Howe, 2011; Schacter, 2022), and may bring along various benefits, for example in the context of creative thinking and problem solving (Gerger et al., 2023; Thakral et al., 2021).

While there exists a large corpus of studies examining false memories using behavioural methods, the use of neuroimaging also has much to offer our understanding of false memory errors. For example, an early meta-analysis identified common neural activity in medial superior frontal gyrus, left precentral gyrus, and left inferior parietal cortex during false memory retrieval, (Kurkela & Dennis, 2016). These findings continue to be observed in studies examining memory errors in young and older adults, irrespective of memoranda and analysis approaches (e.g., the use for hits, correct rejections as contrasts with false

alarms) (i.e., Dennis et al., 2014; Fandakova et al., 2018; Shao et al., 2023; Wing et al., 2020). The results highlight the idea that, generally, false retrieval is supported by episodic retrieval processes and top-down cognitive control mechanisms mediated by the prefrontal cortices and parietal cortex (Fandakova et al., 2018; Webb et al., 2016). Interestingly, while many previous studies have identified a role of the medial temporal lobes (MTL) in false memory retrieval, the foregoing meta-analysis found no evidence for a consistent role of any single MTL region in supporting the encoding or retrieval of false memories (Kurkela & Dennis, 2016). This suggests that any contribution of the MTL to false memory formation or retrieval may be situationally specific (e.g., Herz et al., 2023), requiring the need for more diverse research, as well as replication of past work. Similarly, open questions remain regarding the role of visual areas in false memory. Whereas early work suggested that true and false memories show enhanced activity in early vs. late visual areas respectively (Schacter & Slotnick, 2004), recent studies have implicated early visual areas in false memories as well (Karanian & Slotnick, 2017, 2018). These findings underscore the need for systematic research into the factors that influence retrieval-based processing across early and late visual areas leading to memory errors.

In this special issue of *Memory*, we examine some of the recent findings from labs employing neuroimaging methods to investigate the brain basis of false memories. The papers in this special issue include new empirical investigations that make use of transcranial direct current stimulation, electrophysiology methods, fMRI BOLD signals, and structural neuroimaging to elucidate neural markers underlying memory errors. Many of the works included in the special issue also take on an individual differences approach to understanding the neural basis of false memories, exploring the influence of such factors as sex, age, and performance variability. Additionally, the research covers a range of designs utilised to identify situational events that occur in everyday life, including semantic false memories, schema-based false memories, and the incorporation of misinformation into memory.

Carpenter and Dennis (2024) examined the neural processes through which schemas can influence false memory

across younger and older adults. To this end, they presented participants with scenes depicting specific concepts (e.g., bathroom), including objects that were related to the concept. At retrieval, both studied targets, schema-related novel objects and unrelated lures were presented. Using representation similarity analyses, they showed that brain regions implicated in schematic processing (Gilboa & Marlatte, 2017), including the ventromedial prefrontal cortex (vmPFC) and bilateral middle temporal gyrus, exhibited greater neural similarity for targets and lures sharing schematic content, as opposed to novel objects. Surprisingly, a similar pattern of results was also observed throughout early and late visual regions. Together, these results underscore the powerful effects of schemas on the processing of novel information, thereby increasing susceptibility to false memory.

Pupillo and colleagues (2024) examined how metacognitive efficiency, the ability to distinguish correct vs. incorrect memories in one's subjective confidence ratings (Fleming & Lau, 2014), differs between younger adults ($N = 397$) and older adults ($N = 1522$), and is related to associative false memory and brain structure. The investigation was motivated by the observation that older adults showed higher susceptibility to false memory for face-profession pairs that were encountered again in a recombined constellation. Older, but not younger, adults demonstrated lower metacognitive efficiency for recombined pairs compared to new pairs. A multivariate profile capturing individual differences in structural integrity of the vmPFC, insula, precuneus, and parahippocampal cortex was associated with higher metacognitive efficiency for recombined pairs in a subsample of the older adults. The results highlight the role of maintaining brain integrity for efficient metacognition in the service of avoiding false memories in aging.

Pérez-Mata and colleagues (2024) used EEG to examine the temporal dynamics of false memory in the Deese/Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). The results revealed an old/new effect in the time-range of the late positive component over left centro-parietal scalp electrodes that was enhanced for true relative to false recognition of semantically related lures. Furthermore, the correct rejection of critical lures was accompanied by a more pronounced late sustained positive slow wave across fronto-central electrodes, underscoring the critical role of post-retrieval monitoring processes in the correct recognition of semantically related novel information.

Examining the effect of culture on false memories, Leger et al. (2024) used fMRI to assess whether neural discriminability may account for cultural differences in false memories. Drawing on behavioural evidence suggesting that Western cultures engage in greater memory specificity compared to East Asians, researchers tested a large sample of both American and Taiwanese individuals using visually similar targets and lure objects. Results indicated that the groups differed in their neural responses

across several brain regions. Specifically, neural activity in the left fusiform gyrus, a region linked to the processing of perceptual details of objects, exhibited a positive relationship to behaviour in Americans, but a negative relationship in Taiwanese participants. Additionally, increasing activity in the left parietal cortex, a region linked to attention in memory, also differentially predicted lure discriminability as a function of lure similarity across cultures. Finally, the false alarm activity within the left hippocampus decreased as a function of lure dissimilarity in Americans, with the opposite pattern found in Taiwanese. Taken together, these results provide evidence for differential effects of culture on the neural correlates of visual episodic memory and specifically memory specificity related to the discrimination of visually similar objects within multiple brain regions.

Continuing this investigation into individual differences in false memories, two studies examined the effect of sex on the neural basis of false memories. Shao and colleagues (2024) examined whether sex modulated the relationship between the size of subcortical regions and false recall in the DRM paradigm. Results showed that, across a large sample of 400 healthy college students, males had lower true and false recall but larger subcortical volumes than females. Additionally, higher false recall was associated with a larger caudate in males, but not in females.

Examining functional activation, Spets et al. (2024) investigated whether sex modulated neural activity found common to both true and false memories related to spatial location. They found that, compared to females, males exhibited greater neural overlap across true and false memories, including regions within the prefrontal cortex, parietal cortex, and early/late visual processing cortices (including V1). Males also showed significantly higher neural similarity between true and false memories within these regions. Taken together, results suggest that males may be more susceptible to false memories across different situations based on sex differences in both their neural architecture and their heightened similarity in cortical activations.

In yet another study investigating individual differences in false memories, Ratzan et al. (2023) examined the extent to which susceptibility to misinformation reflects factors related to memory retrieval. Testing 71 individuals, they found individual variability in susceptibility to misinformation in the context of repeated memory retrieval. In a follow up fMRI study they showed that such variability was related to intrinsic functional connectivity in MTL networks. Specifically, they found that stronger resting-state functional connectivity between the MTL and occipital cortex, a region critical to visual memory reactivation, was associated with better reduced interference from misinformation. The authors conclude that one's susceptibility to misinformation may depend upon their ability to reactivate visual details during memory retrieval.

Finally, Haciahmet and colleagues (2024) investigated the degree to which anodal transcranial direct current

stimulation (tDCS) on the left inferior parietal lobe (IPL) during memory retrieval modulates memory for a previously presented movie excerpt as well as susceptibility to auditorily presented post-event misinformation. The IPL is a brain region that has been repeatedly implicated in supporting episodic recollection (Cabeza et al., 2012; Rugg & King, 2018). The authors found pronounced false memories for post-event misinformation that were comparable between the group that received anodal tDCS and the control group receiving sham stimulation. In contrast, anodal tDCS of the left IPL increased the recall of true memories in the anodal tDCS group, thereby underscoring the selective role of parietal regions in recollection and source memory.

Taken together, the papers in this special issue present several novel findings that extend our understanding of the neural basis underlying false memories. This includes a broader understanding of individual differences, particularly with respect to sex differences and the effect of age and cultural influences in accounting for variability in false memories. Across various false memory paradigms, including schema-related, associative, spatial or event-related information, the studies in the present special issues highlight the critical role of post-retrieval monitoring processes and the reinstatement of visual details during retrieval. Future work with large and diverse samples that employ different paradigms within the same participants offers a promising path towards disentangling the contributions of domain-general top-down processes and situation-specific processes related to the processing of perceptual or semantic details.

The present papers also highlight the unique ways by which false memories can be studied using neuroscience methods. The use of univariate and multivariate techniques to examine BOLD activity, along with measures of electrical pulses and structural neuroimaging all lend to an integrated understanding of factors contributing to memory errors. They also highlight the need for future research employing multimodal imaging to integrate various neuroscientific approaches. For example, combining structural and functional neuroimaging can help further our understanding of individual differences in false memory by elucidating the ways in which structural variability influences reactivation and monitoring during memory retrieval to help avoid errors. Combining techniques with high temporal precision (i.e., EEG) with those with high spatial precision (i.e., fMRI) and neuromodulation approaches (i.e., tDCS, TMS) can help uncover the dynamics of encoding-retrieval interactions and their contributions to false memory across different populations.

Future work building on these findings will continue to play a critical role in advancing theories of false memories and the adaptive nature of memory errors.

Disclosure statement

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References

- Brainerd, C. J., & Reyna, V. F. (2005). *The science of false memory*. Oxford University Press.
- Cabeza, R., Ciaramelli, E., & Moscovitch, M. (2012). Cognitive contributions of the ventral parietal cortex: An integrative theoretical account. *Trends in Cognitive Sciences*, 16(6), 338–352. <https://doi.org/10.1016/j.tics.2012.04.008>
- Carpenter, C. M., & Dennis, N. A. (2024). Investigating the neural basis of schematic false memories by examining schematic and lure pattern similarity. *Memory (Hove, England)*, 1–15.
- Ciaramelli, E., Gheiti, S., Frattarelli, M., & Ládavas, E. (2006). When true memory availability promotes false memory: Evidence from confabulating patients. *Neuropsychologia*, 44(10), 1866–1877. <https://doi.org/10.1016/j.neuropsychologia.2006.02.008>
- Deese, J. (1959). On the prediction of occurrence of particular verbal intrusions in immediate recall. *Journal of Experimental Psychology*, 58(1), 17. <https://doi.org/10.1037/h0046671>
- Dennis, N. A., Bowman, C. R., & Peterson, K. M. (2014). Age-related differences in the neural correlates mediating false recollection. *Neurobiology of Aging*, 35(2), 395–407. <https://doi.org/10.1016/j.neurobiolaging.2013.08.019>
- Devitt, A. L., & Schacter, D. L. (2016). False memories with age: Neural and cognitive underpinnings. *Neuropsychologia*, 91, 346–359. <https://doi.org/10.1016/j.neuropsychologia.2016.08.030>
- El-Haj, M., Altintas, E., Chapelet, G., Kapogiannis, D., & Gallouj, K. (2020). High depression and anxiety in people with Alzheimer's disease living in retirement homes during the COVID-19 crisis. *Psychiatry Research*, 291, 113294. <https://doi.org/10.1016/j.psychres.2020.113294>
- Fandakova, Y., Sander, M. C., Grandy, T. H., Cabeza, R., Werkle-Bergner, M., & Shing, Y. L. (2018). Age differences in false memory: The importance of retrieval monitoring processes and their modulation by memory quality. *Psychology and Aging*, 33(1), 119. <https://doi.org/10.1037/pag0000212>
- Fandakova, Y., Werkle-Bergner, M., & Sander, M. C. (2020). (Only) time can tell: Age differences in false memory are magnified at longer delays. *(Only) Time Can Tell: Age Differences in False Memory are Magnified at Longer Delays*, 35(4), 473.
- Fleming, S. M., & Lau, H. C. (2014). How to measure metacognition. *Frontiers in Human Neuroscience*, 8, 443. <https://doi.org/10.3389/fnhum.2014.00443>
- Gerver, C. R., Griffin, J. W., Dennis, N. A., & Beaty, R. E. (2023). Memory and creativity: A meta-analytic examination of the relationship between memory systems and creative cognition. *Psychonomic Bulletin & Review*, 30(6), 2116–2154. <https://doi.org/10.3758/s13423-023-02303-4>
- Gheiti, S., & Fandakova, Y. (2020). Neural development of memory and metamemory in childhood and adolescence: Toward an integrative model of the development of episodic recollection. *Annual Review of Developmental Psychology*, 2(1), 365–388. <https://doi.org/10.1146/annurev-devpsych-060320-085634>
- Gilboa, A., & Marlatte, H. (2017). Neurobiology of schemas and schema-mediated memory. *Trends in Cognitive Sciences*, 21(8), 618–631. <https://doi.org/10.1016/j.tics.2017.04.013>
- Haci Ahmet, C. C., Friehs, M. A., Frings, C., & Pastötter, B. (2024). Anodal tDCS of the left inferior parietal cortex enhances memory for correct information without affecting recall of misinformation. *Memory (Hove, England)*, 1–10.
- Herz, N., Bukala, B. R., Kragel, J. E., & Kahana, M. J. (2023). Hippocampal activity predicts contextual misattribution of false memories. *Proceedings of the National Academy of Sciences*, 120(40), e2305292120. <https://doi.org/10.1073/pnas.2305292120>
- Howe, M. L. (2011). The adaptive nature of memory and its illusions. *Current Directions in Psychological Science*, 20(5), 312–315. <https://doi.org/10.1177/0963721411416571>
- Karanian, J. M., & Slotnick, S. D. (2017). False memories for shape activate the lateral occipital complex. *Learning & Memory*, 24(10), 552–556. <https://doi.org/10.1101/lm.045765.117>

- Karanian, J. M., & Slotnick, S. D. (2018). Confident false memories for spatial location are mediated by V1. *Cognitive Neuroscience*, 9(3-4), 139–150. <https://doi.org/10.1080/17588928.2018.1488244>
- Kurkela, K. A., & Dennis, N. A. (2016). Event-related fMRI studies of false memory: An activation likelihood estimation meta-analysis. *Neuropsychologia*, 81, 149–167. <https://doi.org/10.1016/j.neuropsychologia.2015.12.006>
- Leger, K. R., Cho, I., Valoumas, I., Schwartz, D., Mair, R. W., Goh, J. O. S., & Gutchess, A. (2024). Cross-cultural comparison of the neural correlates of true and false memory retrieval. *Memory (Hove, England)*, 1–18. <https://doi.org/10.1080/09658211.2024.2307923>
- Pérez-Mata, N., Albert, J., Carretié, L., López-Martín, S., & Sánchez-Carmona, A. J. (2024). I heard it before ... or not": time-course of ERP response and behavioural correlates associated with false recognition memory. *Memory (Hove, England)*, 1–20.
- Pupillo, F., Düzel, S., Kühn, S., Lindenberger, U., & Shing, Y. L. (2024). Deficits in memory metacognitive efficiency in late adulthood are related to distinct brain profile. *Memory (Hove, England)*, 1–17. <https://doi.org/10.1080/09658211.2024.2341711>
- Ratzan, A., Siegel, M., Karanian, J. M., Thomas, A. K., & Race, E. (2023). Intrinsic functional connectivity in medial temporal lobe networks is associated with susceptibility to misinformation. *Memory (Hove, England)*, 1–13.
- Roediger, H. L. III. (1996). Memory illusions. *Journal of Memory and Language*, 35(2), 76–100. <https://doi.org/10.1006/jmla.1996.0005>
- Roediger, H. L., & McDermott, K. B. (1995). Creating false memories: Remembering words not presented in lists. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, 21(4), 803. <https://doi.org/10.1037/0278-7393.21.4.803>
- Rugg, M. D., & King, D. R. (2018). Ventral lateral parietal cortex and episodic memory retrieval. *Cortex*, 107, 238–250. <https://doi.org/10.1016/j.cortex.2017.07.012>
- Schacter, D. L. (2022). The seven sins of memory: An update. *Memory (Hove, England)*, 30(1), 37–42. <https://doi.org/10.1080/09658211.2021.1873391>
- Schacter, D. L., & Dodson, C. S. (2001). Misattribution, false recognition and the sins of memory. *Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences*, 356(1413), 1385–1393. <https://doi.org/10.1098/rstb.2001.0938>
- Schacter, D. L., & Slotnick, S. D. (2004). The cognitive neuroscience of memory distortion. *Neuron*, 44(1), 149–160. <https://doi.org/10.1016/j.neuron.2004.08.017>
- Shao, X., Li, A., Chen, C., Loftus, E. F., & Zhu, B. (2023). Cross-stage neural pattern similarity in the hippocampus predicts false memory derived from post-event inaccurate information. *Nature Communications*, 14(1), 2299. <https://doi.org/10.1038/s41467-023-38046-y>
- Shao, X., Li, A., Wang, Z., Xue, G., & Zhu, B. (2024). False recall is associated with larger caudate in males but not in females. *Memory (Hove, England)*, 1–8. <https://doi.org/10.1080/09658211.2024.2319314>
- Spets, D. S., Karanian, J. M., & Slotnick, S. D. (2024). True and false memories for spatial location evoke more similar patterns of brain activity in males than females. *Memory (Hove, England)*, 1–9. <https://doi.org/10.1080/09658211.2024.2333505>
- Thakral, P. P., Devitt, A. L., Brashier, N. M., & Schacter, D. L. (2021). Linking creativity and false memory: Common consequences of a flexible memory system. *Cognition*, 217, 104905. <https://doi.org/10.1016/j.cognition.2021.104905>
- Webb, C. E., Turney, I. C., & Dennis, N. A. (2016). What's the gist? The influence of schemas on the neural correlates underlying true and false memories. *Neuropsychologia*, 93, 61–75. <https://doi.org/10.1016/j.neuropsychologia.2016.09.023>
- Wing, E. A., Geib, B. R., Wang, W. C., Monge, Z., Davis, S. W., & Cabeza, R. (2020). Cortical overlap and cortical-hippocampal interactions predict subsequent true and false memory. *The Journal of Neuroscience*, 40(9), 1920–1930. doi:10.1523/JNEUROSCI.1766-19.2020