Topic: Episodic Memory

2019-03-24

A fundamental decision we have to make in our daily lives is whether our impressions really correspond to memories of events we experienced.

Article Discussed

Rugg, M. D., & Vilberg, K. L. (2013). Brain networks underlying episodic memory retrieval. *Current Opinion in Neurobiology*, *23*(2), 255–260. https://doi.org/10.1016/j.conb.2012.11.005

Brief summary

The main topic of this article is the relationship between the medial temporal lobe (MTL) and episodic memory. More specifically, the article looks to determine the network for retrieval of episodic memories within the different regions of the MTL. Many of the students' questions showed a desire to understand the functions and locations of the lesser known MTL brain regions such as the perirhinal, entorhinal, and parahippocampal regions. Class discussion was more in depth about other functions of the MTL in addition to trying to understand what the lines on the bar graph represented in Figure 1.

This summary includes discussion of the two questions that were not answered by students in the collaborative document nor directly and confidently answered during class discussion, although they were discussed. The first question is about the graph presented in the article and what the lines on that graph represent. In summary, these bars are most likely error bars.

The second unanswered question was about the medial temporal lobe and the role it might play in other types of memory in addition to episodic memory. In summary, the MTL likely plays a role in other types of memory such as semantic memory.

Cognitive process neuroimaging analysis

Neurosynth term: "episodic memory"

Top 5 Pubmed articles:

1: Palombo DJ, Bacopulos A, Amaral RSC, Olsen RK, Todd RM, Anderson AK, Levine B. Episodic autobiographical memory is associated with variation in the size of hippocampal subregions. Hippocampus. 2018 Feb;28(2):69-75. doi:10.1002/hipo.22818. Epub 2018 Jan 6. PubMed PMID: 29171926.

2: Mahr J, Csibra G. Why do we remember? The communicative function of episodic memory. Behav Brain Sci. 2017 Jan 19:1-93. doi: 10.1017/S0140525X17000012. [Epub ahead of print] PubMed PMID: 28100294; PubMed Central PMCID: PMC5404722.

3: Nyberg L. Functional brain imaging of episodic memory decline in ageing. J Intern Med. 2017 Jan;281(1):65-74. doi: 10.1111/joim.12533. Epub 2016 Jul 25. Review. PubMed PMID: 27453565.

4: Moscovitch M, Cabeza R, Winocur G, Nadel L. Episodic Memory and Beyond: The Hippocampus and Neocortex in Transformation. Annu Rev Psychol. 2016;67:105-34. doi: 10.1146/annurev-psych-113011-143733. Review. PubMed PMID: 26726963; PubMed Central PMCID: PMC5060006.

5: Brewin CR. Episodic memory, perceptual memory, and their interaction: foundations for a theory of posttraumatic stress disorder. Psychol Bull. 2014 Jan;140(1):69-97. doi: 10.1037/a0033722. Epub 2013 Aug 5. Review. PubMed PMID: 23914721.

Top 5 Neurosynth articles

Bai, F., Yuan, Y., Yu, H., & Zhang, Z. (2016). Plastic modulation of episodic memory networks in the aging brain with cognitive decline. *Behavioural Brain Research*, *308*, 38–45. https://doi.org/10.1016/j.bbr.2016.04.022

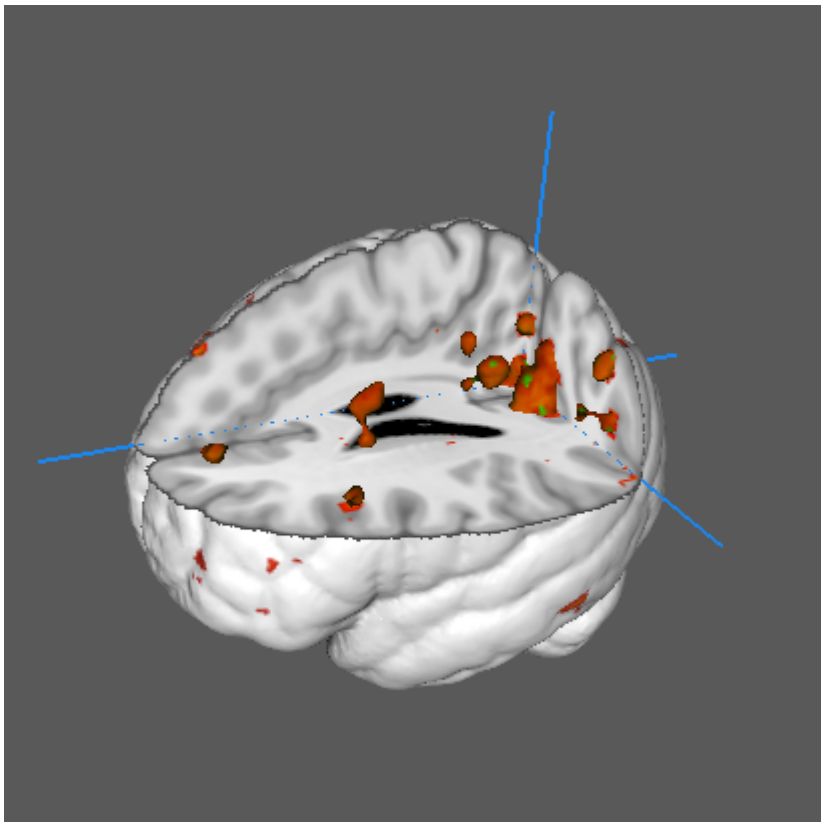
Chanraud, S., Leroy, C., Martelli, C., Kostogianni, N., Delain, F., Aubin, H.-J., … Martinot, J.-L. (2009). Episodic memory in detoxified alcoholics: contribution of grey matter microstructure alteration. *PloS One*, *4*(8), e6786. https://doi.org/10.1371/journal.pone.0006786

Eichenbaum, H. (2017). Prefrontal-hippocampal interactions in episodic memory. *Nature Reviews. Neuroscience*, *18*(9), 547–558. https://doi.org/10.1038/nrn.2017.74

Irish, M., Piguet, O., Hodges, J. R., & Hornberger, M. (2014). Common and unique gray matter correlates of episodic memory dysfunction in frontotemporal dementia and Alzheimer's disease. *Human Brain Mapping*, *35*(4), 1422–1435. https://doi.org/10.1002/hbm.22263

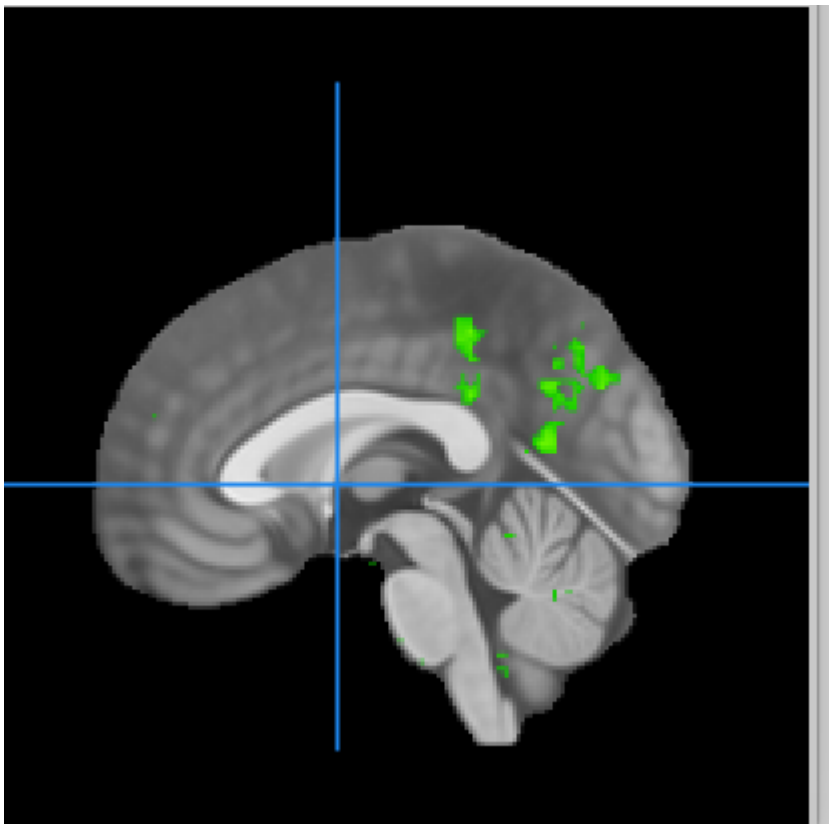
Riggins, T., Geng, F., Blankenship, S. L., & Redcay, E. (2016). Hippocampal functional connectivity and episodic memory in early childhood. *Developmental Cognitive Neuroscience*, *19*, 58–69. https://doi.org/10.1016/j.dcn.2016.02.002

Neurosynth map for the term



Brain region chosen for the term

Brain region: “medial temporal”



Questions Posed by the Class

Defining terminology

Q: What is the dual-process model of memory and its various parts as talked about in the article?

“These models posit that a retrieval cue (such as a recognition memory test item) can elicit two qualitatively distinct kinds of mnemonic information: a multi-dimensional **recollection signal** that provides information about qualitative aspects of a prior event, including its context, and a scalar **familiarity signal** that can support simple judgments of prior occurrence. From this perspective, identifying the neural bases of episodic retrieval requires experimental designs that permit recollection-driven and familiarity- driven memory to be dissociated (Box 1).” - from the article

- Recognition memory is not always tied to a memory source information(recollection) sometimes it is based simply on familiarity

- The dual-process model shows a dissociation between recollection and familiarity signals from patients with amnesia and frontal lobe lesions

Yonelinas, A. P. (19991201). The contribution of recollection and familiarity to recognition and source-memory judgments: A formal dual-process model and an analysis of receiver operating characterstics. https://doi.org/10.1037/0278-7393.25.6.1415

DivideSegment

Q: What does the article mean by the term ‘multi-dimensional’ when discussing recollection signals?

From what I understand and the research that I have found, multi-dimensional signal processing deals with data that can only be adequately detailed using more than one dimension. Processing in more than one dimension requires more complex algorithms. Therefore, I think in the context of this paper, this method is used because various data have to be connected. That being qualitative aspects of a prior event, and scalar familiarity signal that can support simple judgments of a prior occurrence.

Multidimensional signal processing. (2018, June 04). Retrieved from https://en.wikipedia.org/wiki/Multidimensional_signal_processing

SocialAnvil

Q: What is non-spatial contextual information?

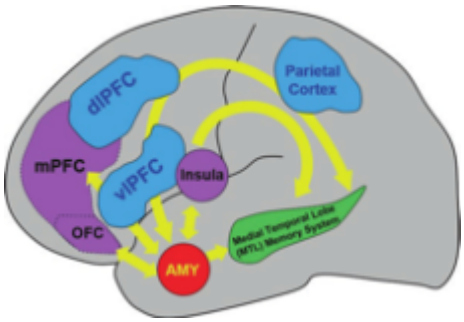
Nonspatial contextual information was specified as the background objects’ identities in one study comparing nonspatial and spatial information. To clarify non spatial information is everything that is in the background such as the white wall or objects you are not paying attention to, but we still filter in the back of our minds. **Non-spatial attention** is defined as the processing resources engagement onto the currently relevant object (measured by attentional masking) and processing resources disengagement from the previously relevant object (measured by attentional blink). (“On the relationship between spatial and non-spatial attention | JOV | ARVO Journals,” n.d.)

SuperMobile

Understanding the regions of the medial temporal lobe (MTL)

Q: Can someone find a diagram or brain image of the MTL?

mPFC = medial prefrontal cortex; OFC = orbitofrontal cortex; dlPFC = dorsolateral prefrontal cortex; vlPFC = ventrolateral prefrontal cortex; AMY = amygdala



> (PDF) Current Issues and Emerging Directions in the Impact of Emotion on Memory: A Review of Evidence from Brain Imaging Investigations. (n.d.). http://dx.doi.org/10.1007/978-4-431-56591-8_5

TelecomElegant

Q: What is the perirhinal cortex?

Most results from animal studies favour the view that recognition memory might be subdivided functionally and neuroanatomically within the temporal lobe into two main components:

(1) One component is a familiarity and recency discrimination system centred on perirhinal cortex. This perirhinal system rapidly processes information about the novelty or prior occurrence of individual stimulus items.

(2) The second component is a recollective system centred on the hippocampus. This hippocampal system is slower, associational and processes information concerning the prior occurrence of individual stimuli or collections of stimuli in relation to other stimuli, including, more generally, information about the prior occurrence of episodes or events.

Brown, M. W., & Aggleton, J. P. (2001). Recognition memory: What are the roles of the perirhinal cortex and hippocampus? *Nature Reviews Neuroscience*, *2*(1), 51–61. https://doi.org/10.1038/35049064

SincereZigzag

The perirhinal cortex aids in object recognition and information storage. Its vast connections to other brain structures allows it to associate sensory information and potential consequences.

Perirhinal Cortex :: DNA Learning Center. (n.d.). Retrieved March 19, 2019, from https://www.dnalc.org/view/2119-perirhinal-cortex-.html

CoolActive

Q: What are the differences between the hippocampal and parahippocampal in terms of location and function?

The hippocampal region is located on the medial temporal lobe, while the parahippocampal region is located in between the hippocampus and the fusiform cortex, also on the medial temporal lobe. The hippocampus has too many functions to count, but in the context of the article, its important role is its function of declarative memory. Specifically, the hippocampus acts as a mediator for declarative memories, organizing them and helping to store them. The parahippocampus is the errand boy for the hippocampus; its main objective when it comes to episodic memory is retrieving and encoding the memories and then handing them off to the hippocampus to be organized and stored.

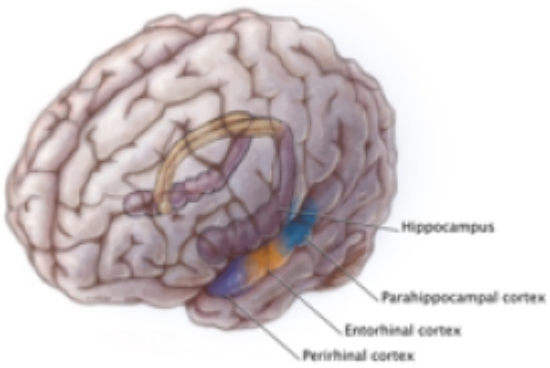
Eichenbaum, H. (2001, December 14). The hippocampus and declarative memory: cognitive mechanisms and neural codes. Retrieved from NCBI website: https://www.ncbi.nlm.nih.gov/pubmed/11718892

Moshe, B. (2014, August 1). The role of the parahippocampal cortex in cognition. Retrieved from NCBI website: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3786097/

PoloBravo

Q: What is the function of the parahippocampal and perirhinal cortices and how do they support the hippocampus with recollection?

The parahippocampal gyrus is a grey matter region that surrounds the hippocampus. This region is important in memory encoding and retrieval. The anterior portion of the parahippocampal gyrus includes the perirhinal and entorhinal cortices. The parahippocampal cortex refers to the area that encompasses both the posterior parahippocampal gyrus and the medial portion of the fusiform gyrus. The perirhinal cortex receives highly processed sensory information from all sensory regions. It is involved in both visual perception and memory, facilitating the recognition and identification of environmental stimuli. The perirhinal cortex is also involved in item memory. The parahippocampal cortex has been associated with many cognitive processes, including visuospatial processing and episodic memory. The parahippocampal cortex is a small portion of the parahippocampal gyrus. The parahippocampal gyrus/cortex regions and the perirhinal cortex aid the hippocampus with recollection by relaying information between the hippocampus and the rest of the brain. The parahippocampal gyrus and the perirhinal cortex basically serve as a bridge between the hippocampus and the rest of the brain.



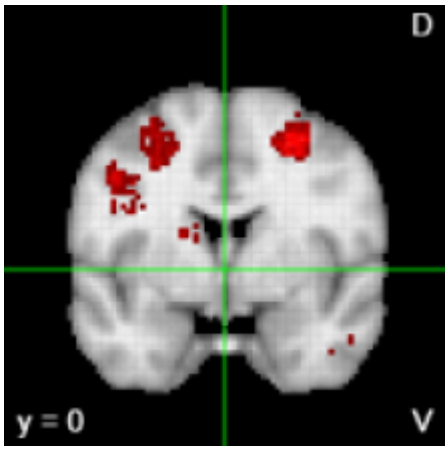
(memorybrain.jpg (861×660). (n.d.). Retrieved March 19, 2019, from http://kshapton.com/images/memorybrain.jpg)

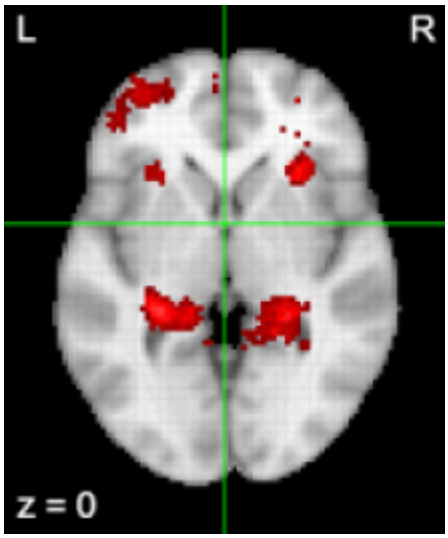
(Parahippocampal gyrus. (2019). In *Wikipedia*. Retrieved from https://en.wikipedia.org/w/index.php?title=Parahippocampal_gyrus&oldid=887697139)

(Perirhinal cortex. (2018). In *Wikipedia*. Retrieved from https://en.wikipedia.org/w/index.php?title=Perirhinal_cortex&oldid=840123114)

WindowComrade

Q: In the article it states that key brain areas for memory include: hippocampus, surrounding perirhinal, entorhinal and parahippocampal cortices. Are these the only regions associated with memory or are there more?





No, there are more (“Neurosynth: memory,” n.d.). (May contain accidentally repeats). Areas such as the striatum (episodic encoding) (“Neurosynth: 20666593,” n.d.), dorsolateral prefrontal cortex (relational memory encoding) (“Neurosynth: 20146616,” n.d.), distinct prefrontal cortex (item memory and source memory for visual shapes) (“Neurosynth: 12763194,” n.d., p. 127), cerebellar (episodic memory encoding) (“Neurosynth: 17350289,” n.d.), amygdala (memory vividness and memory for select episodic memory) (“Neurosynth: 21262244,” n.d.), and medial temporal lobe (recognition) (“Neurosynth:

22049444," n.d.) are all implicated for memory.

VideoSport

Q: What other function is the perirhinal cortex involved in?

"Anatomically, the perirhinal cortex sits at the boundary between the medial temporal lobe and the ventral visual pathway. It has prominent interconnections not only with both these systems, but also with a wide range of unimodal and polymodal association areas. Consistent with these diverse projections, neurophysiological studies reveal a multidimensional set of mnemonic signals that include stimulus familiarity, within- and between-domain associations, associative recall, and delay-based persistence. This wide range of perirhinal memory signals not only includes signals that are largely unique to the perirhinal cortex (i.e., object familiarity), consistent with dual-process theories, but also includes a range of signals (i.e., associative flexibility and recall) that are strongly associated with the hippocampus, consistent with single-process theories. These neurophysiological findings have important implications for bridging the gap between single-process and dual-process models of medial temporal lobe function (Suzuki & Naya, 2014)."

Suzuki, W. A., & Naya, Y. (2014). The perirhinal cortex. *Annual Review of Neuroscience*, *37*, 39–53. https://doi.org/10.1146/annurev-neuro-071013-014207

PolarisUnique

Q: What role does the hippocampus play in procedural memory?

"increasing evidence that the hippocampus also plays a crucial role in procedural memory. Here, we review recent human functional neuroimaging studies demonstrating that the hippocampus is involved in the acquisition and sleep-related consolidation of procedural memories, and motor sequence-based skills in particular. More specifically, we present evidence that hippocampal activity and its functional interactions with other brain structures, particularly competition with the striatum, contribute to initial learning of sequential motor behavior (Albouy, King, Maquet, & Doyon, 2013)."

Albouy, G., King, B. R., Maquet, P., & Doyon, J. (2013). Hippocampus and striatum: dynamics and interaction during acquisition and sleep-related motor sequence memory consolidation. Hippocampus, 23(11), 985–1004. https://doi.org/10.1002/hipo.22183

This article seems to analyze the relationship between the hippocampus and procedural memory from a mechanistic approach. They found that the hippocampus contributes to the procedural memory process by aiding in the learning and consolidation of motor skills through its ability to store and transfer memories during sleep.

ExactTulip

Q: Are the MTL regions only active and related to episodic memory? or are they involved in other types of memory too like semantic memory, working memory, etc?

MTL regions are not only active and related to episodic memory. One study examining the MTL's role in episodic and semantic memory found that the MTL is active in both episodic memory retrieval and semantic memory retrieval (Ryan, Lin, Ketcham, & Nadel, 2010). However, there was increased activation of the MTL and specifically the hippocampus when retrieving episodic memories compared to semantic memories (Ryan, Lin, Ketcham, & Nadel, 2010). This suggests that while the MTL likely does play a role in semantic memory retrieval, it may not be nearly as important as it is in episodic memory retrieval. As for working memory, another study tried to determine if there was any evidence to suggest MTL played a role in working memory, and like many studies before it, the researchers were unable to find significant data and concluded the two were independent of each other (Jeneson & Squire, 2012). Conversely, one website mentions the dentate gyrus as being closely associated with working memory, and the dentate gyrus is part of the MTL by being tied to the hippocampus ("The mediotemporal lobe | About memory," n.d.). Therefore, it appears as if more research would help in determining the exact extent of MTL's role in working memory, assuming there is one at all.

Applying terminology and providing examples

Q: What is an example of a time when episodic memory is used?

Episodic memory is used by humans almost every day. Trying to remember what you ate for breakfast this morning? Recalling the joys of one of your days of vacation? Thinking to where you were when you and your friends laughed until you fell out of your chair? All of this instances and more involved use of episodic memory.

Episodic Memory - an overview | ScienceDirect Topics. (n.d.). Retrieved March 19, 2019, from https://www.sciencedirect.com/topics/neuroscience/episodic-memory

IsotopeNirvana

Q: What is a good example that describes differences between familiarity and recollection?

Recollection is the retrieval of qualitative information about a specific episode, such as when or where an event took place, whereas familiarity is representative of a more broad measure of memory strength or stimulus recency.

Trying to remember the last time you ran into your friend Sally is an example of recollection. Most likely you'd be thinking about where you saw her and how long ago. Going back to the town you grew up in

and being able to recognize different places and things is an example of familiarity.

Yonelinas, A. P., Aly, M., Wang, W.-C., & Koen, J. D. (2010). Recollection and Familiarity: Examining Controversial Assumptions and New Directions. *Hippocampus*, *20*(11), 1178–1194. https://doi.org/10.1002/hipo.20864

ShelfOpus

Navigating neuroscience research methods

Q: What does the line within the bar graph mean?

The article contains a bar graph seen in Figure 1 that shows data “for test items endorsed as familiar(K) or recollected(R)” (Rugg and Vilberg, 2013, p. 256). Further, these items were categorized based on memory judgement into four categories: R-high (high confidence), R-mod (moderate confidence), or R-weak (low confidence) (Rugg and Vilberg, 2013). The bar graph shows lines through each of the four bars; these lines represent standard deviation error bars (“What are errorbars, anyways?”, 2014). Error bars are included on bar graphs to show how the data is spread around the mean. The error bars for R-high and R-mod, and R-weak and K, show significant overlap, showing that the difference between them is not statistically significant. The error bars for R-mod and R-weak show no overlap, meaning that the difference between them is statistically significant (“Interpreting Error Bars”, n.d.).

Q: Are there methods other than an fMRI that would result in more conclusive evidence about the hippocampus role in episodic memory?

Neuropsychological, behavioral and neuroimaging studies have been conducted using VR assisted tests. These tests focused on the hippocampus’ role in spatial memory and how that impacts the role in episodic memory. Five studies using VR and these the different methods concluded that the left left hippocampus was most involved in episodic memory. However, these studies allow room for more questions and need more information for more conclusive evidence.

Burgess, N., Maguire, E. A., & O’Keefe, J. (2002). The Human Hippocampus and Spatial and Episodic Memory. *Neuron*, *35*(4), 625–641. https://doi.org/10.1016/S0896-6273(02)00830-9

Optiontemple

Q: What exactly are animal lesion studies?

Lesion studies are used to investigate the necessity of a brain region for a specific behavior. This is done by comparing performance before and after removal of a part of the brain. This type of study shows which brain regions could be removed with minimal consequences for the animal.

> Brain imaging techniques | School of Psychology & Neuroscience | University of St Andrews. (n.d.).

> Retrieved March 19, 2019, from https://www.st-andrews.ac.uk/psychology/research/brainimaging

SodaOxford

Q: The article references a single human case study. Since it is just one case study is it appropriate to reference this study in the paper?

In this article, they are examining five common misunderstandings about case-study research: (1) Theoretical knowledge is more valuable than practical knowledge; (2) One cannot generalize from a single case, therefore the single case study cannot contribute to scientific development; (3) The case study is most useful for generating hypotheses, while other methods are more suitable for hypotheses testing and theory building; (4) The case study contains a bias toward verification; and (5) It is often difficult to summarize specific case studies. To clear up some of these misconceptions the authors say that “One can often generalize on the basis of a single case, and the case study may be central to scientific development via generalization as supplement or alternative to other methods. But formal generalization is overvalued as a source of scientific development, whereas ‘the force of example’ is underestimated”. I think that depending on what the purpose of the source is being used for it is still a valid article. Case studies can be rather specific and hard to generalize findings for a whole population but the research is still genuine if the researchers followed proper guidelines. Along with the findings of the paper, I think there always should be a good balance between using case studies and generalized population studies when needing to support your own research.

> Flyvbjerg, B. (2006). Five Misunderstandings About Case-Study Research. *Qualitative Inquiry*, *12*(2), 219–245. https://doi.org/10.1177/1077800405284363

RavioliJaguar

Q: What other research/studies deal with recollection signal?

Wais, P. E., Squire, L. R., & Wixted, J. T. (2010). In search of recollection and familiarity signals in the hippocampus. *Journal of cognitive neuroscience*, *22*(1), 109-23.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2888779/

Merkow, M. B., Burke, J. F., & Kahana, M. J. (2015). The human hippocampus contributes to both the recollection and familiarity components of recognition memory. *Proceedings of the National Academy of Sciences of the United States of America*, *112*(46), 14378-83.

https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4655532/

ZeroCanary

Deceiving memories

Q: Do you think that episodic memory can lead to false memory creation of events?

False memories are episodic memories that contain inaccuracies in their recollection of how the events took place. An interesting quote from an article on episodic memory and false memories is, “all memories are to varying degrees false.” Additionally, the same article states “The main contention of this paper is that when people remember they imagine and when they imagine they use memory.” This supports the idea that episodic memory not only leads to false memory creation, but that false memories are intrinsically intertwined at almost every level of memory.

MileImport

Q: Is it true that the strength of a memory to a person is not actually directly related to whether or not the memory is true?

The following article says that strong emotion typically leads to accurate and stronger memory formation and spontaneous intrusive recollections. However, there is some contradictory research that shows that highly emotional events can have the opposite effect on memory and actually impair the ability to accurately recollect those events. Because the strongest memories are linked to emotional events, and because those memories are usually accurate, I think the “truth” of a memory has a minor impact on the strength. This article also talks about the effect of rehearsal. Whether a memory is true or not, and a person thinks about it in one way over and over again or keeps describing it in the same way, the strength of that memory will increase.

> Ferree, N. K., & Cahill, L. (2009). Post-event spontaneous intrusive recollections and strength of memory for emotional events in men and women. *Consciousness and Cognition*, *18*(1), 126–134. https://doi.org/10.1016/j.concog.2008.11.008

Q: How do traumatic events affect how episodic memory is retrieved? I’ve heard that the mind “blocks” out memories that are too painful to remember or can even make new ones to replace it.

“It is suggested that during high anxiety, episodic memory is lost, so that the event is recorded in semantic memory.” This article says that when there has been emotional or brain trauma, the facts surrounding the event can still be recorded but the person might not realize that they have been. They are recorded in a different type of memory.

Meares, R. (1995). Episodic Memory, Trauma, and the Narrative of Self. *Contemporary Psychoanalysis*, *31*(4), 541–556. https://doi.org/10.1080/00107530.1995.10746923

Stress is not the same thing as trauma, but perhaps the literature on the effects of stress on episodic

memory is at least a little relevant here.

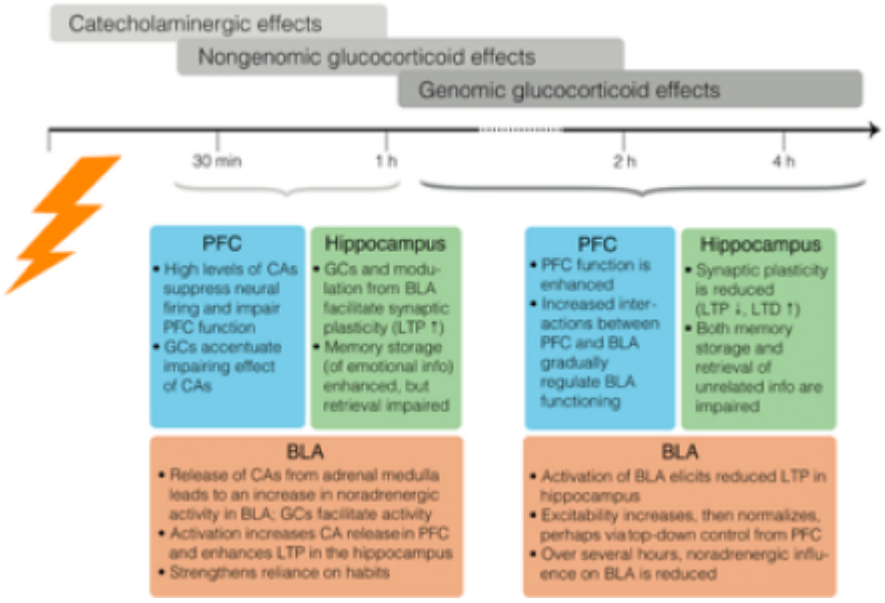


Figure 1 A schematic representation of the effects of stress over time. Approximately 20 min after the onset of a stressor, stress-induced catecholamine and nongenomic glucocorticoid actions interact to increase functioning of the BLA, while enhancing hippocampal plasticity and disrupting prefrontal function. During this time window, memory storage of the stressor and novel emotional information is facilitated, but retrieval of unrelated information is impaired. One to 2 h after exposure to the stressor, cortisol levels decrease and slower genomic glucocorticoid actions begin to reduce dorsal hippocampal plasticity and to modulate amygdala and prefrontal function; these processes impair both storage and retrieval of unrelated information. CA, catecholamine; GC, glucocorticoid; BLA, basolateral amygdala; PFC, prefrontal cortex.

From: [1]

> S. A. Gagnon and A. D. Wagner, “Acute stress and episodic memory retrieval:
>
> neurobiological mechanisms and behavioral consequences,” *Annals of the New York Academy of Sciences*, vol. 1369, no. 1, pp. 55–75, 2016.

RespondLlama

Improving memories

Q: If these findings suggest that the construct of memory strength does not provide a full account of retrieval-related hippocampal activity, what studies have been conducted to account to supplement memory strength?

Studies have been done to show the impact of sleep and emotionality on memory strength, not a neural supplement but a independent variable that can be manipulated to increase memory strength. They concluded that sleep benefits memory retreival dependent on many factors.

Schoch, S. F., Cordi, M. J., & Rasch, B. (2017). Modulating influences of memory strength and sensitivity of the retrieval test on the detectability of the sleep consolidation effect. *Neurobiology of Learning and Memory*, *145*, 181–189. https://doi.org/10.1016/j.nlm.2017.10.009

DivideSegment

Q: Is episodic memory or other forms of memory more important for doing well on college exams? It is said that people do better on exams when they take the exam in the same room as the subject was taught. Is this due to episodic memory? What part of the brain is primarily responsible for this type of information recall?

Most information states that studying material in different places improves memory of material and that variety helps with memory retrieval. However, why information may seem like it is being retrieved through memory more is due to familiarity and not episodic memory.

> Hockley, William E. “The Effects of Environmental Context on Recognition Memory and Claims of Remembering.” *Journal of Experimental Psychology: Learning, Memory, and Cognition* 34, no. 6 (2008): 1412–29. https://doi.org/10.1037/a0013016.

BanditMeter

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Brown, M. W., & Aggleton, J. P. (2001). Recognition memory: What are the roles of the perirhinal cortex and hippocampus? *Nature Reviews Neuroscience*, *2*(1), 51–61. https://doi.org/10.1038/35049064

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