

# Don't You Forget About Me: The Importance of Studying the Brain Basis of Real-world Interpersonal Memory

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## Abstract

■ Despite the fact that humans are a highly social species, we know relatively little about how people remember the rich interpersonal information filling their social lives. This gap is surprising: One function of memory has been suggested to be relationship maintenance [Neisser, U. Time present and time past. *Practical Aspects of Memory: Current Research and Issues*, 2, 545–560, 1988]. A major barrier to understanding the brain basis of interpersonal memory is that traditional brain imaging methods are not ideally suited to study memory for the nuanced interpersonal experiences comprising our social lives.

Yet, recent and rapidly developing advances in the analysis of brain responses to naturalistic social information can help researchers surpass this methodological barrier. This perspective piece articulates the importance of studying the brain basis of real-world social memories and suggests new directions in interpersonal memory research. This includes investigating the brain mechanisms that represent the content and structure of real-world interpersonal memories as well as how they are altered in mental health conditions associated with social memory biases. ■

## INTRODUCTION

The brain basis of memory is one of the most heavily researched topics in cognitive neuroscience, with large swaths of researchers investigating neural mechanisms associated with encoding, working memory, consolidation, and retrieval processes. Yet, despite making many critical and exciting discoveries, many memory researchers have largely neglected to study the neural mechanisms supporting one of the most pervasive forms of memory: memory for the rich interpersonal information humans process every day. Although there is a tradition of studying the brain basis of face and identity recognition (Wang et al., 2017; Gobbini & Haxby, 2007; Quiroga, Reddy, Kreiman, Koch, & Fried, 2005; Haxby, Hoffman, & Gobbini, 2002), these processes only scratch the surface of interpersonal memory. Humans also commit more high-level social information to memory (in addition to low-level social information, like facial identity), such as who said what and why during a conversation or how a series of events unfolded within a social network. Memory for such information is critical for navigating social life and impacts high-stakes outcomes like eye-witness testimony.

The goal of this perspective piece is to (1) make the case that investigating the brain basis of real-world interpersonal memory is an important research direction; (2) briefly review what is known, so far, about the brain basis of interpersonal memory; (3) demonstrate how new data analytic methods may help us better understand the neural mechanisms supporting interpersonal memories; and

(4) present exciting new research directions in interpersonal memory research.

## THE IMPORTANCE OF STUDYING THE BRAIN BASIS OF REAL-WORLD INTERPERSONAL MEMORIES

Humans have a fundamental need to feel connected to others, and our interpersonal memories have a profound impact on well-being (Baumeister & Leary, 1995). Take for example a consistent finding from social psychology, which is that our memories of social disconnection (e.g., a romantic breakup or exclusion from a group) are more easily “reexperienced” than our nonsocial, painful memories (e.g., a sports injury), even when the two events are perceived as equally distressing at the time of the event (Chen & Williams, 2011; Chen, Williams, Fitness, & Newton, 2008). Findings like these may scale to serious mental health conditions associated with memory biases. Posttraumatic stress disorder, a condition characterized by distressing memories, occurs more frequently in response to intentionally caused harms between people (e.g., assault) relative to threatening, nonintentional harms (e.g., a dangerous natural disaster; Santiago et al., 2013). In fact, over the course of the first year after a trauma, posttraumatic stress disorder symptom severity increases over time for intentionally caused traumas, despite decreasing over time for non-intentionally caused traumas (Santiago et al., 2013).

Interpersonal memories are also tightly linked to depression. Multiple theories of depression adhere to a “cognitive vulnerability stress model,” suggesting

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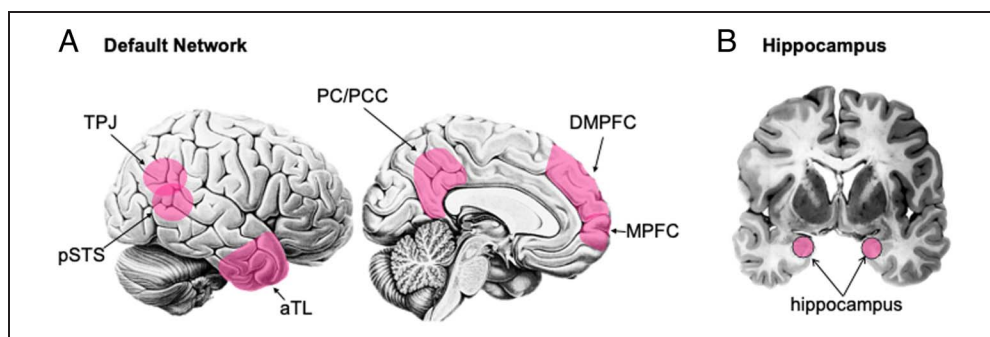
thought patterns in response to stressful memories, particularly stress-reactive rumination, predict the onset of depression (Michl, McLaughlin, Sheard, & Nolen-Koeseema, 2013; Abramson, Metalsky, & Alloy, 1989; Beck, 1967). Critically, when it comes to the link between stress-reactive rumination and depression, not all stressors are created equal. Stress-reactive rumination in response to “social stressors,” such as negative evaluation and exclusion, preferentially induces stress-reactive rumination (Slavich, O’Donovan, Epel, & Kemeny, 2010), and past work indicates that rumination often occurs directly after social interactions (Clark & Wells, 1995). Yet, despite the mental health significance of understanding how our past interpersonal interactions haunt us over time, we still know very little about how—in terms of neural mechanisms—negative interpersonal interactions are translated into lasting memories as well as why they are so easily reexperienced.

Of course, our social memories are not exclusively stressful. Many of our happiest memories are interpersonal in nature. People prefer to retrieve positive memories of times spent with others (e.g., a memory of a party with friends) relative to positive memories removed from interpersonal interaction (e.g., a memory of earning a good grade; Speer & Delgado, 2019). In addition, we experience nostalgia—the bittersweet emotion accompanying memory retrieval—most strongly for our interpersonal memories, and it is thought that nostalgia plays a key role in fostering social connection (Sedikides, Wildschut, Arndt, & Routledge, 2008; Zhou, Sedikides, Wildschut, & Gao, 2008; Wildschut, Sedikides, Arndt, & Routledge, 2006). Reminiscing is itself often a social act: Individuals retrieve their past experiences together during conversation (Hyman & Faries, 1992), a phenomenon that plays important roles across the lifespan. Parent–child reminiscing impacts the child’s development of self, shapes the content of their autobiographical memories, and relates to their social competence (Bauer & Fivush, 2014; Song & Wang, 2013; Fivush, Marin, McWilliams, & Bohanek, 2009). Older-adult reminiscing is associated with positive mood and a sense of connection to one’s identity (Pasupathi & Carstensen, 2003; Carlson, 1984). Yet, we know very little about the neural basis of nostalgia, reminiscing, and how they impact the neural representation of our long-term memories.

## WHAT IS KNOWN ABOUT THE BRAIN BASIS OF INTERPERSONAL MEMORY

Memories for interpersonal interactions likely combine a mixture of information about another person(s) as well as the self (e.g., “she said that to me because she was confused,” “we were both so happy that day”), and self- and other-information processing is known to activate the brain’s default network, a set of interconnected cortical regions broadly associated with internally generated thought (Buckner & DiNicola, 2019; Andrews-Hanna, Reidler, Sepulcre, Poulin, & Buckner, 2010), including medial pFC, dorsomedial pFC (DMPFC), posterior cingulate/precuneus, TPJ, and anterior temporal poles (Figure 1A). In terms of its involvement in interpersonal memory processes, the default network increases in activation as a function of the amount of social information about the self and others managed in working memory (e.g., managing social network members’ personality traits and mental states; Meyer & Collier, 2020; Smith et al., 2018; Meyer, Taylor, & Lieberman, 2015; Meyer, Spunt, Berkman, Taylor, & Lieberman, 2012). Patterns like these are not unique to social forms of “working memory.” The default network—particularly DMPFC and TPJ portions—is also associated with the “encoding” and “retrieval” of social (relative to nonsocial) memory (Meyer, Williams, & Eisenberger, 2015; Satpute, Badre, & Ochsner, 2014; Mitchell, Macrae, & Banaji, 2004) as well as the “consolidation” of social knowledge during postencoding rest (Collier & Meyer, 2020; Meyer, Davachi, Ochsner, & Lieberman, 2019). Outside memory research, the DMPFC and TPJ portions of the default network are reliably associated with “mentalizing,” the process of inferring people’s mental states and traits (Lieberman, Straccia, Meyer, Du, & Tan, 2019; Van Overwalle, 2009; Saxe & Kanwisher, 2003), suggesting these brain regions may play a role in memory when memorial processes engage mentalizing. The default network is also associated with memorial processes that require representing the context of a former experience (Ritchey, Libby, & Ranganath, 2015; Ranganath & Ritchey, 2012), more so than the recognition of items from an experience. Inferences made during mentalizing (e.g., “she said that because she was excited and she is a positive person”) may therefore provide an interpersonal context for a memory trace.

**Figure 1.** (A) The default network. PC/PCC = posterior cingulate/precuneus; MPFC = medial pFC; pSTS = posterior STS; aTPL = anterior temporal lobe. (B) The hippocampus.



In addition to the default network, the hippocampus (Figure 1B)—which is known to play a broad role in memory—is associated with certain aspects of interpersonal memory. The hippocampus has been tied to recognition of familiar others (Kogan, Frankland, & Silva, 2000; Leveroni et al., 2000) and has been shown to represent knowledge about social dimensions, such as affiliation and power (Tavares et al., 2015). These data have been used as evidence in support of hippocampally mediated “social maps” of interpersonal space akin to the nonsocial “cognitive maps” of physical space thought to be maintained by the hippocampus. Interestingly, the paradigms implicating the hippocampus in social maps often require participants to make decisions along social dimensions based on prior social knowledge (e.g., deciding to trust an interaction partner moves them closer on the affiliation dimensions to that partner; Tavares et al., 2015) or make decisions based on past social behavior (e.g., deciding to reengage with someone who treated you nicely and avoid someone who treated you unfairly; FeldmanHall, Montez, Phelps, Davachi, & Murty, 2020). Thus, one possibility is that contextual social knowledge about social network members may be outsourced from the hippocampus to primary default network regions, but when social knowledge is used to make decisions, the hippocampus may come back online. This idea is consistent with prior memory research indicating that the hippocampus plays a key role in representing “where” one is while navigating abstract space (Theves, Fernandez, & Doeller, 2019; O’Keefe & Dostrovsky, 1971) but the memory content moves and is stored in schemas throughout the cortex (McClelland, McNaughton, & O’Reilly, 1995).

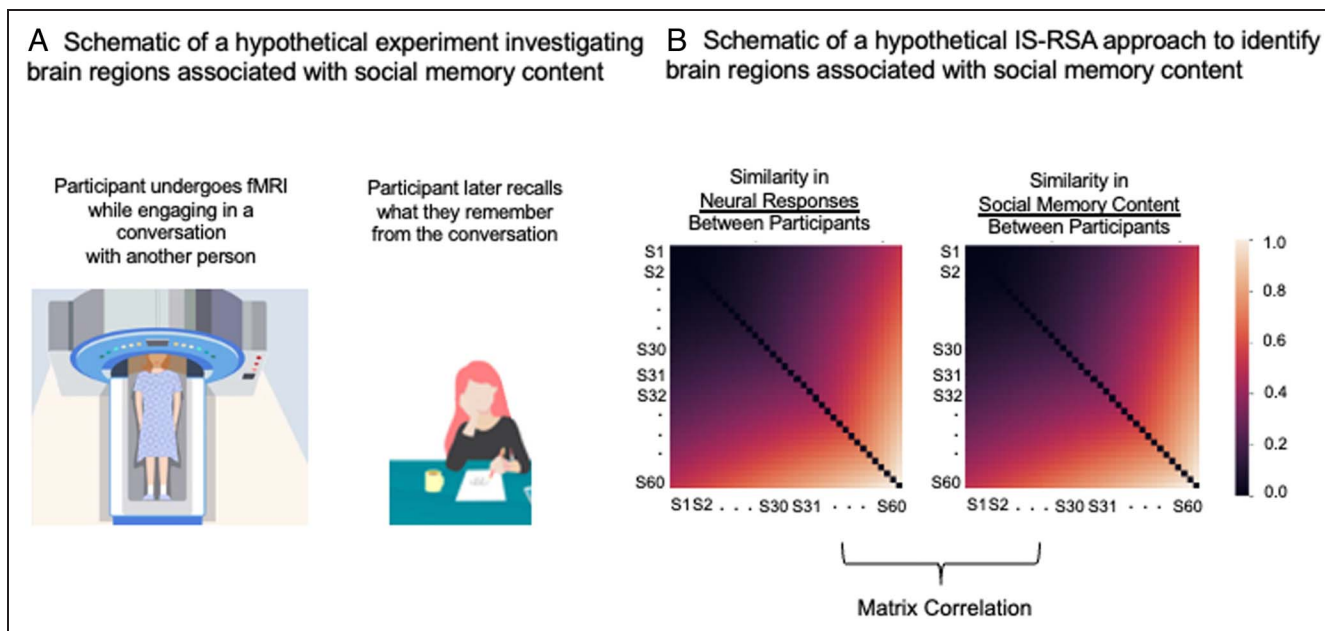
### **SURPASSING THE METHODOLOGICAL BARRIER**

The past research relevant to interpersonal experiences points us to where to look for neural signatures of interpersonal memories. However, traditional brain imaging paradigms do not easily lend themselves to studying complex forms of interpersonal memory. To date, human neuroscience research on social memory has mostly used simplistic approaches such as showing faces one at a time on a screen while participants undergo fMRI and subsequently probing memory with face recognition tests (e.g., Meyer et al., 2019; Mitchell et al., 2004). Although this approach has been generative, it is not up to the task of answering questions about memory for complex social interactions that take place over time and between multiple people simultaneously. However, the recent and rapid growth in approaches for measuring neural activity in response to viewing naturalistic social interactions (Chang et al., 2021; Owen, Chang, & Manning, 2021; Nastase, Gazzola, Hasson, & Keysers, 2019; Chen et al., 2017), such as intersubject correlation analysis (i.e., examining the similarity in neural responses over time across participants;

Nastase et al., 2019; Chen et al., 2017) and multivariate pattern similarity analysis to detect event boundaries in memory (Baldassano et al., 2017), means that scientists can now determine the neural mechanisms supporting naturalistic social memory for the first time.

How can naturalistic data analysis methods push interpersonal memory research forward? Most obviously, embracing naturalistic data analysis methods may enhance the external validity of the findings, given that real-world social memory emerges in response to dynamic social interactions. However, the value is not only in the stimuli—it is also in the kinds of questions the methods can allow researchers to answer. In traditional neuroscience studies investigating social memory, the dependent variable is frequently “how much” or the amount of social information remembered. For example, researchers typically link neural activity with the number of correctly recalled facts from a story or the number of correctly identified faces (i.e., “hits”) versus incorrectly remembered faces (i.e., “false alarms”). Or, they may compare neural activity during encoding for trials that were later accurately recalled versus forgotten. These approaches are very useful in identifying neural mechanisms associated with memory accuracy and skill. However, when it comes to our interpersonal memories (as well as other kinds of memory), accuracy is not the only interesting and important aspect. We often care a great deal about not only “how much” is remembered but also “what” is remembered. A group of conversation partners may all recall 40% of their discussion, and thus be equally accurate, and yet one person may be biased toward remembering only what they said during the conversation, another may be biased toward recalling what high status people said, and yet another may be biased toward recalling tense moments—same recall amount, different content. Recent data analytic approaches developed to analyze naturalistic social stimuli are well suited to answer questions about social memory content.

Specifically, intersubject correlation analysis and its offshoot—intersubject representational similarity analysis (IS-RSA)—have been particularly useful in linking participants’ idiosyncratic neural responses while encoding naturalistic stimuli with their subsequent, idiosyncratic interpretations of the events (Leong, Chen, Willer, & Zaki, 2020; Finn, Corlett, Chen, Bandettini, & Constable, 2018; Yeshurun et al., 2017). In fact, one recent study applied IS-RSA to a data set in which participants listened to a story that, as it unfolded naturally, could generate in the participant a suspicious interpretation of the characters’ intentions (Finn et al., 2018). Participants who exhibited high (vs. low) trait paranoia showed (1) greater intersubject correlations in the default network, including the DMPFC, and (2) similarly suspicious representations of the story (Finn et al., 2018). Such findings suggest that IS-RSA may help unpack the neural mechanisms associated with different memory content of the same social situations. See Figure 2 for a schematic of how IS-RSA could be employed



**Figure 2.** Schematic of a hypothetical social memory experiment designed to use IS-RSA to investigate brain regions associated with similar interpersonal memory content between people. A shows the experimental design. B shows the data analysis approach, where each participant's neural response during conversation is correlated with each other participant's neural response, each subject's memory content (e.g., based on text analysis) is correlated with each other participant's memory content, and then each of those correlation matrices is correlated with one another. In this hypothetical schematic, lighter colors indicate similarity between participants, and darker colors indicate dissimilarity between participants. The social memory content score could reflect any number of dimensions of interest to the researcher, such as “self-focus,” “other-focus,” or “negative affect”). This hypothetical IS-RSA model tests the possibility that participants who score high on the psychological dimension of interest show similar neural responses, whereas participants who score low on the dimension show dissimilar responses, an approach developed by Finn et al. (2020).

to investigate brain regions associated with specific social memory content.

Recent methodological advances may also shed new insight into how the brain organizes the information comprising our interpersonal memories. Event segmentation refers to how the stream of information we encode through ongoing experience is organized into thematic chunks (Ezzyat & Davachi, 2011; Zacks & Swallow, 2007). For example, while at a party, you may first have a conversation with an old friend and then bump into an acquaintance and catch up with them. Event segmentation refers to whether you chunk both of these events into a single memory versus discrete ones. Recent memory research has shown that event segmentation can be determined in a data-driven way, by examining when multivariate neural patterns measured during naturalistic viewing are highly correlated and then by using hidden Markov modeling, determining precisely when they transition into a new multivariate neural pattern (Baldassano et al., 2017). Researchers recently applied this novel approach to a data set in which participants watched an episode of the television show *Sherlock*, a mystery drama in which a detective investigates unsolved cases. Although regions across the brain were associated with different types of event boundaries, default network regions, particularly the DMPFC and TPJ, showed the greatest segmentation for event boundaries operating on longer time scales (e.g., a plot twist, as opposed to a quick scene change). This was the case regardless of whether the *Sherlock* episode was

encoded visually as a television show or auditorily by listening to a narrator. Although this study did not explicitly focus on the interpersonal nature of the television show, given that detective series involve plots of “who did what and why?” and that the DMPFC and TPJ are the two regions most reliably associated with mentalizing (Lieberman et al., 2019; Van Overwalle, 2009; Saxe & Kanwisher, 2003), one interpretation of the findings is that the DMPFC and TPJ may play a key role in segmenting ongoing social experience into meaningful units, which may in turn impact how our interpersonal experiences are organized in memory.

There are potential downsides to embracing the “naturalistic stimuli” movement in neuroscience. Most notably, the approach often comes at the cost of experimental control, which can limit the specificity of result interpretation. For instance, if participants observed a television drama while undergoing fMRI and it was discovered that they preferentially remembered the social information from the show (e.g., character relationships and/or intentions) relative to the nonsocial information (e.g., locations shown in the footage), it would be difficult to determine whether the social memory advantage was because of social information being privileged in memory or whether the narrative and plot of the story creates a schema for social information (but not nonsocial information), which could incidentally improve social memory performance. Any neural data identified as associated with the social memory advantage would be equally hard to interpret.

However, it is possible to approach naturalistic stimuli with an experimenter's eye for confounds. There are forms of naturalistic video footage without narratives; stimuli can be normed in advance by separate participants on confounding dimensions, and data-driven approaches (e.g., creating narrative vs. content classifiers) could be used to parse out neural data associated with interrelated dimensions. Moreover, such steps would not only help rule out confounds—they would also help determine the interaction between social information processing and other related variables on interpersonal memory. This can be illustrated in the earlier example of conversation partners that all recall 40% of their discussion, and yet one person is biased toward recalling tense moments. If independent raters continuously rated both the social and affective content in the naturalistic conversation, those ratings could be used to determine, among participants biased toward recalling tense interpersonal moments, whether it is the social aspect of the memory, the emotion tied to the experience, or their combination that is driving potential changes in memory and their corresponding neural correlates.

In addition, naturalistic and experimental methods are not mutually exclusive and could be combined in the same set of participants to assess conceptual replication across approaches. For example, recent work using traditional brain imaging methods found that the hippocampus contributes to the decision to reengage with another stranger, based on how fairly they treated the participant in a previous round of the Dictator Game (in which the stranger decided how much money to share with the participant; FeldmanHall et al., 2020). This elegant finding could be used to inform the development of new experiments designed to understand how trust decisions unfold during real-world interaction with close others who may have treated us fairly or unfairly in the past. In this sense, findings from experiments with high internal validity can be used as a springboard for answering questions about more externally valid interpersonal experiences (and vice versa). Overall, although naturalistic stimuli do present certain challenges, embracing them thoughtfully and without the exclusion of complementary experimental designs could offset concerns over interpretability.

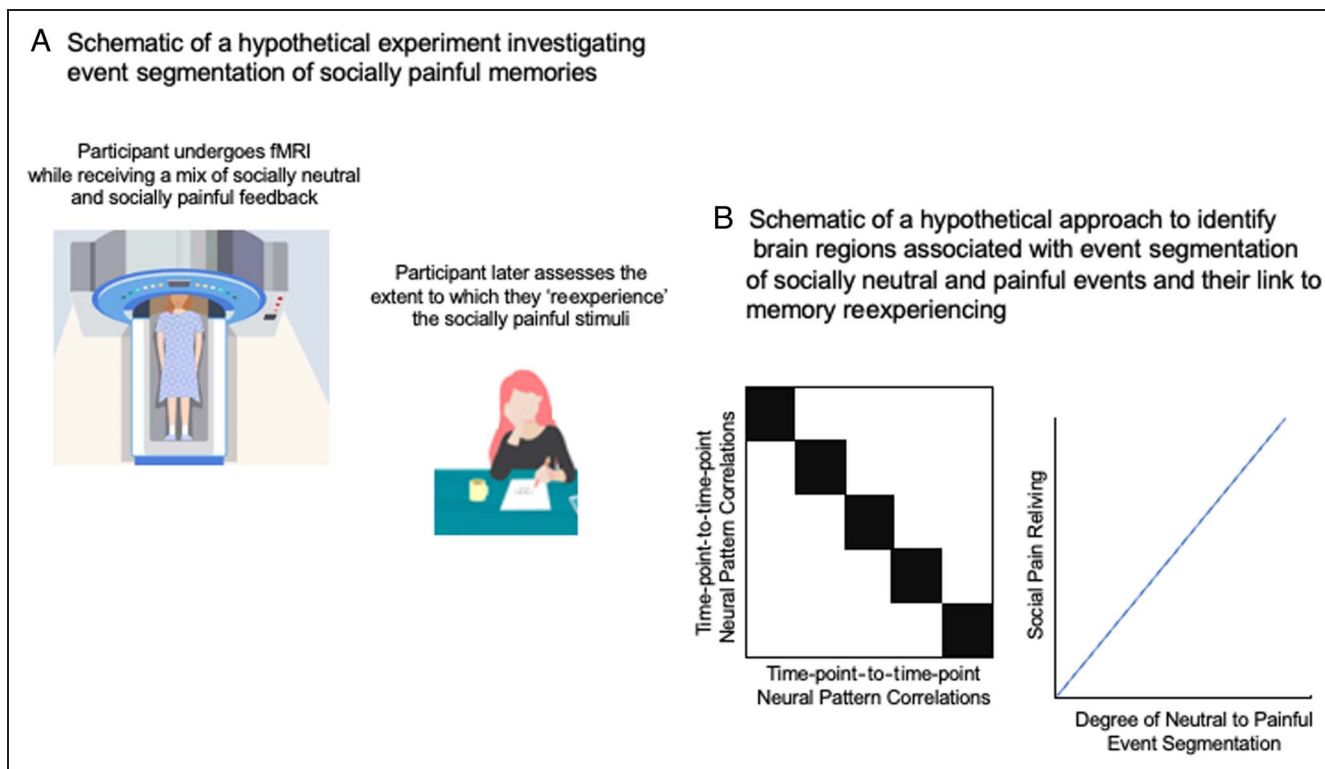
## NEW DIRECTIONS IN INTERPERSONAL MEMORY RESEARCH

The exciting methodological advances in measuring brain responses to naturalistic stimuli (Chang et al., 2021; Finn et al., 2018, 2020; Nastase et al., 2019; Baldassano et al., 2017; Chen et al., 2017) opens the door to exciting new directions in interpersonal memory research. These include investigating how our brains represent the content and structure of our interpersonal memories as well as how social memory neural mechanisms contribute to mental health, in terms of understanding both how

negative social memory biases contribute to poor mental health and how reminiscing about our positive social experiences contributes to well-being.

Just as an example, let us return to the social psychological finding that our emotionally painful social memories (e.g., a romantic breakup or exclusion from a group) are more easily reexperienced than our nonsocial painful memories (e.g., a sports injury), even when the two events are perceived as equally distressing at the time of the event (Chen & Williams, 2011; Chen et al., 2008). To date, why our past socially painful memories are so easily reexperienced is unclear, although some research suggests that the difference may be because, at least in part, of the observation that the default network is more strongly associated with retrieving social (vs. nonsocial) painful memories (Eisenberger, 2016; Meyer, Williams, et al., 2015). Naturalistic data analysis methods are well suited to unpack this phenomenon, for instance, by investigating whether socially painful experiences show strong event segmentation in the default network at encoding, which may make them easier to subsequently bring to mind (see Figure 3 for a schematic of a hypothetical experiment designed to test this possibility). Relatedly, certain social content of past social pains—such as the extent to which they include other people's negative intentions and/or one's own negative self-views—may contribute to the ease with which they are reexperienced, possibilities that IS-RSA are well suited to examine. Yet, another interesting possibility would be to assess intrasubject correlation (i.e., similar neural responses within a subject) when retrieving social (vs. nonsocial) painful memories over time. Retrieving nonsocial, painful memories (e.g., a sports injury) may show decreased intrasubject correlation over time, reflecting the observation that these memories become increasingly less affectively painful. In contrast, when retrieving socially painful memories, participants' intrasubject correlation, possibly within default network regions, may persist over multiple retrieval time points. In other words, intrasubject correlation approaches may be used to recapitulate and identify where in the brain socially painful memories hurt us over and over again.

Naturalistic data analysis methods may also help us better understand how stress-reactive rumination in response to social stressors impairs mental health. Extant research suggests that “post event processing” (e.g., focusing on negative aspects of a social interaction) after stressful social experiences may lead to depression, in part, by generating a negative memory bias for self-relevant information (Joormann & Siemer, 2011; Joormann, Yoon, & Zetsche, 2007; Pyszczynski, Hamilton, Herring, & Greenberg, 1989). Yet, what remains unknown is “how” social stressors generate postevent information processing after the stressor, which of these processes lead to a negative memory bias for the self, and how they may be unique in individuals at a high risk for the onset of depression. Here again, naturalistic data analysis methods may help researchers determine the answers to these



**Figure 3.** Schematic of a hypothetical social memory experiment designed to determine whether neural event segmentation in response to socially painful experiences (e.g., rejection, exclusion) helps explain why those memories are so easily reexperienced. A shows the experimental design. B shows the data analysis approach, where a given participant's time-point-to-time-point neural responses during encoding are correlated with one another. Boundaries between correlation sets in black would reflect event segmentation of socially painful (vs. socially neutral) moments during encoding, and the extent to which participants demonstrate event segmentation should correlate with social pain memory reexperiencing.

open questions, which largely surround understanding differences in the “content” of interpersonal memories, as opposed to “amount” of information recalled.

For example, in memory consolidation paradigms, participants often first encode new information, undergo a resting state scan, and, outside the scanner, complete a memory test for the information encoded (Tambini & Davachi, 2019). Because of findings suggesting that memories are consolidated during postencoding rest (Hoffman & McNaughton, 2002; Kudrimoti, Barnes, & McNaughton, 1999), human memory researchers typically assess whether and how neural patterns engaged during encoding are reinstated during postencoding rest (Schapiro, McDevitt, Rogers, Mednick, & Norman, 2018; Tomparry, Duncan, & Davachi, 2015; Tambini & Davachi, 2013) and whether this rest period explains unique variance in subsequent memory (Murty, Tomparry, Adcock, & Davachi, 2017). Given the observation that stress-reactive rumination occurs after a stressor is encoded, this approach could be combined with naturalistic data analysis methods to begin to determine the brain basis of stress-reactive rumination and how it impacts the content of the stressor memory. This type of experiment would allow researchers to assess whether individuals who tend to develop a negative memory bias for the encoded social stressor show similar neural responses

(possibly in default network regions) during stressor encoding and/or consolidation during rest.

The utility of naturalistic data analysis methods applies to our positive interpersonal memory, too. As mentioned above, we know very little about the neural basis of nostalgic reminiscing and how it impacts the neural representation of our long-term memories. Given that nostalgic reminiscing often unfolds over time through conversation, naturalistic data analysis methods are well suited to probe how reminiscing has its powerful effects. For example, an experiment could employ hyperscanning (i.e., wherein two participants communicate while undergoing fMRI in two separate scanners) and manipulate whether participants collectively recall shared (vs. not shared) memories. Multiple naturalistic data analysis methods, including intersubject correlation, IS-RSA, and/or event segmentation, could be employed to examine why—in terms of neural mechanisms—reminiscing about our shared interpersonal experiences impacts mood and one's sense of self. Indeed, if the hippocampus maintains interpersonal maps, as suggest by prior research (Montagrin, Saiote, & Schiller, 2018; Schafer & Schiller, 2018; Tavares et al., 2015), then future work may be able to assess whether reminiscing with an old friend has its positive effects on well-being, in part, by moving the friend “closer” to the self in hippocampally mediated social maps.

## CONCLUSION

A significant amount of human memory is social in nature: Autobiographical memories include many interpersonal experiences, and people recall memories together while reminiscing. Yet, we know relatively little about the brain basis of our interpersonal memories. Recent methodological advances in analyzing brain responses to naturalistic social information provide a unique opportunity to discover the neural mechanisms supporting real-world social memory in humans. Isolating memory mechanisms for real-world social experiences is not only important for high-stakes outcomes, such as eye-witness testimony. It may further explain why the negative and positive experiences with people from our past seem to linger with us, by either haunting us with pain or consuming us with nostalgia.

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## Diversity in Citation Practices

Retrospective analysis of the citations in every article published in this journal from 2010 to 2021 reveals a persistent pattern of gender imbalance: Although the proportions of authorship teams (categorized by estimated gender identification of first author/last author) publishing in the *Journal of Cognitive Neuroscience (JoCN)* during this period were  $M(\text{an})/M = .407$ ,  $W(\text{oman})/M = .32$ ,  $M/W = .115$ , and  $W/W = .159$ , the comparable proportions for the articles that these authorship teams cited were  $M/M = .549$ ,  $W/M = .257$ ,  $M/W = .109$ , and  $W/W = .085$  (Postle and Fulvio, *JoCN*, 34:1, pp. 1–3). Consequently, *JoCN* encourages all authors to consider gender balance explicitly when selecting which articles to cite and gives them the opportunity to report their article's gender citation balance.

## REFERENCES

- Abramson, L. Y., Metalsky, G. I., & Alloy, L. B. (1989). Hopelessness depression: A theory-based subtype of depression. *Psychological Review*, 96, 358–372. <https://doi.org/10.1037/0033-295X.96.2.358>
- Andrews-Hanna, J. R., Reidler, J. S., Sepulcre, J., Poulin, R., & Buckner, R. L. (2010). Functional-anatomic fractionation of the brain's default network. *Neuron*, 65, 550–562. <https://doi.org/10.1016/j.neuron.2010.02.005>, PubMed: 20188659
- Baldassano, C., Chen, J., Zadbood, A., Pillow, J. W., Hasson, U., & Norman, K. A. (2017). Discovering event structure in continuous narrative perception and memory. *Neuron*, 95, 709–721. <https://doi.org/10.1016/j.neuron.2017.06.041>, PubMed: 28772125
- Bauer, P. J., & Fivush, R. (2014). Maternal reminiscing style: The sociocultural construction of autobiographical memory across childhood and adolescence. *Wiley Handbook on the Development of Children's Memory*, 1088, 568–585. <https://doi.org/10.1002/9781118597705.ch24>
- Baumeister, R. F., & Leary, M. R. (1995). The need to belong: Desire for interpersonal attachments as a fundamental human motivation. *Psychological Bulletin*, 117, 497–529. <https://doi.org/10.1037/0033-2909.117.3.497>, PubMed: 7777651
- Beck, A. T. (1967). *Depression: Clinical, experimental, and theoretical aspects*. New York: Harper & Row.
- Buckner, R. L., & DiNicola, L. M. (2019). The brain's default network: Updated anatomy, physiology and evolving insights. *Nature Reviews Neuroscience*, 20, 593–608. <https://doi.org/10.1038/s41583-019-0212-7>, PubMed: 31492945
- Carlson, C. M. (1984). Reminiscing: Toward achieving ego integrity in old age. *Social Casework*, 65, 81–89. <https://doi.org/10.1177/104438948406500203>
- Chang, L. J., Jolly, E., Hyun Cheong, J., Rapuano, K., Greenstein, N., Chen, P. H. A., et al. (2021). Endogenous variation in ventromedial prefrontal cortex state dynamics during naturalistic viewing reflects affective experience. *Science Advances*, 7, eabf7129. <https://doi.org/10.1126/sciadv.abf7129>, PubMed: 33893106
- Chen, J., Leong, Y. C., Honey, C. J., Yong, C. H., Norman, K. A., & Hasson, U. (2017). Shared memories reveal shared structure in neural activity across individuals. *Nature Neuroscience*, 20, 115–125. <https://doi.org/10.1038/nn.4450>, PubMed: 27918531
- Chen, Z., & Williams, K. D. (2011). Social pain is easily relived and pre-lived, but physical pain is not. In G. MacDonald & L. A. Jensen-Campbell (Eds.), *Social pain: Neuropsychological and health implications of loss and exclusion* (pp. 161–177). Washington, DC: American Psychological Association. <https://doi.org/10.1037/12351-007>
- Chen, Z., Williams, K. D., Fitness, J., & Newton, N. C. (2008). When hurt will not heal: Exploring the capacity to relive social and physical pain. *Psychological Science*, 19, 789–795. <https://doi.org/10.1111/j.1467-9280.2008.02158.x>, PubMed: 18816286
- Clark, D. M., & Wells, A. (1995). A cognitive model of social phobia. In R. G. Heimberg, M. R. Liebowitz, D. A. Hope, & F. R. Schneier (Eds.), *Social phobia: Diagnosis, assessment, and treatment* (pp. 69–73). New York: Guilford Press.
- Collier, E., & Meyer, M. L. (2020). Memory of others' disclosures is consolidated during rest and associated with providing support: Neural and linguistic evidence. *Journal of Cognitive Neuroscience*, 32, 1672–1687. [https://doi.org/10.1162/jocn\\_a\\_01573](https://doi.org/10.1162/jocn_a_01573), PubMed: 32379001
- Eisenberger, N. I. (2016). Social pain and social pleasure: Two overlooked but fundamental mammalian emotions? In L. F. Barret, M. Lewis, & J. Haviland-Jones (Eds.), *The handbook of emotions* (pp. 440–452). New York: Guilford Press.
- Ezzyat, Y., & Davachi, L. (2011). What constitutes an episode in episodic memory? *Psychological Science*, 22, 243–252. <https://doi.org/10.1177/0956797610393742>, PubMed: 21178116
- FeldmanHall, O., Montez, D. F., Phelps, E. A., Davachi, L., & Murty, V. P. (2020). Hippocampus guides adaptive learning during dynamic social interactions. *Journal of Neuroscience*, 41, 1340–1348. <https://doi.org/10.1523/JNEUROSCI.0873-20.2020>, PubMed: 33361462
- Finn, E. S., Corlett, P. R., Chen, G., Bandettini, P. A., & Constable, R. T. (2018). Trait paranoia shapes inter-subject synchrony in brain activity during an ambiguous social narrative. *Nature Communications*, 9, 2043. <https://doi.org/10.1038/s41467-018-04387-2>, PubMed: 29795116
- Finn, E. S., Gleran, E., Khojandi, A. Y., Nielson, D., Molfese, P. J., Handwerker, D. A., et al. (2020). Idiosynchrony: From shared responses to individual differences during naturalistic

- neuroimaging. *Neuroimage*, *215*, 116828. <https://doi.org/10.1016/j.neuroimage.2020.116828>, PubMed: 32276065
- Fivush, R., Marin, K., McWilliams, K., & Bohanek, J. G. (2009). Family reminiscing style: Parent gender and emotional focus in relation to child well-being. *Journal of Cognition and Development*, *10*, 210–235. <https://doi.org/10.1080/15248370903155866>, PubMed: 26705398
- Gobbini, M. I., & Haxby, J. V. (2007). Neural systems for recognition of familiar faces. *Neuropsychologia*, *45*, 32–41. <https://doi.org/10.1016/j.neuropsychologia.2006.04.015>, PubMed: 16797608
- Haxby, J. V., Hoffman, E. A., & Gobbini, M. I. (2002). Human neural systems for face recognition and social communication. *Biological Psychiatry*, *51*, 59–67. [https://doi.org/10.1016/S0006-3223\(01\)01330-0](https://doi.org/10.1016/S0006-3223(01)01330-0), PubMed: 11801231
- Hoffman, K. L., & McNaughton, B. L. (2002). Coordinated reactivation of distributed memory traces in primate neocortex. *Science*, *297*, 2070–2073. <https://doi.org/10.1126/science.107353>, PubMed: 12242447
- Hyman, I. E., & Faries, J. M. (1992). The functions of autobiographical memory. In M. A. Conway, D. C. Rubin, I. I. Spinlers, & W. A. Wagenaar (Eds.), *Theoretical perspectives on autobiographical memory* (pp. 207–221). Amsterdam: Kluwer Academic Publishers. [https://doi.org/10.1007/978-94-015-7967-4\\_12](https://doi.org/10.1007/978-94-015-7967-4_12)
- Joormann, J., & Siemer, M. (2011). Affective processing and emotion regulation in dysphoria and depression: Cognitive biases and deficits in cognitive control. *Social and Personality Psychology Compass*, *5*, 13–28. <https://doi.org/10.1111/j.1751-9004.2010.00335.x>
- Joormann, J., Yoon, K. L., & Zetsche, U. (2007). Cognitive inhibition in depression. *Applied & Preventive Psychology*, *12*, 128–139. <https://doi.org/10.1016/j.appsy.2007.09.002>
- Kogan, J. H., Frankland, P. W., & Silva, A. J. (2000). Long-term memory underlying hippocampus-dependent social recognition in mice. *Hippocampus*, *10*, 47–56. [https://doi.org/10.1002/\(SICI\)1098-1063\(2000\)10:1<47::AID-HIPO>3.0.CO;2-6](https://doi.org/10.1002/(SICI)1098-1063(2000)10:1<47::AID-HIPO>3.0.CO;2-6), PubMed: 10706216
- Kudrimoti, H. S., Barnes, C. A., & McNaughton, B. L. (1999). Reactivation of hippocampal cell assemblies: Effects of behavioral state, experience, and EEG dynamics. *Journal of Neuroscience*, *19*, 4090–4101. <https://doi.org/10.1523/JNEUROSCI.19-10-04090.1999>, PubMed: 10234037
- Leong, Y. C., Chen, J., Willer, R., & Zaki, J. (2020). Conservative and liberal attitudes drive polarized neural responses to political content. *Proceedings of the National Academy of Sciences, U.S.A.*, *117*, 27731–27739. <https://doi.org/10.1073/pnas.2008530117>, PubMed: 33082227
- Leveroni, C. L., Seidenberg, M., Mayer, A. R., Mead, L. A., Binder, J. R., & Rao, S. M. (2000). Neural systems underlying the recognition of familiar and newly learned faces. *Journal of Neuroscience*, *20*, 878–886. <https://doi.org/10.1523/JNEUROSCI.20-02-00878.2000>, PubMed: 10632617
- Lieberman, M. D., Straccia, M. A., Meyer, M. L., Du, M., & Tan, K. M. (2019). Social, self, (situational), and affective processes in medial prefrontal cortex (MPFC): Causal, multivariate, and reverse inference evidence. *Neuroscience & Biobehavioral Reviews*, *99*, 311–328. <https://doi.org/10.1016/j.neubiorev.2018.12.021>, PubMed: 30610911
- McClelland, J. L., McNaughton, B. L., & O'Reilly, R. C. (1995). Why there are complementary learning systems in the hippocampus and neocortex: Insights from the successes and failures of connectionist models of learning and memory. *Psychological Review*, *102*, 419–457. <https://doi.org/10.1037/0033-295X.102.3.419>, PubMed: 7624455
- Meyer, M. L., & Collier, E. (2020). Theory of minds: Managing mental state inferences in working memory is associated with the dorsomedial subsystem of the default network and social integration. *Social Cognitive and Affective Neuroscience*, *15*, 63–73. <https://doi.org/10.1093/scan/nsaa022>, PubMed: 32064502
- Meyer, M. L., Davachi, L., Ochsner, K. N., & Lieberman, M. D. (2019). Evidence that default network connectivity during rest consolidates social information. *Cerebral Cortex*, *29*, 1910–1920. <https://doi.org/10.1093/cercor/bhy071>, PubMed: 29668862
- Meyer, M. L., Spunt, R. P., Berkman, E. T., Taylor, S. E., & Lieberman, M. D. (2012). Evidence for social working memory from a parametric functional MRI study. *Proceedings of the National Academy of Sciences, U.S.A.*, *109*, 1883–1888. <https://doi.org/10.1073/pnas.1121077109>, PubMed: 22308468
- Meyer, M. L., Taylor, S. E., & Lieberman, M. D. (2015). Social working memory and its distinctive link to social cognitive ability: An fMRI study. *Social Cognitive and Affective Neuroscience*, *10*, 1338–1347. <https://doi.org/10.1093/scan/nsv065>, PubMed: 25987597
- Meyer, M. L., Williams, K. D., & Eisenberger, N. I. (2015). Why social pain can live on: Different neural mechanisms are associated with reliving social and physical pain. *PLoS One*, *10*, e0128294. <https://doi.org/10.1371/journal.pone.0128294>, PubMed: 26061877
- Michl, L. C., McLaughlin, K. A., Shepard, K., & Nolen-Hoeksema, S. (2013). Rumination as a mechanism linking stressful life events to symptoms of depression and anxiety: Longitudinal evidence in early adolescents and adults. *Journal of Abnormal Psychology*, *122*, 339–352. <https://doi.org/10.1037/a0031994>, PubMed: 23713497
- Mitchell, J. P., Macrae, C. N., & Banaji, M. R. (2004). Encoding-specific effects of social cognition on the neural correlates of subsequent memory. *Journal of Neuroscience*, *24*, 4912–4917. <https://doi.org/10.1523/JNEUROSCI.0481-04.2004>, PubMed: 15163682
- Montagrin, A., Saiote, C., & Schiller, D. (2018). The social hippocampus. *Hippocampus*, *28*, 672–679. <https://doi.org/10.1002/hipo.22797>, PubMed: 28843041
- Murty, V. P., Tompary, A., Adcock, R. A., & Davachi, L. (2017). Selectivity in postencoding connectivity with high-level visual cortex is associated with reward-motivated memory. *Journal of Neuroscience*, *37*, 537–545. <https://doi.org/10.1523/JNEUROSCI.4032-15.2016>, PubMed: 28100737
- Nastase, S. A., Gazzola, V., Hasson, U., & Keysers, C. (2019). Measuring shared responses across subjects using intersubject correlation. *Social Cognitive and Affective Neuroscience*, *14*, 667–685. <https://doi.org/10.1093/scan/nsz037>, PubMed: 31099394
- Neisser, U. (1988). Time present and time past. *Practical Aspects of Memory: Current Research and Issues*, *2*, 545–560.
- O'Keefe, J., & Dostrovsky, J. (1971). The hippocampus as a spatial map. Preliminary evidence from unit activity in the freely-moving rat. *Brain Research*, *34*, 171–175. [https://doi.org/10.1016/0006-8993\(71\)90358-1](https://doi.org/10.1016/0006-8993(71)90358-1), PubMed: 5124915
- Owen, L. L. W., Chang, T. H., & Manning, J. R. (2021). High-level cognition during story listening is reflected in high-order dynamic correlations in neural activity patterns. *Nature Communications*, *12*, 5728. <https://doi.org/10.1038/s41467-021-25876-x>, PubMed: 34593791
- Pasupathi, M., & Carstensen, L. L. (2003). Age and emotional experience during mutual reminiscing. *Psychology and Aging*, *18*, 430–442. <https://doi.org/10.1037/0882-7974.18.3.430>, PubMed: 14518806
- Pyszczynski, T., Hamilton, J. C., Herring, F. H., & Greenberg, J. (1989). Depression, self-focused attention, and the negative memory bias. *Journal of Personality and Social Psychology*, *57*, 351–357. <https://doi.org/10.1037/0022-3514.57.2.351>
- Quiroga, R. Q., Reddy, L., Kreiman, G., Koch, C., & Fried, I. (2005). Invariant visual representation by single neurons in



- the human brain. *Nature*, *435*, 1102–1107. <https://doi.org/10.1038/nature03687>, PubMed: 15973409
- Ranganath, C., & Ritchey, M. (2012). Two cortical systems for memory-guided behaviour. *Nature Reviews Neuroscience*, *13*, 713–726. <https://doi.org/10.1038/nrn3338>, PubMed: 22992647
- Ritchey, M., Libby, L. A., & Ranganath, C. (2015). Cortico-hippocampal systems involved in memory and cognition: The PMAT framework. *Progress in Brain Research*, *219*, 45–64. <https://doi.org/10.1016/bs.pbr.2015.04.001>, PubMed: 26072233
- Santiago, P. N., Ursano, R. J., Gray, C. L., Pynoos, R. S., Spiegel, D., Lewis-Fernandez, R., et al. (2013). A systematic review of PTSD prevalence and trajectories in DSM-5 defined trauma exposed populations: Intentional and non-intentional traumatic events. *PLoS One*, *8*, e59236. <https://doi.org/10.1371/journal.pone.0059236>, PubMed: 23593134
- Satpute, A. B., Badre, D., & Ochsner, K. N. (2014). Distinct regions of prefrontal cortex are associated with the controlled retrieval and selection of social information. *Cerebral Cortex*, *24*, 1269–1277. <https://doi.org/10.1093/cercor/bhs408>, PubMed: 23300111
- Saxe, R., & Kanwisher, N. (2003). People thinking about thinking people: The role of the temporo-parietal junction in “theory of mind”. *Neuroimage*, *19*, 1835–1842. [https://doi.org/10.1016/S1053-8119\(03\)00230-1](https://doi.org/10.1016/S1053-8119(03)00230-1), PubMed: 12948738
- Schafer, M., & Schiller, D. (2018). Navigating social space. *Neuron*, *100*, 476–489. <https://doi.org/10.1016/j.neuron.2018.10.006>, PubMed: 30359610
- Shapiro, A. C., McDevitt, E. A., Rogers, T. T., Mednick, S. C., & Norman, K. A. (2018). Human hippocampal replay during rest prioritizes weakly learned information and predicts memory performance. *Nature Communications*, *9*, 3920. <https://doi.org/10.1038/s41467-018-06213-1>, PubMed: 30254219
- Sedikides, C., Wildschut, T., Arndt, J., & Routledge, C. (2008). Nostalgia: Past, present, and future. *Current Directions in Psychological Science*, *17*, 304–307. <https://doi.org/10.1111/j.1467-8721.2008.00595.x>
- Slavich, G. M., O’Donovan, A., Epel, E. S., & Kemeny, M. E. (2010). Black sheep get the blues: A psychobiological model of social rejection and depression. *Neuroscience and Biobehavioral Reviews*, *35*, 39–45. <https://doi.org/10.1016/j.neubiorev.2010.01.003>, PubMed: 20083138
- Smith, R., Lane, R., Alkozei, A., Bao, J., Smith, C., Sanova, A., et al. (2018). The role of medial prefrontal cortex in the working memory maintenance of one’s own emotional responses. *Scientific Reports*, *8*, 3460. <https://doi.org/10.1038/s41598-018-21896-8> PubMed: 29472625
- Song, Q., & Wang, Q. (2013). Mother-child reminiscing about peer experiences and children’s peer-related self-views and social competence. *Social Development*, *22*, 280–299. <https://doi.org/10.1111/sode.12013>
- Speer, M. E., & Delgado, M. R. (2019). The social value of positive autobiographical memory retrieval. *Journal of Experimental Psychology: General*, *49*, 790–799. <https://doi.org/10.1037/xge0000671>, PubMed: 31464507
- Tambini, A., & Davachi, L. (2013). Persistence of hippocampal multivoxel patterns into postencoding rest is related to memory. *Proceedings of the National Academy of Sciences, U.S.A.*, *110*, 19591–19596. <https://doi.org/10.1073/pnas.1308499110>, PubMed: 24218550
- Tambini, A., & Davachi, L. (2019). Awake reactivation of prior experiences consolidates memories and biases cognition. *Trends in Cognitive Sciences*, *23*, 876–890. <https://doi.org/10.1016/j.tics.2019.07.008>, PubMed: 31445780
- Tavares, R. M., Mendelson, A., Grossman, Y., Williams, C. H., Shapiro, M., Trope, Y., et al. (2015). A map for social navigation in the human brain. *Neuron*, *87*, 231–243. <https://doi.org/10.1016/j.neuron.2015.06.011>, PubMed: 26139376
- Theves, S., Fernandez, G., & Doeller, C. F. (2019). The hippocampus encodes distances in multidimensional feature space. *Current Biology*, *29*, 1226–1231. <https://doi.org/10.1016/j.cub.2019.02.035>, PubMed: 30905602
- Tompary, A., Duncan, K., & Davachi, L. (2015). Consolidation of associative and item memory is related to post-encoding functional connectivity between the ventral tegmental area and different medial temporal lobe subregions during an unrelated task. *Journal of Neuroscience*, *35*, 7326–7331. <https://doi.org/10.1523/JNEUROSCI.4816-14.2015>, PubMed: 25972163
- Van Overwalle, F. (2009). Social cognition and the brain: A meta-analysis. *Human Brain Mapping*, *30*, 829–858. <https://doi.org/10.1002/hbm.20547>, PubMed: 18381770
- Wang, Y., Collins, J. A., Koski, J., Nugiel, T., Metoki, A., & Olson, I. R. (2017). Dynamic neural architecture for social knowledge retrieval. *Proceedings of the National Academy of Sciences, U.S.A.*, *114*, E3305–E3314. <https://doi.org/10.1073/pnas.1621234114>, PubMed: 28289200
- Wildschut, T., Sedikides, C., Arndt, J., & Routledge, C. (2006). Nostalgia: Content, triggers, functions. *Journal of Personality and Social Psychology*, *91*, 975–993. <https://doi.org/10.1037/0022-3514.91.5.975>, PubMed: 17059314
- Yeshurun, Y., Swanson, S., Simony, E., Chen, J., Lazaridi, C., Honey, C. J., et al. (2017). Same story, different story: The neural representation of interpretive frameworks. *Psychological Science*, *28*, 307–319. <https://doi.org/10.1177/0956797616682029>, PubMed: 28099068
- Zacks, J. M., & Swallow, K. M. (2007). Event segmentation. *Current Directions in Psychological Science*, *16*, 80–84. <https://doi.org/10.1111/j.1467-8721.2007.00480.x>, PubMed: 22468032
- Zhou, X., Sedikides, C., Wildschut, T., & Gao, D.-G. (2008). Counteracting loneliness: On the restorative function of nostalgia. *Psychological Science*, *19*, 1023–1029. <https://doi.org/10.1111/j.1467-9280.2008.02194.x>, PubMed: 19000213