When analyzing experimental data in macaque primary visual cortex, Rosenbaum *et al.*[2] sidestepped the issue and took long-range fluctuations into account without explicitly considering their source. When subtracted from experimentally observed correlations, the resulting correlational structure (positive, then negative, then near zero as distance between neurons increased) was exactly as predicted.

The analysis by Rosenbaum *et al.*[2] was beautiful, elegant and, ultimately, straightforward: they simply extended results from randomly connected networks with high connectivity to networks in which connection probability falls off with distance; the rest was algebra (occupying 35 pages of supplementary information). And this was not just theory; the authors took the laudable additional step of comparing their results to experiments and, fortunately, finding agreement. Their analysis adds much-needed insight into the dynamics of large networks of spiking neurons—exactly the kind of insight we need if we are ever going to understand how the brain works.

How do these correlations affect the ability of networks to store information? The answer, as is typical in neuroscience, is that we don't know. The only correlations that reduce information are ones that make the noise look like the signal[10]. As shown recently, these correlations emerge naturally in circuits that receive very little information compared to their coding capacity[11]. Whether the internally induced correlations described by Rosenbaum *et al.*[2] also introduce such correlations is an open question, one that is likely to keep theorists busy for the foreseeable future.

COMPETING FINANCIAL INTERESTS
The author declares no competing financial interests.

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Cracking the mnemonic code

Eva Zita Patai & Hugo J Spiers

Evidence reveals that humans share remarkably similar patterns of event-specific neural activity during spontaneous spoken recall. Posterior medial cortex appears to play a key role in transforming experience into memory.

Like fingerprints, each person's brain has a unique pattern and organization but looks generally similar to other people's. Thus, when two people experience the same event, a similar set of brain regions will be engaged, but the exact pattern of brain activity elicited will be unique to each individual. Similarly, during subsequent recall it is thought that each person's unique pattern of activity will re-emerge[1] but will become even more differentiated by the fact that people tend to recall events in slightly different ways. Thus, it would be surprising if one person's brain activity pattern during spontaneous recall provided a better match to the activity pattern in another person's brain during recall of the same event than the match between encoding and recall within an individual. Yet this is exactly what Chen and colleagues show in this issue[2]. Their findings imply that humans share a remarkably similar neural circuit for transforming experience into memory.

Much of the basis for this new research comes from previous seminal work showing that neural activity during perception of stimuli is preserved across individuals[3] and is related to the content, not just the physical form, of the stimuli[4]. It has also been shown that patterns of activity during perception are reactivated during recollection in a sensory-specific manner, such that visual and auditory memories are represented in their respective sensory cortices[5]. As a final piece to the puzzle, Bird and colleagues have shown that encoding and recall activity of movie scenes overlap in the posterior medial cortex (PMC), such that higher correlation between these neural patterns predicts better recall performance[6]. This implies that the PMC is involved in consolidation and reinstatement of memories, possibly through its connections with the medial temporal lobe and other memory-related structures.

Chen and colleagues reasoned that if neural activity is preserved across mental states (perception and memory) within individuals and representations during perception are preserved across individuals, then neural activity during recall should also be preserved across individuals. To test this, they recorded functional magnetic resonance imaging (fMRI) data from participants as they viewed a 50-min movie from the BBC TV series *Sherlock*, in which the fictional detective Sherlock Holmes solves murder mysteries in a twenty-first-century London. Subsequently, during fMRI participants were asked to verbally recall the events in the movie. Using a method known as representational similarity analysis[7], the research team then examined, scene-by-scene, whether similar brain activity patterns occurred within and between individuals during both tasks: move viewing and recall.

The analysis revealed that the PMC, medial prefrontal cortex, right anterior temporal lobe, right inferior frontal gyrus and higher level visual areas had scene-specific patterns of activity when directly contrasting recall-to-recall across individuals (**Fig. 1**). This effect was robust and was not dependent on changes in acoustics of the verbal recall or differences in recall length between participants, further underscoring the notion that the neural representations of these recalled events had undergone some systematic transformation. Because everyone saw the same movie, unsurprisingly, brain activity patterns in these areas during movie viewing served to classify scenes far above chance. Impressively, the authors now reveal that classification accuracy of individual scenes during spoken recall was also substantially above chance. Thus, despite all the idiosyncrasies in how people spontaneously recall different movie scenes, there was a remarkably similar pattern of neural activity across brains for the same events.

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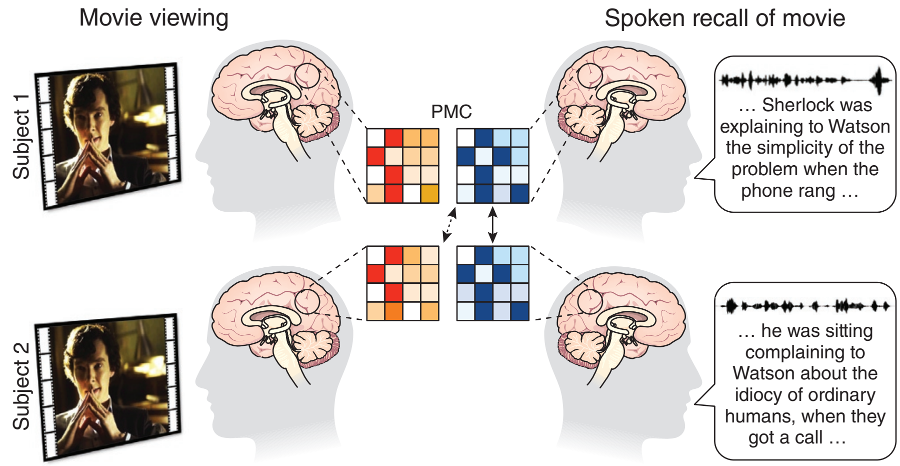

Figure 1 Recall–recall patterns between people are more consistent than movie–recall patterns. Brain activity was recorded for both movie viewing and unstructured verbal recall periods. Square checkerboards illustrate a slice through the fMRI voxel patterns in the PMC, with the darkness of each square indicating the strength of each voxel response. Consistent patterns were seen across participants during movie viewing, as is expected given the same sensory input. Crucially, during recall, the brain activity patterns in the PMC were more similar between participants (recall–recall patterns) than movie–recall patterns within a participant. This indicates that despite the varying words, descriptions and amount of details used, the essence of the memory was similar enough between participants to elicit a robustly consistent pattern in the PMC.

Going a step further, the team then compared movie–recall pattern similarity to recall–recall pattern similarity. If recall is just a noisy version of encoding, and if people form unique memory patterns, then activity patterns should be less similar between individuals during recall. On the other hand, if there is a shared neural system for transforming experience to memory, then two people's activity patterns at recall (recall–recall) should match more closely than the match within a person's brain from encoding to recall (movie–recall). Consistent with this second possibility, the researchers found greater similarity across recall–recall patterns than movie–recall patterns in posterior parahippocampal cortex, right superior temporal pole, PMC, right medial prefrontal cortex and angular gyrus (**Fig. 1**). No areas were found for the opposite contrast; that is, shared recall patterns are specifically more similar. Finally, the authors also showed that, at the individual scene level, the more a scene event was altered (larger difference in recall–recall minus movie–recall similarity in PMC), the more likely it was to be remembered. In effect, there may be a common gist extracted from these remembered scenes. Those scenes with more obviously unique content may become more semanticized, a notion supported by a weak but significant correlation found between semantic similarity of the words spoken during recall (as identified using latent semantic analysis) and the neural pattern similarity shared across individuals. It remains to be explored how much of the recall–recall similarity is driven by the transformation of recollection to spoken language.

While these findings help advance our understanding of memory systems, we can imagine the protagonist of the movie, Sherlock Holmes, raising an eyebrow and asking: did we perhaps miss something? Are not two of the key players in memory function conspicuously absent in the results: the hippocampus and the anterior temporal lobe? Regarding the hippocampus, the authors provide an analysis in which they correlated the activity of the hippocampus during movie viewing across subjects and related it to subsequent memory. They found that in the anterior hippocampus, scenes that were later remembered had more similar hippocampal activity patterns across participants during movie viewing. Though this reveals that the hippocampus had some function during this task, it does not address how this may relate to the systematic transformations that are the purported mechanism underlying the striking recall–recall similarity across people. The hippocampus, by most accounts, is important for memory consolidation[8], and it would seem to be a logical locus of memory transformation, giving rise to the common recall patterns observed. Similarly, the anterior temporal lobe is known for its involvement in semantic memory and for abstracting conceptual properties of objects[9]. It may also be important in the shared recall effects, which will require further investigation.

Such future research will allow exploration of several possibilities. For example, if different people began recall of the movie from different scenes in the timeline of the movie, would this disrupt the correlation in activity patterns across individuals at recall? Could the experiment be reversed? Might patterns of activity evoked during mental imagery of a prompted imagined scenario provide a greater match in PMC than the experience of subsequently watching a movie that follows the same narrative? Recent evidence suggests that, at least for hippocampal activity in rodents, there are similarities in patterns generated before entering unexplored space, compared with actually exploring it[10], which implies that there should be a match between imagination and subsequent experience.

Ultimately, humans like to share memories. It is one of the ways in which we form social bonds with each other. This new research gives us a locus in the brain—the PMC—as a site that provides the shared transformation from experience to re-experience. The neural code that generates abstract memories from specific perceptual inputs is still elusive. Nevertheless, Sherlock Holmes would no doubt have been amused to discover that he is in many ways even more like his archnemesis, Professor Moriarty, than he had hitherto guessed.

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