

RADKA JERSAKOVA, AKIRA R. O'CONNOR AND CHRIS J. A. MOULIN

## What's new in déjà vu?

...it was even possible that none of what he thought had taken place, really had taken place, that he was dealing with an aberration of memory rather than of perception, that he never really had thought he had seen what he now thought he once did think he had seen, that his impression now that he once had thought so was merely the illusion of an illusion, and that he was only now imagining that he had ever once imagined seeing a naked man sitting in a tree at the cemetery.

Joseph Heller, *Catch 22*

This essay outlines current research on the experience of déjà vu. After introducing déjà vu and presenting data on its incidence and character, two categories of explanations are discussed and evaluated. The first group of explanations posits that déjà vu arises from a similarity between the current and some previous situation. The second group posits that the experience results from aberrant neural processes and thus is not related to our current environment in any way. Next we look at what are perceived as two key areas of future research. A crucial question is whether there is only one type of déjà vu or whether there are several, with different causes and different characteristics. The answer to this question informs whether or not we can reconcile competing theories of déjà vu. Finally, we discuss the methodological difficulties faced by those studying déjà vu and the steps that we must take to improve current methodologies.

### Introducing déjà vu

Déjà vu is an experience of familiarity combined with the awareness that this experience is inappropriate. According to a review by Brown

(2004), questionnaire data shows that *déjà vu* occurs in the daily lives of 67% of the population. Its occurrence is typically once every couple of months and it occurs most frequently in young people. Many researchers have linked the experience to being stressed or tired. It can happen in new situations but is also often observed in mundane situations such as when relaxing, commuting or when in familiar, everyday environments such as at school or at work. *Déjà vu* then, is an infrequent and perplexing experience, more common in younger adults, and one which should be particularly pertinent for psychology students.

Those who have had it recently will remember that it is not merely that we experience the feeling of having encountered a single specific object before; rather, we feel as if we have been in this particular place, looking at this particular object, in this particular way before. It is a truly all-encompassing subjective experience as it combines affect, thought, perceptions and cognitions (Wild, 2005). For the psychology student, and even the memory expert, it can be a confusing, paradoxical sensation, as is encapsulated in Joseph Heller's quote that prefaced this chapter.

*Déjà vu* is fascinating for researchers to study because of what it tells us about the functioning of memory (e.g. O'Connor, Moulin & Cohen, 2008). In *déjà vu* one observes a dissociation or clash between the current mnemonic experience and one's assessment of it; it is the experience of familiarity combined with awareness that this feeling is wrong. As such, while *déjà vu* is often described as an instance where memory has somehow failed or tricked us, it can equally be described as an instance where the cognitive processes that allow us to monitor our memory are extremely successful. *Déjà vu* is evidence that two systems are at play in memory – something which relays contents of prior episodes to mind, and something which reflects on what is brought to mind (e.g. Koriat, 2000). In *déjà vu*, the latter system allows us to correctly reject an experience of familiarity as inappropriate. As such, *déjà vu* has been described as 'metacognitive' and as evidence that there are memory 'feelings' which operate in human cognition (see Moulin & Souchay, in press).

## Theoretical explanations of déjà vu

Theories of déjà vu can be divided into two categories, bottom-up and top-down theories. Bottom-up theories assume that the experience is data-driven; elicited by something in the environment that triggers this subjective, internal response. On the other hand, top-down theories assume that déjà vu is triggered by aberrant neural processes that sit above our perceptions of the environment, exerting their influence on whatever we happen to perceive at the time.

### Bottom-up theories of déjà vu

While there are many theoretical explanations of déjà vu (Brown, 2004), currently a key line of research focuses on the similarity hypothesis – the idea that the situation eliciting the déjà vu is in some way similar to a prior experience. For example, Cleary, Ryals and Nomi (2009) used the recognition-without-cued-recall (RWCR) paradigm to study déjà vu. In this paradigm, participants first study pictures of internal and external scenes, such as pictures of a room or a street, and later are presented with new scenes some of which are similar to the pictures they studied. The similarity between scenes is created by positioning different features of a scene in a common configuration, so that the features across different pictures are perceptually comparable in how they relate to each other. An example in daily life might be driving down a country road for the first time and seeing a church by a fountain on the left. You may not have seen that church and that fountain before, but you may have been somewhere before with a similar configuration of a building with a spire and fountain. In Cleary's experiments, participants were asked to indicate whether a presented new scene was similar in its configuration to one of the studied scenes, rate its familiarity and recall the studied scene. On the occasions when participants indicated a scene was similar and yet were unable to recall the original, they were asked whether they had experienced déjà vu. In these instances participants

reported *déjà vu* significantly more often when they identified a similar new scene as familiar (17%) compared to when they identified an unrelated new scene as familiar (13%). We will return to the small difference between reports of *déjà vu* across conditions later. For now, it should be noted that the strength of this approach is that it allows the researchers to capture and isolate instances where subjective awareness of familiarity occurs in the absence of recall – something which undoubtedly does occur when *déjà vu* is experienced.

The previously described approach has been extended by Cleary et al. (2012) to virtual reality 3D environments. Once again, the configural similarity of objects was compared, this time across a number of virtual ‘rooms’. In this virtual reality experiment, Cleary et al. assessed the experience of familiarity but also the experience of newness. They asked participants to rate familiarity of scenes that they said were new (not part of a configural pair) and whether they experienced *déjà vu* whilst viewing them. This is different to the above paradigm where familiarity and *déjà vu* were assessed for scenes that were said to be similar rather than new. They further extended the paradigm by also including actually studied scenes in the recognition phase. They found that the probability of *déjà vu* being reported was highest for old scenes incorrectly identified as new (51%), followed by configurally similar scenes correctly identified as new (33%) and new scenes identified as new (18%). Crucially, familiarity ratings followed the same pattern. This correspondence between *déjà vu* reports and familiarity ratings is consistent with bottom-up theories of *déjà vu*. The conclusion from those involved in this line of empirical work is that *déjà vu* results from situations similar to previous experiences. This creates a feeling of familiarity which can nevertheless sit alongside an explicit assessment of novelty, creating a clash between the subjective experience and the objective evaluation of the situation.

On the face of it, these studies are the closest scientists have come in over 100 years of research to producing *déjà vu* in the lab and therefore understanding its formation. However, as O'Connor and Moulin (2010) pointed out, the researchers have to explain how this RWCR is different from a simple experience of familiarity without recollection, something which happens often in daily life and which doesn't cause *déjà vu*. Memory researchers typically recall Mandler's (1980)

description of the butcher on the bus to illustrate a strong sensation of familiarity (“I know that person on the bus from somewhere”) in the absence of recollection (“but I don’t know who it is”). This experience can be a result of mismatched context (recollection failed because the butcher we’re used to seeing in the supermarket was seen on the bus). It is troubling that the RWCR paradigm doesn’t offer a way to distinguish between experiences of familiarity without recollection and déjà vu, rather it seems to assume they are the same which still leaves us with the question of what specifically triggers déjà vu.

## Top-down theories of déjà vu

The alternative view of déjà vu formation emphasises top-down neural processes. The starting point for this research was the observation that déjà vu is often a symptom experienced as part of the pre-seizure aura in temporal lobe epilepsy (TLE). O’Connor and Moulin (2008) reported a case of a TLE patient who experiences déjà vu that does not subside even as he changes his perceptual focus by diverting his gaze numerous times over the course of his experience. If déjà vu was triggered by what he was looking at as bottom-up theories suggest, it would seem changing the input, such as by looking at something else, should end the experience. It is from this line of research that the top-down approach to déjà vu has emerged.

The perspective of top-down theories on déjà vu is that it is a “random mental event” (Illman, Butler, Souchay and Moulin, 2012, p. 8). That is to say, déjà vu is a result of aberrant neural activation which is not driven by one’s immediate environment. Memory processes are thought to rely mainly on temporal lobe structures with distinct regions mapping onto unique processes. More specifically, Aggleton and Brown (1999) suggested the experience of familiarity is based on processing in the parahippocampal cortex as opposed to remembering which is reliant on the hippocampus (see Fig. 1). Spatt (2002) proposed déjà vu might be linked to incorrect activations in the regions responsible for familiarity. Illman et al. described their theory as the ‘decoupled familiarity

hypothesis': déjà vu is thought to be an instance of the incorrect activation of the experience of familiarity decoupled from the otherwise correct processing of one's environment that informs one everything is in fact new and so ought not be familiar.

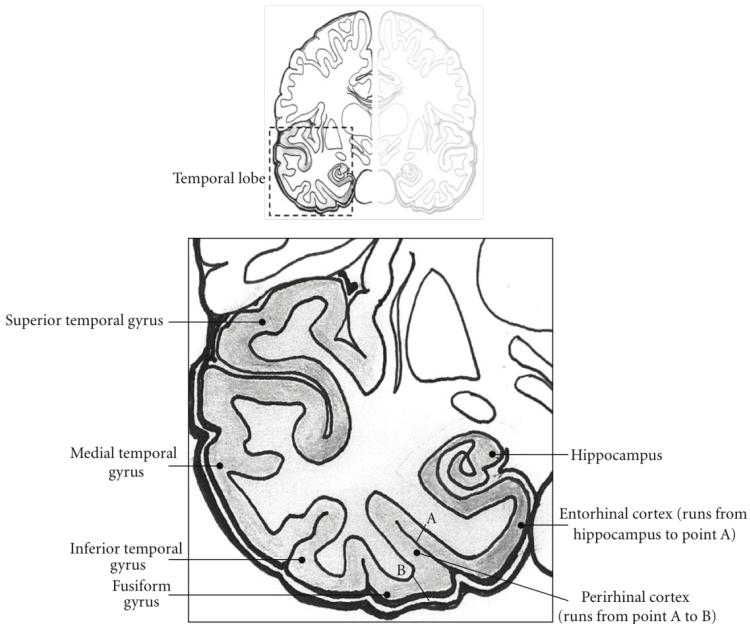


Figure 1: Coronal Section of the Temporal Lobe showing key structures.

Research focused on identifying the specific structures related to déjà vu has often used epileptic patients. As part of routine care and treatment, and part of the work-up for brain surgery, epileptic patients sometimes have electrical current applied directly to their brains. The resulting activations, experiences and behaviours are critical for mapping brain structures which should be spared in surgery targeting epileptic foci (e.g. those involved in language processing). The effects that result from these stimulations are of great value for understanding the brain.

Using such brain techniques, Bartolomei et al. (2004) concluded that déjà vu was most reliably elicited by stimulation of subhippocampal familiarity areas rather than other areas important for memory. More specifically, and consistent with Spatt's hypothesis, they found

stimulation of a tiny region called the entorhinal cortex to be a more reliable elicitor of déjà vu than the amygdala or the hippocampus. However, not only do different methods of stimulations in different areas lead to different results but stimulations of the same areas on different days lead to different results, and this story is a long way from complete. For instance, Kovacs et al. (2009) found that déjà vu could be elicited by stimulation of another region (the globus pallidus). On the other hand, they also observed that the instances where this stimulation did produce déjà vu there was hyperperfusion or increased blood flow in the temporal lobe suggesting a discharge into and involvement of this area. Further, Bowles et al. (2007) reported a case of a TLE patient who following surgery to the temporal lobe ceased experiencing déjà vu with the other product of the intervention being impaired familiarity and preserved recollection. This then lends support to the view that déjà vu is related to familiarity processing and associated brain regions.

Brazdil et al. (2012) have taken the important step of expanding this work beyond the TLE literature by looking at structural differences in the healthy population between people that experience déjà vu and those that do not. They observed differences in grey matter volume between these groups, and again, it is the temporal lobe which is implicated. Those experiencing déjà vu were found to have less grey matter in this area, and the volume was inversely related to the number of reported déjà vu experiences.

That said, Bartolomei et al. (2012) suggested that rather than looking at specific structures, one should, given the current move towards understanding brain activity in terms of complex, interconnected networks (e.g. Fox et al., 2005), consider how the regions work together. Their research suggests “déjà vu is related to increased correlation among MTL [medial temporal lobe] structures rather than being a ‘local’ phenomenon” (p. 494). Illman et al. (2012) agree that given the complexity and uniqueness of déjà vu, it seems unlikely it can be traced to a single structure. As mentioned, this is in line with current research which suggests cognitive processes have to be understood in the context of a pattern of activations rather than in the context of isolated regions of activity (McIntosh, 2000).

In sum, the next step on the path to understanding the neural processes underlying déjà vu will be to look closer at brain networks. For now, however, the evidence suggests that at the very least, déjà vu in TLE can be linked to neural processes in the temporal lobe and there is some indication emerging that this might also be true for the healthy brain and seizure unrelated experiences of déjà vu.

## Different types of déjà vu?

One of the questions facing déjà vu research at the moment is whether there is only one type of déjà vu experienced both as a symptom of certain disorders such as TLE and part of normal, every-day life. One could view the two experiences as distinct, meaning that findings from TLE studies are not relevant to bottom-up theories of every-day occurrences of déjà vu. In support of this argument, Adachi et al. (2010) showed that TLE patients can distinguish between déjà vu experienced as part of the pre-seizure aura and déjà vu experienced as part of their daily life. However, it is worth noting that the difference might also be due to the fact that déjà vu related to seizure activity is not an isolated event. It is likely to be accompanied by other experiences not present in 'healthy' déjà vu, such as headaches, nausea or emotional responses, all part of epileptic activity, making it distinct.

In support of this interpretation, Warren-Gash & Zeman (2014) used a questionnaire to assess déjà vu in TLE and controls (with and without neurological complaint). They found that the TLE experience was similar to the healthy experience, and it could only be differentiated by the 'company it keeps', i.e. the other phenomena part of TLE seizure activity. Furthermore, Brazdil et al., (2012) found structural differences in the healthy population between people who experience déjà vu and those that do not. This suggests a unified source of déjà vu experiences across patient and non-patient groups and provides an important first link between déjà vu in TLE and déjà vu experienced as part of daily life. Indeed the authors suggest there is at least an overlap in the physiology of these two déjà vu experiences. In sum, several research teams



point to a continuity between healthy and epileptic forms of déjà vu. While it is too soon to say there isn't a bottom-up form of déjà vu or a combination of factors in the production of this strange experience, work such as Brazdil et al.'s is moving us toward a unified conceptualization of déjà vu.

## Methodological issues in déjà vu research

The greatest obstacle to déjà vu research and what has prevented researchers from delving into this topic more comprehensively is the necessary reliance on subjective self-reports. Unlike traditional memory impairments where researchers can objectively assess memory performance, the experience of déjà vu is entirely subjective. This means the only way to assess whether the experience has been replicated in the lab is to ask participants a question like "Have you experienced déjà vu?". This is the method Cleary et al. (2009) used to assess déjà vu occurrence following presentation of experimental materials which they hypothesized would trigger déjà vu and following presentation of control materials which should not. As O'Connor and Moulin (2010) noted, while the probability of reporting déjà vu was 17% for the experimental items, it was as high as 13% in the control condition – where we would not expect déjà vu. While this difference was statistically significant, the difference is also surprisingly small. Firstly, the researchers struggle to explain why participants would report experiencing déjà vu in the control condition at all, as it is not consistent with their explanation of déjà vu as familiarity evoked by similarity. Secondly, given that déjà vu is reported to only occur once in a couple of months in daily life (Brown, 2004), the 13% and 17% seems really high for a laboratory estimate. There are two possible explanations here. First, it might be that the laboratory and real life déjà vu are similar but differ in intensity or completeness – that is, there may be a mild or incomplete laboratory form of déjà vu which is easily produced. This is something which needs further research. Second, O'Connor and Moulin (2010) suggested it

might rather be the case that the way the experiment was set up created demand characteristics.

Orne (1962) introduced the idea of demand characteristics, conceptualized as cues in the experiment that convey the experimental hypothesis to the participant without the experimenter intending them to. He pointed out participants' motivation to behave as they perceive the experimenter wants them to, so as to aid the experiment by producing the expected result. Research has shown participants tailor their responses to what they perceive to be the expectations of the experimenter in an attempt to be relevant (Norenzayan and Schwarz, 1999). What this means in context of *déjà vu* research is that when participants are asked repeatedly about experiencing *déjà vu*, they might simply assume they ought to be experiencing it and they might even want to respond affirmatively so as to give what they suspect is the expected result. This is clearly troubling for *déjà vu* research and emphasises the necessity for better measurement tools. O'Connor and Moulin (2010) stressed that *déjà vu* should be clearly defined and space should be given to participants to give descriptive accounts of their experience along with the chance for them to spontaneously report experiencing *déjà vu*. Only after such measures should researchers start asking specific yes/no type questions about the participants' experiences during the experiment, what is often referred to as 'funnel' debriefing. As is the case with the know/remember distinction (Gardiner and Java, 1993), many studies explain the difference carefully before asking participants to make judgments on which one they experienced (e.g. Rajaram, 1993). A similar kind of dialogue between participants and experimenters should be established in the study of *déjà vu*. Part of this might be asking participants to bring to mind specific instances of their previous *déjà vu* experiences to make them fully appreciate the nature of the experience before they are asked whether they have experienced it during an experiment. As such, the next important step for further *déjà vu* research is to establish better methodologies that allow the study of the experience whilst simultaneously eliminating (or at least minimizing) demand characteristics.

## Conclusion

We have seen that déjà vu can be researched in the laboratory using memory experiments and questionnaires in healthy groups of people as well as people with neurological disorders. The different approaches and populations studied give rise to different theories and results, and we gave an overview of two competing ideas – bottom up and top down theories of déjà vu formation. In fact, the extent to which these theories might compete is not clear. Despite the massive progress we have made in the last ten years, it seems that we are still in the early days of understanding déjà vu.

To follow from here, there are two main points to consider. First, we should not confuse déjà vu with other similar mental experiences such as familiarity without recollection. Rather the focus should be on understanding how déjà vu differs from, or indeed incorporates, these related, more prevalent phenomena as a way of gaining better understanding of it. Second, we must recognize that déjà vu research is susceptible to demand characteristics and that this needs to be carefully controlled for to increase confidence in and usefulness of our data. Reaching a common consensus on means of experimentally generating déjà vu and exerting better control over our experimental paradigms opens up the opportunity to start bridging the gaps in our understanding of this nebulous, fascinating experience.

## References

- Adachi, N., Akanuma, N., Ito, M., Adachi, T., Tekekawa, Y., Adachi, Y., Kato, M. (2010). Two forms of déjà vu experiences in patients with epilepsy. *Epilepsy and Behavior*, *18*, 218–220.
- Aggleton, J. P., & Brown, M. W. (1999). Episodic memory, amnesia and the hippocampal-anterior thalamic axis. *Behavioral and Brain Sciences*, *22*, 425–498.

- Bartolomei, F., Barbeau, E., Gavaret, M., Guye, M., McGonigal, A., Regis, J., & Chauvel, P. (2004). Cortical stimulation study of the role of rhinal cortex in déjà vu and reminiscence of memories. *Neurology*, *63*, 858–864.
- Bartolomei, F., Barbeau, E. J., Nguyen, T., McGonigal, A., Regis, J., Chauvel, P., & Wendling, F. (2012). Rhinal-hippocampal interactions during déjà vu. *Clinical Neurophysiology*, *123*, 489–495.
- Bowles, B., Crupi, C., Mirsattari, S. M., Pigott, S. E., Parent, A. G., Pruessner, J. C., Yonelinas, A. P., & Kohler, S. (2007). Impaired familiarity with preserved recollection after anterior temporal-lobe resection that spares the hippocampus. *PNAS*, *104*, 16382–16387.
- Brazdil, M., Marecek, R., Urbanek, T., Kaspárek, T., Mikl, M., Rektor, I., & Zeman, A. (2012). Unveiling the mystery of déjà vu: The structural anatomy of déjà vu. *Cortex*, *48*, 1240–1243.
- Brown, A. S. (2004). *The déjà vu experience*. Hove: Psychology Press.
- Cleary, A. M., Brown, A. S., Sawyer, B. D., Nomi, J. S., Ajoku, A. C., & Ryals, A. J. (2012). Familiarity from the configuration of objects in 3-dimensional space and its relation to déjà vu: A virtual reality investigation. *Consciousness and Cognition*, *21*, 969–975.
- Cleary, A. M., Ryals, A. J., & Nomi, J. S. (2009). Can déjà vu result from similarity to a prior experience? Support for the similarity hypothesis of déjà vu. *Psychonomic Bulletin and Review*, *16*, 1082–1088.
- Fox, M. D., Snyder, A. Z., Vincent, J. L., Corbetta, M., Essen, D. C. & Raichle, M. E. (2005). The human brain is intrinsically organized into dynamic, anticorrelated functional networks. *Proceedings of the National Academy of Sciences of the United States of America*, *102*, 9673–9678.
- Gardiner, J. M., & Java, R. I. (1993). Recognising and remembering. In A. F. Collins, S. E. Gathercole, M.A. Conway and P.E. Morris (Eds.), *Theories of memory* (pp. 163–188), Hove: Erlbaum.
- Illman, N. A., Butler, C. R., Souchay, C. & Moulin, C. J. A. (2012). Déjà experiences in temporal lobe epilepsy. *Epilepsy Research and Treatment*, 15 pages. doi:10.1155/2012/539567.
- Koriat, A. (2000). The Feeling of Knowing: Some Metatheoretical Implications for Consciousness and Control. *Consciousness and Cognition*, *9*, 149–171.

- Kovacs, N., Auer, T., Balas, I., Karadi, K., Zambo, K., Schwarcz, A., Janszky, J. (2009). Neuroimaging and cognitive changes during déjà vu. *Epilepsy and Behavior*, *14*, 190–196.
- Mandler, G. (1980). Recognizing: The judgment of previous occurrence. *Psychological Review*, *87*, 252–271.
- McIntosh, A. R. (2000). Towards a network theory of cognition, *Neural Networks*, *113*, 861–870.
- Moulin, C. J. A., & Souchay, C. (in press). Epistemic feelings and memory. In T. Perfect & S. Lindsay (Eds.), *Handbook of Applied Memory*.
- Norenzayan, A., & Schwarz, N. (1999). Telling what they want to know: participants tailor causal attributions to researchers' interests. *European Journal of Social Psychology*, *29*, 1011–1020.
- O'Connor, A. R., & Moulin, C. J. A. (2008). The persistence of erroneous familiarity in an epileptic male. Challenging perceptual theories of déjà vu activation. *Brain and Cognition*, *68*, 144–147.
- O'Connor, A. R., & Moulin, C. J. A. (2010). Recognition without identification, erroneous familiarity and déjà vu. *Current Psychiatry Reports*, *12*, 165–173.
- O'Connor, A. R., Moulin, C. J. A., & Cohen, G. (2008). Memory and Consciousness. In G. Cohen & M. A. Conway (Eds.), *Memory in the real world* (3rd edn, pp. 327–365), Hove: Psychology Press.
- Orne, M. T. (1962). On the social psychology of the psychological experiment: With particular reference to demand characteristics and their implications. *American Psychologist*, *17*, 776–783.
- Rajaram, S. (1993). Remembering and knowing: Two means of access to the personal past. *Memory and Cognition*, *21*, 89–102.
- Spatt, J. (2002). Déjà vu: Possible parahippocampal mechanisms. *Journal of Neuropsychiatry and Clinical Neuroscience*, *14*, 6–10.
- Warren-Gash, C., & Zeman, A. (2014). Short report: is there anything distinctive about epileptic déjà vu?. *Journal of Neurology, Neurosurgery and Psychiatry*, *85*, 143–147.
- Wild, E. (2005). Déjà vu in neurology. *Journal of Neurology*, *252*, 1–7.