Neuroscience and Biobehavioral Reviews 155 (2023) 105467

Contents lists available at ScienceDirect

Neuroscience and Biobehavioral Reviews

journal homepage: www.elsevier.com/locate/neubiorev

Review article

Towards a conflict account of déjà vu: The role of memory errors and memory expectation conflict in the experience of déjà vu☆

Courtney B.A. Aitken *, Ines Jentzsch, Akira R. O'Connor

School of Psychology & Neuroscience, University of St Andrews, United Kingdom

ARTICLE INFO

Keywords:
Déjà vu
Metacognition
Memory retrieval control
Conflict
Cognitive control

ABSTRACT

Déjà vu can be defined as conflict between a subjective evaluation of familiarity and a concurrent evaluation of novelty. Accounts of the déjà vu experience have not explicitly referred to a "conflict account of déjà vu" despite the acceptance of conflict-based definitions of déjà vu and relatively recent neuroimaging work that has implicated brain areas associated with conflict as underpinning the experience. Conflict monitoring functioning follows a similar age-related trajectory to déjà vu with a peak in young adulthood and a subsequent age-related decline. In this narrative review of the literature to date, we consider how déjà vu is defined and how this has influenced the understanding of déjà vu. We also review how déjà vu can be understood within theories of recognition memory and cognitive control. Finally, we summarise the conflict account of déjà vu and propose that this account of the experience may provide a coherent explanation as to why déjà vu experiences tend to decrease with age in the non-clinical population.

1. Introduction

Déjà vu, a term translated to English as "already seen", refers to the illusory memory experience of a sense of recognition towards something that is known to not be familiar (Brown, 2004; Cleary and Brown, 2022; Moulin, 2018; O'Connor and Moulin, 2010). One of the earliest references to an experience that could be considered comparable to modern conceptions of déjà vu was from St Augustine in Book XII, Chapter XV of *On the Trinity*. This account of "untrue recollections" led St Augustine to reason that experients "were affected in this way at the suggestion of malignant and deceitful spirits" (Augustine, 2012, pp. 403–405). The association of the experience with the occult has held for centuries with parapsychological societies continuing to survey the experience through to the current century (Brown, 2003, 2004; Castro et al., 2014). The arrival of a name ("sensation de déjà vu") and Boirac (1876) description of déjà vu prompted not only the scientific inquiry of the experience, mainly with people who have temporal lobe epilepsy, but also widespread cultural awareness (Brown, 2004; Moulin, 2018; Cleary and Brown, 2022). References to déjà vu can be found in various works of literature, art, film, and song. One of the more recent references was from the television show *The Big Bang Theory* which merged colloquial notions of déjà vu with a neat exposition of neuroimaging work on the experience (see Urquhart, Sivakumaran, Macfarlane, and O'Connor, 2018).

Amy: Wow. Déjà vu.

Sheldon: Amy, you're a neuroscientist. You know the latest research into déjà vu suggests it's nothing but the frontal regions of the brain attempting to correct an inaccurate memory.

Amy: You telling me stuff I already know is definitely déjà vu.

The Decision Reverberation, The Big Bang Theory (Lorre et al., 2019).

Sheldon's description of the neural basis of déjà vu (and indeed the title of the episode) is apt at illustrating how the experience of déjà vu indicates to us that there has been some disturbance in how the different processes within our memory system normally interact with one another. There is the process of memory retrieval (inferred from Sheldon's reference to an inaccurate memory) and there is another process of memory verification or retrieval control (inferred from Sheldon's reference to the frontal regions of the brain being involved in correction of the inaccurate memory). This disturbance between the two memory processes comes to the fore of our subjective experience such that we can introspect and identify the experience as déjà vu (like Amy does).

Successful memory retrieval and memory decision-making (i.e., accurate judgements of previous occurrences) typically relies on two independent processes known as recollection and familiarity (Mandler,

☆ This work was supported by the Biotechnology and Biological Sciences Research Council (BBSRC) [grant number BB/M010996/1].

* Correspondence to: School of Psychology & Neuroscience, University of St Andrews, St Mary's Quad, South Street, St Andrews, Fife, KY16 9JP, United Kingdom.
E-mail address: cbaa@st-andrews.ac.uk (C.B.A. Aitken).

https://doi.org/10.1016/j.neubiorev.2023.105467
Received 10 May 2023; Received in revised form 22 October 2023; Accepted 13 November 2023
Available online 18 November 2023
0149-7634/© 2023 The Author(s). Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

1980; Yonelinas, 2002; Yonelinas et al., 2010). Recollection is the deliberate and conscious remembering of experiences (or aspects of experiences). Familiarity, on the other hand, is a much faster, phenomenologically more ambiguous process underpinning recognition (Yonelinas, 2002). Déjà vu indicates to us the divergence of these usually coherent processes of recognition memory. The erroneous familiarity process is opposed by top-down processes (such as the recollection of contextual information) that concludes the familiarity experienced is false (Blank, 2017; Brown, 2003, 2004; Moulin, 2018). Like the title of the earlier episode of *The Big Bang Theory*, the divergence of these decision-making processes has a subsequent reverberation on our metacognitive experience (i.e., our awareness and knowledge of our underlying cognition).

The apparent divergence of memory processes in déjà vu and the conflict between evaluations of those memory processes is central to many contemporary definitions and conceptualisations of the experience (Moulin, 2018; Brown, 2004; Aitken and O'Connor, 2020). This is especially so for perspectives that view déjà vu as an indication of healthy memory function. Estimates of the incidence and frequency of déjà vu experiences are often used to support the proposition that déjà vu is indicative of healthy memory function (Urquhart and O'Connor, 2014; Urquhart et al., 2018). Most studies where incidence and frequency of déjà vu are reported (and reviews re-examining such evidence) have all indicated that déjà vu experiences are widespread, with a majority of individuals reporting such occurrences at different points in their lives (Brown, 2004; Chapman and Mensh, 1951; Moulin, 2018). Notably, these experiences tend to peak in young adulthood and decrease in frequency thereafter (Brown, 2004; Chapman and Mensh, 1951; Adachi et al., 2003; Adachi et al., 2010; Lacinová et al., 2016; Labate et al., 2019). It may be the case that the memory system in younger (adult) individuals actively engages in memory verification and draws upon a range of recollections and contextual cues to validate recognition (Urquhart et al., 2018). The occurrence of déjà vu in this context might then be seen as a transient conflict state that signals efficiency in cross-referencing of current and past experiences (Martin et al., 2015). Conversely, the reduced incidence of déjà vu in older adults could suggest the ability to access and cross-reference detailed recollections becomes more limited or declines throughout adulthood, leading to a diminished likelihood of encountering the type of memory conflict that may be associated with déjà vu (Moulin, 2013, 2018; Moulin et al., 2014; O'Connor and Moulin, 2010).

However, déjà vu is not a distinctly "healthy" experience and does not fit into a neat category of typical memory function despite the logical reasoning from its relationship with age. Déjà vu is associated with temporal lobe epilepsy and often experienced as part of the pre-seizure aura (Illman et al., 2012; Martin et al., 2015). Incidentally, the most significant body of research on déjà vu investigates the experience in the context of ictal states and activity (Hughlings-Jackson, 1888; Illman et al., 2012; Mullan and Penfield, 1959). Similarly, déjà vécu (a French loanword meaning "already lived" and also known as recollective confabulation) is an experience associated with dementia that occurs when the false familiarity is not corrected by the experient. This leads them to confabulate in order to justify the errant memory signaling (Moulin, 2013; O'Connor, Lever, and Moulin, 2010). Thus, the peculiar characteristics of déjà vu, and the seemingly paradoxical relationships with age and clinical conditions, force us to consider the relationship between memory accuracy, memory conflict and metacognitive experience.

Whereas previous perspectives have used these clinical conditions to inform our understanding of déjà vu and the role of recognition memory in the experience in the general population, the role of memory errors and memory conflict monitoring within memory retrieval control are relatively less well explored. This narrative review will describe key features of the déjà vu experience and outline how déjà vu can be understood within theories of recognition memory and in the context of clinical conditions like temporal lobe epilepsy. Fundamental to this narrative review is the characterisation of déjà vu as an experience of metamemory conflict. As such, we will review approaches to studying déjà vu with a view to clarifying how more recent work is informing a "conflict account of déjà vu". Finally, we explore possible links between déjà vu and conflict monitoring in memory (and cognition more generally).

2. Deconstructing the Déjà vu experience

2.1. Common definitions of Déjà vu

The collation of the early references to déjà vu and the early scientific literature in Brown (2004) highlighted that the déjà vu experience could be deconstructed into its constituent parts (a feeling of familiarity and an awareness the familiarity is false) and considered in the context of wider psychological theories. Brown (2004) characterised déjà vu in this way:

> "Reduced to its simplest form, the déjà vu experience represents the clash between two simultaneous and opposing mental evaluations: an objective assessment of unfamiliarity juxtaposed with a subjective evaluation of familiarity" (p. 2).

This definition of déjà vu is now commonly used as the formal description of the déjà vu experience (Brown and Marsh, 2008; Cleary, Ryals, and Nomi, 2009; Urquhart and O'Connor, 2014; Urquhart et al., 2018). However, prior to Brown (2004), this deconstruction of the déjà vu experience into two mental evaluations was not the dominant characterisation of the experience. Definitions of déjà vu have either concentrated solely on the feeling of familiarity or introduced an additional conflict with an awareness that the familiarity is incorrect. For example, another definition that sometimes features in contemporary déjà vu research is from Neppe (1983) who defines déjà vu more broadly as:

> "any subjectively inappropriate impression of familiarity of the present experience with an undefined past" (p. 3).

The definition set out by Neppe (1983) focusses on the salience of the familiarity in déjà vu and relegates the experient's awareness to a feeling of subjective inappropriateness. More recent definitions, such as that proposed by O'Connor and Moulin (2010), summarise déjà vu as a metacognitive familiarity-novelty conflict resolved in favour of novelty:

> "The sensation of déjà vu arises as a conjunction of two streams of cognition: the phenomenological experience of recognising a current situation and the awareness that this feeling of recognition is inappropriate. Most importantly, the overall evaluation of the déjà vu-eliciting situation sides with the higher-order metacognitive awareness of inappropriate recognition" (p. 165).

2.2. Clarifying the Déjà vu experience through negation

The variety of definitions of déjà vu and the differing extent to which they implicate additional mental evaluations prompts the consideration of what components of the experience actually contribute to our understanding of déjà vu. There is no behavioural marker against which an independent observer can verify someone has experienced déjà vu. As such, it becomes necessary to consider similar experiences that are distinguishable from déjà vu in order to settle on an operational definition for the experience.

2.2.1. Butcher on the bus

When déjà vu is defined as familiarity in an atypical context without necessarily including an additional evaluation of conflict or conflict awareness, it is reminiscent of the "butcher on the bus" scenario described by Mandler (1980). In this example, Mandler (1980) describes a situation where you experience a strong sense of familiarity towards someone on your bus but you are unable to recall who they are or where

you know them from. This sense of familiarity prompts a retrieval search process to determine why the person is familiar. Eventually, you remember that this person is in fact the local butcher. It is indeed a familiar person, just seen in a different context from where you normally interact with them. Similarly to déjà vu, the butcher on the bus experience happens almost automatically and is initially fleeting but prompts other mental evaluations and subjective experiences. There is also a lack of immediate stimuli that can be used to facilitate recollection of details. However, unlike déjà vu, the butcher on the bus experient usually does not consider the familiarity as false and they may also have a sense of imminent retrieval (akin to "tip of the tongue" experiences). The similar experience incidence in young and older adults for butcher on the bus experiences is another departure from variables associated with déjà vu (Brown, 2020). Thus, in the butcher on the bus experience, familiarity is more likely to be an accurate signal rather than an errant one since the subjective familiarity can be resolved through successful memory retrieval. The butcher on the bus phenomenon highlights that the assessment of the accuracy of the familiarity and the potential for subsequent recollection could potentially demarcate the distinctions between déjà vu and a mere sense of undefined familiarity.

2.2.2. *Déjà vécu*

Déjà vécu, in contrast to déjà vu, does have a behavioural outcome from experiencing subjectively false familiarity. Experients of déjà vécu describe similar feelings to those experiencing déjà vu but resolve their memory conflict in favour of their erroneous familiarity (Barzykowski and Moulin, 2022). This is like false recognitions more generally where the familiarity is not necessarily a direct product of memory (Barzykowski and Moulin, 2022). Given the experience of déjà vécu typically happens in individuals with dementia or temporal lobe pathology, the experience of déjà vécu goes further than a typical false recognition because it often leads to the experient withdrawing from the activity associated with the sensation and confabulating other details to counterfactually explain how they have experienced the situation before (Moulin et al., 2005). Critically, for our understanding of déjà vu, déjà vécu is distinct from déjà vu because the recognition is so convincing that the experient behaves as if those sensations are correct regardless of how plausible it is that the situation could have been experienced before. Therefore déjà vécu, with its difference in the behavioural outcome and its signalling of a metacognitive failure, stresses the importance of settling on a definition that characterises how the experient is aware of and resolves their subjective experience.

2.3. *Déjà vu as conflict and resolution in favour of novelty*

Brown (2004) prioritises the false familiarity and metacognitive conflict that is present in the déjà vu experience. O'Connor and Moulin (2010) expand upon this by prioritising the subjective phenomenological experience alongside how those mental evaluations are resolved. After appraising the constituent experiences of similar phenomena in relation to déjà vu, it seems the awareness of conflict between two mental evaluations and the resolution of this in favour of novelty is integral to the déjà vu experience. This conclusion largely rests on the evaluation that resolution in favour of familiarity tends to be indicative of different memory phenomena ranging from accurate memory signalling through to pathological memory errors. As such, this review adopts the definitions set out by Brown (2004) and O'Connor and Moulin (2010) as primary operational definitions.

3. The neural basis of recognition memory

Regardless of the definition that is used to characterise déjà vu, familiarity is often presented as the central subjective experience and process in déjà vu (Barzykowski and Moulin, 2022). Even in conceptually related experiences like déjà vécu where inaccurate recollection seems like the predominant process contributing to the resolution of subjective familiarity, the implication is that an experience of erroneous familiarity precedes any confabulations or justifications the experient might make. This next section will review how the neural basis of recognition relates to whole-brain theories of memory retrieval control and how such recognition processes may interact with related mechanisms such as novelty perception and memory expectation conflict. The purpose of this exploration is to identify the conflicting memory signals that may be present in déjà vu and how an initial instance of erroneous familiarity may come to be perceived as subjectively inappropriate with the experient ultimately favouring a resolution in favour of novelty.

A review of functional neuroimaging studies by Diana et al. (2007) set out the following on the neural basis of recognition. Recollection has primarily been associated with activity in the hippocampus and posterior parahippocampal gyrus. Specifically, the parahippocampal cortex has been proposed to support recollection by encoding and retrieving contextual information. Familiarity, on the other hand, has been associated with activity in the perirhinal cortex which is proposed to support familiarity by encoding and retrieving specific item information. More recent reviews of the neural basis of recognition argue that recognition is also supported by broader cortico-hippocampal circuits and neural activity in the prefrontal cortex (Eichenbaum, 2017b; Geib et al., 2017). These "whole brain" theories of memory retrieval posit that retrieval relies on a wide but interconnected set of brain areas rather than activations in select regions (Geib et al., 2017). In short, the two main processes that support functioning declarative memory are the organisation of networks of context-specific memories in the hippocampus and the control of retrieval by the prefrontal cortex in a bidirectional relationship (see Eichenbaum, 2017a, 2017b for reviews). Early models of memory retrieval such as that by Burgess and Shallice (1996) stipulated that there needs to be a "fact checking" process in any model of memory retrieval that assesses and verifies whether retrieved memory signals are appropriate for the current task's demands. Notably, people with frontal lobe damage have been reported to experience elevated rates of false recognition (Moulin, 2018; Schacter et al., 1996). It has been suggested that the prefrontal cortex supports this cognitive control of memory by selecting context-appropriate memory representations and inhibiting the selection of context-inappropriate memory representations (Eichenbaum, 2017a; Simons and Spiers, 2003).

3.1. *Contextual novelty and memory expectations*

The selection and inhibition of context-dependent memory representations is an aspect of memory retrieval control that is quite pertinent to the understanding of déjà vu given the clash in evaluations that make up the experience. One other aspect of recognition that may support this is (contextual) novelty. Under both the theoretical premise of single and dual process models, novelty is typically considered to be equivalent to the low level or absence of familiarity (Kafkas and Montaldi, 2014). More recent positions nuance this understanding and link novelty with match-mismatch signals in memory expectation processes (Martin et al., 2015). A key assumption of this research area is that the generation of match-mismatch signals depends on the presence of overlap between novel sensory inputs and stored representations (i.e. some aspect of the current environment has to match or mismatch with memory expectations derived from previous experience; Kumaran and Maguire, 2007).

Kafkas and Montaldi (2018a) present a study that indicates how novelty detection may contribute to memory expectation conflict or at the very least differential contributions of familiarity and recollection in recognition decisions. They used a memory expectation paradigm to assess whether contextual novelty at encoding and just before retrieval affected the subsequent contributions of familiarity and recollection processes to memory performance. The study found that expected stimuli at study resulted in enhanced familiarity performance whereas unexpected (or distinctive) stimuli resulted in enhanced recollection performance. A similar set of contrasting relationships was found when expectation was modulated just before the test stimulus was shown. At

test, expected stimuli were more likely to rely on familiarity whereas unexpected (distinctive) stimuli were more likely to rely on recollection. Overall, it indicates that sensitivity to novelty or distinctiveness at encoding and retrieval plays a role in determining what process makes a greater contribution to the memory judgement. Recent reviews have supported this view and considered that novelty's impact on memory is influenced by an individual's expectations and experiences whereby unusual events tend to be remembered better as they result in discrepancies between anticipated and actual outcomes (Quent et al., 2021; Frank and Kafkas, 2021).

In terms of the neural dynamics of novelty and match-mismatch signals, the hippocampus has been proposed to generate contextual novelty signals as expectations about upcoming items are generated and when these expectations are violated (Davachi and DuBrow, 2015; Frank and Kafkas, 2021). It has also been shown that these hippocampal match-mismatch signals can be observed for violations that pertain to temporal sequencing and spatial characteristics of events (Davachi and DuBrow, 2015; Thakral et al., 2015; Frank and Kafkas, 2021). Similarly, neural evidence from rodents and humans suggest that novelty and familiarity are parallel sensations potentially supported by neuroanatomically distinct systems which become integrated to support recognition memory decisions (Duszkiewicz et al., 2019; Kafkas and Montaldi, 2018b; O'Connor, Guhl, Cox, and Dobbins, 2011). Kafkas and Montaldi (2018b) propose that the mediodorsal thalamus has a significant coordinating role in detecting familiarity and for combining novelty signals from the medial temporal lobe cortex with outputs from control processes in the prefrontal cortex (Dias and Honey, 2002; Pergola et al., 2018). Such findings underscore that the experience of déjà vu may arise from the discord between these processes with a prevailing familiarity signal being perceived as oddly out of place when memory expectations about familiarity and novelty are violated.

3.2. Déjà vu within the recognition memory framework

The consideration of recognition processing beyond familiarity and recognition potentially offers a comprehensive framework for understanding the intricate interplay of recognition processes, novelty perception, and conflicts in memory expectations. This exploration could shed light on situations where conflicting evaluations are pivotal, the conditions under which such expectation conflicts emerge, and whether inappropriate familiarity alone is adequate to trigger déjà vu-like experiences. Moreover, this approach has the potential to reconcile earlier research on déjà vu, particularly investigations centred on the phenomenology of the phenomenon (as discussed in *Deconstructing the Déjà vu Experience*). The spectrum of déjà vu definitions and reports, ranging from mixed feelings of novelty and familiarity to a certainty of false familiarity, could find cohesion within this framework. Likewise, the variability in the pervasiveness of familiarity reported by individuals could be better understood within this framework if such an approach is adopted. For example, some experients associate familiarity in déjà vu with discrete elements of the situation, others extend it to encompass the entirety of the situation, while some experients may not be able to identify the aspect of the current situation to which the familiarity pertains (Sno et al., 1994).

3.3. Neurological accounts of Déjà vu in temporal lobe epilepsy

The study, observation and elicitation of pre-seizure auras in temporal lobe epilepsy offered an early insight into the brain areas that may underpin the experience of déjà vu. This research can be traced back to Hughlings-Jackson (1888) description of various illusory memory experiences, including déjà vu, which were collectively described as the "dreamy states" (Brown, 2004; Vignal et al., 2007). Later electrical cortical stimulation studies by Wilder Penfield elicited déjà vu and a range of experiences akin to the dreamy state from stimulation of areas in the medial temporal lobe such as the lateral temporal neocortex and superior temporal gyrus (Illman et al., 2012; Mullan and Penfield, 1959; Penfield, 1955; Penfield and Perot, 1963). Despite difficulties in defining and comparing déjà vu across studies assessing dreamy state reminiscences, a broad pattern of results has emerged from the cortical stimulation and SEEG approach in patients with temporal lobe epilepsy (Illman et al., 2012; Cleary et al., 2021a; b). Incidentally, the areas implicated by this approach typically align with those implicated in recognition memory (Barzykowski and Moulin, 2022).

3.4. Déjà vu and electrical cortical stimulation studies

One of the clearer studies adopting this electrical cortical stimulation approach to elicit déjà vu is from Bartolomei et al. (2004). This study sought to directly assess whether the stimulation of the entorhinal and perirhinal cortices could elicit déjà vu and dreamy state reminiscences. The study reported that déjà vu was more likely to be experienced after stimulation of areas in extra-hippocampal structures in the anterior parahippocampal region and entorhinal cortex than from stimulation of the amygdala and hippocampus. Dreamy state reminiscences were more likely to be associated with stimulation of the perirhinal cortex. This study resulted in subsequent debate about the extent to which déjà vu relied on the rhinal cortices and by extension whether this could be considered as a proxy for familiarity impairments in recognition memory (Curot et al., 2017, 2020; Martin et al., 2015; Vignal et al., 2007). One further issue raised by Curot et al. (2017) with regards to déjà vu and electrical stimulation studies in temporal lobe epilepsy is whether the sub-categorisation of the dreamy state is necessary for our understanding of the neural basis of clinical déjà vu. This is largely because cortical stimulation can elicit discrete experiences that would be less likely to occur in a spontaneous seizure or spontaneous déjà vu. Indeed, this view that triangulating upon a déjà vu zone in the brain should be avoided was raised by O'Connor and Moulin (2010). Instead, their suggestion was that when suggesting a causal relationship between direct stimulation (or activation) and déjà vu, that spreading physiological activation and spreading functional network activation should be considered. This approach is likely to be more useful in understanding both how the erroneous familiarity is generated and how the familiarity in déjà vu comes to be interpreted as subjectively inappropriate. A later study by Bartolomei et al. (2012) found that rhinal cortex stimulations that resulted in déjà vu experiences led to greater involvement of medial temporal lobe structures. Thus, Bartolomei et al. (2012) lends greater support to the view that déjà vu is not merely the isolated disruption of the familiarity system in anterior parahippocampal structures.

3.5. Déjà vu and recognition memory impairments in temporal lobe epilepsy

Given these brain areas align with those theorised as underpinning recognition in "healthy" participants more generally, it does suggest that disrupting the physiology of the medial temporal lobe can cause déjà vu experiences. This observation prompted researchers to use behavioural methods to assess whether relative deficits in recollection and familiarity in patients with temporal lobe epilepsy may contribute to their déjà vu experiences. For example, Martin et al. (2012) assessed the constituent behavioural processes in recognition memory (i.e., recollection and familiarity) with a group of unilateral temporal lobe epilepsy patients who experienced déjà vu as part of their seizures, a group of patients who did not, and a standard control group of non-patients. Déjà vu experients with temporal lobe epilepsy demonstrated impairments in familiarity assessment but preserved recollection performance. Patients who did not experience déjà vu demonstrated broader impairments in both familiarity and recollection. A further experiment used an exclusion task designed to place familiarity and recollective processes in opposition to one another such that participants should use recollection to recall contextual details in order to oppose (exclude) familiarity evidence generated by repeated lures. This experiment saw déjà vu

experients with temporal lobe epilepsy committing a similar level of exclusion errors as their control counterparts. Thus, these findings suggest déjà vu experients with temporal lobe epilepsy can use recollection to oppose false familiarity. The study also assessed patient lesions with magnetic resonance imaging (MRI). This analysis found that ipsilateral medial temporal lobe structures were less affected in the temporal lobe epilepsy patients who experienced déjà vu compared to those who did not experience déjà vu. Typically, patients that experienced déjà vu had scans suggesting more focal volume reductions in the rhinal cortices. A case study of an individual with déjà vu as part of temporal lobe epilepsy and a lesion in the left entorhinal cortex also suggested the same pattern of selective familiarity impairments with intact recollective processing (Brandt et al., 2021).

Martin et al. (2019) found a slightly different pattern of results in patients with *bilateral* temporal lobe epilepsy. In this study, patients who experienced déjà vu demonstrated broader impairments in both familiarity and recollection. A relatively recent case report on an amnesic patient with hippocampal damage also suggested that déjà vu can occur in patients with severe recollective memory impairment (Curot et al., 2021). Overall, this integration of behavioural and clinical evidence points to the processing of episodic context playing a role in identifying erroneous familiarity during déjà vu as part of temporal lobe epilepsy. However, the evidence from déjà vu experients with bilateral temporal lobe epilepsy suggests it may be inappropriate to universally characterise déjà vu as selective familiarity impairments with preserved recollective functioning. This point is also made by Martin et al. (2019) in their discussion of the study. The authors suggest that signalling of contextual novelty and in-tact recollective processing are not likely to be the only processes by which déjà vu experients conclude the familiarity is inappropriate. Martin et al. (2019) suggested that cognitive processes supported by the prefrontal regions could play a role in opposing the subjective familiarity. Specifically, Martin et al. (2019) suggested that mnemonic conflict processing, deductive reasoning and fast affective evaluations may also play a role. This is in line with other arguments that have suggested déjà vu is the divergence of subjective experience from metacognitive knowledge (e.g., Metcalfe and Schwartz, 2016; see *Conflict Account of Déjà vu*).

3.6. Distinguishing clinically relevant Déjà vu from naturalistic experiences

In a similar manner to the integration of Martin et al.'s (2012, 2019) behavioural tasks with clinical temporal lobe epilepsy groups, neuroimaging research on déjà vu often aims to distinguish patients with temporal lobe epilepsy on the basis of those who do and do not experience déjà vu. These studies have provided evidence on the neural basis of déjà vu in temporal lobe epilepsy which converges with studies using the electrical cortical stimulation and SEEG approach (Guedj et al., 2010; Kovacs et al., 2009; Nigro et al., 2019). Other approaches have adopted direct comparisons between participants from the general population who do and do not experience déjà vu (Brázdil et al., 2012). However, a review by Labate et al. (2011) had previously suggested that déjà vu experiences in "healthy" participants could be indicative of benign temporal lobe epilepsy (i.e. epilepsy without febrile seizures but with prominent déjà vu experiences). This has resulted in a number of studies trying to differentiate déjà vu experiences which may be on the temporal lobe epilepsy spectrum (Labate et al., 2019; Perucca et al., 2017; Pešlová et al., 2019; Shaw et al., 2016; Zatloukalova et al., 2022).

Perucca et al. (2017) summarised some of the key differences between naturally-occurring and epileptic déjà vu. For example, experiences of déjà vu in the general population were more frequently associated with being in a new situation or with certain sensory modalities. Epileptic cases of déjà vu were characterized as prolonged (i.e., few seconds to several minutes), of a severe intensity, and occurring several times a year with potential occurrence in clusters. On the other hand, cases of déjà vu from the general population were described as mild, fleeting, and occurring infrequently. However, Perucca et al. (2017) noted poor inter-rater reliability when characterizing déjà vu experiences which lends support to the point regarding a limited ability to diagnose cases based on their phenomenological characteristics. Notwithstanding that point, the ability to distinguish healthy non-clinical déjà vu from those experiences that may be underpinned by different neurophysiological activity could be important for clarifying whether a momentary glitch in memory processing or even an occasion of pathological processing (as in temporal lobe epilepsy) is necessary to generate déjà vu (Spatt, 2002).

4. Experimental approaches in cognition for assessing Déjà vu

Methods for generating déjà vu in non-clinical populations prior to the publication of Brown (2004) were sparse. However, the development of experimental lab analogues involving word, auditory and virtual reality stimuli is now a priority within déjà vu research (see Table 1). Given naturally-occurring déjà vu is not necessarily predictable and is generally regarded in the non-clinical population to be infrequent and fleetingly experienced, the generalisation of déjà vu research from patient samples and lab analogues becomes an important consideration. Despite the efforts to categorise déjà vu into variants of clinical relevance in temporal lobe epilepsy, the subjective relationship that experients may have with déjà vu could be inconsequential to the underlying cognitive functioning and neural activity that gives rise to the experience. Moreover, when participants narrate their experience in intracortical stimulation and SEEG studies, it is not clear whether the experience elicited is related to an actual memory or whether it is a memory distortion (e.g., false memory). This consideration makes it clear why stimulus-driven accounts (i.e., where the déjà vu experience

Table 1
Table of experimental approaches in cognitive Déjà vu research.

Account	Explanation	Associated Studies
Prior Exposure	This approach posits that when you see a scene twice in quick succession (the first time superficially and the second with full awareness), the processing break prompts the feeling that you have seen two separate and duplicated experiences.	Jacoby and Whitehouse (1989) Brown and Marsh (2008) Brown and Marsh (2009)
Recognition without Identification	Déjà vu is the result of familiarity from prior exposure to similar stimuli where experients are unable to identify the source of the familiarity.	Cleary and Reyes (2009) Cleary et al. (2012) Cleary and Claxton (2018)
Sensitivity to Similarity	Déjà vu is the result of monitoring processes assessing whether cues from the current scene overlap with aspects of scenes held in memory. Subjective familiarity increases as cues from the current scene are identified.	Kusumi (1994) Kusumi (1996) Sugimori and Kusumi (2014)
Conflict with Awareness of Novelty	Déjà vu is thought to be the result of a clash in two mnemonic evaluations, the feeling of familiarity and the knowledge this familiarity is false. Thus, for déjà vu to be elicited there should be a conflict between two mnemonic evaluations that is resolved in favour of the situation being novel.	Urquhart and O'Connor (2014) Urquhart et al. (2018)

can be wholly or in part attributed to a stimulus in the environment) are also important to consider. That way, the environmental contexts that could prompt, disambiguate and contribute to resolving the experience may also be considered in addition to observing behaviour outcomes of false familiarity.

4.1. Priming through prior exposure

One of the most enduring individual differences relationships in the déjà vu literature is between travel frequency and déjà vu such that those individuals who travel long(er) distances from their home on a more regular basis are more likely to experience déjà vu (Brown, 2003, 2004; Chapman and Mensh, 1951; O'Connor and Moulin, 2013). In the context of déjà vu, this relationship makes intuitive sense given those who travel more often are likely to see many different scenes that are similar to ones they have seen before. Consequently, this may mean they occasionally experience a greater sense of familiarity in novel settings. As such, cognitive approaches to researching déjà vu have often used study designs that attempt to engineer situations that could elicit déjà vu or "déjà vu like" experiences in experimental settings. One of these approaches has used principles of prior exposure to emulate situations where an inflated sense of familiarity towards a stimuli might arise akin to how déjà vu arises in everyday life (Brown, 2003, 2004).

Jacoby and Whitehouse (1989), referencing Titchener (1928) description of a déjà vu experience while crossing the road, developed a task to assess false familiarity illusions caused by unconscious or fleeting perception of the same stimuli. In his original description, Titchener (1928) describes the experience of a temporal and cognitive disconnect between a preliminary glance and a more thorough look resulting in the sensation of déjà vu. Titchener's interpretation is that the unconscious perception of the initial glance arouses feelings of familiarity and creates an illusion of having previously crossed the road before. Jacoby and Whitehouse (1989) false recognition task borrows from this idea of unconscious or split perception by priming participants with context words before the presentation of test words in a recognition memory task. This manipulation at test was intended to be like the hasty glance before looking at the road in Titchener (1928) description. They found that on "new" trials preceded by an identical context word that there was an increase in the likelihood of misidentifying the new word as having occurred on the study list. Thus, the short glance at the upcoming item is able to contribute to a heightened sense of familiarity when it is then consciously viewed in full (Brown and Marsh, 2010).

Whereas the Jacoby and Whitehouse (1989) task does not explicitly generate déjà vu, the generation of false familiarity in the absence of attributing a source to that familiarity has informed the recent development of lab analogues of the déjà vu experience (Cleary et al., 2020). Brown and Marsh (2009) in a similar experiment to Jacoby and Whitehouse (1989) used symbols of varying familiarity in a recognition test and replicated Jacoby and Whitehouse (1989) findings that a brief encounter with a matching symbol increased the likelihood of misattributing the item as having been seen before. When asked post-experimentally, half of the participants reported experiencing déjà vu during the experiment. A related experiment by Brown and Marsh (2008) demonstrated that when participants superficially viewed images of places they had never been to (verified by a separate questionnaire), they were more likely to report that they had visited that place before in follow-up sessions held weeks later. This study did not ask about déjà vu experiences but overall it suggests that the inflated familiarity ratings from brief prior exposure may prompt recognition illusions involving one's personal experience and autobiographical memory (Brown and Marsh, 2010).

4.2. Recognition without identification

Other analogues focus on generating subjective sensations of familiarity from similarly configured scenes in the absence of awareness or knowledge of its source (Cleary, Ryals, and Nomi, 2020, 2009). These *recognition without identification* analogues of déjà vu have been replicated with static virtual reality scenes (e.g. Cleary et al., 2012) and virtual reality scenes incorporating navigational paths (e.g. Cleary and Claxton, 2018). Familiarity ratings and déjà vu reports tend to be higher when new scenes resemble previously viewed scenes in the same configuration and when there is a failure to recall the previously viewed scene (Cleary et al., 2012; Cleary and Claxton, 2018; Cleary and Reyes, 2009). The subjective familiarity generated by these tasks has also been associated with feelings of prediction and a postdictive bias towards reporting the ability to predict what was going to happen next while in a "déjà vu state" (Cleary and Claxton, 2018; Cleary et al., 2019; Cleary et al., 2021a; b).

Recent iterations of the recognition without identification approach have used auditory stimuli (McNeely-White and Cleary, 2019). This is supported by various studies demonstrating familiarity with retrieval failure can occur with stimuli like music, voices and speech (Kostic and Cleary, 2009). The auditory iteration of the recognition without identification déjà vu paradigm used "*Piano Puzzler*" clips taken from a radio programme where listeners call in to the guess the name of song that is disguised by being recomposed in the style of classical composer (McNeely-White and Cleary, 2019). In this study, déjà vu was termed as déjà entendu (meaning already heard). This study found that familiarity ratings were higher when a Piano Puzzler led to a report of déjà entendu and corresponded to a previously studied song clip than when a Piano Puzzler led to a report of déjà entendu but did not correspond to a song clip that was heard in the study phase. It should be noted that the results from the auditory variation of the recognition without identification déjà vu paradigm are not as robust and clear as their counterparts using visual stimuli. The identification rates of Piano Puzzler clips were fairly low (participants could identify the songs in 16 % of piano clips at study, 6 % of Piano Puzzlers corresponding to studied clips and 2 % of Piano Puzzlers corresponding to unstudied clips). However, just because participants could not identify the song does not mean it was unfamiliar in the first place. The songs in the study could reasonably be expected to be well known in their original compositions. The examples mentioned in the study include *The Girl from Ipanema* and *Take Me to the Ball Game*. Whereas the déjà entendu state is well defined by the study (participants were to identify this subjective state if they felt like they had heard the clip before despite knowing it is completely new), a baseline familiarity or feeling of knowing rating towards the song clip in question could have been useful to help tease apart whether the auditory stimuli recognition without identification effect is more similar to a tip of the tongue state where one has a song in their head and does not know the name of it.

The question of how experimental déjà vu can be differentiated from other familiarity-based experiences and introspective phenomena is one of the predominant issues with the prior exposure and recognition without identification approaches. It is unclear whether an in-experiment déjà vu report in conjunction with retrieval failure for familiar scenes is sufficient to justify an experimental experience akin to déjà vu (O'Connor and Moulin, 2010). Or, at least, it has not been wholly considered how the "déjà vu" reports in prior exposure or recognition without identification studies differ from other experiences where there is a retrieval failure and an awareness of familiarity. This matters because there is evidence in the literature that affirmative reports of déjà vu can be solicited during continuous recognition tasks where there is no theoretical expectation that the task would trigger a déjà vu experience (Jersakova, Moulin and O'Connor, 2016). It is possible that natural déjà vu experiences do occur during experiments but given estimates of naturally-occurring déjà vu are very low it would be unlikely for this to happen at the elevated rate reported in Jersakova between 32 % and 58% of participants across four experiments). Demand characteristics are a straightforward explanation of the effect reported in Jersakova et al. (2016). However, as set out by Jersakova et al. (2016), participants may also be interpreting implicit cues such as uncertainty over the status of stimuli. For example, participants may report déjà vu in a study when

feeling uncertainty about whether a stimulus is new because the question of whether they are experiencing déjà vu has been posed. This is particularly likely to be the case if the studies use highly familiar scenes, words, or symbols. In turn, this could result in elevated déjà vu reports that despite being associated with a specific trial type or response cannot necessarily be attributed to the manipulations in the study.

It should be a priority of déjà vu research to test the assumptions and modify the manipulations of lab analogues in order to assess the veracity of their déjà vu effects. One way that this could be done is by manipulating task demands and the sources of information available to participants in their consideration of stimuli. Since several prior exposure and recognition without identification tasks use the example of experiencing déjà vu while travelling as the premise for using scenes and places as their stimuli, participants could be provided with additional information while completing the task to emulate the self-knowledge of places they have visited before. For example, when people travel to a new place and experience déjà vu they can interpret the familiarity as false because they know they have never been to that place before. Participants could study stimuli within a set of scenes in a prior exposure or recognition without identification task and be cued with information about the upcoming item status before it is presented at test (e.g., likely visited, or likely old). Such an approach could help avoid the conflation of déjà vu with familiarity without recollection because the déjà vu report would be supported by evidence from the additional information and manipulation of stimuli context.

4.3. Sensitivity to similarity

Whereas previous accounts prioritised a glitch in recognition processing or familiarity misattribution in recognition without identification, sensitivity to similarity perspectives on déjà vu have tended to prioritise metacognitive monitoring in various forms as a means of detecting similarities between stored representations and the current environment (Spatt, 2002). For example, Kusumi (1994) investigated déjà vu as a mechanism that traces a present experience back to a similar past experience. Kusumi (1994) used questionnaires and found 89 % of people had experienced déjà vu in relation to a place, of which 36 % claimed they could trace a source experience. In addition, 61 % of respondents had experienced déjà vu in relation to a person with 21 % of those respondents being able to trace a source experience. Kusumi (1996) then followed this up by asking participants to rate the frequency of déjà vu experiences in the context of various places and situations and also asked participants to rate the effectiveness of retrieval cues such as perceptual or physical qualities (e.g. mood, weather and atmosphere). Kusumi (1996) suggested that déjà vu was a result of conflict between two source monitoring processes: one that relied on general knowledge or episodic memory and the other based on a more transitory representation of a past experience. The studies presented by Kusumi (1994, 1996) were then developed into the Typicality and Analogical Reminding Model of Déjà vu (Kusumi, 1998, 2006). In this model, déjà vu is described as arising from the increasing feeling of familiarity felt towards the current scene while matching cues such as perceptual attributes with those from typical representations of various scenes. Thus, whilst some of the earlier Kusumi studies suggest that two source-monitoring processes are in conflict with one another, the eventual model does not argue that the clash in evaluations is required, only an awareness of (increasing) familiarity. This account of déjà vu has been termed as the Sensitivity to Similarity approach given its focus on similarity judgements between the present scene and one held in memory to conclude the déjà vu experience (Sugimori and Kusumi, 2014).

One of the key ideas that this model introduces to the déjà vu literature is that the experience of déjà vu is indicative of an ongoing monitoring system that is seeking out overlaps between various experiences to assess the novelty of the current experience (Moulin, 2018). This idea, that participants should be able to identify a mismatch between current experience and memory, is perhaps what differentiates the sensitivity to similarity approach from recognition without identification approaches. However, although the Kusumi (1998, 2006) conflict model posits that experients can identify the source of familiarity or match cues from the current environment to similar ones held in memory during déjà vu, it is not always clear how participants are able to do this in the context of sensitivity to similarity studies. This is particularly the case for studies predominantly employing a self-report or individual differences approach. For example, Sugimori and Kusumi (2014) found that people who self-reported experiencing déjà vu more frequently also reported being more sensitive to configural similarities and could better determine configural similarity in laboratory tests. Although the link between sensitivity to similarity in self-report and experimental measures suggests that it could provide a useful individual differences construct for experiencing déjà vu, empirical and experimental evidence of participants being able to attribute the disambiguation of subjectively inappropriate familiarity to similar representations stored in memory has not yet been presented. The criticism, that it is not clear how the experient interprets the familiarity as incongruous with the current environment, is one that is therefore shared with studies from across the prior exposure, recognition without identification, and sensitivity to similarity approaches (Brown and Marsh, 2008, 2009; Cleary and Ryals, and Nomi, 2012, 2009).

5. Conflict account of Déjà vu

In most definitions and conceptualisations of déjà vu, the experient knows that the familiarity is false or is at least experienced as subjectively inappropriate (Brown, 2004). This feeling of conflict is often reflected in anecdotal accounts of the déjà vu experience (e.g., experiencing subjectively inappropriate familiarity while visiting a place that the experient knows they have never been before; Urquhart and O'Connor, 2014). This idea that conflict rather than awareness of familiarity is what underpins the déjà vu experience is not new by any means. For example, Roediger (1996) asserted that introspective memory phenomena such as déjà vu and jamais vu were illusions of metacognitive conflict. Metcalfe and Schwartz (2016) argued that déjà vu can be conceptualised as a seemingly spontaneous metacognitive state arising when the current subjective experience is inconsistent with what one knows to be true about their memory. This section summarises the evidence in support of proposing a conflict account of déjà vu and how positioning déjà vu as conflict may help reconcile extant questions in the field such as why the experience declines with age and whether it reflects a sensitivity to erroneous familiarity or a propensity to experience fragmented memory recall. First, we consider the behavioural and neural evidence for positioning déjà vu as conflict from a lab analogue of déjà vu. Then, we consider the evidence for the age-related decline in déjà vu and its similarities with age-related dynamics in cognitive control and memory retrieval control. Finally, we propose how the proposed déjà vu as conflict account could be tested.

5.1. Conflict-based lab analogues of Déjà vu

Urquhart and O'Connor (2014) developed a lab analogue of déjà vu that aimed to mimic the clash in evaluations defined by Brown (2004). The lab analogue is an adaptation of the DRM false memory recognition task where participants are presented with a list of words at study that are all semantically related to an unpresented word known as the critical lure (Roediger and McDermott, 1995). When this unpresented word is shown at test, it generates a feeling of subjective familiarity. However, the manipulation in Urquhart and O'Connor's (2014) adapted version of the task required that participants monitor the list of words for a prefix that is only present in the critical lure (e.g., at study they were instructed to monitor for "sle-" when the critical lure at test is the word "sleep"). Thus, a clash in evaluations analogous to déjà vu is generated with the knowledge that the prefix of the critical lure was not presented

combined with the subjective familiarity of the critical lure. Novelty and subjective familiarity were also manipulated in this study. They found that reports were highest for high novelty critical lures, but that familiarity strength did not have a significant effect on déjà vu reporting frequency. Although it is perfectly plausible that participants in other analogues (such as those in recognition without identification déjà vu paradigms) experience déjà vu, the benefit of this analogue is that the novelty of the stimulus can be verified from the information presented (i.e., the number of words that were seen with the prefix) ensuring that participants' déjà vu experiences within the analogue are driven by a clash in evaluations.

5.2. Neural evidence for Déjà vu as conflict

This lab analogue of déjà vu was conducted in conjunction with functional neuroimaging (fMRI) in a study by Urquhart et al. (2018). They found that the mnemonic conflict generated by the familiarity of the critical lure and the information that this word could not have been seen before activated brain areas associated with cognitive control and conflict resolution. Primarily, the areas associated with reporting déjà vu in this analogue included the anterior cingulate cortex, medial prefrontal cortex, and parietal cortex. In addition, greater activation of these brain areas resulted in a greater likelihood of reporting déjà vu. Crucially, it is not just that brain areas associated with conflict monitoring and resolution were activated in this study but that the behavioural evidence demonstrated that déjà vu was more likely to be reported for correctly resolved critical lures (i.e., a falsely familiar new item correctly judged as new). Thus, the behavioural and neural findings are consistent with the Brown (2004), and O'Connor and Moulin (2010) definitions of déjà vu whereby déjà vu is the presence of mnemonic conflict plus the resolution of the conflict in favour of novelty. This is important because the presence of conflict resolution sets déjà vu apart from clinical manifestations of illusory familiarity like déjà vécu and benign manifestations of undefined familiarity like the butcher on the bus phenomenon (Urquhart et al., 2018). In terms of how this might fit in with the broader déjà vu literature, it is not clear whether these memory conflict brain areas are the essential processes involved in déjà vu given most studies have implicated brain areas that support recognition memory. However, it does signal that conflict and conflict resolution are important aspects of déjà vu that should be given due consideration alongside false familiarity. Perhaps, those people that experience déjà vu more often may be people who can better inhibit their responding to inaccurate memory signals, have more awareness of conflict in their memory systems and maintain optimal activation of frontoparietal areas of the brain.

5.3. Incidence of Déjà vu across the lifespan

One aspect of positioning déjà vu as conflict that has hitherto been discussed in a rather limited manner is that the déjà vu experience occurs more frequently in young people. Brown (2004) argued that one of the research priorities for déjà vu going forward should be to understand why déjà vu experiences decrease with age. This age relationship was first reported by Chapman and Mensh (1951). The authors reported that déjà vu frequency peaks at 2.5 average experiences a year in young adults aged 20–24 years with the frequency of experience declining thereafter. This age-related decline in déjà vu has since been reported in various studies (Adachi et al., 2007, 2008; Fortier and Moulin, 2015; O'Connor and Moulin, 2013; Sno et al., 1994; Wells, O'Connor, and Moulin, 2018). The correlation is considered so robust that it was also used to validate Sno et al.'s (1994) IDEA scale (Moulin, 2018). Brown (2004) also noted that many papers in the déjà vu literature made subjective estimates of the incidence of the déjà vu experience (often referring to it as a common and universal experience). However, the best estimate provided by Brown (2004), in the context of wide variability between estimates from large scale survey studies, suggested that two thirds of the population have had at least one déjà vu experience at some point in their lives. This finding was presented with the caveat that if déjà vu was reported as occurring in a person's lifetime, it was very likely that they had experienced it more than once. Brown (2004) also suggested that it may not be until older ages of childhood and early adolescence that individuals have developed sufficient metacognitive awareness to recognise and report inappropriate familiarity as such. Indeed, most individuals report that they first experienced déjà vu when they were between 6 and 10 years, or 11 and 15 years (Fukuda, 2002).

There were several other considerations raised from Brown (2004) summation of estimates of lifetime déjà vu incidence. These considerations included that the mean age of the sample influences the lifetime incidence estimates reported in the study. This is such that studies with younger samples suggest higher lifetime incidence (consistent with the age and déjà vu frequency relationship where we would expect younger samples to be reporting more déjà vu experiences). Other considerations included that the more recent a study was, the more likely it was to suggest a higher lifetime déjà vu incidence. This finding suggests there may be cohort effects at play such that increased awareness of the experience in younger sectors of the population has the ability to inflate incidence estimates (Fortier and Moulin, 2015; Moulin, 2018). There are also methodological issues when calculating déjà vu incidence estimates from across various studies because there are various response formats and temporal scales with which self-reports are solicited in survey studies (Aitken and O'Connor, 2020; Brown, 2004). Despite these issues, the age relationship is verifiable and remains a consistent finding in the literature. Although, the universality of the experience may be contested given a conservative estimate suggests around one third of people do not experience déjà vu.

5.4. Significance of an age-related decline in Déjà vu

It is worth remarking here that this correlation does not easily fit in with neurological accounts of déjà vu which link the experience with disrupted memory function. If déjà vu was underpinned exclusively by erroneous or disrupted memory processing akin to something that has been temporarily forgotten, one would expect a memory error like this to increase with age but paradoxically déjà vu decreases in frequency with age. In other words, people experience less déjà vu during stages of development and ageing where typically they experience an increase in memory errors, intrusions and distortions (Moulin, 2018). This paradox is one that the conflict account of déjà vu seeks to resolve. This account posits that if déjà vu is framed as metacognitive conflict, then the disrupted memory processing is not the central experience. Rather, déjà vu is indicative of a positive recognition error that is resolved when the memory system has identified other evidence to counter the positive recognition. This framing of déjà vu suggests a more nuanced position where the experience is at the nexus of both error and adaptive behaviour. It suggests that our cognitive processes are finely tuned to detect subtle discrepancies between our memories and current experience. This detection of error or conflict and our response to that uncertainty may act as a protective mechanism by ensuring we do not act on errant or conflicting memory signalling (Urquhart et al., 2018).

5.5. Convergence with conflict monitoring and cognitive control

The age-related incidence of déjà vu also aligns with what we know about cognitive control. Conflict monitoring and inhibitory control performance follows a similar age-related trajectory whereby young adults are better able to override prepotent responses to external stimuli and respond accurately (Lucci et al., 2013; Mathalon et al., 2003; Strozyk and Jentzsch, 2012). Likewise, in memory retrieval control research, our ability to identify and resolve conflict declines from young adulthood through to older adulthood which is consistent with the age-related incidence of déjà vu (Jaeger, Selmeczy, O'Connor, Diaz and Dobbins, 2012). The fact that younger people experience it more often

indicates that not only is there an ability to adapt to errant memory signalling, but that metacognitive awareness and correction of the potential error is also a significant component of the experience. Therefore, the inclusion of a metacognitive or conflict monitoring component is entirely consistent with the converging neural evidence of disrupted memory signals and situating the illusory memory event within a framework of memory retrieval control, rather than memory performance. The clash between subjective familiarity and a metacognitive evaluation that the familiarity is false establishes déjà vu as a case of metacognitive conflict or at least a divergence between normally synchronised cognitive and metacognitive states (Kusumi, 1996; Metcalfe and Schwartz, 2016; Roediger, 1996).

Cognitive control research benefits from long-established paradigms and theoretical perspectives from which to understand how the selection and suppression of goal-incompatible responses occurs behaviourally and in the brain. Interference tasks such as the Stroop (i.e. naming the colour of an incompatible colour word), Simon (i.e. making stimulus responses consistent with their associated keyboard response rather than location on screen) and Flanker task are used to assess ongoing conflict monitoring and adaptation (Eriksen and Eriksen, 1974; Simon and Rudell, 1967; Stroop, 1935). These paradigms require that participants inhibit prepotent responses triggered without recourse to the task goals (Gratton et al., 2018). For example, in the Flanker task, participants are required to respond to the central item in an array of items that is flanked by items congruent or incongruent to the associated response of the central item (e.g. in an array of ">><>>" where central item "<" is associated with a left response, the flanking stimuli are incongruent with the associated response of the central stimuli). Trials with incongruent stimuli result in conflict and significantly slower reaction times. This interference effect is known as the Flanker Effect (or Congruency Effect), and it is the difference in reaction time between incongruent trials and congruent trials. Therefore, a larger Flanker Effect indicates greater distraction from flanker stimuli. The Gratton Effect (or Congruency Sequence Effect) refers to the reduction in the Flanker Effect following incongruent trials compared to congruent trials (Gratton et al., 1992; Gratton et al., 2018). This lowered interference effect after an incongruent trial as compared with a congruent trial indicates the adjustment to information processing in response to conflict (Eriksen and Eriksen, 1974; Gratton et al., 1992, 2018). Thus, a larger Gratton Effect indicates greater adaptations between monitoring for conflict on the previous and current trials. Incongruent trials are also more likely to produce errors (which tend to be faster than all other types of responses). Responses are also slower on the trial following the error trial in an effect known as post-error slowing (Rabbitt, 1979).

Conflict monitoring theory proposes that errors are a case of high conflict that indicate the need for control (Botvinick, 2007; Botvinick et al., 2001; Botvinick et al., 2004; Botvinick and Cohen, 2014). There are two event-related potentials (ERPs) associated with error commission that are useful for understanding conflict monitoring and error processing. The first is the Error Related Negativity (ERN) which is elicited within 50–150 ms of the error over fronto-central electrode sites and the second is the Error Positivity (Pe) which is elicited within 200–500 ms of the error over centro-parietal electrode sites. Activity in the anterior cingulate cortex is thought to be the source of the neural activity underpinning the ERN (Falkenstein et al., 1990; Gehring et al., 1993; Larson et al., 2014; Taylor et al., 2007; van Veen and Carter, 2002). The anterior cingulate cortex as a neural substrate underpinning conflict monitoring was later corroborated by fMRI research implicating increased activity during error trials (Carter et al., 1998; Kiehl et al., 2000; van Veen and Carter, 2002). In line with the view that cognitive control is reactive to the indication of increased conflict, it has been demonstrated that activity in the anterior cingulate cortex predicts the behavioural adjustments (e.g. post-error slowing) and the level of activation in the prefrontal cortex (Kerns et al., 2004). Thus, it would suggest that anterior cingulate cortex engages the recruitment of control by the prefrontal cortex.

Despite much control over conflict happening without conscious awareness, the Pe is often associated with awareness of error detection (Falkenstein et al., 1990; Gehring et al., 1993; Orr and Carrasco, 2011). This awareness of conflict may just be an awareness of task difficulty, ease of action selection or recognition of response slowing. However, it has also been shown to occur on both uncorrected trials in generic interference tasks, false alarms in memory tasks, and associated with metacognitive judgements on the presence and absence of conflict (Boldt and Yeung, 2015; Jiang et al., 2018). These patterns of neural activity, in line with what was described with regards to memory expectation conflict, are potentially quite reinforcing for the hypothesised significance of déjà vu. As much memory error monitoring happens unconsciously, perhaps when déjà vu is experienced and there is an awareness of conflict in typically synchronised memory processes, it is an indication of increased cognitive control. Thus, those who experience déjà vu more (and hence, awareness of memory conflict more often) may be those who better recruit memory control in the face of uncertain memory evidence.

The other relationship in favour of this view is age-related performance in conflict monitoring and cognitive control ability across the lifespan. Strozyk and Jentzsch (2012) demonstrated that neurophysiological decline (as measured by ERN amplitudes) preceded effects on behavioural measures of error monitoring and cognitive control. In this study, the authors tested young adults (aged 18–31 years) and middle-aged adults (aged 41–59 years) on a Flanker task. Both groups of participants demonstrated faster error responses and slower post-error responses compared to correct and post-correct responses, respectively. Participants also demonstrated an increase in accuracy following post-error slowing. Thus, behavioural performance from both groups was consistent with post-error slowing reflecting adaptive adjustments towards more conservative responding to maintain accuracy. Whilst middle-aged participants were generally slower than young adult participants, there were no significant differences in the speed of error responses and the extent of post-error slowing which suggests that adaptive behavioural changes in error processing may not become markedly different until later in life. However, despite preserved behavioural performance, there were indications of neurophysiological decline in the middle-aged adult sample. The amplitude of the ERN and Pe were significantly reduced in middle-aged adults. In addition, the Pe in the middle-aged sample showed an increase in latency relative to young adults. Thus, it is likely that error processing in the middle-aged brain reaches a threshold to maintain behavioural performance and post-error adjustments but that the effectiveness of this processing begins to decline in middle-age. The reduction in the amplitude of Pe possibly reflects a reduction in error awareness. This may help inform why middle-aged adults experience less déjà vu. For example, conflict monitoring and error processing performance is still adequate for ensuring broadly accurate memory functioning but mechanisms that are involved in awareness of conflict and errors are less effective. Hence why they may not interpret instances of subjective familiarity as déjà vu as often as young adults. Thus, there are several links with cognitive control and conflict monitoring that warrant further investigation to assess whether déjà vu is indicative of memory retrieval control and conflict monitoring processes as the Urquhart et al. (2018) neuroimaging evidence suggests.

5.6. Convergence with memory retrieval control

5.6.1. Conflict between medial temporal lobe signals versus retrieval control processing in frontal structures

Although there is plenty of evidence that intact recollection plays a role in déjà vu, and indeed recollective processing is better in young people than older adults, there are also indications that recollection is not necessary for the déjà vu experience to occur (Martin et al., 2012; O'Connor and Moulin, 2013). Martin et al., (2012, 2019), indicated that in unilateral temporal lobe epilepsy errant memory processing gives rise

to the false familiarity while sparing the ability to retrieve rich contextual information. However, there is some evidence from individual differences approaches that this is not the case in standard research samples. O'Connor and Moulin (2013) investigated whether *healthy* participants with better recognition memory performance would report experiencing déjà vu more frequently. Contrary to Martin et al. (2012), O'Connor and Moulin (2013) found no such relationship between self-reported déjà vu incidence and the ability to use recollection to support recognition judgements. They concluded that individual differences in metacognitive ability and the role of monitoring processes not easily identified by experimental procedures used to probe recognition memory could underpin the experience of déjà vu.

Nigro et al. (2019) also found that individuals who experienced déjà vu did not differ from non-experients in behavioural measures of recollection and familiarity performance. However, déjà vu experients could be differentiated by patterns of neural activation identified when assessing group effects independent of task with the use of fMRI. Déjà vu experients showed less activation in parahippocampal and middle temporal gyrus alongside greater activation in the left insula. The insula is the subject of research programmes investigating its role in cognitive control, conscious error perception, interoceptive awareness and emotional salience detection (Craig, 2009; Grabenhorst et al., 2008; Gradin et al., 2013; Menon and Uddin, 2010; Seeley et al., 2007). Thus, further investigation of this increased activation of the insula could inform why déjà vu is so surprising and noticeable to experients. The study also implicated areas of the prefrontal cortex, namely the right superior frontal gyrus, whereby déjà vu experients engaged this area more so than their non-experient counterparts. The prefrontal cortex has a broad-ranging role in cognitive control related processes with the superior frontal gyrus specifically being proposed to have a role in monitoring of current scene and information outputs from episodic memory networks (Fletcher and Henson, 2001; Henson, Shallice, & Dolan, 1999).

The Nigro et al. (2019) findings should be interpreted with caution given the challenges associated with interpreting the main effects of group independent of task (Bennett and Miller, 2013). However, the Nigro et al. (2019) view, that déjà vu could be related to a cognitive predisposition rather than temporarily disrupted memory physiology, is possibly also complemented by evidence suggesting frontal lobe lesions are associated with false recognition (Gallo et al., 2006; Schacter et al., 1996). A relatively recent case report described an individual experiencing persistent déjà vu who was trained to identify possible sources of erroneous familiarity which, the authors argued, improved the experient's metacognitive awareness of their déjà vu experiences (Ernst et al., 2021). The intervention reported in the study reduced the frequency of the individual's déjà vu experiences and the rate of false recognition on standard memory tasks. Thus, these findings lend support to the proposition that relationships between déjà vu and typical measures of memory performance remain elusive because déjà vu may be more indicative of individual differences in memory retrieval control and metacognitive monitoring (O'Connor and Moulin, 2013).

5.6.2. Links with memory expectation conflict and metacognitive monitoring

In consideration of precise mechanisms that could give rise to a sense of inappropriate familiarity, neurological accounts of the déjà vu experience have proposed that déjà vu in non-clinical experients could result from a match-mismatch signal supported by the hippocampus (Martin et al., 2015). It may be that such match-mismatch signals represent expectancy violations derived from information stored in memory and specific environmental contexts (or other situational cues) that do not rely on conscious recollection (Martin et al., 2015). Thus, from this perspective, the match-mismatch signal would be perceived by the experient as contextual novelty and inform the impression that the concurrent familiarity generated from other medial temporal lobe structures is false. There is also potential convergence with neural mechanisms. This is a speculative point, but as mentioned previously, novelty signals are coordinated by the mediodorsal thalamus which incidentally also receives outputs from prefrontal control processes and thus may be a potential locus for how monitoring of these contextual novelty and match-mismatch signals integrate within whole-brain theories of memory retrieval to elicit memory illusions like déjà vu (Dias and Honey, 2002; Duszkiewicz et al., 2019; Kafkas and Montaldi, 2018b; Pergola et al., 2018). Crucially, a conflict account of déjà vu that integrates contextually based match-mismatch signals is in line with the finding that familiarity is generally more striking under conditions in which expectations are violated or come into conflict (Whittlesea and Williams, 1998).

There are several key expectancy violation studies that are relevant to this understanding of déjà vu, particularly because they also indicate how recognition memory processing of match-mismatch signals interact with cognitive control. In these cases, a match-mismatch signal may be generated by cued expectations of upcoming memory content which may match with what is contained in memory or come in to conflict with stored representations. O'Connor, Han, and Dobbins (2010) in an fMRI study manipulated memory expectations by presenting participants with anticipatory cues that the upcoming item status was "likely old" or "likely new". The study found that brain regions associated with retrieval success demonstrated an invalid cueing effect such that there was greater activation of these areas when participants responded correctly despite expectation conflict generated by invalid cueing. The fMRI data supported the assumption that invalid cueing resulted in higher control demands with the engagement of the medial and lateral prefrontal cortex and inferior parietal lobule. Notably, these areas are associated with conflict detection and the subsequent engagement of control processes in response monitoring tasks which do not engage episodic memory (Cabeza et al., 2008; Koechlin et al., 2003; Macdonald III et al., 2000; Ridderinkhof et al., 2004). A related study by Mill, Cavin, and O'Connor (2015) investigated the broader functional networks involved in memory expectation conflict. The study also sought to investigate whether mnemonic conflict detection and retrieval control could be identified as separable neural processes. This study identified similar task-evoked activations in prefrontal and parietal brain regions as the aforementioned study by O'Connor et al. (2010). The functional networks associated with conflict detection and retrieval success were then assessed via resting connectivity analyses (fcMRI). This study found that within medial prefrontal cortex and lateral prefrontal cortex regions of the invalid cueing network, there was a dissociation between conflict regions which were sensitive to cue strength and confirmatory retrieval regions which were sensitive to response confidence. Time course analyses suggested that memory control processes consisted of memory expectation conflict detection followed by retrieval analysis processes. Thus, this study indicates that there is a rapport, as has been conjectured in proposing a conflict account of déjà vu, between recognition processing and evaluative processes involved in ensuring accuracy and ongoing performance typically associated with cognitive control processes (Moulin et al., 2023).

Furthermore, Jaeger et al. (2012) investigated the engagement of prefrontal regions using fMRI while adolescent (aged 13–15 years) and young adult participants (aged 20–22 years) made memory judgements in a modified version of the above O'Connor et al. (2010) task. Adolescents responded significantly faster than young adults on invalidly cued trials but showed no other reliable differences in recognition memory performance and accuracy. The fMRI data demonstrated that both groups showed greater activation in posterior dorsolateral prefrontal cortex, and lateral parietal regions for invalidly cued trials relative to validly cued trials. Similarly, adolescents' greater activation of the dorsolateral prefrontal cortex on invalid trials did not lead to improved performance in adolescents, but young adults did show improved performance with greater activation of this area relative to adolescents. Resting state analysis revealed greater functional connectivity between hippocampal and frontal areas in adults but not in adolescents indicating a protracted development of the abilities required to

make context-appropriate memory judgements. Time course analyses indicated that this neural response ended sooner in adolescents, perhaps because of their quicker responding on trials preceded by invalid cues. Moreover, increased dorsolateral prefrontal cortex activation on trials with invalid cues was associated with better performance in young adults and poorer performance in adolescents. A resting state connectivity analysis demonstrated that young adults had greater connectivity between dorsolateral prefrontal cortex and brain areas associated with recognition memory compared to adolescents. Thus, given the similarities in memory performance, it is unlikely that the different patterns of activation between adolescents and young adults reflects a memory deficit (or ignorance of the cues). Rather, it may be a more nuanced difference in how cued memory expectations combine to influence performance, which may in turn rely on developmental maturation of functional connectivity networks between medial temporal lobe and prefrontal cortex.

A charitable explanation of these findings may be that adolescents are just more efficient at these tasks than younger adults. However, the response speed on invalid trials may relate to déjà vu in terms of metacognitive control and awareness. Adolescents do report déjà vu albeit at a lower frequency than young adults but still more often than older adults (Chapman and Mensh, 1951; more recent reports of déjà vu frequency in adolescents are not available). The results considered here indicate that adolescents do have sufficient memory functioning to interpret match-mismatch signals but the speed of responding may indicate that they are not metacognitively aware of the mnemonic uncertainty or they are not using metacognitive control strategies to guide decision-making (Fandakova et al., 2016; Fandakova et al., 2015; Souchay and Isingrini, 2004). It may be that adolescents have sufficient maturation of the memory and cognitive systems to support the constituent experiences of déjà vu but do not have sufficiently developed metacognitive abilities for the consistent and conscious recognition of memory expectation conflict (Brown, 2004). Hence, adolescents show a lower frequency of déjà vu experiences. The central theme of our summary of the conflict account of déjà vu revolves around the age-modulated relationship between the processing of mismatch signals in the medial temporal lobe and conflict signals in the anterior cingulate cortex. Thus, for completeness, we anticipate that in older adults, the presence of match-mismatch signals still occurs, but that their responsiveness to these signals may be diminished compared to younger adults (Moulin et al., 2014). This could be attributed to various factors, such as age-related changes in neural processing, attentional mechanisms, or cognitive resources (Strozyk and Jentzsch, 2012).

5.7. Testing the conflict account of Déjà vu

The aim of a programme of research on the conflict account of déjà vu should be to establish whether there is a role for memory errors, memory error monitoring and memory expectation conflict in the experience and reporting of déjà vu. This should entail rigorous testing to ascertain whether these cognitive processes can consistently and reliably correlate with self-reported and experimentally induced déjà vu experiences. As the above review has indicated, contemporary déjà vu research tends to use several broad approaches including self-report methods, individual differences approaches, clinical research, and the development of lab analogues. To build on this approach, future research should also incorporate individual differences approaches to assess whether there are any relationships between déjà vu and the memory expectation conflict processes that show similar age-related trajectories. A preliminary study could use three experimental tasks (e.g., a feeling of knowing performance task, a conflict monitoring task such as the Eriksen-Flanker task, and the O'Connor et al., 2010 mnemonic likelihood-cueing task) to obtain performance-based indices of metacognitive monitoring, inhibitory control, and memory retrieval control. Questionnaire measures of déjà vu should also be used to assess whether there are any relationships between cognitive function and self-reported tendency to experience déjà vu. According to the conflict account, it would be expected that those individuals who are better able to predict their future memory performance in a feeling of knowing task will be those who are more likely to report déjà vu. As for conflict monitoring and adaptation performance, it is expected that those participants who show less distraction from incongruent stimuli (i.e., a smaller congruency effect on the flanker task) and greater adaptations when monitoring for conflict from one trial to the next (i.e., a larger congruency sequence effect) will be more likely to report experiencing déjà vu frequently. Similarly, participants who show greater adaptations to performance from error processing (i.e., post-error slowing) will also be likely to report déjà vu more often. Similarly, if déjà vu is related to responding accurately under conflicting mnemonic conditions, then those individuals who demonstrate higher sensitivity under invalid cue probs will also be more likely to report experiencing déjà vu.

Another key argument of the déjà vu as conflict account purports that both a familiarity and novelty evaluation are required to elicit déjà vu. However, most experimental lab analogues of déjà vu do not include a novelty cue for participants to disambiguate the familiarity as false. Moreover, if analogues do include novelty cues, the study design does not permit the assessment of conflict adjustments in memory performance. If déjà vu is a conflict-based memory quirk, then post-conflict response adjustments could reasonably be expected. For example, responding may become slower or another déjà vu experience may be less likely if a resource-intensive mnemonic experience has taken place (Moulin, 2018). Unfortunately, existing recognition without identification and conflict with awareness of novelty analogues do not have a sufficient number of trials to allow exploration of this adaptive memory performance. We suggest that this could be investigated by adapting the Jacoby and Whitehouse (1989) false recognition to incorporate environmental context as a novelty cue and generate illusory familiarity. Like other lab analogues, participants should be asked to indicate whenever they experience déjà vu throughout the experiment. An adapted Jacoby and Whitehouse (1989) task, with its capacity for a larger number of trials, would permit a two-pronged exploration of its efficacy to produce a "déjà vu like" experience and assess the impact of déjà vu on memory performance.

6. Conclusion

Brown (2004) in his seminal book, *The Déjà vu Experience,* argued that two of the most important issues in déjà vu research were to understand why déjà vu experiences decrease in frequency as we get older and how déjà vu relates to memory deficits. On the former ageing research question, Brown stated the pervasiveness of the age relationship "*may be an important litmus test for the credibility of any explanation [of the déjà vu experience]*" (p. 190). This review has argued that déjà vu can be considered as metacognitive conflict, or as an indication of memory expectation conflict. Earlier accounts of the déjà vu experience have not explicitly referred to a "conflict account of déjà vu" but recent developments in the research area such as the neuroimaging of the Urquhart and O'Connor (2014) lab analogue of déjà vu by Urquhart, Sivakumaran, Macfarlane, and O'Connor (2018) make a significant contribution towards explaining why conflict is central to the déjà vu experience and the neural activity that forms the basis of the experience. More importantly, this conflict account of déjà vu is one that does provide a coherent explanation as to why déjà vu experiences tend to decrease with age and is consistent with what is known about the ageing of memory and metacognitive systems. While the conflict-based explanation offers insight into the age-related patterns of déjà vu, it is imperative to subject its underlying assumptions to empirical scrutiny.

This narrative review summarises the proposal for a conflict account of déjà vu as follows. Memory retrieval and retrieval awareness typically happen concurrently during successful memory decision-making. During déjà vu, positive retrieval awareness arises in the absence of true retrieval which yields an overall sensation of inappropriate familiarity

(O'Connor and Moulin, 2010). The experient's clash in evaluations between a sense of retrieval and a concurrent evaluation of the falsity of this familiarity signals conflict within the cognitive system. In addition to this, the frequency of déjà vu is not uniform across the lifespan. Young adults experience déjà vu more often than older adults. Memory errors (e.g., forgetting or false memories) typically increase with age and are also likely to have a behavioural consequence (e.g., failure to recall events or "recalling" events that did not happen). If déjà vu was akin to a memory error, we might expect there to be a behavioural consequence of the experience but déjà vu experients do not act on the false familiarity they experience. The familiarity is recognised as false and the mnemonic experience is resolved in favour of novelty. In addition to considering demographic associations and the qualities of the déjà vu experience, neurological accounts of déjà vu in people with temporal lobe epilepsy indicate that erroneous memory activity in the temporal lobe regions (specifically the parahippocampal regions) may play a role in the experience of false familiarity. However, neuroimaging of déjà vu lab analogues with participants from the general population indicate that neural activity in the frontal cortex associated with inhibitory control and conflict monitoring underpins the experience of déjà vu. These findings mirror what is known about memory retrieval control (including memory expectation conflict) across the lifespan whereby memory retrieval relies on a wide but interconnected set of brain areas rather than activations in select regions with younger adults demonstrating greater functioning than older adults.

The final speculative point that we consider in relation to the conflict account of déjà vu is whether there is a difference in the functional purpose of mismatch signals in the hippocampus and conflict signals in the anterior cingulate. We suggest that mismatch signals are more likely to be influential in the generation of déjà vu experiences and prompting the feeling of having experienced the situation before. In contrast, the hippocampus, generates mismatch signals when the current sensory input mismatches with pre-existing memory traces, enabling the recognition of novelty or familiarity. Conflict signals on the other hand are more likely to be influential in triggering the resolution or conclusion of the experience. We suggest this because conflict signals in the anterior cingulate are associated with detecting and resolving conflicts arising from incongruent information, often observed in real-time decision-making processes.

Overall, these links suggest that déjà vu may be underpinned by basic neurocognitive characteristics integral to healthy cognition. The importance of such a finding would be that déjà vu is not indicative of the memory decision-making system breaking down, but of the memory decision-making system interacting with response monitoring systems to detect fragmentation of memory decision-making and adapt cognition to stop us making decisions based on inaccurate memory information or signalling.

Conflict of interest

We have no known conflicts of interest to disclose.

References

Adachi, N., Adachi, T., Kimura, M., Akanuma, N., Takekawa, Y., Kato, M., 2003. Demographic and psychological features of Déjà vu experiences in a nonclinical Japanese population. J. Nerv. Ment. Dis. 191 (4), 242–247. ⟨http://journals.lww⟩.

Adachi, N., Adachi, T., Akanuma, N., Matsubara, R., Ito, M., Takekawa, Y., Ikeda, H., Arai, H., 2007. Déjà vu experiences in schizophrenia: relations with psychopathology and antipsychotic medication. Compr. Psychiatry 48 (6), 592–596. https://doi.org/10.1016/j.comppsych.2007.05.014.

Adachi, N., Akanu, N., Adachi, T., Takekawa, Y., Adachi, Y., Ito, M., Ikeda, H., 2008. Déjà vu experiences are rarely associated with pathological dissociation. J. Nerv. Ment. Dis. 196 (5), 417–419. ⟨http://journals.lww.com/jonmd/Fulltext/2008/05000/D_j__Vu_Experiences_Are_Rarely_Associated_With.9.aspx⟩.

Adachi, N., Akanuma, N., Ito, M., Adachi, T., Takekawa, Y., Adachi, Y., Matsuura, M., Kanemoto, K., Kato, M., 2010. Two forms of déjà vu experiences in patients with epilepsy. Epilepsy Behav. 18 (3), 218–222. https://doi.org/10.1016/j.yebeh.2010.02.016.

Aitken, C., O'Connor, A., 2020. Converging on an understanding of the Déjà vu experience. In: Cleary, A.M., Schwartz, B.L. (Eds.), Memory Quirks: The Study of Odd Phenomena in Memory. Routledge, pp. 288–305. https://doi.org/10.4324/9780429264498-20.

Augustine, 2012. On the Trinity. Veritatis Splendor Publications,.

Bartolomei, F., Barbeau, E., Gavaret, M., Guye, M., McGonigal, A., Régis, J., Chauvel, P., 2004. Cortical stimulation study of the role of rhinal cortex in déjà vu and reminiscence of memories. Neurology 63 (5), 858–864. https://doi.org/10.1212/01.wnl.0000137037.56916.3f.

Bartolomei, Fabrice, Barbeau, E.J., Nguyen, T., McGonigal, A., Régis, J., Chauvel, P., Wendling, F., 2012. Rhinal-hippocampal interactions during déjà vu. Clin. Neurophysiol. 123 (3), 489–495. https://doi.org/10.1016/j.clinph.2011.08.012.

Barzykowski, K., Moulin, C., 2022. Are involuntary autobiographical memory and déjà vu natural products of memory retrieval? Behav. Brain Sci. 1–66. https://doi.org/10.1017/S0140525X22002035.

Bennett, C.M., Miller, M.B., 2013. fMRI reliability: influences of task and experimental design. Cogn. Affect. Behav. Neurosci. 13 (4), 690–702. https://doi.org/10.3758/s13415-013-0195-1.

Blank, H., 2017. Recollection, belief and metacognition: a reality check. Memory 25 (7), 869–875. https://doi.org/10.1080/09658211.2016.1238486.

Boirac, E., 1876. Correspondence [Letter to the editor]. Rev. Philos. 430–431.

Boldt, A., Yeung, N., 2015. Shared neural markers of decision confidence and error detection. J. Neurosci. 35 (8), 3478–3484. https://doi.org/10.1523/JNEUROSCI.0797-14.2015.

Botvinick, M.M., 2007. Conflict monitoring and decision making: reconciling two perspectives on anterior cingulate function. Cogn. Affect. Behav. Neurosci. 7 (4), 356–366. https://doi.org/10.3758/CABN.7.4.356.

Botvinick, Matthew M., Cohen, J.D., 2014. The computational and neural basis of cognitive control: charted territory and new frontiers. Cogn. Sci. 38 (6), 1249–1285. https://doi.org/10.1111/cogs.12126.

Botvinick, Matthew M., Braver, T.S., Barch, D.M., Carter, C.S., Cohen, J.D., 2001. Conflict monitoring and cognitive control. Psychol. Rev. 108 (3), 624–652. https://doi.org/10.1037//0033-295X.I08.3.624.

Botvinick, Matthew M., Cohen, J.D., Carter, C.S., 2004. Conflict monitoring and anterior cingulate cortex: an update. Trends Cogn. Sci. 8 (12), 539–546. https://doi.org/10.1016/j.tics.2004.10.003.

Brandt, K.R., Conway, M.A., James, A., von Oertzen, T.J., 2021. Déjà vu and the entorhinal cortex: dissociating recollective from familiarity disruptions in a single case patient. Memory 29 (7), 859–868. https://doi.org/10.1080/09658211.2018.1543436.

Brázdil, M., Mareček, R., Urbánek, T., Kašpárek, T., Mikl, M., Rektor, I., Zeman, A., 2012. Unveiling the mystery of déjà vu: the structural anatomy of déjà vu. Cortex 48 (9), 1240–1243. https://doi.org/10.1016/j.cortex.2012.03.004.

Brown, A.S., 2003. A review of the Déjà vu experience. Psychol. Bull. 129 (3), 394–413. https://doi.org/10.1037/0033-2909.129.3.394.

Brown, A.S. (2004). *The Deja Vu Experience*. https://doi.org/10.4324/9780203485446.

Brown, A.S., 2020. The butcher on the bus experience. In: Cleary, Anne M., Schwartz, B. L. (Eds.), Memory Quirks. Routledge, pp. 224–247.

Brown, A.S., Marsh, E.J., 2008. Evoking false beliefs about autobiographical experience. Psychon. Bull. Rev. 15 (1), 186–190. https://doi.org/10.3758/PBR.15.1.186.

Brown, A.S., Marsh, E.J., 2009. Creating illusions of past encounter through brief exposure. Psychol. Sci. 20 (5), 534–538. https://doi.org/10.1111/j.1467-9280.2009.02337.x.

Brown, A.S., Marsh, E.J., 2010. Digging into Déjà Vu: recent research on possible mechanisms. In: Psychology of Learning and Motivation - Advances in Research and Theory, 1st ed..,, vol. 53. Elsevier Inc,. https://doi.org/10.1016/S0079-7421(10)53002-0.

Burgess, P.W., Shallice, T., 1996. Confabulation and the control of recollection. Memory 4 (4), 359–411.

Cabeza, R., Ciaramelli, E., Olson, I.R., Moscovitch, M., 2008. The parietal cortex and episodic memory: an attentional account. Nat. Rev. Neurosci. 9 (8), 613–625. https://doi.org/10.1038/nrn2459.

Carter, C.S., Braver, T.S., Barch, D.M., Botvinick, M.M., Noll, D.C., Cohen, J.D., 1998. Anterior cingulate cortex, error detection, and the online monitoring of performance. Science 280 (May), 747–749.

Castro, M., Burrows, R., Wooffitt, R., 2014. The paranormal is (still) normal: the sociological implications of a survey of paranormal experiences in Great Britain. Sociol. Res. Online 19 (3), 30–44. https://doi.org/10.5153/sro.3355.

Chapman, A.H., Mensh, I.N., 1951. Deja vu experience and conscious fantasy in adults. Psychiatr. Q. Suppl. 25, 163–175.

Cleary, A., Huebert, A., & McNeely-White, K. (2020). The Déjà vu Phenomenon's Entry into the Realm of Science (pp. 271–287). https://doi.org/10.4324/9780429264498–19.

Cleary, A.M., Brown, A.S., 2022. The déjà vu experience, 2nd ed. (pp. x, 279–x, 279 The déjà vu Experience, 2nd ed..,. Routledge/Taylor & Francis Group,.

Cleary, Anne M., Claxton, A.B., 2018. Déjà vu: an illusion of prediction. Psychol. Sci. 29 (4), 635–644. https://doi.org/10.1177/0956797617743018.

Cleary, Anne M., Reyes, N.L., 2009. Scene recognition without identification. Acta Psychol. 131 (1), 53–62. https://doi.org/10.1016/j.actpsy.2009.02.006.

Cleary, Anne 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. Psychon. Bull. Rev. 16 (6), 1082–1088. https://doi.org/10.3758/PBR.16.6.1082.

Cleary, Anne 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. Conscious. Cogn. 21 (2), 969–975. https://doi.org/10.1016/j.concog.2011.12.010.

Cleary, Anne M., Huebert, A.M., McNeely-White, K.L., Spahr, K.S., 2019. A postdictive bias associated with déjà vu. Psychon. Bull. Rev. 26 (4), 1433–1439. https://doi.org/10.3758/s13423-019-01578-w.

Cleary, Anne M., McNeely-White, K.L., Huebert, A.M., Claxton, A.B., 2021a. Déjà vu and the feeling of prediction: an association with familiarity strength. Mem. (Hove, Engl.) 29 (7), 904–920. https://doi.org/10.1080/09658211.2018.1503686.

Cleary, Anne M., Neisser, J., McMahan, T., Parsons, T.D., Alwaki, A., Okada, N., Vosoughi, A., Kheder, A., Drane, D.L., Pedersen, N.P., 2021b. Subjective distinguishability of seizure and non-seizure Déjà Vu: A case report, brief literature review, and research prospects. Epilepsy Behav. 125, 108373 https://doi.org/10.1016/j.yebeh.2021.108373.

Craig, A.D., 2009. How do you feel — now? The anterior insula and human awareness (Bud). Nat. Rev. Neurosci. 10 (1), 59–70. https://doi.org/10.1038/nrn2555.

Curot, J., Busigny, T., Valton, L., Denuelle, M., Vignal, J.-P., Maillard, L., Chauvel, P., Pariente, J., Trebuchon, A., Bartolomei, F., Barbeau, E.J., 2017. Memory scrutinized through electrical brain stimulation: a review of 80 years of experiential phenomena. Neurosci. Biobehav. Rev. 78, 161–177. https://doi.org/10.1016/j.neubiorev.2017.04.018.

Curot, J., Roux, F.-E., Sol, J.-C., Valton, L., Pariente, J., Barbeau, E.J., 2020. Awake craniotomy and memory induction through electrical stimulation: why are Penfield's findings not replicated in the modern era? Neurosurgery 87 (2), E130–E137. https://doi.org/10.1093/neuros/nyz553.

Curot, J., Pariente, J., Hupé, J.M., Lotterie, J.-A., Mirabel, H., Barbeau, E.J., 2021. Déjà vu and prescience in a case of severe episodic amnesia following bilateral hippocampal lesions. Memory 29 (7), 843–858. https://doi.org/10.1080/09658211.2019.1673426.

Davachi, L., DuBrow, S., 2015. How the hippocampus preserves order: the role of prediction and context. Trends Cogn. Sci. 19 (2), 92–99. https://doi.org/10.1016/j.tics.2014.12.004.

Diana, R.A., Yonelinas, A.P., Ranganath, C., 2007. Imaging recollection and familiarity in the medial temporal lobe: a three-component model. Trends Cogn. Sci. 11 (9), 379–386. https://doi.org/10.1016/j.tics.2007.08.001.

Dias, R., Honey, R.C., 2002. Involvement of the rat medial prefrontal cortex in novelty detection. Behav. Neurosci. 116 (3), 498.

Duszkiewicz, A.J., McNamara, C.G., Takeuchi, T., Genzel, L., 2019. Novelty and dopaminergic modulation of memory persistence: a tale of two systems. Trends Neurosci. 42 (2), 102–114. https://doi.org/10.1016/j.tins.2018.10.002.

Eichenbaum, H., 2017a. Memory: organization and control. Annu. Rev. Psychol. 68 (1), 19–45. https://doi.org/10.1146/annurev-psych-010416-044131.

Eichenbaum, H., 2017b. Prefrontal-hippocampal interactions in episodic memory. Nat. Rev. Neurosci. 18, 547–558.

Eriksen, B.A., Eriksen, C.W., 1974. Effects of noise letters upon the identification of a target letter in a nonsearch task. Percept. Psychophys. 16 (1), 143–149.

Ernst, A., Delrue, G., Willems, S., 2021. Overcoming familiarity illusions in a single case with persistent déjà vu. Memory 29 (7), 869–883. https://doi.org/10.1080/09658211.2018.1510965.

Falkenstein, M., Hohnsbein, J., Hoorman, J., Blanke, L., 1990. Effects of errors in choice reaction tasks on the ERP under focused and divided attention. In: Brunia, C.H.M., Gaillard, A.W., Kok, A. (Eds.), Psychophysiological Brain Research. Tilburg University Press, pp. 192–195.

Fandakova, Y., Lindenberger, U., Shing, Y.L., 2015. Episodic memory across the lifespan: general trajectories and modifiers. Wiley Handb. Cogn. Neurosci. Mem. (May), 309–325.

Fandakova, Y., Bunge, S.A., Wendelken, C., Desautels, P., Hunter, L., Lee, J.K., Ghetti, S., 2016. The importance of knowing when you don't remember: neural signaling of retrieval failure predicts memory improvement over time. Cereb. Cortex (May), 1–13. https://doi.org/10.1093/gbe/evw245.

Fletcher, P.C., Henson, R.N.A., 2001. Frontal lobes and human memory: insights from functional neuroimaging. Brain 124 (5), 849–881.

Fortier, J., Moulin, C.J.A., 2015. What is French for déjà vu? Descriptions of déjà vu in native French and English speakers. Conscious. Cogn. 36, 12–18. https://doi.org/10.1016/j.concog.2015.05.013.

Frank, D., Kafkas, A., 2021. Expectation-driven novelty effects in episodic memory. Neurobiol. Learn. Mem. 183, 107466 https://doi.org/10.1016/j.nlm.2021.107466.

Fukuda, K., 2002. Most experiences of precognitive dream could be regarded as a subtype of déjà-vu experiences. In: Sleep and Hypnosis, vol. 4. Kure Iletisim Grubu, pp. 111–114.

Gallo, D. a, Kensinger, E. a, Schacter, D.L., 2006. Prefrontal activity and diagnostic monitoring of memory retrieval: FMRI of the criterial recollection task. J. Cogn. Neurosci. 18, 135–148. https://doi.org/10.1162/089892906775250049.

Gehring, W.J., Goss, B., Coles, M.G.H., Meyer, D.E., Donchin, E., 1993. A neural system for error detection and compensation. Psychol. Sci. 4 (6), 385–390.

Geib, B.R., Stanley, M.L., Dennis, N.A., Woldorff, M.G., Cabeza, R., 2017. From hippocampus to whole-brain: the role of integrative processing in episodic memory retrieval. Hum. Brain Mapp. 38 (4), 2242–2259. https://doi.org/10.1002/hbm.23518.

Grabenhorst, F., Rolls, E.T., Parris, B.A., 2008. From affective value to decision-making in the prefrontal cortex. Eur. J. Neurosci. 28 (9), 1930–1939. https://doi.org/10.1111/j.1460-9568.2008.06489.x.

Gradin, V.B., Waiter, G., O'Connor, A., Romaniuk, L., Stickle, C., Matthews, K., Hall, J., Douglas Steele, J., 2013. Salience network-midbrain dysconnectivity and blunted reward signals in schizophrenia. Psychiatry Res.: Neuroimaging 211 (2), 104–111. https://doi.org/10.1016/j.pscychresns.2012.06.003.

Gratton, G., Coles, M.G., Donchin, E., 1992. Optimizing the use of information: strategic control of activation of responses. J. Exp. Psychol. Gen. 121 (4), 480–506. https://doi.org/10.1037/0096-3445.121.4.480.

Gratton, G., Cooper, P., Fabiani, M., Carter, C.S., Karayanidis, F., 2018. Dynamics of cognitive control: theoretical bases, paradigms, and a view for the future. Psychophysiology 55 (3), 1–29. https://doi.org/10.1111/psyp.13016.

Guedj, E., Aubert, S., McGonigal, A., Mundler, O., Bartolomei, F., 2010. Déjà-vu in temporal lobe epilepsy: metabolic pattern of cortical involvement in patients with normal brain MRI. Neuropsychologia 48 (7), 2174–2181. https://doi.org/10.1016/j.neuropsychologia.2010.04.009.

Hughlings-Jackson, J., 1888. On a particular variety of epilepsy ("Intellectual Aura"), one case with symptoms of organic brain disease. Brain 11 (2), 179–207.

Illman, N.A., Butler, C.R., Souchay, C., Moulin, C.J.A., 2012. Déjà experiences in temporal lobe epilepsy. Epilepsy Res. Treat. 2012, 1–15. https://doi.org/10.1155/2012/539567.

Jacoby, L.L., Whitehouse, K., 1989. An illusion of memory: false recognition influenced by unconscious perception. J. Exp. Psychol.: Gen. 118 (2), 126–135. https://doi.org/10.1037/0096-3445.118.2.126.

Jaeger, A., Selmeczy, D., O'Connor, A., Diaz, M., Dobbins, I.G., 2012. Prefrontal cortex contributions to controlled memory judgment: fMRI evidence from adolescents and young adults. Neuropsychologia 50, 3745–3756. https://doi.org/10.1016/j.neuropsychologia.2012.10.022.Prefrontal.

Jersakova, R., Moulin, C.J.A., O'Connor, A.R., 2016. Investigating the role of assessment method on reports of Déjà Vu and tip-of-the-tongue states during standard recognition tests. PLoS ONE 11 (4), 1–18. https://doi.org/10.1371/journal.pone.0154334.

Jiang, J., Correa, C.M., Geerts, J., Gaal, S.Van, 2018. The relationship between conflict awareness and behavioral and oscillatory signatures of immediate and delayed cognitive control. NeuroImage 177 (May), 11–19. https://doi.org/10.1016/j.neuroimage.2018.05.007.

Kafkas, Alex, Montaldi, D., 2018a. Expectation affects learning and modulates memory experience at retrieval. Cognition 180, 123–134. https://doi.org/10.1016/j.cognition.2018.07.010.

Kafkas, Alex, Montaldi, D., 2018b. How do memory systems detect and respond to novelty? Neurosci. Lett. 680, 60–68. https://doi.org/10.1016/j.neulet.2018.01.053.

Kafkas, Alexandros, Montaldi, D., 2014. Two separate, but interacting, neural systems for familiarity and novelty detection: a dual-route mechanism. Hippocampus 24 (5), 516–527. https://doi.org/10.1002/hipo.22241.

Kerns, J.G., Cohen, J.D., MacDonald III, A.W., Cho, R.Y., Stenger, V.A., Carter, C.S., 2004. Anterior cingulate conflict monitoring and adjustments in control. Science 303 (5660), 1023–1026. https://doi.org/10.1126/science.1089910.

Kiehl, K. a, Liddle, P.F., Hopfinger, J.B., 2000. Error processing and the rostral anterior cingulate: an event-related fMRI study. Psychophysiology 37 (2), 216–223. https://doi.org/10.1017/S0048577200990231.

Koechlin, E., Ody, C., Kouneiher, F., 2003. The architecture of cognitive control in the human prefrontal cortex. Science 302 (5648), 1181–1185.

Kostic, B., Cleary, A.M., 2009. Song recognition without identification: when people cannot" name that tune" but can recognize it as familiar. J. Exp. Psychol.: Gen. 138 (1), 146.

Kovacs, N., Auer, T., Balas, I., Karadi, K., Zambo, K., Schwarcz, A., Klivenyi, P., Jokeit, H., Horvath, K., Nagy, F., Janszky, J., 2009. Neuroimaging and cognitive changes during deja vu. Epilepsy Behav. 14 (1), 190–196. https://doi.org/10.1016/j.yebeh.2008.08.017.

Kumaran, D., Maguire, E.A., 2007. Match–mismatch processes underlie human hippocampal responses to associative novelty. J. Neurosci. 27 (32), 8517–8524. https://doi.org/10.1523/JNEUROSCI.1677-07.2007.

Kusumi, T. (1994). Deja vu phenomena by analogical reminding. Paper Presented at the 11th Annual Meeting of the Japanese Cognitive Science Society.

Kusumi, T. (1996). Situational factors of deja vu experiences: Representational similarities in autobiographical memory and dream. *Paper Presented at the 7th Annual Meeting of the Japan Society of Developmental Psychology*.

Kusumi, T. (1998). Deja vu experiences: An explanation based on similarities of experiences in analogical reminding. *Paper Presented at the 1st Tsukuba International Conference on Memory*.

Kusumi, Takashi, 2006. Chapter 14: Human metacognition and the déjà vu phenomenon (Kyoto University Press). In: Fujita, K., Itakura, S. (Eds.), Diversity of Cognition: Evolution, Development, Domestication, and Pathology. Kyoto University Press, pp. 302–314.

Labate, A., Baggetta, R., Trimboli, M., Tripepi, G., Bisulli, F., D'Aniello, A., Daniele, O., Di Bonaventura, C., Di Gennaro, G., Fattouch, J., Ferlazzo, E., Ferrari, A., Gasparini, S., Giallonardo, A., La Neve, A., Romigi, A., Sofia, V., Tinuper, P., Zummo, L., Gambardella, A., 2019. Insight into epileptic and physiological déjà vu: from a multicentric cohort study. Eur. J. Neurol. 26 (3), 407–414. https://doi.org/10.1111/ene.13806.

Labate, Angelo, Gambardella, A., Andermann, E., Aguglia, U., Cendes, F., Berkovic, S.F., Andermann, F., 2011. Benign mesial temporal lobe epilepsy. Nat. Rev. Neurol. 7 (4), 237–240. https://doi.org/10.1038/nrneurol.2010.212.

Lacinová, L., Neužilová Michalcáková, R., Širucek, J., Ježek, S., Chromec, J., Masopustová, Z., Urbánek, T., Brázdil, M., 2016. Déjà vu experiences in healthy Czech Adults. J. Nerv. Ment. Dis. 204 (12). ⟨https://journals.lww.com/jonmd/Fulltext/2016/12000/D_j__Vu_Experiences_in_Healthy_Czech_Adults.8.aspx⟩.

Larson, M.J., Clayson, P.E., Clawson, A., 2014. Making sense of all the conflict: a theoretical review and critique of conflict-related ERPs. Int. J. Psychophysiol. 93 (3), 283–297. https://doi.org/10.1016/j.ijpsycho.2014.06.007.

Lorre, C., Prady, B., & Kaplan, E. (2019). The Decision Reverberation. In M. Cendrowski (Ed.), *The Big Bang Theory*.

Lucci, G., Berchicci, M., Spinelli, D., Taddei, F., Di Russo, F., 2013. The effects of aging on conflict detection. PLOS ONE 8 (2), e56566. https://doi.org/10.1371/journal.pone.0056566.

Macdonald III, A.W., Cohen, J.D., Stenger, A., Carter, C.S., 2000. Dissociating the role of the dorsolateral prefrontal and anterior cingulate cortex in cognitive control. Science 288, 1835–1838. https://doi.org/10.1126/science.288.5472.1835.
Mandler, G., 1980. Recognizing: the judgment of previous occurrence. Psychol. Rev. 87 (3), 252–271. https://doi.org/10.1037/0033-295X.87.3.252.
Martin, C.B., Mirsattari, S.M., Pruessner, J.C., Pietrantonio, S., Burneo, J.G., Hayman-Abello, B., Köhler, S., 2012. Déjà vu in unilateral temporal-lobe epilepsy is associated with selective familiarity impairments on experimental tasks of recognition memory. Neuropsychologia 50 (13), 2981–2991. https://doi.org/10.1016/j.neuropsychologia.2012.07.030.
Martin, C.B., Fiacconi, C.M., Köhler, S., 2015. Déjà vu: a window into understanding the cognitive neuroscience of familiarity. The Wiley handbook on the cognitive neuroscience of memory. Wiley Blackwell,, pp. 172–189. https://doi.org/10.1002/9781118332634.ch9.
Martin, C.B., Mirsattari, S.M., Pruessner, J.C., Burneo, J.G., Hayman-Abello, B., Köhler, S., 2019. Relationship between déjà vu experiences and recognition-memory impairments in temporal-lobe epilepsy. Memory 0 (0), 1–11. https://doi.org/10.1080/09658211.2019.1643891.
Mathalon, D.H., Bennett, A., Askari, N., Gray, E.M., Rosenbloom, M.J., Ford, J.M., 2003. Response-monitoring dysfunction in aging and Alzheimer's disease: an event-related potential study. In: Neurobiology of Aging, vol. 24. Elsevier Science,, pp. 675–685. https://doi.org/10.1016/S0197-4580(02)00154-9.
McNeely-White, K.L., Cleary, A.M., 2019. Music recognition without identification and its relation to déjà entendu: a study using "Piano Puzzlers. N. Ideas Psychol. 55, 50–57. https://doi.org/10.1016/j.newideapsych.2019.04.002.
Menon, V., Uddin, L.Q., 2010. Saliency, switching, attention and control: a network model of insula function. Brain Struct. Funct. 214 (5), 655–667. https://doi.org/10.1007/s00429-010-0262-0.
Metcalfe, J., Schwartz, B.L., 2016. The ghost in the machine: self-reflective consciousness and the neuroscience of metacognition. The Oxford handbook of metamemory. Oxford University Press,, pp. 407–424.
Mill, R.D., Cavin, I., O'Connor, A.R., 2015. Differentiating the functional contributions of resting connectivity networks to memory decision-making: fMRI support for multistage control processes. J. Cogn. Neurosci. 27 (8), 1617–1632. https://doi.org/10.1162/jocn_a_00808.
Moulin, C., 2018. The Cognitive Neuropsychology of Déjà Vu. Routledge,. ⟨https://books.google.co.uk/books?id=7WMmvgAACAAJ⟩.
Moulin, C.J.A., Carreras, F., Barzykowski, K., 2023. The phenomenology of autobiographical retrieval. WIREs Cogn. Sci. 14 (3), e1638 https://doi.org/10.1002/wcs.1638.
Moulin, Chris J.A., 2013. Disordered recognition memory: Recollective confabulation. Cortex 49 (6), 1541–1552. https://doi.org/10.1016/j.cortex.2013.01.010.
Moulin, Christopher J.A., Conway, M.A., Thompson, R.G., James, N., Jones, R.W., 2005. Disordered memory awareness: recollective confabulation in two cases of persistent déjà vecu. Neuropsychologia 43 (9), 1362–1378. https://doi.org/10.1016/j.neuropsychologia.2004.12.008.
Moulin, C.J.A., Souchay, C., Bradley, R., Buchanan, S., Karadöller, D.Z., Akan, M., 2014. Deja vu in older adults. In: Brown, A.S., Schwartz, B.L. (Eds.), *Tip of the Tongue States and related phenomena*. essay, Cambridge University Press, pp. 281–304.
Mullan, S., Penfield, W., 1959. Illusions of comparative interpretation and emotion; production by epileptic discharge and by electrical stimulation in the temporal cortex. A. M. A. Arch. Neurol. Psychiatry 81 (3), 269–284.
Neppe, V.M., 1983. The psychology of deja vu: have I been here before? Witwatersrand University Press,.
Nigro, S., Cavalli, S.M., Cerasa, A., Riccelli, R., Fortunato, F., Bianco, M.G., Martino, I., Chiriaco, C., Vaccaro, M.G., Quattrone, A., Gambardella, A., Labate, A., 2019. Functional activity changes in memory and emotional systems of healthy subjects with déjà vu. Epilepsy Behav.: EB 97, 8–14. https://doi.org/10.1016/j.yebeh.2019.05.018.
O'Connor, A.R., Moulin, C.J.A., 2010. Recognition without identification, erroneous familiarity, and déjà vu. Curr. Psychiatry Rep. 12 (3), 165–173. https://doi.org/10.1007/s11920-010-0119-5.
O'Connor, A.R., Moulin, C.J.A., 2013. Déjà vu experiences in healthy subjects are unrelated to laboratory tests of recollection and familiarity for word stimuli. Front. Psychol. 4 (Nov), 1–9. https://doi.org/10.3389/fpsyg.2013.00881.
O'Connor, A.R., Lever, C., Moulin, C.J.A., 2010. Novel insights into false recollection: a model of déjà vécu. Cogn. Neuropsychiatry 15 (1–3), 118–144. https://doi.org/10.1080/13546800903113071.
O'Connor, A.R., Han, S., Dobbins, I.G., 2010. The inferior parietal lobule and recognition memory: expectancy violation or successful retrieval? J. Neurosci. 30 (8), 2924–2934. https://doi.org/10.1523/JNEUROSCI.4225-09.2010.The.
O'Connor, A.R., Guhl, E.N., Cox, J.C., Dobbins, I.G., 2011. Some memories are odder than others: judgments of episodic oddity violate known decision rules. J. Mem. Lang. 64 (4), 299–315. https://doi.org/10.1016/j.jml.2011.02.001.
Orr, J.M., Carrasco, M., 2011. The role of the error positivity in the conscious perception of errors. J. Neurosci. 31 (16), 5891–5892. https://doi.org/10.1523/JNEUROSCI.0279-11.2011.
Penfield, W., 1955. The twenty-ninth Maudsley lecture: the role of the temporal cortex in certain psychical phenomena. J. Ment. Sci. 101, 451–465.
Penfield, Wilder, Perot, P., 1963. The brain's record of auditory and visual experience: a final summary and discussion. Brain 86 (4), 595–696. https://doi.org/10.1093/brain/86.4.595.
Pergola, G., Danet, L., Pitel, A.-L., Carlesimo, G.A., Segobin, S., Pariente, J., Suchan, B., Mitchell, A.S., Barbeau, E.J., 2018. The regulatory role of the human mediodorsal thalamus. Trends Cogn. Sci. 22 (11), 1011–1025. https://doi.org/10.1016/j.tics.2018.08.006.
Perucca, P., Crompton, D.E., Bellows, S.T., McIntosh, A.M., Kalincik, T., Newton, M.R., Vajda, F.J.E., Scheffer, I.E., Kwan, P., O'Brien, T.J., Tan, K.M., Berkovic, S.F., 2017. Familial mesial temporal lobe epilepsy and the borderland of déjà vu. Ann. Neurol. 82 (2), 166–176. https://doi.org/10.1002/ana.24984.
Pešlová, E., Mareček, R., Shaw, D.J., Kašpárek, T., Pail, M., Brázdil, M., 2019. Hippocampal involvement in nonpathological déjà vu: Subfield vulnerability rather than temporal lobe epilepsy equivalent. Brain Behav. 9 (5), e01299 https://doi.org/10.1002/brb3.1299.
Quent, J.A., Henson, R.N., Greve, A., 2021. A predictive account of how novelty influences declarative memory. Neurobiol. Learn. Mem. 179, 107382 https://doi.org/10.1016/j.nlm.2021.107382.
Rabbitt, P., 1979. How old and young subjects monitor and control responses for accuracy and speed. Br. J. Psychol. 70 (2), 305–311.
Ridderinkhof, K.R., Ullsperger, M., Crone, E.A., Nieuwenhuis, S., 2004. The role of the medial frontal cortex in cognitive control. Science 306 (5695), 443–447.
Roediger, H.L., 1996. Memory illusions. J. Mem. Lang. 35, 76–100.
Roediger, H.L., McDermott, K.B., 1995. Creating false memories: remembering words not presented in lists. J. Exp. Psychol.: Learn., Mem. Cogn. 21 (4), 803–814.
Schacter, D.L., Curran, T., Galluccio, L., Milberg, W.P., Bates, J.F., 1996. False recognition and the right frontal lobe: a case study. In: Neuropsychologia, vol. 34. Elsevier Science,, pp. 793–808. https://doi.org/10.1016/0028-3932(95)00165-4.
Seeley, W.W., Menon, V., Schatzberg, A.F., Keller, J., Glover, G.H., Kenna, H., Reiss, A.L., Greicius, M.D., 2007. Dissociable intrinsic connectivity networks for salience processing and executive control. J. Neurosci. 27 (9), 2349–2356. https://doi.org/10.1523/JNEUROSCI.5587-06.2007.
Shaw, D.J., Mareček, R., Brázdil, M., 2016. Structural covariance mapping delineates medial and medio-lateral temporal networks in déjà vu. Brain Imaging Behav. 10 (4), 1068–1079. https://doi.org/10.1007/s11682-015-9471-8.
Simon, J.R., Rudell, A.P., 1967. Auditory S-R compatibility: the effect of an irrelevant cue on information processing. J. Appl. Psychol. 51 (3), 300–304. https://doi.org/10.1037/h0020586.
Simons, J.S., Spiers, H.J., 2003. Prefrontal and medial temporal lobe interactions in long-term memory. Nat. Rev. Neurosci. 4 (8), 637–648. https://doi.org/10.1038/nrn1178.
Sno, H.N., Schalken, H.F.A., Onghe, F.D.E., Koeter, M.W.J., 1994. The inventory for Deja vu experiences assessment: development, utility, reliability, and validity. J. Nerv. Ment. Dis. 182 (1). ⟨http://journals.lww.com/jonmd/Fulltext/1994/01000/The_Inventory_for_Deja_Vu_Experiences_Assessment_.6.aspx⟩.
Souchay, C., Isingrini, M., 2004. Age related differences in metacognitive control: Role of executive functioning. Brain Cogn. 56 (1), 89–99. https://doi.org/10.1016/j.bandc.2004.06.002.
Spatt, J., 2002. Déjà vu: possible parahippocampal mechanisms. J. Neuropsychiatry Clin. Neurosci. 14 (1), 6–10. https://doi.org/10.1176/jnp.14.1.6.
Stroop, J.R., 1935. Studies of interference in serial verbal reactions. J. Exp. Psychol. 18, 643–662.
Strozyk, J.V., Jentzsch, I., 2012. Weaker error signals do not reduce the effectiveness of post-error adjustments: comparing error processing in young and middle-aged adults. Brain Res. 1460, 41–49. https://doi.org/10.1016/j.brainres.2012.04.028.
Sugimori, E., Kusumi, T., 2014. The similarity hypothesis of déjà vu: on the relationship between frequency of real-life déjà vu experiences and sensitivity to configural resemblance. J. Cogn. Psychol. 26 (1), 48–57. https://doi.org/10.1080/20445911.2013.854248.
Taylor, S.F., Stern, E.R., Gehring, W.J., 2007. Neural systems for error monitoring. Neuroscientist 13 (2), 160–172. https://doi.org/10.1177/1073858406298184.
Thakral, P.P., Yu, S.S., Rugg, M.D., 2015. The hippocampus is sensitive to the mismatch in novelty between items and their contexts. Brain Res. 1602, 144–152. https://doi.org/10.1016/j.brainres.2015.01.033.
Titchener, E.B., 1928. A Textbook of Psychology. Macmillan,.
Urquhart, J.A., O'Connor, A.R., 2014. The awareness of novelty for strangely familiar words: a laboratory analogue of the déjà vu experience. PeerJ 2, e666. https://doi.org/10.7717/peerj.666.
Urquhart, J.A., Sivakumaran, M.H., Macfarlane, J.A., O'Connor, A.R., 2018. fMRI evidence supporting the role of memory conflict in the déjà vu experience. Memory. https://doi.org/10.1080/09658211.2018.1524496.
van Veen, V., Carter, C.S., 2002. The anterior cingulate as a conflict monitor: fMRI and ERP studies. Physiol. Behav. 77 (January 2003), 477–482. https://doi.org/10.1016/S0031-9384(02)00930-7.
Vignal, J.P., Maillard, L., McGonigal, A., Chauvel, P., 2007. The dreamy state: hallucinations of autobiographic memory evoked by temporal lobe stimulations and seizures. Brain 130 (1), 88–99. https://doi.org/10.1093/brain/awl329.
Wells, C.E., O'Connor, A.R., Moulin, C.J.A., 2018. Déjà vu experiences in anxiety. Memory 1–9. https://doi.org/10.1080/09658211.2018.1538418.
Whittlesea, B.W.A., Williams, L.D., 1998. Why do strangers feel familiar, but friends don't? A discrepancy-attribution account of feelings of familiarity. In: Acta Psychologica, vol. 98. Elsevier Science,, pp. 141–165. https://doi.org/10.1016/S0001-6918(97)00040-1.
Yonelinas, Andrew P., 2002. The nature of recollection and familiarity: a review of 30 years of research. J. Mem. Lang. 46 (3), 441–517. https://doi.org/10.1006/jmla.2002.2864.
Yonelinas, Andrew, P., Aly, M., Wang, W., 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.Recollection.
Zatloukalova, E., Mikl, M., Shaw, D.J., Marecek, R., Sakalosova, L., Kuratkova, M., Mitterova, K., Sklenarova, B., Brazdil, M., 2022. Insights into déjà vu: associations between the frequency of experience and amplitudes of low-frequency oscillations in

resting-state functional magnetic resonance imaging. Eur. J. Neurosci. 55 (2), 426–437. https://doi.org/10.1111/ejn.15570.