Déjà vu in older adults

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"On the bus with my Uni friends and felt like I had been there before, had the same conversation and people had the same positions, although I don't remember seeing the faces before but when I was on the bus in that position the faces I saw fitted the vision perfectly."

Research participant

It does not come round in hundreds of thousands of years,
It comes round in the split of a wink, you will be sitting exactly
Where you are now and scratching your elbow, the train
Will be passing exactly as now and saying It does not come round,
It does not come round, It does not come round

Louis MacNeice, "Déjà vu" (1963)

Overview

Déjà vu is the 'phenomenological experience of recognising a current situation and the awareness that this feeling of recognition is false' captured in the two quotes above (O'Connor & Moulin, 2010). Brown (2004) reports an average lifetime prevalence of 67% across 41 studies; approximately two thirds of the population have had at least one déjà vu experience in their lifetime. The focus of the current chapter is whether or not the incidence of déjà vu increases or decreases with age, and what that might tell us about the nature of the experience and possibly, the aging process. We report two studies on déjà vu incidence in younger and older adults, assess its relationship with other relatively infrequent and notable experiences – intrusive memories and the tip of the tongue state – and finish with an overview of theories of déjà vu formation, and how the reduction in déjà vu experiences in older adults might be interpreted.

A review of the literature suggests that, older people report fewer instances of déjà vu (Brown, 2004). Chapman and Mensh (1951) found a negative correlation between déjà vu experience and age of -.23; Adachi and colleagues found negative correlations of -.38 (Adachi et al., 2003; 2007), -.34 (Adachi et al., 2008) and -.37 (Adachi et al., 2010); Sno et al. (1994) found a negative correlation of -.22, and Kohr (1980) of -.31. In a review of studies which report mean age, Brown (2004) found that those studies with

an older sample had a lower lifetime incidence of the phenomenon, r(13) = -.44. As such, correlational studies are clear: the older you are, the less frequently you have experienced déjà vu.

This is a critical issue since contemporary theories of déjà vu formation connect it with episodic memory function, and so we might expect it to increase with age, not decrease, since episodic memory declines as part of the healthy aging process. This has been the angle adopted by the Nobel laureate Tonegawa[1] and his colleagues when interpreting their data from a mouse model of Alzheimer's disease.

> "Déjà vu is a memory problem, Tonegawa explained, occurring when our brains struggle to tell the difference between two extremely similar situations. As people age, Tonegawa said, déjà-vu-like confusion happens more often—and it also happens in people suffering from brain diseases like Alzheimer's. "It's not surprising," he said, "when you consider the fact that there's a loss of or damage to cells in the dentate gyrus."
>
> (Halber, 2007).

This idea is a logical continuation of the temporal lobe pattern-matching theory of déjà vu formation (Spatt, 2002), and is theoretically feasible. According to this view, older adults have subtle memory deficits that manifest as an increased likelihood to have déjà vu experiences; they *mismatch* current perception with stored representations. Thus, whilst there is some empirical evidence that aging leads to a *decrease* in déjà vu experiences, at least one theory of déjà vu formation (pattern mismatch) suggests it might *increase* with age.

Cohort effects and déjà vu

There seems then to be overwhelming evidence that the frequency of déjà vu experiences does indeed decrease with age. However, all the studies which examine this issue have been cross-sectional, i.e. comparing groups of people of different ages, rather than longitudinal, following the same individuals over time. In aging research, such designs can fall foul of cohort effects, whereby the differences that we intend to measure between different age groups actually reflect differences in the cultural and environmental differences between those groups rather than the internal psychological processes at

[1] Interestingly, Tonegawa's willingness to forward his own personal theory on déjà vu (based on his experience) is at odds with Brown's (2004) observation that there might be less research into déjà vu than other memory phenomena because as it occurs less with age, and as such more 'mature' researchers might just not find it personally relevant or interesting.

work in the aging individual, or age per sé (Back & Bourque, 1970). A classic example is the influence of the Second World War, an event that caused a massive shift in societal values, traumatic events, and even nutrition (at least in the UK, where there was rationing) amongst a whole cohort of people. Such a major event will undoubtedly shape the psychology and biology of people born in 1940, in a way that it would not for a group of people born in 1980. Of course, the best way to control for cohort effects is to use a longitudinal design, which also has its disadvantages, and the differences between cross-sectional and longitudinal designs mirrors that of between and within subject designs respectively. There are no known longitudinal studies of déjà vu incidence, and for reasons of cost, time and patience, we are not suggesting one here. The critical point is that there may well be cohort effects that influence both the rates of experiencing and reporting déjà vu in older adults (i.e. perhaps old people had fewer déjà vu experiences even when they were young).

The more likely explanation would be a change in the reporting over time (here we are assuming that brains and memory systems remain relatively stable through the ages, whereas cultural trends and linguistic usage is relatively changeable). That is, there could be differences in the déjà vu experience across the lifespan due to a shift in cultural or environmental factors influencing the individual, rather than due to cognitive changes. It is possible that fewer older adults report experiencing déjà vu simply because it is a concept with which they are less comfortable. Déjà vu is a nebulous and complex experience with a loose definition, which may therefore see some change over time. Indeed, one major problem for aging studies is that the belief, or acceptance of the existence of déjà vu has increased in recent years. Gallup and Newport (1991) reported that from 1978 to 1990, déjà vu experients increased from 30 percent of the population to 55 percent. Figure 1 presents an overview of Brown's (2004) review, plotting the lifetime incidence of déjà vu against population year for 41 studies. This shows a relationship between when the survey was conducted and how many people say that they have had the experience, $r(41) = .50$, $p<.01$.

Thus, changes in collective societal beliefs may account for age differences mentioned in previous studies; these findings might not reflect genuine age differences but rather cohort effects: 'older cohorts matured during an era in which belief in déjà vu was not as accepted as it is today' (Brown, 2003, p.400). That is, perhaps older adults do not understand the term or have not experienced the use of the phrase

in relation to cognitive difficulties, and this creates a false impression of reduced déjà vu in old age. In fact, there seems to be a slippage of the term towards a meaning, which is applied to any repeated action, e.g. 'déjà vu in every gulp' (Pepsi Advertising, 2005).

In summary, there seems to be empirical evidence that déjà vu experiences decrease with age, whilst a few researchers have suggested it should increase with age. Whether or not déjà vu does increase or decrease with age is an important issue, because it may shed some light on the mechanisms of déjà vu formation, and more generally the nature of beliefs about memory function in older adults. The present studies aim to shed light on the incidence of déjà vu in older adults. In particular, we will address possible cohort effects in the understanding of the term déjà vu, by presenting participants with a definition (Study 1) and by assessing whether the groups can correctly define the term (Study 2). In turn, to put the rates of experience in some sort of context, and to make links with other memory-related phenomena, we also measure in the same individuals the rates of involuntary memories (Study 1) and the tip-of-the-tongue experience (Study 2). We finish by presenting two current hypotheses of déjà vu formation, and how the aging process may relate to those.

Study 1

The motivation behind this study was to examine the incidence of déjà vu in a group of older adults who had been provided with a definition of the sensation. We examined participant's estimates of déjà vu occurrence in the last year and more generally in their life. If aging leads to experiencing déjà vu less frequently, we would expect that whereas recent experiences might be reduced, the lifetime incidence should be similar to younger people. We also asked about the frequency of intrusive memories.

Method

Participants

There were 131 participants, with 74 younger adults ($\underline{M}$ = 18.59 years, $\underline{SD}$ = .94, range = 18-24 years, 92% women) and 56 older adults ($\underline{M}$ = 71.00, $\underline{SD}$ = 6.50, range = 60-84 years, 72% women). The two groups had equivalent levels of education, having completed education until a mean age of 18.08 years (older group) and 18.23 years (younger group), $t<1$. Participants in the older adult group were recruited

from an open day at the Leeds Memory Group, and as such all had experience of taking part in memory experiments and the notion of psychological research. Participants in the younger adult group were all undergraduate students taking a degree in Psychology.

Materials and Procedure

Participants received a simple one-page questionnaire. They reported gender and age and the age at which they left school. They were asked about their memory efficacy: 'How would you say your memory is compared to other people your age?' They answered on a three-point scale: better, about the same, or worse. We then asked them about déjà vu and involuntary memory incidence:

> How often would you say you experienced 'involuntary memories', where scenes from your past life pop into your head? ("Involuntary memories are conscious and unintentional recollections of personal experiences and have been described as being peculiarly vivid and emotional and having a strong feeling of immediacy." daily / once a week / once a month / once every six months / never
>
> How often would you say you experience 'déjà vu', where you have the feeling that you've experienced something before, but know that you haven't? ("Déjà vu is a feeling of familiarity when you know that in fact you can't have experienced the present moment before.") How many times have you had déjà vu in the last year? How many times have you had déjà vu in your life?

Participants responded with integers for the déjà vu questions. Where they responded with a range, such as 10-15, the higher value was entered. The textual answers, such as 'several' were not analysed, except where they could be interpreted as numbers, i.e. 'never' = 0, 'couple' = 2.

Results and Discussion

Incidence of déjà vu experiences. Table 1 shows the incidence of déjà vu. First we present the frequency of experience for the whole sample who generated meaningful, numeric responses (the differences in the sample sizes reflect missing data due to non-numeric responses). Twenty-two older adult participants said that they had not had déjà vu in the last year (39% of the sample). Only 8 people in the younger group (11%) said that they had not had déjà vu in the last year. The difference between the mean number of déjà vu experiences between the groups was significant, $t(128) = 3.08$, $p=.003$, with the older adults having had fewer déjà vu experiences in the last year. There was a marginally significant difference in lifetime incidence, with the older adults reporting fewer instances of déjà vu in the lifespan – despite having lived considerably longer, $t(102)=1.85$, $p=.068$. By way of reference, Brown (2004) found

that on average, people between the ages of 15 and 24 experience déjà vu between 2 and 3 times a year, somewhat less than our undergraduate sample, who on average reported having had it 9 times in the last year.

The rates of déjà vu varied considerably across individuals, and responses such as ‘too many times to count’, ‘countless’ and ‘lots’ may reflect that this is a particularly difficult estimation task. One issue (see below), is that perhaps people just forget when they last had déjà vu. That might explain age differences in reporting the experience, as the older adults are likely to be more forgetful. We also note that there is a very large standard deviation in the responses for the whole sample, with the range of responses between 0-100 in the incidence in the last year, and 0-1000 in the lifetime experience. Moreover, the frequency in the last year statistic may reflect differences according to those people who report never having had déjà vu in their lifetime (6 in the old sample, and 5 in the young sample).

To address this, a clean sample removed individuals who did not report déjà vu at all in their lifetime, and removed any responses that were 3 standard deviations above the aggregate mean for the two groups on either the incidence in the last year or the lifetime. On this basis, three people were removed from the young sample with incidences of over 40 in the last year, and 800-1000 lifetime experiences. With this clean sample (see Table 1) there was still a highly significant difference in levels of the experience in the last year, $t(87)=3.96$, $p<.001$, although the difference in lifetime experiences was still only marginally significant, $t(89)=1.92$, $p=.058$. Bear in mind that we asked participants about the lifetime incidence in total, however, and if we adjust the scores according to the ages of the participants, these marginally significant raw scores come out as very significantly different, with older adults having less than one déjà vu experience per year, and the younger adults having about three a year – which is in concert with Brown’s (2004) estimate.

We did not find an age difference in the rates at which our young and old groups experienced involuntary memories (an ANOVA on the ratings scores and a chi-squared both revealed no group differences, nor did the rating of frequency of involuntary memory correlate with age). Both young and old participants indicated that on average they experienced an involuntary memory between once a week and once a month, although 11% of each sample reported having an involuntary memory once a day.

Correlational Analyses. We ran non-parametric correlations separately within each group. Within the older group, there was a negative correlation between age and the incidence of déjà vu in the last year r(44)=-.356, p=.018, but not lifetime incidence of déjà vu r(38) = .-072, p=.668. Education level did not correlate with any other variable, nor did self-rated memory performance. The number of involuntary memories correlated with déjà vu – such that more involuntary memories were reported with higher levels of déjà vu, r(44)=.723, p<.001. The lifetime and last year incidences of déjà vu correlated with each other, r(35)=.521, p<.001. The young people's correlations with age were null, as you might expect with age being such a restricted range. But the relationship between involuntary memories and déjà vu was not borne out in the young group, although the two ratings of déjà vu correlated with each other very highly, r(66)=.90, p<.001.

In summary, this study replicates the previously demonstrated reductions in incidence and frequency of déjà vu in older adults. Critically, the novelty of this finding is that this lower level of déjà vu in older adults is found even when we provide older adults with a description of the experience. However, we do find some evidence of a cohort effect: the older group report lower incidence of déjà vu in total across their lifespan compared to young people. That is, although we have controlled for whether or not each group is using a different definition of the experience, the older adult group report both fewer instances of déjà vu for the last year, but also for their life in general. Naturally, one does not keep a tally of one's infrequent mental experiences, and of course, it is possible that to gauge lifetime incidence one looks back over the last year – this of course would explain why the two measures of déjà vu incidence were correlated. Critically, there was not a difference in how the two groups rated their involuntary memories, although both groups had involuntary memories more frequently than they had déjà vu. The incidence of déjà vu and involuntary memory was related in our older sample though, and we return to this issue below.

Study 2

The second study focussed on three issues. First, we were interested how older adults assess déjà vu in comparison to another similar experience, the ToT experience (e.g. Brown, 2012). Secondly, we were interested in how well older adults can define déjà vu (and whether younger and older groups differ in

how they define it). Finally we investigated if participants can report a previous example of a déjà vu experience. One interpretation of the difference in déjà vu experiences between the young and old is that they experience it equally frequently, but that the older adults forget that they have had it.

Method

Participants

The sample consisted of 347 participants. The sample had a mean (and standard deviation) age of 31.9 years (17.76), range (18-90) and was 59% female. To offer a comparison with Study 1, 64% of the sample was aged in the range of our young sample above, and 14% were aged 60 and over, although we did not recruit separate groups in this study, nor did we analyse the data split by age.

Procedure and Materials

The study was conducted by means of an online questionnaire, made available to the general public. Participants were not explicitly informed that the study was related to age and memory, only that it was exploring certain 'phenomena of memory'. Ethical approval was obtained from the Ethics committee of the Institute of Psychological Sciences at the University of Leeds.

The questionnaire consisted of a number of items concerning déjà vu. The first item involved participants selecting which they believed to be the correct definition from a set of three. The correct answer (a) includes the dissociation necessary for a déjà vu experience, whereas (c) gives the incorrect but popular conception of a repeated experience:

> Which of the following definitions most closely resembles your idea of what a déjà vu is?
>
> a) The unsettling feeling of having been in a particular situation before, although you know it is highly unlikely that you ever were.
>
> b) Suddenly feeling outside of a situation, as if you're on the outside looking in.
>
> c) When a conversation you've had before comes up, and you go through the same topics all over again.

The following items assessed how recently the person had experienced déjà vu and three questions on specific forms of déjà vu and their general frequency of experience.

The questionnaire's website address was posted on several social networking sites (including MSN Groups and AOL Community) in English. It was arranged as a series of pages; when one page was completed, the participant was required to press 'submit' before moving on to the next page. The questionnaire began with a number of demographic questions, including gender, age and level of education achieved, as well as the number of medications taken. Participants were then asked to select what they thought was the best definition of déjà vu, from a selection of three possible definitions (see appendix). Following this, participants responded to items relating to the participant's own déjà vu and tip of the tongue experiences, mainly in a closed, tick-box style format, and text boxes were provided which allowed participants to put in any additional information they thought might be relevant.

Results and Discussion

Correct understanding of definitions. Overall, 54 (15.6%) participants incorrectly defined the déjà vu phenomenon. Relatively more of the older adults failed to correctly define déjà vu; of the 50 older adults, (i.e. people 60 and over) 32% gave the incorrect definition. An independent samples t-test showed that the people who incorrectly defined déjà vu were significantly older than those who correctly defined it ($M=41.37$ vs. $M=30.23$, $t(344)=-4.336$, $p<.001$). For the following analyses, we exclude people who incorrectly defined the déjà vu phenomenon, in order to focus on the incidence and quality of déjà vu in older adults.

Analysis of lifetime déjà vu incidence. We explicitly asked whether participants had ever had the experience, as part of a question assessing whether the experience had decreased or increased with age. Eight people (3.1%) responded that they had never had the experience. These 8 people had a mean age of 22.75 years (range 19-37), i.e. none of them were older adults. Thus, to address the issue of whether déjà vu increased or decreased with age, we had a select sample of people who had reported having déjà vu on at least one occasion and who could correctly define the term. However, this clean sample only included 29 older adults.

Memory for last déjà vu experience. Participants used a rating scale to report when they had had their last déjà vu or ToT experience. This rating scale included 5 points which assessed recency: in the last day, last week, last month, last six months and last year, and the final point on the scale was used if

participants could not remember their last déjà vu experience. Forty-six percent of older adults groups could not remember their last déjà vu experience. If we exclude those people who cannot remember their last experience and run a correlation between age and recency of last déjà vu experience, we find exactly what Study 1 would predict: the younger people have experienced déjà vu more recently, $r(196) = .240$, $p=.001$. However this clean sample of 196 people contains only 14 older adults, an unreasonable sub-sample size which clearly stretches the generalisability of our results.

If we exclude older adults who have never had the experience, who fail to define the experience correctly, and who cannot remember the last instance of the experience, we are left with only a very limited sample, but we still have evidence that déjà vu decreases as one gets older. Certainly, this approach is a little conservative, and for instance, if older adults genuinely do have reductions in their déjà vu experience, it is not unreasonable that they last occurred so long ago that they are difficult to remember. If we group together the ends of our scales for recency of experience, so that we interpret the inability to remember the last déjà vu as a statement about how long ago it occurred, and group together 'in the last day' and 'in the last week' we are left with a four point scale of recency. If, using this scale, we switch back to using our full sample regardless of the understanding of the déjà vu term, we continue to find a significant non-parametric correlation between age and recency, $r(306) = .226$, $p<.001$; people who are older rate their last déjà vu experience as having occurred less recently. At this stage, we support the idea that older adults have fewer experiences of déjà vu, but it is also clear that they struggle to remember their last déjà vu experience, which may point to them making inaccurate assessments of how frequently it occurs (i.e. they experience it, but forget that they do so), or it is a genuine finding that since they have it less frequently, older adults have to look a lot further back in order to retrieve the last instance of déjà vu. This is a finding to take into the laboratory: we could investigate the characteristics of memories of mental experiences such as déjà vu, ToT, and involuntary memory in different age groups.

Déjà vu and Tip-of –the –Tongue experiences. Another aim was to set the questionnaire in the context of the tip of the tongue experience. Using the same scale for recency and the large, un-trimmed sample showed that there was not a correlation between age and TOT experience, $r(306)=.025$. However, there was a significant correlation between TOT and déjà vu experiences – people who had had a déjà vu

experience more recently also reported having had a TOT more recently, r(306)=.19, p=.001. A comparison of the scales used to rate recency of experience using a paired samples t-test showed that people had experienced a TOT significantly more recently than déjà vu, t(213)=11.46, p<.001.

The questionnaire also included a number of specific questions about the frequencies of various types of déjà vu and TOT experiences (see Table 2). This showed that of our nine comparisons between déjà vu and ToT experiences, six were significant, and the other three were marginally significant (all p<.13)[2]. That is, in general, people who report déjà vu more frequently report having ToT more frequently too.

However, it should also be noted that correlations with age were a little unusual with these questions in Table 2, possibly reflecting the fact that a large number of the older adults in the sample did not endorse the correct definition of déjà vu. For instance, there was a positive correlation with age for the frequency of feeling that a conversation was repeating, r(323)=.241, p<.001, suggesting that older people have this feeling more often, contrary to Study 1 and the foregoing analyses. (The other two questions about déjà vu had non-significant correlations with age.) The ToT questions yielded results closer to what would be expected with regards to age, significant correlations with age for the frequency of ToTs for actors' names and word finding, r(322) = .135, p=.016 and r(322)=.152, p=.006, respectively, although the correlation between ToTs for place names and age was non-significant.

In summary, our second study confirms the age differences in déjà vu experiences. There is also evidence on this study that older adults do not endorse the correct definition of déjà vu, in line with our hypothesis that cohort effects in the understanding of the definition may lie behind the differences in young and old rates of déjà vu. Study two also shows a relationship between déjà vu experiences and the tip of the tongue experience, in that people who have more ToT experiences have more déjà vu experiences. We also showed that ToTs were reported more recently than déjà vu experiences, in line with them being experienced more frequently.

Discussion: Déjà vu as metacognition

We started this chapter with the idea that déjà vu results from a pattern mismatch. Pattern mismatch in itself should not lead to déjà vu – it is only half the story. Déjà vu requires two simultaneous evaluations.

[2] Note that if we correct for multiple comparisons using Bonferroni corrections, five of these correlations remain significant.

One – which could be a mismatch – is the sensation that a particular event or instance matches a previous one. The second critical one is the knowledge that this feeling is false. If an older adult visits a place that they erroneously match with a previous place, they won't necessarily recognise that this feeling is false. However, if they mismatch the memory AND are aware of this erroneous match – or know the place to be novel, they will be left with a 'clash in mental evaluations,' which is at the heart of the déjà vu experience.

We have recently put forward the idea that like other brief and nebulous experiences such as the Tip of the Tongue state, déjà vu is in some regards, metacognitive (e.g. Moulin & Souchay, in press; for a description of ToTs as metacognitive, see Bacon et al., 2007). It is only because we are able to metacognitively reflect on the error at the heart of the illusion of familiarity that we are aware of it at all. If we are not aware that the feeling of familiarity is false, we do not have the déjà vu – we presumably just accept our feeling that the current location or conversation, is, in fact a repetition of one we have encountered previously. That is, déjà vu must derive from some feeling, belief or knowledge that the familiarity is false. In this way, the déjà vu state suggests that there are two levels of evidence at play in recognition memory, and two different forms of epistemic information in consciousness, a fast and obligatorily sensed feeling that something is familiar, and an evaluation that this feeling is in fact false (see Moulin and Souchay, in press; Arango, 2010; and de Sousa, 2009) for accounts of two levels of metacognition and this notion of epistemic feelings.

Two theories of déjà vu formation

We have previously complained that there is probably a little too much theorizing about déjà vu in the absence of a strong empirical basis for said theories (Moulin & Chauvel, 2010). At least one popular theory, the idea that déjà vu is caused by information from one eye being processed in advance of the other, for instance, was dispatched with the most minimal of empirical work – the demonstration of déjà vu in a blind subject (O'Connor and Moulin, 2006). But other theories of déjà vu based on dreams, for instance, are pervasive among the population more widely, and are difficult to shift, but should receive a little more attention from empirical work. For dreaming, our view is that when faced with a strange and inexplicable feeling of familiarity, people are drawn to dreams as a way of explaining the sensation – the

feeling can be made sense of with the post-hoc justification that it was encountered in dream. If one has a robust paradigm for generating déjà vu, this would be an easy idea to test.

There are two broad theories of déjà vu formation, which draw on different literatures, but are sustainable according to current views of memory function. Here we outline these two: the Gestalt similarity hypothesis (e.g. Cleary et al., 2012; Dashiel, 1937) and the decoupled familiarity hypothesis (e.g. Illman et al., 2012; Penfield, 1955). We then offer an explanation of how they may be seen in the healthy aging process.

The Gestalt similarity hypothesis

The key feature of the similarity hypothesis is that there is some overlap between a perceptual experience (which is responsible for triggering the déjà vu) and a previously stored representation, not unlike the pattern mismatch idea above. The 'Gestalt' in the title refers to an overarching 'form' or 'structure' into which perceptual elements can fall:

> *"… déjà vu is elicited by familiarity with the arrangement of the elements within a scene. For example, when visiting a friend's home for the first time, one may have a strange sense of having been in that living room before. Perhaps the arrangement of the furniture in the new friend's living room (e.g., the way that the couches, tables and lamps are arranged) maps onto an arrangement that was seen before, perhaps in the person's doctor's office waiting area. The inability to recall the doctor's office waiting area as the source of this familiarity leads to the experience of déjà vu."*
>
> Cleary et al., 2012, p.969

The critical issue is developed in the last sentence: the experient should be unaware of the source of the familiarity, and this would lead to the inherent conflict in feelings in a déjà vu experience. The beauty of this account of déjà vu is that it lends itself to an existing laboratory task, the recognition without identification paradigm, which is where it is possible to make a stimulus familiar in such a way that the participant is not aware of the source of the familiarity (e.g. Cleary et al., 2012; Cleary et al., 2009; Cleary and Reyes, 2009; Cleary, 2008). For instance, in perhaps its most elegant manifestation (Cleary et al., 2012), participants 'studied' rooms in a virtual reality environment (where the experimenter provided a label, such as 'bedroom'). Participants then encountered similar and dissimilar rooms in a test (Exp. 1; or similar, dissimilar and identical rooms, Exp. 2). Participants reported whether they could recall the label or not, followed by a rating of familiarity for the room and a report (yes/no) as to whether

they are experiencing déjà vu. Cleary and colleagues arranged the rooms such that half match the studied rooms configurally, and half did not. In Experiment 1, they report that participants can recall the label of nearly half the configurally similar rooms, leaving a set of rooms which are similar in some way, but in which the similarity is undetected. These similar rooms can be compared to the rooms that do not resemble previously encountered rooms. Déjà vu was measured for these rooms with a yes/no question, with 27% of similar rooms giving rise to déjà vu, significantly higher than for the dissimilar rooms (17%). Furthermore, the familiarity ratings were higher for the configurally similar scenes, and an item-by-item correlation showed that the more familiar a room feels, the more likely it is to give rise to a felling of déjà vu. Experiment 2 produced similar results, with again participants reporting déjà vu experiences on about a third of items.

Experiment 2 is also of interest, because it re-presented participants with rooms at test that were identical to studied rooms, as would be usual in tests of recognition memory ('old' items). Naturally, because these test items actually are a repetition of a previous stimulus, we should not expect them to generate a feeling of déjà vu: standard recognition memory tests do not routinely give rise to déjà vu. Indeed, Cleary et al. (p.973) state that 'we defined déjà vu as a simultaneous recognition of newness alongside a feeling of familiarity' and report that two participants gave déjà vu responses for 100% of old items, consistent with a misunderstanding of the definition of déjà vu. In line with our reasoning above, and our approach, these subjects highlight the difficulties in working with such an ephemeral and subjective experience, and their data was removed from the study, as we did above in our analysis. In sum, Cleary et al. present experimental support for the idea that déjà vu arises when scenes (for instance) have some overlap with a prior scene, giving rise to a feeling of familiarity, but for which the cause for this familiarity is undetected.

The decoupled familiarity hypothesis

An alternate (but not necessarily incompatible) view is that déjà vu arises when the sensation of familiarity becomes decoupled from the current outputs of memory processing, such that there is a false feeling of familiarity independently from what is actually being perceived in the environment. The chief support for this idea has been neuropsychological, arising from data from neuropsychological

populations, most particularly temporal lobe epilepsy (TLE; see Illman et al., 2012). An early presentation of this idea (O'Connor and Moulin, 2008) emphasized that déjà vu is not connected to what was being received from the perceptual system – it is a higher order error caused by processing problems in the brain. The genesis of this idea was the observation that in cases of TLE, the feeling of déjà vu is essentially unpredictable, and when it does occur, it is felt for all domains and modalities, and does not reduce according to what the experient pays attention to (the same occurs in other pathologies, e.g. Kalra et al., 2007).

The decoupled familiarity hypothesis does not lend itself so readily to experimentation in healthy subjects, and thus the chief evidence for this idea rests with clinical reports and our knowledge of the memory system. In brief, in TLE there is a disturbance in the synchronization of brain waves in the region responsible for memory, with the result that the feeling of familiarity can be activated independently of retrieval from memory. Indeed, this can also be achieved artificially. Direct application of electrical current to the cortex of the temporal lobes produces sensations of déjà vu in epileptic patients (who have this procedure to 'map' brain areas responsible for symptomology and function prior to surgery; Bartolomei, et al., 2004; Penfield and Perot, 1960).

Like many areas of cognitive neuropsychology, the deficit and dysfunction in TLE hints at how the healthy brain is organized and how it operates. In the healthy experient, the idea is that a physiological event akin to a brief and otherwise inconsequential epileptic glitch, activates a feeling of familiarity. The fact that tiredness and intoxication is related to déjà vu experiences (Brown, 2003) supports the idea that there is a physiological basis for déjà vu. Moreover, observations such as déjà vu being experienced more by people who travel more (Brown, 2003) can be explained by the fact that it is only when in a novel situation would one notice that there has been an erroneous activation of familiarity. Of course, there are many interpretations of such a correlation; not least, it is educated people who travel more and it is educated people who are more tuned in to their mental experiences.

The difficulty in using neuropsychological cases and phenomena like this is making a link between healthy and pathological déjà vu. Several researchers have examined the quality of déjà vu in TLE, with some finding that déjà vu is phenomenologically the same in healthy and epileptic forms (e.g. Warren-

Gash & Zeman, in press) and others finding that epileptics can differentiate between seizure related and non-seizure related déjà vu – although this is largely due to the fact that seizure-related déjà vu is related to other experiential phenomena, what Warren-Gash and Zeman (in press) refer to as the 'company that déjà vu keeps'. The investigation of the phenomenology and quality in déjà vu when it occurs naturally is somewhat limited by the inventory commonly used to assess it which predates the recent resurgence of interest shown in déjà vu by cognitive psychologists since Brown's review and the two principal theories of formation outlined here. A priority for future research would be to develop a measure that takes on board the theoretical insights of the familiarity approaches.

Aging and theories of déjà vu formation

How might our aging data fit into these two theories of déjà vu formation? In one of her early papers, Cleary offers an interpretation of the Gestalt similarity hypothesis, which hinges on the fact that as we get older, we become more reliant on familiarity and less able to recollect specifics of a previous scene:

> Because reliance on familiarity likely increases with age, people may become accustomed to experiencing familiarity-based recognition as they age. Thus older people may frequently attribute feelings of familiarity to failures of recalling specific prior experiences or to forgetting rather than labeling them as déjà vu instances.
>
> Cleary (2008), p.356

By this view, older adults are not metacognitively aware of the inconsistent feelings of familiarity, because they often make assessments based on familiarity, and without being able to recognize the error in their memory attribution. We have developed this idea to include recollective processes (Moulin and Souchay, in press). Memory researchers commonly contrast two evaluations: recollection and familiarity. One of the main functions of recollection is to minimize memory errors and avoid 'illusions of familiarity' (Jacoby et al., 1989). For instance, an eyewitness who has seen two people, a bystander and a perpetrator, needs to be able to recall the information about who was who in order to not be 'seduced' by the overwhelming sensation of familiarity of the bystander. This ability has been termed 'recollection rejection' (Brainerd et al., 1993) and consists in correctly rejecting errors on the basis of recollection, e.g. remembering that the man with glasses was the man who was sat opposite on the bus, and not the one who ran off with the iPad. Recollection is also involved in reducing susceptibility to memory distortions such as misattribution (i.e. the act of attributing a recollection or idea to an incorrect source).

We suggest that to experience déjà vu one needs intact recollection to produce the clash in evaluations (see Spatt, 2002 for neurological account of this view). In short, many research themes converge on the idea that recollection is impaired in older adults (e.g., Souchay et al., 2007). For example, older adults are less likely to experience memory in the form of 'remembering' (e.g. Perfect and Dasgupta, 1997; Souchay et al. 2007). This is a rather specific memory failure: older adults are as capable of recognising items in a memory test as younger adults, but their subjective experience is different from younger people's: they do not 'remember' specifics of the study phase. This view neatly explains the lower rates of déjà vu in older adults – it's because of less recollection.

This view of déjà vu receives support from the temporal lobe epilepsy literature. Martin et al. (2012) took two groups of TLE some of whom did and and some of whom did not have déjà vu as part of their seizure manifestation. They show that the patients with TLE who experience déjà vu have a familiarity disorder, as we would predict here. However, a disorder in familiarity did not differentiate those who did and did not experience déjà vu – both their groups of TLE patients had a familiarity disorder, whereby there were less able to use familiarity signals to judge whether a stimulus had been previously seen or not. It was recollection that differentiated the groups – those who had déjà vu had significantly *better* recognition scores than the TLE patients without déjà vu. The interpretation of this finding is that recollection is required to be aware of the erroneous familiarity at play in the déjà vu phenomenon. Patients with TLE who have both familiarity and recollection deficits do not possess sufficient memory capacity to detect the error of familiarity.

In sum, younger adults have the requisite processes to detect a clash between two evaluations, whereas the older adults have a diminished ability to detect a clash between familiarity and more objective sources. Older adults either cannot use recollection to reject feelings of familiarity or become habitually used to familiarity-alone assessments of the environment in the absence of recollection. This interpretation follows for both theoretical accounts of the déjà vu phenomena, and cannot differentiate between the two theories outlined above. The Gestalt similarity and decoupled familiarity accounts both explain how the familiarity mismatch arises – and either or both may be correct, but the decline in déjà vu experiences in aging, by our view is most likely linked to a deficit in recollection, or at least a change in the relationship between familiarity and recollection in older adults. The most obvious means for

assessing the recollection and familiarity hypothesis is to use Cleary and colleagues' paradigms in older adults. First, we might expect that if these experiments do produce something akin to the real déjà vu experience, that it should be less successful in older adults. Second, we might expect the differences in susceptibility to déjà vu to change with relation to recollection, in line with Martin et al.'s (2012) results.

Déjà vu: Taking a lead from the ToT and Involuntary memory literatures

Finally, because we have looked at other phenomena in the empirical literature in this chapter, we wanted to outline some thoughts for future work based on research into these other phenomena. We have previously outlined the differences and similarities between déjà vu and the tip-of-the-tongue experiences. Both can be thought of as metacognitive, and infrequent memory errors that expose epistemic feelings at play in cognition (Arango, 2010). In this study we found a relationship between the two: people who experienced a ToT more recently (our proxy for frequency of experience) had also experienced déjà vu more frequently. And yet, déjà vu was a less frequent memory error. This correlation may point to the fact that some people are more aware of their cognitive failings and epistemic feelings than others.

The main issue we want to draw out here is the relationship between laboratory and questionnaire evaluations of ToT and déjà vu. Despite Cleary and colleagues clear successes in laboratory analogues of déjà vu, it is remains rather difficult to produce in the laboratory and is something of a ephemeral entity. One criticism of the laboratory variety of déjà vu is that it is produced somewhat too successfully, that is, the déjà vu rates are higher than anything one might observe naturally (see O'Connor and Moulin, 2010 for a critique). The ToT is easier to produce in the laboratory than déjà vu, being that it can be elicited reliably by a set of purposefully designed general knowledge questions, but even here it is has also been criticised for being too easy to produce in the laboratory, with a common criticism being that the real-world and laboratory experiences may not share phenomenology or even the same cause. Typically, the ToT might be experienced multiple times on one test in the laboratory, whereas diary studies indicate that it is experienced only about once a week in young adults, and once a day in the oldest old (Brown, 2012). Heine et al. (1999) examined diary ToT and laboratory ToT rates in the same groups of participants. In the laboratory, their group of young adults (mean age 21 years) generated 23

ToTs on a 112-item test. In the real world, over a four-week period, the same group repeated a mean of 5.21 ToTs. Similar figures are found in déjà vu, too. Cleary and Reyes (2009) found 87% of participants (33 of 38) report at least one incidence of déjà vu. This is striking in that the generation of déjà vu is almost as frequent as the generation of the ToT, which was achieved in 97% of participants in the same experiment. Unlike in the ToT literature, there are no studies that attempt to reconcile rates of déjà vu in the laboratory and in the real world, and this is a priority for future research.

The déjà vu literature needs to develop in the manner of the ToT literature, where researchers share a generally accepted definition, and a central paradigm behind which researchers can align themselves. The ToT has the advantage that there are behavioural consequences of the feeling (such as search time, and the production of associated information, and the effects of a concurrent task; Schwartz, 2001; 2002; 2008). In comparison, it is difficult to see what the behavioural consequences of a déjà vu experience are. One promising idea is to examine the after-effects of the déjà vu eliciting trial. If the experimenter really has produced an attention-grabbing experience, one might expect a cost to processing on the next trial (or possibly on a dual task). In an elegant demonstration of this idea, Schwartz (2011) has shown that ToTs are less likely to occur in the trial after a ToT has been reported, with the interpretation being that the high level of resources required to generate a metacognitive evaluation have been depleted, and take a while to recover. This occurs even though recall is not affected for the subsequent trial.

We examined involuntary memories in Study 1 and would like to briefly point to areas ripe for future research. In a similar way to the ToT literature, there is mixed evidence about involuntary memories in older adults according to differing methodology. Questionnaires by Berntsen and Rubin (2002) and diary studies by Schlagman et al. (2009), found that older adults report fewer involuntary memories than younger people during their day-to-day lives, but a later study by Rubin and Berntsen (2009) with participants aged 15 to over 90 concluded that involuntary memories had similar frequencies. Again, the involuntary memory literature is at pains to discuss and comprehend the differences between the real-world phenomenon and its laboratory analogue, and how aging might help us understand that picture. But the point here is that when there is a divergent pattern between age changes in laboratory and field studies, it should tell us something about the processes involved in the phenomena and the validity of the theory. In the current chapter we showed that déjà vu was

related to involuntary memory – at least in the older adult group. Involuntary memories more frequently experienced than déjà vu. We have previously suggested that according to the decoupled familiarity hypothesis, these two experiences should be related. Indeed, in TLE, when the erroneous neural firing is sufficient, whole veridical memories are intruded into consciousness rather than just a feeling of familiarity (Vignal et al., 2007). We have presented the idea that in TLE there is a continuum between déjà vu feelings and the retrieval of prior events (Illman et al., 2012), but this is an idea that needs some development in healthy groups.

Conclusions

The idea that déjà vu decreases with age is not new – déjà vu all over again – and before this empirical chapter there were datasets larger and more detailed than ours that clearly showed that it decreased with age. The data reported here add to this picture however, and neatly illustrate that as well as a genuine decline according to age (which might be confirmed with laboratory investigations of déjà vu in older adults) there are also cohort differences in the understanding of the term, and estimates of lifetime incidence. Once these factors are taken into consideration, however, there is still a clear finding that déjà vu is experienced less frequency by older adults.

We have presented a summary of theories of déjà vu formation and offered a couple of suggestions for future research. In sum, we argue that déjà vu rests not only on falsely finding an event or location familiar, but also on detecting that familiarity as inappropriate, and it is in this second factor, in line with neuropsychological evidence from TLE, in which we hypothesise that older adults are particularly impaired. The ability to know that a familiar event is not in fact a repetition of a similar occurrence presumably relies on some recall or recollection process requiring the retrieval of specifics and a sense of certainty, and current theories of memory in older adults, suggest that this type of memory is impaired.

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Table 1. Mean (and standard deviation) of Frequency of déjà vu experiences in the last year and across the lifetime, Study 1.

	In the last year	Lifetime
Whole sample		
Young	8.94 (15.86) n=70	68.57 (159.08) n= 65
Old	1.60 (2.29) n=45	20.15 (48.82) n= 39
Clean sample		
Young	6.62 (6.95) n= 60	45.71 (53.10) n=59
Old	1.41 (1.68) n=29	23.31 (53.11) n=32

Table 2. Correlations between déjà vu and ToT experiences, across all participants, Study 2.

	2	3	4	5	6
1	.50**	.23**	.18**	.09	.24**
2		.24**	.10	.10	.19**
3			.12*	.16**	.21**
4				.33**	.29**
5					.28**

Notes: Déjà vu: 1. Same conversation before, 2. Same room before, 3. Same information before. ToT: 4. Can't access actor's name, 5. Can't access place name, 6. Can't find the right word

Figure 1. Relationship between Lifetime Incidence of Déjà vu and date of publication, taken from Brown (2004).