A postdictive bias associated with déjà vu

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Abstract

Recent research links reports of déjà vu – the feeling of having experienced something before despite knowing otherwise – with an illusory feeling of prediction. In the present study, a new finding is presented in which reports of déjà vu are associated not only with a predictive bias, but also with a postdictive bias, whereby people are more likely to feel that an event unfolded as expected after the event prompted déjà vu than after it did not. During a virtual tour, feelings of predicting the next turn were more likely during reported déjà vu, as in prior research. Then, after actually seeing the turn, participants exhibited a postdictive bias toward feeling that the scene unfolded as expected following déjà vu reports. This postdictive bias following déjà vu reports was associated with higher perceived scene familiarity intensity. A potential reason for this association may be that high familiarity intensity as an event outcome unfolds falsely signals confirmatory evidence of having sensed all along how it would unfold. Future research should further investigate this possibility.

Introduction

Déjà vu – the jarring feeling of having experienced something before despite knowing otherwise – has a long-held association with perceptions of premonition. This has been documented in people's subjective impressions of past déjà vu experiences (Brown, 2004; Moulin, 2018). Perceptions of premonition may occur while déjà vu is being experienced. Mullan and Penfield (1959) observed that stimulation within the temporal cortex – an area now known to be associated with déjà vu (Bowles et al., 2007) – led a patient to report feelings of knowing what would happen next.

Recent laboratory research suggests that feelings of prediction can indeed accompany feelings of déjà vu (Cleary & Claxton, 2018). Cleary and Claxton hypothesized that the reason for the association between déjà vu and perceptions of premonition is that déjà vu may often be accompanied by actual predictive ability. Their logic is as follows: Déjà vu appears to be rooted in memory such that the specific source of the feeling fails to be retrieved but a sense of recognition persists nonetheless (e.g., Cleary, 2008; Cleary, Ryals, &

Nomi, 2009; Cleary et al., 2012). If one of the adaptive purposes of memory is to enable prediction (e.g., Szpunar, Spreng, & Schacter, 2014), then a feature of déjà vu may be that it sometimes allows memory-based prediction. Specifically, a sense about what should happen next might be rooted in memory for how the event unfolded in the past.

Cleary and Claxton (2018) had participants virtually tour scenes, some of which mapped onto earlier-viewed scenes in their spatial configuration, a manipulation that has been shown to contribute to déjà vu reports (Cleary et al., 2012). Movement through scenes stopped short of a turn potentially taken in an earlier-viewed spatially-mapped scene, thus enabling possible memory-based prediction during retrieval failure regarding the direction of the next turn. However, although the situation was set up to enable memory-based prediction, participants exhibited no accurate predictive ability during déjà vu yet reported stronger feelings of prediction during reported déjà vu states than non-déjà vu states. Thus, déjà vu was associated with feelings of prediction, not actual prediction.¹ This may relate to the finding that premonitions of insight predict impending insight failures in problem-solving (Metcalf, 1986).

If a feeling of prediction can accompany déjà vu states, might a feeling of postdiction also follow the initial perception of being in a déjà vu state? Postdictive illusions are

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One Sentence Summary: A postdictive bias follows déjà vu reports.

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¹ Reporting a feeling of prediction is not necessarily equivalent to believing that one actually can predict the direction of the next turn. It is theoretically possible that a person can have a feeling of prediction yet recognize that it is only a feeling and not an actual ability to predict.

documented in the cognitive science literature and have been speculatively linked to illusions of clairvoyance. For example, Bear and Bloom (2016) found that post-choice saliency influenced participants' perceived choices, despite having occurred *after* the choices were made. Participants mistakenly believed that they chose the salient option. This has led to speculation that subjective impressions of clairvoyance may sometimes be due to perceiving the timing of events in the wrong order (Bear, Fortgang, & Bronstein, 2017). Another type of postdictive illusion that may relate to illusions of clairvoyance is the hindsight bias, which is a pervasive bias toward believing that an outcome was more predictable than it was (Roese & Vohs, 2012).

The possibility that déjà vu is associated with feelings of postdiction remains scientifically unexplored. We hypothesized that such an association might exist as follows. Familiarity-detection during retrieval failure (Ryals & Cleary, 2012) contributes to reports of déjà vu (Cleary & Claxton, 2018; Cleary et al., 2012; Cleary, McNeely-White, Huebert, & Claxton, 2018; Cleary et al., 2009; Cleary, 2014; Cleary, 2008) and may produce a sensation of imminent recall of a prior experience with the current event, much like a tip-of-the-tongue experience produces a feeling of imminent word retrieval (Brown, 2012). In the case of déjà vu, it may be more like feeling on the tip-of-an-experience (e.g., like a memory for the current situation is about to come to mind) than having a word on the tip-of-the-tongue. The feeling of imminent recall of a past experience with the current event may involve a sense that what happens next is right on the verge of retrieval, leading to the feeling of prediction shown in Cleary and Claxton's (2018) study. Continued strong familiarity as the event unfolds might then be perceived as confirmatory regarding knowing how the event would unfold, even though the actual unfolding of the event never did come to mind while feeling on the tip of retrieving it from memory.

The present study investigated whether feelings of postdiction would be associated with déjà vu reports and their accompanying feelings of prediction. In Experiment 1, we searched for feelings of postdiction when the virtual tours used in Cleary and Claxton's (2018) study continued to unfold after participants reported their initial déjà vu and feeling of prediction judgments. In Experiment 2, we searched for evidence that familiarity is involved. If continued familiarity with an event as it unfolds can lead to feelings of postdiction (as hypothesized above) there should be evidence of (1) a continued feeling of familiarity as the scene unfolds and (2) an association between familiarity and any déjà vu-associated postdictive bias.

To investigate these hypotheses, we added a postdictive judgment phase to the test procedure from Cleary and Claxton's (2018) study. Example pre- and post-turn video segments with pre- and postdictive judgments about them are depicted in Fig. 1. Because Cleary and Claxton

compellingly demonstrated that déjà vu was associated with a feeling of prediction when there was no actual predictive ability, we eliminated any role of memory for the direction of the turn altogether so that any feeling of prediction before the turn would necessarily be illusory. We did so using a methodological tool sometimes used in memory research to isolate decision biases that occur during the test phase: counterfeit study lists. With a counterfeit study list, participants are told that items will be presented in a study list for a later memory test; however, none of the studied items is actually presented later at the time of test. For example, Frigo, Reas, and LeCompte (1999) told participants that spoken words to remember for a later memory test were embedded within white noise and difficult to hear. In actuality, there were no spoken words (only white noise). This enabled isolation of decision biases occurring at the time of test. A similar approach was taken in the present study. The video tour of interior and exterior spaces presented in the purported study phase did not relate to the later test phase. Participants subsequently completed 62 trials of novel virtual tour video segments using the procedure exemplified in Fig. 1. Prior research has repeatedly shown that déjà vu reports still occur among test items that bear no intended relation to studied items (Cleary & Claxton, 2018; Cleary et al., 2012; Cleary et al., 2009; see Cleary, 2014, for an explanation). These déjà vu reports are like false alarms on a recognition test, and are likely driven by inadvertent familiarity, such as from the similarity resulting from the stimuli being created in the same gaming platform (Cleary, 2014). Therefore, we expected to obtain enough déjà vu reports to search for relationships between reported déjà vu and feelings of prediction and postdiction.

Method

Participants Thirty-seven Colorado State University students participated in Experiment 1, and 68 participated in Experiment 2 in exchange for course credit. Some participants in Experiment 2 did not finish the experiment (in some cases due to a computer crash). Among participants who did not finish, our criterion for inclusion was: If participants completed at least 40 of the 62 trials, their data were included. Three participants met this criterion (one completing 44 trials, one completing 56 trials, and one completing 59 trials) and two did not (one completed 17 and one completed 35 trials). The remaining 63 of the 66 to-be-included participants completed all 62 trials.

As in prior research (e.g., Cleary & Claxton, 2018), some participants reported no instances of the subjective reports under examination (e.g., no instances of déjà vu, no instances of feelings of prediction, etc.). Therefore, some were lost from the various analyses that compared judgments given during

(a) Before the turn

A stopping point in a virtual tour. Upon stopping, participants were prompted with “Did this scene prompt you to experience déjà vu? Yes or no?” Then, “Do you have a sense of knowing which way to turn? (Y=Yes, N=No).” After responding, the next turn was taken. For half of participants the turn was left; for half it was right. In Experiment 2 they were additionally asked to rate the familiarity of the scene (0=very unfamiliar; 10=very familiar) before the turn.

(b) After the turn

After the turn was taken (in this case left), in Experiment 1 participants were prompted with “Did the scene unfold the way you expected? Give a rating between 0 and 10 (0=definitely unfolded differently than expected; 10=definitely unfolded exactly as expected).” In Experiment 2, they were prompted with “Did the scene unfold the way you expected? (Y=Yes, N=No)” before being prompted to rate the familiarity of the scene (0=very unfamiliar; 10=very familiar).

Fig. 1 Test procedure

the particular subjective reports in question, which is why the degrees of freedom differ across analyses.

Equipment Participants completed each experiment individually on a Dell computer. Windows Media video player delivered the first part and E-prime software delivered the second part.

Stimuli Stimuli were videos of first-person navigation (virtual tours) through different scenes that had been created using the Sims game platform. The first phase contained a single 21:09-min video that was a string of multiple segments of different Sims-created video tours, available publicly on YouTube, that were connected together into a single video displayed using Windows Media Player. This virtual tour included indoor and outdoor scenes and bore no direct relationship to any subsequent scenes presented in the test phase (though all scenes had some slight cartoon-like resemblance to one another from being created using the same game engine platform).

The second phase contained 62 short (average duration 22.5 s) Sims-created video segments taken from those used in the encoding phase of Cleary and Claxton’s (2018) study. Each of the 62 video segments was spliced into two separate segments using video-editing software. The first segment of the spliced video stopped short of a final turn; the second segment was of the turn itself. For counterbalancing purposes, there were two versions of spliced videos created from those used by Cleary and Claxton: In one, the turn was toward the right; in the other, the turn was toward the left. For each participant, half of the turns were to the right and half were to the

left in a randomized order. To achieve counterbalancing, videos for which the turn was right for odd-numbered participants were then left for even-numbered participants and vice versa. On each test trial, participants viewed the first segment that stopped before the turn, answered the questions pertaining to it, then viewed the segment containing the turn itself.

Procedure Participants began by viewing the 21:09-min video tour of various indoor and outdoor Sims scenes. This video was a counterfeit encoding phase (e.g., Frigo et al., 1999) that would be unrelated to any particular scene in the test phase. When that video was finished, participants were instructed regarding the test phase: They would see a series of video clips and some might be similar but not identical to scenes viewed in the first phase. They were told that they would be prompted with several questions pertaining to each video clip; the first prompt would ask them if that particular scene prompted them to experience déjà vu. Déjà vu was defined as follows: “Déjà vu is the feeling of having been someplace or done something before, without being able to pinpoint why and despite knowing that the current situation is new.” The other prompts and their ordering were also briefly described before beginning the test phase.

The 62 video segments in the test phase were randomly ordered for each participant. At the end of the first portion of any given test video segment, the movement through the scene stopped just before the final turn (as in Fig. 1A), and the screen remained frozen in that position as the prompts (dialog boxes) appeared in the center of the screen. The first dialog box asked, “Did this scene prompt you to experience déjà vu (Y=Yes,

N=No).” They could proceed to the next dialog box only by typing “Y” or “N” into the box and pressing Enter. The next dialog box asked, “Do you have a sense of knowing which way to turn? (Y=Yes, N=No).” After typing “Y” or “N” and pressing Enter, the video then continued into the turn (as in Fig. 1B). For any given participant, there was a .50 probability that the turn would be left and a .50 probability that the turn would be right. Thus, predicting the direction of the turn beforehand was like trying to predict the outcome of a coin flip beforehand. After the turn was taken and the video stopped, participants were then prompted with a dialog box that asked, “Did the scene unfold the way you expected? Give a rating between 0 and 10 (0=definitely unfolded differently than you expected; 10=definitely unfolded exactly as you had expected).” After typing an integer between 0 and 10 and pressing Enter, the next test video clip was presented. This procedure continued until the participant completed all 62 test videos.

In Experiment 2, the procedure was identical with the following exceptions: (1) Following the second prompt and before the video continued into the turn, participants were prompted to rate how familiar the scene seemed to them on a scale of 0 (very unfamiliar) to 10 (very familiar). (2) After the turn was taken and the video stopped, participants were prompted to give a yes-no response instead of a rating; the dialog box asked, “Did the scene unfold the way you expected? (Y=Yes, N=No).” (3) Participants were then asked to rate

how familiar that segment of the scene seemed to them on a scale of 0 (very unfamiliar) to 10 (very familiar).

Results

Results of primary interest

Predictive bias associated with déjà vu Experiments 1 and 2 extended Cleary and Claxton’s (2018) finding to yes-no judgments, replicating Cleary et al. (2018). In Experiment 1, participants reported feelings of prediction before the turn more often during déjà vu ($M=.75$, 95% CI [.66, .83]) than during non-déjà vu states ($M=.43$, 95% CI [.33, .53]), $t(33)=5.29$, $SE=.06$, $p<.001$, $d=1.18$. In Experiment 2, participants again reported feelings of prediction before the turn more often during déjà vu ($M=.72$, 95% CI [.64, .79]) than during non-déjà vu states ($M=.27$, 95% CI [.21, .34]), $t(63)=9.96$, $SE=.04$, $p<.001$, $d=1.58$. Two participants who reported no déjà vu states could not be included in this analysis for Experiment 2.

Postdictive bias associated with déjà vu Stronger feelings that the event unfolded as expected followed déjà vu than non-déjà vu (Fig. 2), $t(33)=3.80$, $SE=.42$, $p=.001$, $d=.80$. Furthermore, déjà vu states that were accompanied by feelings of prediction before the turn were followed by greater feelings of postdiction

Feeling of Postdiction as a Function of Preceding Déjà vu Reports

Fig. 2 A postdictive bias associated with déjà vu reports in Experiment 1. Mean postdictive ratings regarding how the scene unfolded (Fig. 1, Panel B) in Experiment 1 (error bars = SE). Participants exhibited greater

feelings of postdiction following déjà vu reports ($M=5.73$, 95% CI [5.01, 6.44]) than following non-déjà vu reports ($M=4.15$, 95% CI [3.49, 6.44])

after the turn, ($M=6.33$, 95% CI [5.65, 7.02]) than déjà vu states that were unaccompanied by feelings of prediction before the turn ($M=2.83$, 95% CI [1.81, 3.84]), $t(25)=5.51$, $SE=.64$, $p<.001$, $d=1.64$. Experiment 2 replicated this déjà vu-associated postdictive bias in the form of yes-no judgments (Fig. 3), $t(63)=8.03$, $SE=.04$, $p<.001$, $d=1.23$. Again, déjà vu states accompanied by feelings of prediction before the turn were followed by a greater likelihood of feelings of postdiction afterward ($M=.71$, 95% CI [.65, .76]) than déjà vu states unaccompanied by feelings of prediction before the turn ($M=.36$, 95% CI [.27, .46]), $t(45)=6.51$, $SE=.05$, $p<.001$, $d=1.30$. It is worth noting that a bias also seems to exist in the opposite direction among non-déjà vu states: Feelings that the event unfolded as expected were much lower than the .50 probability of correctly guessing the direction of the turn beforehand, $t(63)=-7.81$, $p<.001$, 95% CI [-.27, -.16]. Because the majority of trials are non-déjà vu reports, this likely indicates a general baseline bias toward believing that one cannot and did not predict what would happen next; this might be considered a healthy bias to have in situations that cannot be predicted beforehand. This possibility makes the large boost in feelings of pre- and postdiction during déjà vu, which was significantly higher than the .50 probability of correctly guessing, $t(63)=2.76$, $p<.007$, 95% CI [.03, .17], even more intriguing.

Finally, higher postdictive feelings were associated with higher scene familiarity ratings (Fig. 4). This is consistent with the hypothesis that continued persistent familiarity as the scene unfolds can be construed as confirmatory regarding whether an event unfolded as expected.

Additional results

Déjà vu rates The rate of reporting déjà vu among the 37 participants in Experiment 1 was .28 (95% CI [.22, .35]). Three of these participants had zero déjà vu reports. In Experiment 2, the rate was .29 (95% CI [.24, .34]); two of the 66 participants had zero déjà vu reports. These rates are comparable to those reported among scenes that did not correspond to studied scenes in Cleary and Claxton's (2018) study.

Association between familiarity intensity and déjà vu As reported in prior research (Cleary et al., 2012; Cleary et al., 2018; Cleary et al., 2009), in Experiment 2, higher familiarity intensity ratings were associated with déjà vu reports ($M=5.27$, 95% CI [4.81, 5.74]) compared to non-déjà vu reports ($M=1.47$, 95% CI [1.04, 1.90]), $t(63)=18.37$, $SE=.21$, $p<.001$, $d=2.13$. The primary focus here was on familiarity ratings given before the turn, to maximize comparability with

Probability of Reporting a Feeling of Postdiction as a Function of Preceding Déjà vu Reports

Fig. 3 A postdictive bias associated with déjà vu reports in Experiment 2. Probability of reporting “yes” when prompted to indicate if the turn unfolded as expected or not (after the turn was taken; Fig. 1B) in Experiment 2 (error bars = SE). The postdictive bias shown with ratings

in Experiment 1 manifested in the form of yes-no judgments in Experiment 2. Participants were more likely to report that the scene unfolded as expected following initial déjà vu reports ($M=.60$, 95% CI [.53, .67]) than non-déjà vu reports ($M=.29$, 95% CI [.23, .34])

Relationship of Familiarity Intensity to the Postdictive Bias

Fig. 4 A relationship between familiarity intensity and the postdictive bias. Evidence that perceived scene familiarity intensity is involved in the postdictive bias reported here. As hypothesized, a scene's perceived familiarity persisted from before the turn (see Fig. 1A) to after the turn (see Fig. 1B). The correlation between familiarity intensity ratings given before versus after the turn was .98. Furthermore, as predicted, the postdictive bias was associated with higher scene familiarity. A 2×2 Postdictive Status (feeling of postdiction vs. no feeling of postdiction) $\times$ Before-After Condition (before the turn vs. after the turn) repeated measures ANOVA revealed a main effect of Postdictive Status such that

higher familiarity intensity ratings were given among trials for which a feeling postdiction was indicated, $F(1, 62)=74.67$, $MSE=2.24$, $p<.001$. This was apparent in the levels of familiarity indicated both before the turn and after it took place; however, a significant interaction, $F(1, 62)=17.80$, $MSE=.19$, $p<.001$, suggests that the association between perceived familiarity levels and the postdictive bias was stronger among familiarity ratings given after the turn was taken than before. This pattern suggests a possible role of familiarity intensity in the postdictive bias. There was no main effect of Before-After Condition, $F(1, 62)=1.39$, $MSE=.18$, $p=.24$

prior research (Cleary & Claxton, 2018; Cleary et al., 2012; Cleary et al., 2018). When familiarity ratings given after the turn were examined (which also involved a delay following the déjà vu report), the same association was found, with higher familiarity intensity ratings given following déjà vu reports ($M=4.70$, 95% CI [4.14, 5.25]) than non-déjà vu reports ($M=1.54$, 95% CI [1.11, 1.98]), $t(63)=14.08$, $SE=.22$, $p<.001$, $d=1.55$. The association between déjà vu and perceived familiarity intensity diminished somewhat after the turn was taken, as there was a significant interaction revealed by a 2×2 Déjà vu State Status (déjà vu vs. non-déjà vu state reported) $\times$ Before-After Condition (before vs. after the turn) repeated measures ANOVA performed on the familiarity intensity ratings, $F(1, 63)=20.87$, $MSE=.32$, $p<.001$. In particular, perceived familiarity intensity during déjà vu diminished after the turn was taken, as shown by a significant main effect of Before-After Condition, $F(1, 63)=11.02$, $MSE=.37$, $p=.002$. As expected, there was a main effect of Déjà vu State Status, $F(1, 63)=291.96$, $MSE=2.65$, $p<.001$, reflecting the higher perceived familiarity intensity during and following déjà vu reports than non-déjà vu reports.

Association between familiarity intensity and feelings of prediction during déjà vu Among instances of reported déjà vu, perceived familiarity intensity ratings given before the turn was

taken were higher when feelings of prediction were indicated ($M=5.79$, 95% CI [5.29, 6.29]) than when they were not ($M=4.71$, 95% CI [4.18, 5.25]), $t(46)=4.56$, $SE=.24$, $p<.001$, $d=.61$. Note that not all participants reported feelings of prediction (or a lack thereof) during reports of déjà vu, which explains the degrees of freedom relative to other analyses. The association between familiarity intensity and the feeling of prediction during déjà vu persisted among familiarity intensity ratings that were given after the turn was taken. Higher familiarity intensity ratings were given after the turn following instances of feelings of prediction during déjà vu ($M=5.65$, 95% CI [5.12, 6.19]) than following instances of no feelings of prediction during déjà vu ($M=4.54$, 95% CI [3.98, 5.10]), $t(46)=4.22$, $SE=.26$, $p<.001$, $d=.60$. A 2×2 Feeling of Prediction State Status (feeling of prediction vs. no feeling of prediction) $\times$ Before-After Condition (before vs. after the turn) repeated measures ANOVA performed on the familiarity intensity ratings showed no interaction, $F(1, 46)<1.0$. This suggests that the association between familiarity intensity and initial feelings of prediction during déjà vu did not diminish after the turn was taken. However, in addition to the expected main effect of Feeling of Prediction Status, $F(1, 46)=19.74$, $MSE=2.85$, $p<.001$, there was a main effect of Before-After, $F(1, 46)=7.60$, $MSE=.15$, $p=.008$, such that overall familiarity intensity during déjà vu diminished after the turn was taken.

General discussion

The present study demonstrates a novel postdictive bias associated with the déjà vu experience. Following déjà vu reports, especially those accompanied by feelings of prediction in the first place, participants reported greater feelings that the event unfolded as they had expected. Although it might be expected for participants to sometimes feel as if an event generally unfolded as expected, in the present study, there was no rational reason for an association between such feelings and déjà vu reports. The study had been designed in the first place to ensure that déjà vu would be associated with no actual predictive or postdictive ability. Predicting the outcome of the event, in this case a turn, was designed to be like predicting the outcome of a coin flip. Although one might often feel that the outcome went generally as expected, there should be no association between the likelihood of that feeling and the initial report of déjà vu and its accompanying feeling of prediction beforehand. Furthermore, the baseline bias during non-déjà vu was toward believing that the outcome did *not* unfold as expected. Our results suggest that déjà vu is strongly associated with feeling that the outcome *did* unfold as expected.

Why should there be a postdictive bias associated with déjà vu? One possibility is that there is some inertia associated with experiencing the initial feelings in the first place. That is, the initial feeling of prediction might persist in a way that prompts consistency of perception as a scene unfolds over time. One factor that might drive such inertia is the continued perceived familiarity intensity throughout the unfolding of the scene (Fig. 4). High familiarity intensity levels before the turn might be experienced as a feeling of being on the verge of retrieving how the scene unfolds (e.g., being on the tip of an experience). Then, continued high familiarity intensity as it does unfold might be construed as a confirmatory feeling regarding how the scene did unfold, resulting in a knew-it-all-along feeling. It is important to note that our results at this stage are correlational; it is not clear yet whether déjà vu drives the postdictive bias or whether a third factor is involved. Determining whether familiarity drives both déjà vu and the postdictive bias is an important future direction.

Author note The data for this study are available at the following link: https://osf.io/qkb54/?view_only=3388b99b80904a228ea10626ac4ba645

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