Memory of the UK's 2016 EU Referendum: The effects of valence on the long-term measures of a flashbulb memory.

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Supplemental Material: Additional details of coding and analysis, included tables and figures is also included.

Sharing of Materials and Data: Summarized data, survey questions, coding manuals and experiment codes are accessible through the following link: <https://osf.io/swu5a/>

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Abstract

Emotional public events, relative to non-emotional ones, are typically remembered more accurately, more vividly and with more confidence. Such memories are referred to as flashbulb memories. However, the majority of previous studies on this phenomenon have focused on negative public events and less is known about positive ones. The current study examined whether positive and negative public events were remembered in a similar manner by assessing individuals' memory for the time when they learned the results of the UK's 2016 Referendum on its European Union (EU) membership. Participants included UK residents who voted to '*leave*' the EU in the referendum and found the event highly positive, UK residents who voted to '*remain*' in the EU and found the event highly negative, and US residents who did not vote and found the event neutral. Data from a total of 845 participants were assessed at four time points over the course of 16 months. Growth curve modelling showed that differences in memory between Remain voters (who reported the highest levels of negative emotion) and Leave voters (who reported the highest levels of positive emotion) emerged over time. Specifically, Remain voters maintained higher levels of memory consistency than Leave voters, while Leave voters maintained higher levels of memory confidence than Remain voters. These results indicate that positive and negative public events are remembered differently, such that negative valence enhances memory accuracy, while positive valence results in overconfidence.

Keywords: Emotion and memory; Rehearsal; Personal importance; Memory consolidation; Autobiographical memory; Episodic memory

Introduction

Emotional items and events are typically remembered better than non-emotional items and events (for reviews see LaBar & Cabeza, 2006; Talmi, 2013) and are often preserved in memory for longer, sometimes spanning several years (Dolcos et al., 2005; Levine & Edelstein, 2009). While this emotion-enhancing pattern is frequently shown in lab-based experiments (Dewhurst & Parry, 2000; Dolcos et al., 2004, 2005; Dolcos & Cabeza, 2002; Kensinger et al., 2006; Sakaki et al., 2012, 2019), it also extends to real-life autobiographical memories. Flashbulb memories are a unique example of such memories that are typically formed following a surprising and highly emotional public event such as a national disaster or the death of a well-known public figure. These memories are not necessarily about the public event itself but are the personal circumstances in which one first learns about the public event (Conway et al., 1994; Hirst et al., 2018). They have been considered as long-lasting memories that are associated with high levels of subjective vividness and confidence (Brown & Kulik, 1977).

Flashbulb memories are typically more accurate than memories for ordinary events (Christianson, 1989; Conway et al., 1994; Curci & Luminet, 2006; Hornstein et al., 2003) though they are still susceptible to distortion (Schmolck et al., 2000; Talarico & Rubin, 2003). Flashbulb memories are also associated with high confidence (Hirst et al., 2009; Talarico & Rubin, 2007) and high vividness even after a long interval (Hirst et al., 2015). These preserved phenomenological features of flashbulb memories are believed to depend on a number of factors such as surprise (Brown & Kulik, 1977; Páez et al., 2018), rehearsal (Berntsen & Thomsen, 2005; Breslin & Safer, 2011; Koppel et al., 2013), emotional intensity (Berntsen & Thomsen, 2005; Tekcan, 2001) and personal importance (Brown & Kulik, 1977; Conway et al., 1994).

Despite the large number of studies on flashbulb memories, however, many of them focused predominantly on negative public events such as the 9/11 terrorist attack (Curci & Luminet, 2006; Hirst et al., 2009; Kvavilashvili et al., 2009) or the deaths of well-known figures (Brown & Kulik, 1977; Day & Ross, 2014; Hornstein et al., 2003). Consequently, our understanding of the relationship between positive emotion and flashbulb memories is limited. In the current paper, we address whether a public event that is interpreted as either positive or negative is similarly remembered over time by assessing individuals' memory for the United Kingdom (UK)'s 2016 Referendum on their European Union (EU) membership.

Early reports suggested that valence yielded no significant differences in how vivid flashbulb memories were or what information could be recalled (i.e. where they were, what they were doing, how they heard of the event, what they did afterwards and how they and others felt; Scott & Ponsoda, 1996). Recent research, however, provides mixed evidence for the effects of valence on flashbulb memory measures of vividness, confidence and memory consistency (i.e., a measure for accuracy; Talarico & Rubin, 2003). For example, some studies found that vividness (Berntsen & Thomsen, 2005; Breslin & Safer, 2011; Kensinger & Schacter, 2006), confidence (Bohn & Berntsen, 2007; Liu et al., 2012; Talarico & Moore, 2012) and memory consistency (Liu et al., 2012; Talarico & Moore, 2012) are similar for both positive and negative events. However, there is also evidence that positive and negative emotions are differently associated with vividness (Liu et al., 2012; Talarico & Moore, 2012), confidence (Kensinger & Schacter, 2006; Kraha & Boals, 2014) and consistency (Bohn & Berntsen, 2007; Demiray & Freund, 2015; Kensinger & Schacter, 2006; Levine & Bluck, 2004). Thus, it remains unclear whether memories for positive and negative events are associated with the same levels of vividness, consistency and confidence.

Across these studies, there are two issues which make the interpretation and comparability between them difficult. Firstly, the events themselves are often two separate

events (one representative of each valence) that are arguably different in their qualities (Koppel et al., 2013; Kraha et al., 2014). For example, positive events are often personal ones such as being accepted to college, while the negative events are frequently public events such as natural disasters or tragedies, like the 9/11 terror attack (Kraha et al., 2014; Kraha & Boals, 2014; Liu et al., 2012). Therefore, it is difficult to know whether the differences in memory measures are due to the valence of the events or due to other confounds (e.g., public events receive more media attention than personal events).

Secondly, even when a single event is used that is interpreted by some as positive and others as negative, they often rely on one single follow-up. Not only does this prevent us from being able to understand how flashbulb memories may manifest over time, the time at which memory consistency is assessed following the event differs across studies. For example, Talarico and Moore (2012) assessed memories 10-11 weeks after a sports fixture and concluded that fans of both winning and losing teams were equally consistent and confident in their memory about a football game. Kensinger and Schacter (2006), on the other hand, assessed memory between 23 and 27 weeks after a sports fixture and revealed that negative emotion, compared to positive emotion, lead to better memory accuracy but lower confidence. However, these conflicting findings may simply be due to the differences in the duration between the event and the assessment of memory consistency.

Current Research

The current research aims to address these two issues by assessing participants' memory for a single event over four separate surveys in order to reveal the effects of valence on flashbulb memories. Our second aim is to examine whether or not the maintenance of memories for positive and negative public events similarly rely upon emotional reactions, feelings of surprise, levels of rehearsal and personal importance – factors that have been

implicated in the formation of flashbulb memories (Conway et al., 1994; Finkenauer et al., 1998; Talarico & Rubin, 2017).

To achieve these goals, we assessed memory for the same event – the UK’s 2016 EU Referendum in which the public voted for the UK to leave the European Union (EU) membership, in three groups of participants: a) UK residents who voted to leave the EU and found the event highly positive (i.e., Leave voters), b) UK residents who voted to remain in the EU and found the event highly negative (i.e., Remain voters), and c) US residents who did not vote and found the event neutral. The referendum result indicated the UK’s future intention to end the political and economic partnership with the EU that had been maintained since 1975. Leading up to the official vote, both online- and telephone-polls yielded neck and neck results for both *Leave* and *Remain* parties, signaling a high level of uncertainty in the overall outcome (Barnes, 2016). The marginal ‘Leave’ win with 51.9% of the votes (The Electoral Commission, 2016) was met with high levels of surprise both amongst the UK public and World-Leaders. Therefore, this political event provided us with an ideal opportunity to investigate peoples’ memories for a highly surprising event that yielded both a positive and negative outcome depending on peoples’ voting choice (i.e. Leave vs Remain voters).

Using such a design, we examined the effects of valence on consistency, confidence and vividness for memory for the same event over time. In four separate surveys, at one week and then, three, nine and 16 months after the EU Referendum results, participants answered a number of questions relating to their memory for when they learnt about the EU Referendum results. We focused on the consistency of canonical features of the memories (Brown & Kulik, 1977), including where they were, what time it was, who they were with, how they found out (source of information), what they were doing beforehand, and what they did afterwards. We also assessed subjective memory vividness, subjective memory confidence,

and other factors that have been implicated in the formation of flashbulb memories, such as emotional intensity, surprise, rehearsal, and personal importance.

UK residents were able to vote in the referendum, thus were more likely to be invested in the outcome and were more likely to be directly impacted by the results than United States (US) residents were. Therefore, we expected that compared to their US counterparts, the two UK voting groups would be more likely to form flashbulb memories (i.e. memories that were more confidently held, more consistent and more vivid) due to their higher levels of long-term personal importance, emotional intensity, surprise and rehearsal. We also expected Remain voters to report higher ratings of negative emotional intensity than Leave voters because the results of the referendum were not congruent with their voting choice. Given that the previous literature provides mixed results on whether a particular valence is associated with more consistent, more vivid and/or more confidently held memories, we did not have a specific directional hypothesis but examined a) whether Remain and Leave voters demonstrated different levels of memory consistency, vividness and confidence; and b) whether any differences between the two groups changed across time. We also examined whether the effects of valence on our memory measures were mediated by any of the factors identified in the literature such as emotional intensity, surprise, rehearsal and personal importance.

Methods

Survey Overview

The surveys were administered using SurveyGizmo (<https://www.surveygizmo.com>). Figure 1 represents the timing of each survey. Survey 1 started on July 01, 2016 - one week after the EU Referendum results were announced on June 24, 2016, and continued for a period of ten days until the 11 July, 2016. For the second and third surveys (Surveys 2 and 3), we recruited participants for three weeks and for the fourth survey (Survey 4), the duration of

recruitment was increased to 3 weeks and 5 days to maximize participant retention. The recruitment dates and duration for each follow-up survey were as follows: Survey 2 was between October 14, 2016 and November 11, 2016, Survey 3 was between April 5, 2017 and April 26, 2017 and Session 4 was between October 13, 2017 and November 8, 2017.

Figure 1. Timeline of survey administration including start and end dates and duration for each survey.

Participants and Recruitment

Participants were aged between 18 and 87 and resided in either the UK or the US. They were recruited through Prolific (<https://prolific.ac.uk>), other websites such as <http://psych.hanover.edu/research/exponnet.html>, personal communications, the Undergraduate Research Panel at the University of Reading in the UK and the Older Adult Research Panel at the University of Reading. Participants recruited from Prolific were paid £1 after completing each survey and students from the Undergraduate Research Panel received course credit after completing each survey. The remaining participants received an Amazon money voucher (£1 per survey), or a check (£1 per survey) after completing all follow up surveys. Participants signed an electronic version of the consent form that was given a favorable opinion by the School of Psychology and Clinical Language Sciences Ethics Committee at the University of Reading.

In order to model the change in memory consistency over time, it was important for us to have data from participants who had completed the initial survey and at least two other

follow-up surveys. Considering an expected return rate between 55 and 70% for each survey as is seen in previous longitudinal flashbulb memory studies (Holland & Kensinger, 2012; Levine & Bluck, 2004), we aimed to recruit at least 150 participants (per group) in the first survey to achieve the statistical power of .80 to detect the valence effects observed in Kensinger & Schacter (2006) in the final sample. At the end of each survey, participants were asked if they would be happy to be contacted again for a follow-up survey and if so, were asked to provide an email address. For ethical reasons, only those that stated ‘yes’ to the follow-up invitation were invited back. For the third and fourth survey, we invited all participants who had previously indicated their willingness to be contacted again, even if they had missed a survey in between. For each follow-up study, we also recruited additional participants who had not completed the previous survey to increase our statistical power.

Prior to data analysis, we excluded participants who (i) did not complete the consent form process correctly ($n = 3$), (ii) who provided answers that were not genuine and did not answer the questions correctly ($n = 1$; e.g., entering lengthy paragraphs relating to a completely different topic), (iii) who completed the same survey more than once ($n = 41$), (iv) who never had a UK or US IP address across four surveys ($n = 44$), (v) who did not provide consistent answers to questions on gender, voting choices and age across surveys ($n = 78$), or (vi) who could not be tracked due to inaccuracies in their unique identifying code/ Prolific ID ($n = 8$). Data from a further 166 participants across the four surveys were excluded because they did not meet criteria to be assigned to either voting group or the US group (e.g., non-UK nationals who resided in the UK but were not eligible to vote). An additional 769 participants (Leave: $n = 197$, Remain: $n = 271$, US: $n = 301$) who only took part in the study once were also not included in the main analyses.

Participants included in the final analysis for memory vividness and confidence included 266 Leave voters (146 females; age range: 18-82; $M_{age} = 41.78$, $SD = 13.92$;

Survey 1: 151, Survey 2: 212, Survey 3: 209, Survey 4: 174), 274 Remain voters (178 females; age range: 18-84; $M_{age} = 38.07$, $SD = 15.98$; Survey 1: 189, Survey 2: 223, Survey 3: 219, Survey 4: 176) and 307 US residents (143 females; age range: 18-77; $M_{age} = 35.62$, $SD = 13.66$; Survey 1: 213, Survey 2: 230, Survey 3: 230, Survey 4: 164; see Table 1). As memory consistency scores could only be generated if the participant had taken part in the initial survey (see Coding of Autobiographical Memories), analyses on this measure were performed on data from a sub-set of participants who completed the first survey: 151 Leave voters (89 females; age range: 18-82; $M_{age} = 41.39$, $SD = 14.98$; Survey 1: 150, Survey 2: 139, Survey 3: 96, Survey 4: 78), 189 Remain voters (121 females; age range: 18-84; $M_{age} = 39.82$, $SD = 16.90$; Survey 1: 189, Survey 2: 171, Survey 3: 140, Survey 4: 113) and 213 US residents (89 females; age range: 18-74; $M_{age} = 36.36$, $SD = 13.78$; Survey 1: 213, Survey 2: 173, Survey 3: 144, Survey 4: 94).

Surveys

Each survey began with an electronic information sheet, detailing the purpose and aim of the study along with an electronic consent form. Each returning participant was also sent a unique identifying code that they generated in the previous survey, allowing us to track them over time. Participants were told that the study concerned their memories for the UK's 2016 EU referendum. The main content in each survey was similar across the four surveys (see: <https://osf.io/swu5a/>). In the current study, we focused on the following questions: a) participants' voting choice, b) their memories of learning the outcome of the EU referendum, and c) potential predictors of the formation and maintenance of flashbulb memories implicated in the literature (see Table 2 for a summary of the questions that are relevant to the results presented in this paper).

Voting choice. Participants were asked to indicate if they were eligible to vote or not (Question 9) and those who were eligible to vote in the EU referendum were further asked to indicate their voting choice (Question 10); *to leave* or *to remain* in the EU.

Memory properties. We administered six main questions to establish consistency of flashbulb memories (Questions 2-7 in Table 2) asking for (i) the time when they found out the results, (ii) the source of information (e.g., how they found the referendum outcome), (iii) their location, (iv) who they were with, (v) what they were doing beforehand and (vi) what they did after. We also administered questions assessing their subjective feelings of vividness (Question 1) and confidence in their memory on 7-point Likert scales (Question 8).

Potential predictors.

Emotional intensity (negative emotion). Participants indicated their current emotional reactions towards the event (Questions 11a-11e; angry, sad, anxious, happy and proud all with 7-point Likert scales). An averaged emotion score was created for each time point by averaging negative emotions (*angry*, *sad* and *anxious*) with reverse-scored positive emotion ratings (*happy* and *proud*), resulting in a single measure to represent current feelings of negative emotion (Cronbach α values $>.82$; see Table 3), referred to as *negative emotion* throughout the rest of this paper.

Surprise. Participants also indicated their levels of surprise towards the event (Question 11f; using a 7-point Likert scale). Although surprise is considered to be an emotional reaction, it is often considered to be a separate predictor to emotional intensity (Bohn & Berntsen, 2007; Conway et al., 1994; Er, 2003; Finkenauer et al., 1998). In addition, surprise is often emotionally neutral (Fontaine et al., 2007). Therefore, ratings of surprise were used as an independent measure from the other items on emotion (see Table 3).

Personal importance. Levels of personal importance were assessed using a 7-point Likert scale (Question 12).

Rehearsal. We also assessed levels of rehearsal. Levels of rehearsal in Survey 1 were recorded on a 5-point Likert scale (Questions 13-16), but on 7-point Likert scales in the remaining surveys (Questions 17-19). A current rehearsal score was calculated for Surveys 2, 3 and 4 (α values $>.92$; see Table 3); for Surveys 2-4, we averaged the four rehearsal related questions (Questions a-d for 17-19 respectively), each of which were rated on a Likert scale of 1 “Very little” to 7 “A great deal”. We also obtained the average level of rehearsal at Survey 1 by averaging Questions 13-16; since these questions were answered using a different scale (a 5-point scale) than rehearsal-related questions in the rest of the surveys (a 7-point scale), we did not compare levels of rehearsal at Survey 1 versus those at the follow-up surveys.

Coding of Autobiographical Memories

In order to assess memory consistency over time, the responses to the six main questions (Questions 2-7) from each survey were coded using an adapted version of the Hirst et al. (2009) coding scheme (see Supplementary Materials for further details). This allowed us to create a consistency score for each of the six main questions by comparing the coding values in Survey 1 with coding values in Surveys 2, 3 and 4 separately, using the Survey 1 coding value as the baseline measure. Unlike other coding schemes that allow for memories to be considered consistent with varying levels of specificity (e.g. Neisser & Harsch, 1992), the one developed by Hirst and colleagues uses a two-point classification scheme in which responses are classified as either *inconsistent* or *consistent*. For example, if the coding values in Surveys 2, 3 and 4 were the same as Survey 1, the response was given a “1” to reflect *consistency*. If the coding values differed to Survey 1, then a “0” was given to reflect *inconsistency*. Our final memory consistency score was the averaged overall consistency of the six questions ranging from 0 to 1. The coding was done by several coders who were blind to the survey time and the group the participant belonged to. For each question, a subset (5%)

of the responses was coded by two coders to assess interrater reliability. The percentage agreement between coders was high (>82%); see Supplemental Materials for results when we used a coding approach similar to the one used in Neisser & Harsch (1992).

Coding of Changes in Memory Content over Time

To determine whether a positive event was associated with a greater tendency to repeat inconsistent memories than a negative event was and to examine how incorrectly remembered memories change over time, we undertook a second round of coding to assess the consistency between inter-survey responses (i.e., comparing Survey 2 with Survey 3 and Survey 4 and comparing Survey 3 with Survey 4). As in Hirst et al.'s (2009) paper, this allowed us to examine whether incorrect memories were repeated, corrected or changed in the subsequent survey. For each question, a subset (10%) of the responses was coded by two coders to assess interrater reliability. The percentage agreement between coders was high (>88%).

Data Analysis

Effects of residency and voting choice on memory properties. Our primary analysis concerned the effects of voting choice (Leave vs Remain) and residency (UK vs US) on memory consistency, memory vividness and memory confidence. A series of analyses using structural equation modelling (SEM) were carried out in RStudio (v. 1.1.463) using the *lavaan* (v. 0.6-5) package (Rosseel, 2012). Specifically, we specified a growth curve modelling with SEM (Duncan et al., 2006). This model allowed us to estimate whether voting groups have any short-term effects (initial levels that are reflected by the *intercept*) and long-term effects (the growth over time that are reflected by the *slope*) on our dependent variables. Memory consistency, confidence and vividness were treated as the dependent variables and each were modelled separately (see Figure 2 for a path diagram for memory consistency). Orthogonal contrast coding was used to create two group variables; the first was used to

compare US participants with UK participants (Leave voters = -1, Remain voters = -1, and US participants = 2; referred to as *UK vs US* in the model) and the second was used to compare Remain voters with Leave voters (Remain voters = 1, Leave voters = -1 and US participants = 0; referred to as *Leave vs Remain* in the model). Each model was estimated using maximum likelihood estimations. In addition, a Comparative Fit Measure (CFI), the Robust Tucker-Lewis Index (TLI) and Root Mean Square Error of Approximation (RMSEA) were used to compare the fit of the model. In order to determine a good statistical fit, we accepted models that had CFI and TLI values $>.90$ (Kline, 2016) and RMSEA values $< .08$ (Browne & Cudeck, 1993).

Effects of residency and voting choice on emotional intensity and other potential predictors of memory measures. To examine how residency and voting choice affected emotional intensity and potential predictors of flashbulb memories, such as surprise, rehearsal, and personal importance, another series of growth curve modelling were carried out in RStudio, again using the *lavaan* package. The dependent variables were participants' ratings of the intensity of negative emotion, surprise, rehearsal, and importance, each of which was modelled separately. As in the previous analysis, effect coding was used to create two group variables; '*UK vs US*' and '*Leave vs Remain*'. This analysis allowed us to assess whether the initial ratings of negative emotion, surprise, rehearsal and personal importance differed across residency and voting group; and whether these variables changed over time in a similar manner across the three groups of participants.

Mediation analysis. In order to understand whether levels of the potential predictors (e.g. surprise, personal importance, negative emotion and rehearsal) mediate the effects of residency and voting group on memory consistency, confidence and vividness, we ran three separate mediation analyses (see Figure 3 for a path diagram). Memory consistency, confidence and vividness were each treated as the dependent variable in these three separate

models. Across all three models, the independent variables were residency and voting group and the mediation variables were Survey 1 measures of negative emotion, surprise, personal importance and rehearsal.

Results

Table 1 describes the demographic characteristics of participants included in our analyses. As described in the Supplemental Materials, our three groups of participants differed on measures of age, gender and education. However, controlling for these variables did not change our key results concerning the differences across the three groups (with the exception of the initial levels of memory vividness). Therefore, we report results from analyses without controlling for age, gender and education (see Supplemental Materials for results when we controlled these additional variables).

Effects of Residency and Voting Choice on Emotional Intensity

We expected Remain voters to experience more negative emotions than Leave voters and US residents to experience a more neutral emotional reaction than the two UK voting groups. To test these predictions, levels of negative emotion were firstly analyzed to confirm that our three groups differed on this measure. Growth curve modelling was performed with current levels of negative emotion as the dependent variable and residents (2: US, -1: Remain, -1: Leave) and voting choice (1: Remain vs. -1: Leave) as predictors of growth parameters. The analysis revealed that US participants, compared to UK participants, had lower initial levels of negative emotion, $\beta = -.07$, $t = -2.72$, $p = .006$, and a steeper decline over time, $\beta = -.01$, $t = -3.18$, $p = .001$ (see Table 4). In addition, within our UK participants, Remain voters had higher initial levels of negative emotion, $\beta = 1.35$, $t = 29.50$, $p < .001$, compared to Leave voters. These results suggest that while UK participants initially had stronger negative emotional responses than US participants did, such effects of residency were primarily driven by Remain voters who felt more negative than Leave voters did. We

also found that Remain voters showed a steeper decline in their negative emotion than did Leave voters, $\beta = -.02$, $t = -2.94$, $p = .003$, but Remain voters still reported significantly stronger negative emotion than Leave voters at Survey 4, $t(347) = 21.37$, $p < .001$, $d = 2.29$, 95% CI [2.17, 2.61]. These results support our expectation that Remain voters experienced more negative emotions about the event while Leave voters experienced more positive emotions. Thus, our two UK voting groups interpreted the event differently in terms of its valence.

Effects of Residency and Voting Choice on Memory

Next, we addressed our main research question: whether positive and negative emotions may lead to different outcomes on measures of memory consistency, confidence and vividness over time.

Memory consistency. The analysis on consistency revealed that UK participants had a higher memory consistency score for Survey 2, $\beta = -.05$, $t = -6.72$, $p < .001$, but a steeper decline when compared to US participants, $\beta = .003$, $t = 2.10$, $p = .036$ (Figure 4A). Despite their steeper decline in memory consistency, even at Survey 4, UK participants showed more consistent memories than US participants, $t(283) = 4.64$, $p < .001$, $d = .58$, 95% CI [0.07, 0.16], supporting our prediction that UK participants formed more consistent memories for this political event than US participants.

In addition, while Leave and Remain voters were not significantly different in their initial memory consistency level at Survey 2 ($p = .498$), the two voting groups significantly differed in the slope, which shows that Leave participants exhibited a quicker rate of decline in memory consistency, $\beta = .01$, $t = 2.49$, $p = .013$ (see Table 5A). To follow up this interaction, we computed simple slopes for Leave voters and Remain voters separately and found that the difference was being driven by a significant decline in memory consistency over time for Leave voters, simple slope = $-.01$, $p = .001$, but not for Remain voters, simple

slope = $-.0004$, $p = .887$. These results suggest that positive and negative public events are remembered equally accurately within a short-period of time but differ in the long-term memory accuracy: negative public events tend to be remembered more accurately than positive ones after a long-term delay.

Memory confidence. A similar analysis on memory confidence (Table 5B) revealed that initial confidence levels at Survey 2 (which is reflected by intercepts) were higher for UK participants compared to US participants, $\beta = -.49$, $t = -11.22$, $p < .001$ (Figure 4B). Unlike memory consistency, there were no significant differences between the US and UK participants in their slopes ($p = .096$). These results suggest that UK participants remembered the event with higher confidence both after a short and long-term delays than US participants did.

In addition, we found a significant effect of voting choice on slope, which was in the opposite direction to the memory consistency findings, $\beta = -.03$, $t = -2.07$, $p = .04$. More specifically, Remain participants exhibited a quicker rate of decline in memory confidence compared to Leave voters. In contrast, the two voting groups were not significantly different in the initial levels of confidence ($p = .096$). We next computed simple slopes for Leave and Remain voters separately, and found that both Leave and Remain voters showed significant negative slopes: Leave simple slope = $-.06$, $p = .007$; Remain simple slope = $-.11$, $p < .001$, though the decline is more pronounced for Remain voters. These results suggest that while positive and negative public events are remembered with a similar level of confidence within a short-period of time, the effects of long-term delay on memory confidence are different across them – in the opposite pattern from those observed in memory consistency: after a long-term delay, positive events were remembered with more confidence than negative events even though they were remembered less consistently.

Memory vividness. A similar analysis on memory vividness (Table 5C) revealed that UK participants, compared to US participants, had higher intercepts for their memory vividness, $\beta = -.51, t = -12.96, p < .001$, with a smaller decline over time (Figure 4C), $\beta = -.04, t = -4.47, p < .001$. As in memory consistency and memory confidence, these results support our prediction that UK participants were more likely to form flashbulb memories for this event than US participants were.

We also found that Remain participants yielded a higher intercept for memory vividness compared to Leave voters, $\beta = .10, t = 2.02, p = .047$, but had a similar level of decline over time ($p = .94$). Thus, Remain voters initially had more vivid memories than Leave voters. However, this effect was no longer significant when controlling for age, levels of education and gender (see Supplemental Results). Taken together, these results suggest that negative public events, compared to positive ones, may be remembered more vividly but the differences are smaller than memory consistency and confidence.

Effects of Residency and Voting Choices on Predictive Factors

Next, to examine whether the maintenance of memories for positive and negative events rely upon the same predictive factors, a series of growth curve modelling were performed separately for levels of surprise, personal importance, and rehearsal (Table 6 A, B and C respectively). The results show that UK participants, compared with US participants, had higher intercepts for surprise, $\beta = -.13, t = -2.97, p = .003$, personal importance, $\beta = -.80, t = -23.46, p < .001$ and rehearsal, $\beta = -.67, t = -16.58, p < .001$, suggesting that UK participants initially experienced surprise, perceived the event as personally important, and engaged in rehearsal more than US participants did. Furthermore, when examining Leave and Remain voters, we found that Remain voters had higher intercepts for personal importance, $\beta = .15, t = 3.15, p = .002$, and rehearsal $\beta = .19, t = 2.57, p = .01$, than Leave voters did. However, there was no difference between the two voting groups for the intercept of surprise

($p = .41$). Thus, it appears that Remain voters considered the EU referendum results to be more personally important and engaged in more rehearsal than Leave voters did while both Leave and Remain voters were as equally as surprised by the EU referendum results. We also found a significant rate of change for US participants when compared with UK participants on levels of surprise, $\beta = -.03$, $t = -2.74$, $p = .006$, and importance, $\beta = -.02$, $t = -2.44$, $p = .015$, but not for rehearsal ($p = .72$). These results indicate that US participants, compared to UK participants, showed steeper levels of decline in ratings of surprise and importance but similar levels of decline for rehearsal. We did not find any significant rates of change between Remain and Leave voters on levels of surprise, importance or rehearsal, suggesting that both Remain and Leave voters showed similar levels of decline over time. These results confirm our hypotheses concerning the predictive factors in that we expected UK participants to yield higher long-term levels of surprise, importance and rehearsal compared to US participants.

Mediation Analysis

To address whether negative emotion and any of other predictive factors such as surprise, personal importance and rehearsal are associated with different patterns in memory consistency across Leave vs. Remain voters, we ran a mediation analysis on memory consistency. This mediation analysis found a significant effect of negative emotion in Survey 1 on the slope of memory consistency. However, the effect was in the opposite direction from what we would expect based on our previous analysis; given that Remain voters reported the highest levels of negative emotion and maintained higher memory consistency over time (Table 7A; Figure 3), we expected that negative emotion may be associated with a smaller decline in memory consistency. Instead, we found that while Remain voters reported stronger negative emotions in Survey 1, $\beta = 1.30$, $t = 22.94$, $p < .001$, stronger negative emotion led to *a larger decline* in memory consistency after a long-term delay, $\beta = -.004$, $t = -2.06$, $p = .039$.

These results suggest that sustained memory consistency observed in Remain voters compared to Leave voters after a delay is not necessarily due to negative emotion in Survey 1 *per se*. Instead of negative emotion, we found that rehearsal in Survey 1 mediates the relationship between voting group and memory consistency (Figure 3). Specifically, Remain voters reported greater levels of rehearsal, $\beta = .36$, $t = 6.64$, $p < .001$, and greater levels of rehearsal in turn led to a smaller decline in memory consistency over time, $\beta = .01$, $t = 2.18$, $p = .029$. These results suggest that Remain voters maintained memory consistency better than Leave voters because they had higher levels of initial rehearsal but not necessarily because they experienced stronger negative emotion (see Table 7A). None of the other predictive factors showed significant effects on the slope or intercept.

Two separate mediation models, one for the growth curve of memory confidence (see Table 7B) and another for that of memory vividness (see Table 7C), were also carried out to test the potential mediating effects of the predictive factors on the relationship between voting group and vividness and voting group and confidence. In both models, none of the predictive factors were found to be significant mediators on the slope. However, both models identified importance and rehearsal as significant mediators for the effects of residency on the intercept. More specifically, compared with US participants, UK participants engaged in more rehearsal (memory confidence, $\beta = -.43$, $t = -14.99$, $p < .001$; memory vividness, $\beta = -.43$, $t = -15.02$, $p < .001$), and reported higher levels of importance (memory confidence, $\beta = -.77$, $t = -18.31$, $p < .001$; memory vividness, $\beta = -.77$, $t = -18.16$, $p < .001$). Higher levels of rehearsal and importance in turn predicted higher levels of the intercepts both for memory confidence (rehearsal, $\beta = .32$, $t = 3.98$, $p < .001$; importance, $\beta = .23$, $t = 3.77$, $p < .001$) and memory vividness (rehearsal, $\beta = .38$, $t = 4.87$, $p < .001$; importance, $\beta = .21$, $t = 3.01$, $p = .003$). These results suggest that higher initial levels of memory confidence and vividness

among UK voters may be driven by higher levels of perceived importance and stronger engagement in rehearsal.

Changes in Inconsistent/Inaccurate Memories over Time

Lastly, we examined the changes that occurred in inconsistent/inaccurate memories over time. More specifically, following previous studies (Hirst et al., 2009, 2015), we were interested in whether individuals were more likely to repeat the same error in reporting their memories (“*repeated*”) or to correct their errors in subsequent surveys (“*corrected*”). In addition, we wanted to examine whether residency and voting group influenced the likelihood of these incidences. Firstly, we focused on inconsistent memories in Survey 2 and then calculated the proportion of memories that were then either corrected, repeated or changed to other errors (if the memory was neither corrected nor repeated) in Survey 3 (see Table 8). Proportion scores for corrected, repeated and changed memories were then calculated by dividing the sum of each memory type by the total number of incorrect memories. We then repeated the process but this time, concentrated on inconsistent memories in Survey 3 and calculated the proportion of memories that were then corrected, repeated or changed in Survey 4.

Two separate 3 (Group: Remain vs Leave vs US) X 3 (Memory Type: Repeated vs Corrected vs Changed) Mixed Measures ANOVAs were carried out to examine these effects. The first ANOVA was carried out on participants who had at least one inconsistent memory in Survey 2 and then later took part in Survey 3, comprising of 77 Leave participants (43 females; age range: 18-82; $M_{age} = 45.78$, $SD = 15.80$), 102 Remain participants (66 females; age range: 18-83; $M_{age} = 42.79$, $SD = 17.72$) and 99 US residents (45 females; age range: 18-70; $M_{age} = 39.28$, $SD = 13.92$). This ANOVA revealed a significant main effect of memory type, $F(1, 550) = 27.88$, $p < .001$, $\eta^2 = .09$, without a significant interaction between group and memory type ($p = .69$). Post-hoc analysis using a Bonferroni correction

revealed that across all participants, incorrect memories in Survey 2 were more likely to be repeated ($M = .48$, $SD = .34$) than corrected ($M = .29$, $SD = .33$, $p < .001$, $d = .57$, 95% CI [0.11, 0.28]) or changed ($M = .24$, $SD = .31$, $p < .001$, $d = .74$, 95% CI [0.16, 0.33]) in Survey 3. There was no significant difference between changed and corrected memories, $p = .45$.

The second ANOVA was carried out on participants who had at least one inconsistent memory in Survey 3 and then later took part in Survey 4, including 46 Leave participants (32 females; age range: 18-82; $M_{age} = 46.30$, $SD = 15.37$), 77 Remain participants (49 females; age range: 19-84; $M_{age} = 44.49$, $SD = 17.81$) and 52 US residents (25 females; age range: 19-70; $M_{age} = 39.58$, $SD = 13.87$). Like the previous ANOVA, there was a main effect of memory type, $F(1, 438) = 6.77$, $p = .001$, $\eta^2 = .03$, without a significant interaction ($p = .61$). Post-hoc analysis using a Bonferroni correction revealed that once again, there was a greater tendency for participants to repeat ($M = .42$, $SD = .38$) incorrect memories from Survey 3 in Survey 4 than they were to correct them ($M = .29$, $SD = .32$, $p = .007$, $d = .35$, 95% CI [0.03, 0.23]), or change them ($M = .29$, $SD = .35$, $p = .008$, $d = .35$, 95% CI [0.03, 0.25]). Taken together, these findings suggest that incorrect memories were more likely to be *repeated* over time than they were to be *corrected* irrespective of voting choice or residency.

Discussion

Flashbulb memories are thought to be formed for both positive and negative events (Bohn & Berntsen, 2007; Liu et al., 2012; Tekcan, 2001). However, the majority of the literature has focused on negative events. In addition, in studies that examined both positive and negative events, the effects of valence on memory consistency and confidence have been mixed, possibly due to the lack of comparability across surveys in terms of the number of follow-up surveys, the duration between the event and flashbulb memory assessment and the types of events that are used. To address these issues within the literature, in the current study, we examined peoples' memory for the UK's 2016 EU Referendum results. Over four

surveys, spanning 16 months, we tested whether memories for the same event differed in short and long-term measures of memory consistency, vividness and confidence across those who perceived the event positively (those who voted to *leave* the EU), those who perceived the event negatively (those who voted to *remain* in the EU), and US residents who served as controls. Thus, the current study has advantages in the sense that the same event was used for each valence thereby controlling for potential differences in the characteristics of the event.

Consistent with our hypothesis, the two UK groups, compared to their US counterparts, reported higher personal importance, higher engagement in rehearsal, stronger feelings of surprise, and stronger emotional reactions. The UK participants also displayed higher levels of memory consistency, confidence, and vividness, both initially and over time, lending support to the idea that flashbulb memories were more likely to be formed among the UK participants than US ones. These findings are consistent with the literature and suggest that flashbulb memories are typically formed for more surprising, emotional and personally important events (Brown & Kulik, 1977; Conway et al., 1994).

In addition, we found valence specific effects within our UK participants. Specifically, Remain voters (who demonstrated the highest level of negative emotions) were initially just as confident and consistent in their memories three months after the referendum results as Leave voters (who demonstrated the highest level of positive emotions). However, over time, Remain voters became more consistent but less confident in their memory for the EU referendum than those who voted to *leave*. These results suggest that the difference in flashbulb memories for positive and negative public events emerges over time; they are remembered in a more similar manner in the short term, but differ after long term retention. Our further analyses showed that while Remain voters were just as surprised as Leave voters were, Remain voters reported stronger negative emotion, reported higher levels of personal importance, and engaged in rehearsal more than Leave voters did. These results point to the

likelihood that the difference between the two voting groups in their memory measures may be due to the difference in their emotional reactions, their perception of personal importance and rehearsal.

In order to test this possibility, we ran a mediation analysis on memory consistency which identified rehearsal as a significant mediator for the effects of voting group on the slope of memory consistency (after controlling for the effects of negative emotion). This means that higher initial rehearsal levels at Survey 1 among Remain voters enabled them to maintain more consistent memories even after a long-term delay. The same mediation analysis also found that stronger negative emotion was associated with *less* consistent memories. Thus, negative emotion is unlikely to be a primary reason why Remain voters (who experienced more negative emotion) had higher memory consistency than Leave voters. Taken together, our results suggest that compared with positive public events, negative public events are remembered in a more consistent manner even after a long interval because they tend to be rehearsed more.

Although it has not always been found to predict memory consistency and/or accuracy (Day & Ross, 2014; Hirst et al., 2009; Kensinger et al., 2005; Kvavilashvili et al., 2003; Pillemer, 1984), rehearsal has been implicated as an important factor in maintaining flashbulb memories (Bohannon, 1988; Neisser et al., 1996). Rehearsal has often been highlighted in studies examining positive and negative flashbulb memories because positive events are often rehearsed more than negative ones (Berntsen & Thomsen, 2005; Breslin & Safer, 2011; Tekcan, 2001). While these patterns are the opposite from what we saw in this study (where Leave voters who experienced positive emotion engaged in less rehearsal than Remain voters who experienced negative emotion), it is important to note that the effects of valence on rehearsal depend on the conditions after the event, such as increased media

attention (Breslin & Safer, 2011). In the UK “Brexit”¹ headlines have dominated the news not only in the immediate aftermath of the Referendum but also for several years after too. We have shown here that even when conditions are similar following an event that is both negative to some and positive to others, negative memories were initially rehearsed more which lead to greater memory consistency over time.

In contrast to memory consistency and memory confidence, another memory measure we had, memory vividness, showed smaller differences between Leave and Remain voters. Specifically, Leave and Remain voters showed similar rates of decline in their memory vividness over time, though Remain voters initially had higher ratings of vividness due to their stronger personal importance ratings and stronger engagement in rehearsal. In addition, this difference in the initial level of vividness was no longer significant after including other control variables, such as age and education (see Supplemental Results). These findings are consistent with previous results in which differences between positive and negative flashbulb memories are observed more in memory consistency and memory confidence than in memory vividness (Berntsen & Thomsen, 2005; Scott & Ponsoda, 1996).

In summary, we found that positive and negative public events are remembered differently after a long-term delay by assessing individuals’ memory for the UK’s EU Referendum. Remain voters who experienced negative emotion maintained more consistent memories even after 16 months, compared to Leave voters who experienced positive emotion. This difference between the two voting groups appears to be driven by differences in rehearsal but not necessarily due to negative emotion. Despite being less consistent and less vivid, Leave voters maintained higher levels of memory confidence than Remain voters.

¹ An abbreviation for “British exit” used to describe the United Kingdom’s decision in 2016 to withdraw its European Union membership.

Our results are consistent with previous findings in which negative emotion has been associated with greater flashbulb memory consistency and/or event accuracy (Bohn & Berntsen, 2007; Holland & Kensinger, 2012) and positive emotion has been associated with greater confidence (Holland & Kensinger, 2012; Kensinger & Schacter, 2006; Levine & Bluck, 2004). Recent experimental research has also demonstrated that relative to positive emotion, negative emotion enhances the mnemonic precision (Cooper et al., 2019; Xie & Zhang, 2017) and higher mnemonic precision leads to higher confidence in retrieval (Xie & Zhang, 2017). One theory which explains this valence effect is the affect-as-information framework (Clore et al., 2001). According to this framework, negative emotion signals a problem, and encourages a type of processing in which more attention is given to the specific details of an event. Positive emotion, on the other hand, is considered to encourage a greater reliance on general knowledge, which can lead to more reconstructive errors and/or false memories (Levine & Bluck, 2004; Storbeck & Clore, 2005). Thus, overconfidence among Leave voters compared to Remain voters and greater memory consistency in Remain voters compared to Leave voters may be due to the effects of valence on the way these voters processed the event. However, this framework does not necessarily explain why the differences in memory consistency between positive and negative events emerge only after a delay.

Another factor which may play a role is arousal. In other words, while valence differed between the two UK voting groups, so too could levels of arousal which may affect long-term memory accuracy. In fact, Storbeck and Clore (2005) argue that valence influences processing, but it is arousal that influences what is to be remembered. Arousing information relative to non-arousing information is consolidated more effectively (LaBar & Phelps, 1998) through the activation of the noradrenergic system and the hippocampal memory formation, resulting in a more stable memory over time (McGaugh, 2000). Negative events are also

sometimes associated with a stronger arousal levels than positive events (Kuppens et al., 2013; Warriner et al., 2013). Therefore, if Remain voters experienced higher levels of arousal compared to Leave voters, this may explain why over time they held more consistent memories. However, as we did not obtain measures of arousal in the current study, we do not know whether levels of arousal contributed to the long-term differences in memory consistency. Future research investigating positive and negative flashbulb memories should also include measures of arousal.

There are also several limitations that need to be mentioned. The first limitation of the current study is that due to the nature of the study, we could not randomly assign participants to the two voting or control group (US participants) meaning that the results may simply reflect the characteristics of the people who voted to *leave* or *remain* in the EU referendum rather than reflecting the effects of valence. In fact, the two groups were significantly different in their age, gender and levels of education. While controlling for age, gender and education did not change our overall results (see Supplemental Results), it is possible that the effects of valence we observe are driven by other factors than valence, which prevents us from establishing the causal effects of valence from our results.

Another limitation to consider is that we have not controlled for the time at which participants learnt the EU referendum results. Given the event's political nature, results from each region within the UK became available whenever counting of the votes within the region was complete up until the official results across the UK were published early the following day. This meant that those watching the live footage could learn the results of individual regions first and may have eventually been able to predict the outcome before the results were officially announced. While some participants made a conscious effort to watch the results throughout the night, others woke up to the news. Between these two sub-groups of participants, levels of surprise may differ causing differences in the way in which the

memories were encoded. In addition, when it came to asking participants questions about where they were and what they were doing etc. participants who stayed up to watch the results, may have provided us with information relating to a different time compared to their initial report. In other words, it is possible that those who monitored the results throughout the night could have two memories regarding the reception event: one for the time before the results were official (i.e. while watching the live footage) and one for after. In the current study, we did not obtain information about whether participants stayed awake all night to monitor the results or not.

Finally, it is also worth noting that over the course of the survey period, the UK underwent two significant political events including the official intention of the UK to leave the EU within two years (i.e. the triggering of Article 50) on 29th March, 2017 and a general election on 8th June, 2017 in which the current governing party lost its majority, resulting in the formation of a minority government. Both of these events dominated the news and as such may have influenced participants' emotional reactions and/or memories.

In summary, the current study provides evidence that memories surrounding the personal circumstances of a significant event that is either interpreted as positive or negative can be remembered with a great deal of consistency, vividness and confidence over a year later. Furthermore, the results suggest that valence can yield different outcomes on flashbulb memory measures both in the short- and the long-term, and corroborate previous findings whereby negative emotion has been associated with better memory consistency while positive emotion has been associated with over-confidence (Kensinger et al., 2006). We also found that higher memory consistency for negative than positive events is primarily driven by rehearsal but not by negative emotion. Our findings highlight the importance of considering rehearsal and the time between the event and when memory measures are obtained when interpreting the results on flashbulb memories.

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Table 1.

Demographic information for participants included in the analysis.

Group	Demographic items	Survey 1 (n = 553)	Survey 2 (n = 665)	Survey 3 (n = 658)	Survey 4 (n = 514)
Remain	n	189	223	219	176
	Age range in years	18-87	18-87	18-84	19-85
	Age Mean (SD)	39.82 (16.90)	39.58 (16.71)	39.88 (16.60)	41.43 (16.95)
	Females	121	145	149	110
	Recruit Type (n)				
	Volunteer	136	167	127	103
	Prolific	28	74	91	91
	Older Adult Research Panel	25	29	23	22
	Student	-	27	32	45
	Education Level (%)				
	GCSE/ High School	3%	8%	3%	3%
	A-Level/ College Equivalent	12%	9%	17%	11%
	Undergraduate Degree	43%	4%	43%	44%
	Post-graduate Degree	24%	1%	23%	27%
	PhD	19%	0%	15%	14%
	Prefer not to say / Did not answer	0%	1%	0%	0%
	Missing	-	77%	-	-
	Political Affiliation (%)				
	Extreme/ moderate left-wing	41%	14%	36%	50%
	Extreme/ moderate right-wing	12%	8%	15%	13%
	Centre	12%	4%	13%	12%
	Other	14%	61%	9%	3%
	Prefer not to say / None	22%	12%	28%	23%
Leave	n	151	212	209	174
	Age range in years	18-82	18-81	18-82	19-83
	Age Mean (SD)	41.39 (14.98)	42.84 (14.65)	43.13 (13.76)	44.27 (13.09)
	Females	89	121	114	95
	Recruit Type (n)				
	Volunteer	16	24	25	15
	Prolific	125	208	208	215
	Older Adult Research Panel	10	13	12	10
	Student	-	2	6	6
	Education Level (%)				
	GCSE/ High School	19%	8%	21%	21%
	A-Level/ College Equivalent	26%	13%	26%	25%
	Undergraduate Degree	42%	3%	37%	39%
	Post-graduate Degree	9%	1%	10%	10%
	PhD	2%	0%	3%	3%
	Prefer not to say / Did not answer	1%	8%	2%	2%
	Missing	-	67%	-	-
	Political Affiliation (%)				
	Extreme/ moderate left-wing	15%	7%	12%	24%
	Extreme/ moderate right-wing	49%	19%	58%	42%
	Centre	2%	2%	0%	1%
	Other	2%	59%	5%	2%
	Prefer not to say / None	32%	13%	24%	30%
US	n	213	230	230	164
	Age range in years	18-74	18-74	18-77	18-77
	Age Mean (SD)	36.36 (13.78)	36.66 (13.66)	36.66 (13.51)	38.41 (14.02)
	Females	89	103	114	81
	Recruit Type (n)				
	Volunteer	3	19	9	7
	Prolific	210	264	284	264
	Student	-	4	-	-
	Education Level (%)				
	GCSE/ High School	15%	1%	10%	15%
	A-Level/ College Equivalent	26%	8%	26%	22%
	Undergraduate Degree	45%	10%	46%	42%
	Post-graduate Degree	11%	4%	13%	17%
	PhD	2%	0%	3%	2%
	Prefer not to say / Did not answer	0%	76%	3%	1%
	Missing	-	76%	-	-
	Political Affiliation (%)				
	Extreme/ moderate left-wing	47%	19%	51%	50%
	Extreme/ moderate right-wing	17%	6%	18%	19%
	Centre	2%	1%	2%	2%
	Other	13%	63%	9%	9%
	Prefer not to say / None	20%	11%	21%	20%

Table 2.

Survey Questions That are Relevant to the Current Analyses

Memory Properties

- 1) How vividly do you remember the time you became aware of the referendum outcome? (1. Not very 7. Extremely)
- 2) What time was it when you found out the results?
- 3) How did you learn the outcome? [TV/ Internet/ Friends or Family/ Newspaper/ Radio / Other] Please use the box below to give us a little bit more detail about the source (such as the name of the TV programme you watched; the
- 4) Where were you when you found out the results? Please describe in one sentence and be specific.
- 5) Who else was there when you found out? Please describe in one sentence and be specific.
- 6) What were you doing beforehand?
- 7) What did you do immediately after finding out the results?

Follow-Up Surveys 2, 3 and 4 - Additional memory property questions.

- 8) How confident are you in your overall recollection of when you found out the referendum results? (1. Not at all – 7. Extremely)

Voting Choice

- 9) Were you eligible to vote in the 2016 UK's EU referendum?
- 10) How did you vote? [To remain in the EU/ To leave the EU/ I was eligible but did not vote]

Emotional Intensity and Surprise

Current feelings about the EU referendum result.

- 11) How strongly do you feel the following emotions when you think of the referendum now? (1. Not at all to 7. Very strongly)
 - a. Angry
 - b. Proud
 - c. Sad
 - d. Happy
 - e. Anxious
 - f. Surprise

Personal Importance

- 12) How important are the referendum results to you? (1. Not important to 7. Extremely important)

Rehearsal

- 13) In the past week how closely have you followed the media coverage of the referendum result? [1. Rarely or none of the time or less than 1 day, 2. Some (1 - 2 days), 3. Occasionally (3 - 4 days), 4. Most of the time (5 - 6 days), 5. Daily]
- 14) Have you thought about the referendum since finding out the results? [1. Rarely or none of the time or less than 1 day, 2. Some (1 - 2 days), 3. Occasionally (3 - 4 days), 4. Most of the time (5 - 6 days), 5. Daily]
- 15) Have you spent on the internet reading the latest news about the referendum? [1. Rarely or none of the time or less than 1 day, 2. Some (1 - 2 days), 3. Occasionally (3 - 4 days), 4. Most of the time (5 - 6 days), 5. Daily]
- 16) Have you talked about the referendum with your friends/family and colleagues? [1. Rarely or none of the time or less than 1 day, 2. Some (1 - 2 days), 3. Occasionally (3 - 4 days), 4. Most of the time (5 - 6 days), 5. Daily]

Follow-Up Surveys - Additional rehearsal questions

Survey 2

- 17) *In the past 3 months.. Using the scale below, please select the most appropriate answer (1 = Very little to 7 = A great deal).*
 - a. How closely have you followed the media coverage of the referendum result?
 - b. Have you thought about the referendum since finding out the results?
 - c. Have you spent on the internet reading the latest news about the referendum?
 - d. Have you talked about the referendum with your friends/family and colleagues?

Survey 3

- 18) *In the past 9 months.. Using the scale below, please select the most appropriate answer (1 = Very little to 7 = A great deal).*
 - a. How closely have you followed the media coverage of the referendum result?
 - b. Have you thought about the referendum since finding out the results?
 - c. Have you spent on the internet reading the latest news about the referendum?
 - d. Have you talked about the referendum with your friends/family and colleagues?

Survey 4

- 19) *In the past 16 months.. Using the scale below, please select the most appropriate answer (1 = Very little to 7 = A great deal).*
 - a. How closely have you followed the media coverage of the referendum result?
 - b. Have you thought about the referendum since finding out the results?
 - c. Have you spent on the internet reading the latest news about the referendum?
 - d. Have you talked about the referendum with your friends/family and colleagues?

Demographics

- 20) Please enter your age.
 - 21) Where do you currently reside?
 - 22) Please indicate your nationality.
 - 23) Please indicate your gender / sex.
 - 24) Please select your highest level of education.
-

Table 3.

Consistency, Confidence and Vividness in Flashbulb Memories and Negative Emotion, Personal Importance, Surprise and Rehearsal as a Function of Voting Group and Residency, Across All Surveys

	Remain		Leave		US	
Memory assessments and survey	<i>M</i> (SD)	<i>n</i>	<i>M</i> (SD)	<i>n</i>	<i>M</i> (SD)	<i>n</i>
Flashbulb Memory Consistency						
3 Months	0.71 (0.20)	171	0.68 (0.19)	139	0.55 (0.22)	173
9 Months	0.68 (0.19)	140	0.63 (0.21)	97	0.56 (0.23)	144
16 Months	0.71 (0.19)	113	0.60 (0.18)	78	0.55 (0.20)	94
Flashbulb Memory Confidence						
3 Months	5.91 (1.03)	223	5.76 (1.30)	212	4.34 (1.65)	230
9 Months	5.58 (1.24)	222	5.66 (1.39)	212	4.31 (1.69)	230
16 Months	5.40 (1.27)	176	5.52 (1.42)	174	3.98 (1.76)	164
Flashbulb Memory Vividness						
0 Months	6.54 (0.83)	189	6.26 (1.14)	151	5.11 (1.74)	213
3 Months	6.22 (1.06)	223	6.02 (1.37)	212	4.12 (1.83)	230
9 Months	6.05 (1.17)	222	5.99 (1.31)	212	4.15 (1.77)	230
16 Months	5.78 (1.37)	176	5.57 (1.70)	174	3.67 (1.71)	164
Negative Emotion						
0 Months	5.57 (0.86)	189	2.97 (1.16)	212	3.95 (1.15)	212
3 Months	5.35 (0.95)	223	2.76 (1.16)	212	3.72 (0.99)	230
9 Months	5.30 (0.99)	222	2.64 (1.04)	174	3.76 (1.12)	230
16 Months	5.29 (1.00)	176	2.90 (1.08)	212	3.64 (1.04)	164
Personal Importance						
0 Months	6.43 (0.77)	188	5.85 (1.28)	151	3.82 (1.67)	213
3 Months	6.15 (1.01)	223	5.85 (1.24)	212	3.40 (1.53)	230
9 Months	5.99 (1.15)	222	5.95 (1.19)	212	3.53 (1.65)	230
16 Months	6.07 (1.12)	176	5.79 (1.26)	174	3.31 (1.63)	164
Surprise						
0 Months	3.95 (1.79)	189	4.23 (1.85)	151	3.72 (1.80)	213
3 Months	3.78 (1.82)	223	3.74 (1.90)	212	3.09 (1.86)	230
9 Months	3.52 (1.68)	222	3.86 (1.77)	212	3.15 (1.91)	230
16 Months	3.65 (1.65)	176	3.59 (1.74)	174	2.78 (1.68)	164
Rehearsal						
0 Months *	4.27 (0.85)	189	3.55 (1.09)	148	2.59 (1.02)	212
3 Months	4.84 (1.42)	223	4.41 (1.62)	212	2.69 (1.46)	230
9 Months	4.68 (1.39)	222	4.55 (1.42)	212	2.66 (1.38)	230
16 Months	4.39 (1.43)	176	4.16 (1.45)	174	2.39 (1.32)	164

* Rehearsal measures were recorded on a 5 point Likert scale for Survey 1 and on a 7 point Likert scale for Surveys 2 (3 months), 3 (9 months) and 4 (16 months).

Table 4.

Growth Curve Models of Negative Emotion

	<i>b</i> (SE)	t-value	95% CI
<i>Intercept</i>	4.02 (0.04)***	106.65	3.85 – 4.01
US vs UK	-0.07 (0.03)**	-2.72	-0.12 – -0.02
Remain vs Leave	1.35 (0.05)***	29.50	1.25 – 1.43
<i>Slope</i>	-0.02 (0.01)***	-3.23	-0.02 – 0.00
US vs UK	-0.01 (0.004)***	-3.18	-0.02 – 0.01
Remain vs Leave	-0.02 (0.01)***	-2.94	-0.04 – 0.01
Correlations			
Intercept ~ Slope	-.19 (.13)	-1.47	-0.45 – 0.04
Model Fit Indices			
Comparative Fit Index (CFI)		0.975	
Robust Tucker-Lewis Index (TLI)		0.961	
Root Mean Square Error of Approximation (RMSEA)		0.082	

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 5.

Growth Curve Models of (A) Memory Consistency, (B) Memory Confidence and (C) Memory Vividness

	A. Memory Consistency			B. Memory Confidence			C. Memory Vividness		
	<i>b</i> (SE)	t-value	95% CI	<i>b</i> (SE)	t-value	95% CI	<i>b</i> (SE)	t-value	95% CI
<i>Intercept</i>	0.64 (0.01)***	61.94	0.62 – 0.66	5.46 (0.06)***	96.33	5.34 – 5.57	5.84 (.05)***	114.06	5.74 – 5.94
US vs UK	-0.05 (0.01)***	-6.72	-0.07 – -0.04	-0.49 (0.04)***	-11.22	-0.02 – 0.23	-.51 (.04)***	-12.96	-0.59 – -0.43
Remain vs Leave	0.01 (0.01)	0.68	-0.02 – 0.03	0.10 (0.06)	1.66	-0.02 – 0.02	.10 (.05)*	2.02	0.00 – 0.19
<i>Slope</i>	-0.003 (0.002)***	-1.55	-0.01 – 0.00	-0.08 (0.01)***	-6.54	-0.11 – -0.06	-.14 (.01)***	-12.38	-0.16 – -0.12
US vs UK	0.003 (0.002)*	2.10	0.00 – 0.01	0.00 (0.01)	0.26	-0.02 – 0.02	-.04 (.01)***	-4.47	-0.05 – -0.02
Remain vs Leave	0.01 (0.003)*	2.49	0.001 – 0.01	-0.03 (0.01)*	-2.07	-0.06 – 0.00	-.001 (.01)	-0.08	-0.02 – 0.02
Correlations									
Intercept ~ Slope	-0.38 (0.19)*	-2.02	-0.75 – -0.01	-0.22 (0.24)	-0.92	-0.68 – 0.25	.24 (.26)	0.92	-0.27 – 0.75
Model Fit Indices									
Comparative Fit Index (CFI)		0.985		—	1		—	0.939	
Robust Tucker-Lewis Index (TLI)		0.958		—	1		—	0.921	
Root Mean Square Error of Approximation (RMSEA)		0.052		—	0.006		—	0.092	

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 6.

Growth Curve Models of the Predictive Factors (A) Surprise, (B) Rehearsal and (C) Importance

	A. Surprise			B. Importance			C. Rehearsal		
	<i>b</i> (SE)	t-value	95% CI	<i>b</i> (SE)	t-value	95% CI	<i>b</i> (SE)	t-value	95% CI
<i>Intercept</i>	3.82 (0.07)***	58.09	3.69 – 3.95	5.29 (0.05)***	118.40	5.20 – 5.37	4.15 (0.06)***	70.67	4.04 – 4.27
US vs UK	-0.13 (0.05)**	-2.97	-0.22 – -0.05	-0.80 (0.03)***	-23.46	-0.87 – -0.74	-0.67 (0.04)***	-16.58	-0.75 – -0.59
Remain vs Leave	-0.07 (0.08)	-0.82	-0.22 – 0.09	0.15 (0.05)**	3.15	0.06 – 0.25	0.19 (0.07)*	2.57	0.05 – 0.33
<i>Slope</i>	-0.09 (0.01)***	-7.19	-0.12 – -0.07	-0.05 (0.01)***	-5.80	-0.07 – -0.03	-0.09 (0.01)***	-9.05	-0.11 – -0.07
US vs UK	-0.03 (0.01)**	-2.74	-0.04 – -0.01	-0.02 (0.01)*	-2.44	-0.03 – -0.00	0.002 (0.01)	0.35	-0.01 – 0.02
Remain vs Leave	0.01 (0.02)	0.33	-0.03 – 0.04	-0.003 (0.01)	-0.35	-0.02 – 0.02	-0.01 (0.01)	-0.95	-0.04 – 0.01
Correlations									
Intercept ~ Slope	-.46 (.13)***	-3.55	-0.71 – -0.21	-.12 (.10)	-1.23	-0.30 – 0.07	-0.34 (0.15)*	-2.31	-0.64 – -0.05
Model Fit Indices									
Comparative Fit Index (CFI)	—	0.930		—	0.979		—	0.991	
Robust Tucker-Lewis Index (TLI)	—	0.901		—	0.975		—	0.978	
Root Mean Square Error of Approxima	—	0.070		—	0.065		—	0.065	

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7.

Predictive Factors as Mediators Between Residency and Voting Choice in (A) Memory Consistency, (B) Memory Confidence and (C) Memory Vividness

	A. Memory Consistency			B. Memory Confidence			C. Memory Vividness		
	<i>b</i> (SE)	t-value	95% CI	<i>b</i> (SE)	t-value	95% CI	<i>b</i> (SE)	t-value	95% CI
<i>Importance predicted by:</i>									
US vs UK	-0.78 (0.04)***	-18.11	-0.86 – -0.69	-0.77 (0.04)***	-18.31	-0.85 – -0.69	-0.77 (0.04)***	-18.16	-0.85 – -0.68
Remain vs Leave	0.28 (0.06)***	4.79	0.17 – 0.4	0.28 (0.06)***	4.82	0.16 – 0.39	0.26 (0.06)***	4.52	0.15 – 0.38
<i>Negative emotion predicted by:</i>									
US vs UK	-0.11 (0.03)***	-3.37	-0.17 – -0.05	-0.11 (0.03)***	-3.37	-0.17 – -0.05	-0.11 (0.03)***	-3.29	-0.17 – -0.04
Remain vs Leave	1.30 (0.06)***	22.94	1.19 – 1.41	1.30 (0.06)***	22.88	1.19 – 1.41	1.29 (0.06)***	22.71	1.18 – 1.41
<i>Rehearsal predicted by:</i>									
US vs UK	-0.44 (0.03)***	-14.78	-0.50 – -0.38	-0.43 (0.03)***	-14.99	-0.49 – -0.38	-0.43 (0.03)***	-15.02	-0.49 – -0.38
Remain vs Leave	0.36 (0.06)***	6.64	0.26 – 0.47	0.36 (0.05)***	6.65	0.25 – 0.46	0.34 (0.05)***	6.31	0.23 – 0.45
<i>Surprise predicted by:</i>									
US vs UK	-0.12 (0.05)*	-2.33	-0.23 – -0.02	-0.12 (0.05)*	-2.28	-0.22 – -0.02	-0.12 (0.05)*	-2.25	-0.22 – -0.02
Remain vs Leave	-0.13 (0.10)	-1.35	-0.33 – 0.06	-0.14 (0.10)	-1.39	-0.33 – 0.06	-0.15 (0.10)	-1.51	-0.35 – 0.04
<i>Intercept predicted by:</i>									
Importance	0.003 (0.01)	0.31	-0.02 – 0.02	0.23 (0.06)***	3.77	0.11 – 0.35	0.21 (0.07)**	3.01	0.07 – 0.34
Negative Emotion	0.03 (0.01)**	2.50	0.01 – 0.05	-0.10 (0.08)	-1.35	-0.25 – 0.05	-0.02 (0.07)	-0.29	-0.16 – 0.12
Rehearsal	-0.01 (0.01)	-0.95	-0.04 – 0.01	0.32 (0.08)***	3.98	0.16 – 0.47	0.38 (0.08)***	4.87	0.23 – 0.54
Surprise	-0.01 (0.01)	-1.11	-0.02 – 0.01	0.06 (0.04)	1.59	-0.01 – 0.13	0.04 (0.04)	0.88	-0.05 – 0.13
US vs UK	-0.05 (0.01)***	-5.13	-0.07 – -0.03	-0.19 (0.06)***	-3.00	-0.31 – -0.06	-0.32 (0.07)***	-4.88	-0.45 – -0.19
Remain vs Leave	-0.03 (0.02)	-1.28	-0.06 – 0.01	0.06 (0.12)	0.54	-0.17 – 0.3	-0.05 (0.13)	-0.43	-0.3 – 0.19
<i>Slope predicted by:</i>									
Importance	-0.003 (0.002)	-1.54	-0.01 – 0.00	-0.01 (0.02)	-0.83	-0.05 – 0.02	-0.03 (0.02)	-1.57	-0.06 – 0.01
Negative Emotion	-0.004 (0.002)*	-2.06	-0.01 – 0.00	0.01 (0.02)	0.54	-0.03 – 0.05	-0.01 (0.02)	-0.46	-0.04 – 0.03
Rehearsal	0.01 (0.003)*	2.18	0.00 – 0.01	-0.02 (0.02)	-0.70	-0.06 – 0.03	0.01 (0.02)	0.50	-0.03 – 0.05
Surprise	0.001 (0.001)	0.46	-0.00 – 0.00	-0.004 (0.01)	-0.43	-0.02 – 0.02	0.01 (0.01)	0.42	-0.02 – 0.03
US vs UK	0.003 (0.002)	1.53	-0.00 – 0.01	-0.01 (0.01)	-0.95	-0.04 – 0.01	-0.02 (0.01)	-1.60	-0.05 – 0.01
Remain vs Leave	0.01 (0.004)**	2.71	0.00 – 0.02	-0.03 (0.03)	-1.10	-0.09 – 0.03	0.01 (0.03)	0.47	-0.04 – 0.07
Model Fit Indices									
Comparative Fit Index (CFI)	—	0.993		—	0.999		—	0.998	
Robust Tucker-Lewis Index (TLI)	—	0.965		—	0.997		—	0.991	
Root Mean Square Error of Approximation (RMSEA)	—	0.053		—	0.015		—	0.026	

* $p < .05$. ** $p < .01$. *** $p < .001$.

Table 8.

Change of inconsistent flashbulb memories from Survey 2 to Survey 3 and from Survey 3 to Survey 4.

		Corrected	Repeated	Changed
Time	Group	<i>M</i> (SD)	<i>M</i> (SD)	<i>M</i> (SD)
Survey 2 - 3 (3-9 months)	Remain	0.27 (0.33)	0.50 (0.37)	0.23 (0.34)
	Leave	0.26 (0.34)	0.49 (0.36)	0.25 (0.33)
	US	0.32 (0.31)	0.45 (0.30)	0.23 (0.27)
Survey 3 - 4 (9-16 months)	Remain	0.33 (0.38)	0.39 (0.40)	0.28 (0.38)
	Leave	0.30 (0.26)	0.45 (0.37)	0.25 (0.33)
	US	0.25 (0.29)	0.42 (0.37)	0.32 (0.33)

Figure 2. Path diagram of a growth curve model we tested with memory consistency. The two group variables used orthogonal contrast coding: UK vs US (UK = -1; US = 2) and Leave vs Remain (Leave = -1; Remain = 1). Values represent path coefficients from the *intercept* and *slope*.

Figure 3. Path diagram of the mediation model for memory consistency. The two group variables used orthogonal contrast coding: UK vs US (UK = -1; US = 2) and Leave vs Remain (Leave = -1; Remain = 1). Dashed grey lines were nonsignificant paths.

Figure 4. Mean ratings for Remain and Leave voters and US participants for (A) memory consistency, (B) memory confidence and (C) memory vividness. Error bars represent standard errors of means.