

Flashbulb Memory for 11 September 2001

ANDREW R. A. CONWAY^{*,†}, LINDA J. SKITKA,
JOSHUA A. HEMMERICH and TRINA C. KERSHAW[‡]

University of Illinois at Chicago, USA

SUMMARY

The recollection of particularly salient, surprising or consequential events is often called ‘flashbulb memories’. We tested people’s autobiographical memory for details of 11 September 2001 by gathering a large national random sample ($N = 678$) of people’s reports immediately following the attacks, and then by contacting them twice more, in September 2002 and August 2003. Three novel findings emerged. First, memory consistency did not vary as a function of demographic variables such as gender, geographical location, age or education. Second, memory consistency did not vary as a function of whether memory was tested before or after the 1-year anniversary of the event, suggesting that media coverage associated with the anniversary did not impact memory. Third, the conditional probability of consistent recollection in 2003 given consistent recollection in 2002 was $p = .73$. In contrast, the conditional probability of consistent recollection in 2003 given inconsistent recollection in 2002 was $p = .18$. Finally, and in agreement with several prior studies, confidence in memory far exceeded consistency in the long term. Also, those respondents who revealed evidence for consistent flashbulb memory experienced more anxiety in response to the event, and engaged in more covert rehearsal than respondents who did not reveal evidence for consistent flashbulb memory. Copyright © 2008 John Wiley & Sons, Ltd.

Brown and Kulik (1977) introduced the phrase ‘flashbulb memory’ to refer to ‘memories for the circumstances in which one first learned of a very surprising and consequential (or emotionally arousing) event’ such as the assassination of President Kennedy. Brown and Kulik asked participants to provide detailed accounts of where they were, what they were doing, etc. when they heard about different newsworthy events such as the assassinations of John F. Kennedy, Martin Luther King and Robert F. Kennedy. Based on the number of details in these accounts, such as the place in which the participant learned of the event, the informant who brought the news and the ongoing event that was interrupted by the news, Brown and Kulik classified the responses as either reflecting a flashbulb memory or not. As predicted, there was a high incidence of flashbulb memory for salient events such as the assassination of President Kennedy. Moreover, African-American participants reported a higher incidence of flashbulb memory than Caucasian participants for events related to the civil rights movement such as the assassinations of Martin Luther King and Malcolm X. Based on these results, Brown and Kulik argued that a special mechanism, perhaps related

*Correspondence to: Andrew R. A. Conway, Department of Psychology, Princeton University, Green Hall, Princeton, NJ 08544, USA. E-mail: aconway@princeton.edu

† Present address: Department of Psychology, Princeton University, NJ, USA.

‡ Department of Psychology, University of Massachusetts at Dartmouth, MA, USA.

to emotional arousal and triggered by surprise and personal consequentiality, is involved in the formation of flashbulb memories.

Unfortunately, there was no way for Brown and Kulik to verify the *accuracy* of their participants' accounts. The only way to do this would be to record people's accounts of where they were, what they were doing, etc. immediately after the event in question occurred, and then query the same participants some time later and compare the two sets of responses. Experiments that have utilized this test–retest approach have demonstrated that flashbulb memories are often *inaccurate* and that flashbulb memories are actually just as susceptible to memory distortion over time as 'ordinary' memories (Neisser & Harsch, 1992; Talarico & Rubin, 2003; Weaver, 1993) and so it seems that there is no special mechanism for the formation of flashbulb memories (McCloskey, Wible, & Cohen, 1988; Schmolck, Buffalo, & Squire, 2000).

Documentation of *accurate* flashbulb memory is further complicated by the fact that very few researchers have been able to obtain initial reports *immediately* after the event in question. This is problematic because it is well known that forgetting can occur very rapidly (e.g. Ebbinghaus, 1885) and so initial reports that are not obtained immediately are themselves subject to forgetting. Thus, when initial reports are not obtained immediately, subsequent consistent responses may not necessarily be accurate responses. For example Winningham, Hyman, and Dinnel (2000) examined the *consistency* of reports about the O. J. Simpson verdict as a function of the time of initial documentation. They found that participants who completed the initial report 5 hours after the verdict were *less* consistent 8 weeks later than participants who completed the initial report 1 week after the verdict. They speculated that there is an initial consolidation period in which the narrative structure of a memory changes and becomes more permanent. In the current study we were not able to obtain initial reports until at least 1 week after the terrorist attacks. Therefore, we use the term *consistent* rather than *accurate* when an individual participant's responses from time 2 match those produced at time 1.

The terrorist attacks on the United States of America on 11 September 2001 are the latest event to be studied with respect to flashbulb memory. So far the results of these studies seem to support the conventional wisdom in the field, which is that confidence in memory, rather than accuracy or consistency, is what distinguishes flashbulb memories from other memories (for studies of autobiographical memory of 9/11, see Greenberg, 2004; Kvavilashvili, Mirani, Schlagman, & Kornbrot, 2003; Lee & Brown, 2003; Pezdek, 2003; Talarico & Rubin, 2003; Tekcan, Ece, Gulgoz, & Er, 2003). For example Talarico and Rubin (2003) tested people's memory for the circumstances in which they heard about the events of 11 September 2001 and compared memory for 9/11 with memory for a 'recent everyday event'. There was no difference in either the number of consistent or inconsistent details reported with respect to 9/11 and the everyday event. Furthermore, the number of reported consistent details decreased over time and the number of reported inconsistent details increased over time for both reports of 9/11 and the everyday event (memory was tested 1, 6 and 32 weeks after the event). In contrast, measures of belief in memory and in vividness of memory for the event decreased over time for the everyday event but remained stable for 9/11.

The purpose of the current study is to provide another account of autobiographical memory for the events of 11 September 2001, while making three novel contributions. First, group differences in memory performance are examined. Most prior studies of flashbulb memory have relied upon convenience samples such as undergraduate students. Here, a large nationally representative sample was obtained, which allows for an analysis

of memory performance as a function of several demographic variables such as geographical location, age and education level. Geographical location and age are of particular interest because each of these variables has been shown to impact the consistency and/or accuracy of flashbulb memory. Pezdek (2003) found that participants in Manhattan had better event memory but worse autobiographical memory of 9/11 than participants from either California or Hawaii. Thus, we might expect that participants in the Northeast or mid-Atlantic region will show less consistent responding to our questions of autobiographical memory than participants from other parts of the country. With respect to age, there is evidence that autobiographical memory is worse among the elderly relative to young adults (Cohen, Conway, & Maylor, 1994; Tekcan & Peynircioglu, 2002). Thus, we might expect less consistent responding from our elderly participants.

The second novel contribution of the current study is that degradation of memory over time is assessed with two retest stages, both 1 and 2 years after the event. Very few studies in the flashbulb memory literature have tested memory multiple times over a long term (e.g. 2 years). Thus, we tested memory in both 2002 and 2003. This repeated measures approach allows for a more detailed examination of consistency. That is, the likelihood of consistent responding in 2003 will be assessed contingent upon consistent responding in 2002. It is our prediction that participants will be more likely to be consistent in 2003 given that they were consistent in 2002.

The third and final novel contribution of the current study is that we examined the possible effect that media coverage has on memory for events like 9/11. Half of the 2002 sample was tested before the anniversary of 9/11 and the other half was tested after the anniversary. It is possible that the intense media coverage on the anniversary would distort people's memory for the initial event.

We also attempted to replicate prior findings with respect to flashbulb memory. Perhaps the most consistent finding in the literature, as Talarico and Rubin (2003) emphasized, is that confidence, rather than consistency, is what characterizes flashbulb memories. Thus, for each question in our survey we asked participants to also provide confidence ratings. Another common, but not universal, finding in the field is that emotional reaction to the initial event is related to memory accuracy (Bohannon, 1988; Bohannon & Symons, 1992; Christianson, 1989; Finkenauer, Luminet, Gisle, El-Ahmadi, Van der Linden, & Philippot, 1998; Pillemer, 1984; Rubin & Kozin, 1984). We therefore asked several questions in our initial survey, which was administered just days after 9/11, that were designed to gauge emotional reaction to the event. According to Finkenauer et al., initial emotional reaction to the event (as well as surprise) triggers rehearsal of the event, which is also related to accuracy. We therefore asked questions to assess both overt rehearsal, that is how often does one talk about the event, as well as covert rehearsal, that is how often does one think about the event. Finally, another common finding in the flashbulb memory literature is that personal involvement, or what has been termed 'consequentiality', is a predictor of memory accuracy (Brown & Kulik, 1977; Christianson, 1989; Conway et al., 1994; Rubin & Kozin, 1984). We therefore asked questions about personal consequentiality.

PROS AND CONS OF THE CURRENT STUDY

Relative to the rest of the flashbulb memory literature the current project has several strengths as well as some weaknesses. First, the strengths: (1) the terrorist attacks on the World Trade Center and the Pentagon on 11 September 2001 were arguably among the

most salient public events in American history. Many people learned about the events as they unfolded in real time on the radio and television. (2) A large and nationally representative sample of people was included in this study ($N = 678$), which allows us to develop population base-rate estimates of the number of people who developed a flashbulb memory of 9/11. The use of a representative sample also allows for group comparisons and the analysis of the effects of age on memory; (3) Recent advances in survey methodology and technology, as well as a fast-track funding programme at the National Science Foundation, allowed us to collect initial baseline data about where people were and their emotional reactions in the heat of the moment. Specifically, our survey was in the field by Friday, 14 September and 63% of the sample responded within 1 week of 9/11; (4) Memory was tested in both 2002 and 2003, which allows for an examination of the potential degradation of memory over time.

The benefits of this study come with a cost. Our internet methodology allowed for multiple-choice questions only. This means that we were not able to directly examine the details of people's memory and how the details changed over time. The internet-survey format also means that we could only ask a limited number of questions per session. Thus, although we wish we were able to ask more of our respondents, we asked the questions that we felt were most relevant to the examination of flashbulb memory, based on the existing literature.

METHOD

Participants

The study sample was drawn from a panel of respondents maintained by Knowledge Networks (KN). KN recruits panel members using random-digit-dialling telephone selection methods to create a true probability sample of households in the United States. The characteristics of the KN panel therefore closely match those of the US Census (see <http://www.knowledgenetworks.com/knpanel/index.html> for comparisons of the panel with current Census figures). Once a panel member agrees to participate, they are given a free interactive device to access the World Wide Web (e.g. a Web TV), and free internet access in exchange for participation in regular surveys. About 50% of the panellists had no prior access to the web before becoming KN members, so the KN panel is the only web-enabled household panel that is truly representative of the American public.

A random sample of panel members received a password-protected e-mail to alert them that they had a survey to complete during each fielding period, with a 'clickable' link in the e-mail that allowed them to initiate the survey. Participants could access each survey only once, and the surveys were protected from non-panel member access.

The 2001 survey

A random sample of 678 adult KN panel members (reflecting a 93% within panel cooperation rate) responded to a survey between 14 September and 2 October 2001, with over 63% of the completions within the first week of data collection.¹ There were no significant differences in demographic profile (in age, gender, education, income, political

¹Memory performance did not differ for those who completed the initial survey within 1 week of 9/11 and all other respondents.

orientation, region or urban/rural settings) of those who did *versus* did not respond to the first survey.

The 2002 pre- and post-anniversary surveys

Half of the panellists who completed the 2001 survey were sent an e-mail invitation to participate in the second survey several weeks before the anniversary of the 9/11 attacks (23 August 2002) and the other half was sent the invitation to participate after the anniversary of the 9/11 attacks (Friday, 13 September 2002). Each group was given 2 weeks to respond. A total of 458 ($N = 223$ pre- and $N = 235$ post-anniversary) participants responded to the 2002 survey, reflecting a 67% sample retention rate from 2001 to 2002. The demographics of the 2002 sample were similar to that of the 2001 sample, with the exception that older participants were more likely to respond than younger participants ($\chi^2 = 43.18, p < .05$) and participants with some college or a college degree were more likely to respond than participants with only a high school diploma ($\chi^2 = 38.26, p < .05$) (see Table 1).

The 2003 survey

All participants who completed both the 2001 and 2002 surveys were sent a third and final e-mail invitation to participate in the study on 9 August 2003. As in 2001 and 2002, they were given 2 weeks to respond. A total of 319 completed the third survey, reflecting a panel

Table 1. Demographic information for respondents in 2001, 2002 (pre-9/11/02 are those who responded before the first anniversary and post-9/11/02 are those who responded after the first anniversary) and 2003

Demographic information	2001	Pre-9/11/02	Post-9/11/02	2003
Sample size	678	223	235	319
Gender (%)				
Males	49	47	48	47
Females	51	53	52	53
Region (%)				
Northeast	20	25	16	21
Midwest	22	17	26	22
South	35	39	36	37
West	23	20	22	19
Age (%)				
18–29	19	6	14	8
30–44	34	27	31	23
45–59	25	36	34	36
60+	22	31	21	34
Education (%)				
Some high school or less	8	12	6	4
High school diploma	45	37	25	38
Some college	30	29	47	36
Bachelors degree or more	17	22	22	22
Race/ethnicity (%)				
White	78	80	79	82
Black	8	8	9	7
Hispanic	9	8	8	5
Other	5	4	5	5

Note: Some percentage totals are greater than 100% due to rounding error.

retention rate of 70% from 2002 to 2003, and an overall sample retention of 47%. The demographics of the 2003 sample were similar to that of the 2002 sample, with the exception that once again, older participants were more likely to respond than younger participants ($\chi^2 = 13.04, p < .05$) and participants without a high school diploma were less likely to respond than other participants ($\chi^2 = 14.02, p < .05$) (see Table 1).

Materials

The 2001 and follow-up surveys were exactly the same with a few exceptions, which are noted below. All questions were asked in a multiple-choice format with potential responses provided. Each question was followed by a confidence rating, which was scored on a scale of 1 to 5 (1 = not at all, 5 = extremely). Participants responded by 'clicking' the appropriate button, which initiated the next question. The initial survey consisted of 12 questions related to the circumstances in which the person heard the news, followed by a series of questions designed to assess emotional reaction (see Appendix A for the entire survey).

The follow-up surveys administered in 2002 and 2003 consisted of the same exact questions as the initial survey (except emotion was not assessed again) plus an additional eight questions that were designed to test possible effects of overt rehearsal, covert rehearsal and consequentiality on memory. Overt rehearsal was assessed by asking the respondent how often he or she talked about where they were, what they were doing and how they felt on 11 September 2001. Similarly, to assess covert rehearsal, they were asked how often they thought about where they were, what they were doing and how they felt on 11 September 2001. All of the rehearsal questions were scored on a scale of 1 to 5 (1 = never, 5 = all the time). To assess consequentiality, they were also asked how much they thought the world had changed and how much their own life had changed since 11 September 2001 (scored on a five-point scale, 1 = not at all, 5 = extremely).

RESULTS

Results are presented in five sections. First, consistency and confidence for each individual question is presented as a function of when the survey was administered (pre-9/11/02, post-9/11/02 or 8/03). Second, the percentage of participants who revealed evidence for consistent flashbulb memory is presented as a function of when the survey was administered (pre-9/11/02, post-9/11/02 or 8/03) and for several different cohorts (based on demographic variables such as gender, geographical location, age and education). Third, conditional probability analyses are presented, in which the probability of revealing evidence for a consistent flashbulb memory in 2003 is calculated as a function of whether evidence was revealed for a consistent flashbulb memory in 2002. Fourth, emotional reaction to the initial event is presented. Fifth, determinants of a consistent flashbulb memory are investigated by contrasting initial emotional reaction, overt rehearsal, covert rehearsal and consequentiality for those who revealed evidence for a consistent flashbulb memory to those who did not. For all null hypothesis significance tests, $\alpha = .05$ and the tests were non-directional.

Memory and confidence for individual questions

A question was scored as consistent if the participant provided the same response in 2001 and at a later time (pre-9/11/02, post-9/11/02 or 8/03). The percentages of participants who

answered each question consistently and mean confidence ratings for each question as a function of when the memory survey was administered are reported in Table 2. Consistency on individual questions was relatively high; the majority of key questions used to assess flashbulb memory were answered consistently by at least 75% of the participants. Consistency was diminished on more detailed questions such as ‘when did you hear the news?’ (32%), ‘who was the first person you called?’ (53%) and ‘who was the first person who called you?’ (44%). Confidence ratings were consistently high with mean ratings in the ‘very’ to ‘extremely’ confident range.

The anniversary of the event did not seem to affect either memory performance or confidence rating. The consistency percentages and confidence ratings for the pre- and post-anniversary groups were remarkably similar (for all consistency comparisons, χ^2 was not significant, $p > .05$, except for ‘Who was the first person who called you’, which was actually higher post-9/11/02; for all confidence comparisons, t values were not significant,

Table 2. Consistency (C) and confidence ratings (CR) to individual questions in 2002 (pre- and post-9/11/02) and 2003

Question	Pre-9/11/02 ^a		Post-9/11/02 ^b		2003 ^c	
	C (%) ^d	CR ^e	C (%)	CR	C (%)	CR
Where were you when you first learned about the terrorist attack on targets in the United States, 11 September 2001?	83	4.4	87	4.5	87	4.5
How did you first learn about these events?	76	4.5	74	4.6	74	4.5
What were you doing when you first heard the news of these events?	74	4.5	78	4.6	72	4.5
Were you alone or with others with when you first learned the news of the terrorist attack?	87	4.5	86	4.7	84	4.6
Who were you with when you first learned the news of these events?^f	80	4.6	79	4.8	77	4.6
What time did you learn about these events? ^g	29	3.8	35	4.0	30	3.7
Did you donate blood within the first few days after these events?	96	4.7	94	4.8	96	4.7
Did you go to church or other form of memorial service within the first few days of these events?	77	4.6	78	4.6	79	4.6
Who was the first person YOU called on the telephone after you learned of these events?	53	4.2	53	4.3	52	4.2
Who was the first person WHO CALLED YOU on the telephone after you learned of these events?	37	4.0	50	3.8	42	3.8

Note: Average standard error across questions for pre and post = 3%, .10 (C, CR, respectively). Average standard error across questions in 2003 = 2%, .05 (C, CR, respectively). Questions considered as components of a flashbulb memory are in bold.

^aPre- $N = 223$.

^bPost- $N = 235$.

^c $N = 319$.

^dC = percentage of respondents who recalled consistently.

^eCR = confidence rating on a scale of 1–5 (1 = not at all, 2 = slightly, 3 = moderately, 4 = very, 5 = extremely).

^fAsked only to those respondents who indicated they were with others (pre- $N = 154$, post- $N = 147$, $N(2003) = 212$).

^gChoices were half-hour windows; question was scored correct only if the same half-hour window was indicated at time 1 and time 2.

$p > .05$). Thus, it appears that there is no such thing as an ‘anniversary effect’ of media coverage on flashbulb memory.

Consistency and confidence ratings to individual questions also did not change from 2002 to 2003. Consistency to the main individual questions ranged between 74 and 87% in 2002, and remained high in 2003, ranging between 72 and 87% (for all questions, McNemar’s test for comparing dependent proportions was not significant, $p > .05$). Confidence also remained high from 2002 to 2003 (none of the t values comparing confidence ratings were significant, for all $p > .05$, except for the time question, which did reveal a decrease in confidence, $p < .05$). Mean confidence ratings to the main questions in 2002 hovered between 4.4 and 4.8 and similarly ranged between 4.5 and 4.6 in 2003.

Flashbulb memory analyses

Classification of ‘consistent flashbulb memory’ required that participants were consistent in answering questions about where they were, what they were doing, how they heard and who they were with. The percentage of participants who answered all four of these questions consistently is reported in Table 3. In 2002, regardless of when the memory survey was administered (i.e. pre- or post-9/11/02) 48% of participants met the criteria for consistent flashbulb memory, again suggesting that the anniversary did not affect memory performance. In 2003, 45% of participants met the criteria for consistent flashbulb memory. This result is consistent with the findings with respect to consistency to the individual

Table 3. Percentage of participants who revealed evidence for consistent flashbulb memory in 2002 and 2003 (indicated by consistent memory for where they were, what they were doing, how they heard and who they were with)

Cohort	2002	2003
All respondents (%)	48	45
Date of survey (%)		
Pre-9/11/02	48	44
Post-9/11/02	48	45
Gender (%)		
Males	47	44
Females	49	46
Region (%)		
Northeast	51	54
Midwest	53	49
South	46	36
West	44	47
Age (%)		
18–29	43	35
30–44	52	50
45–59	48	45
60+	48	45
Education (%)		
Some high school or less	45	41
High school diploma	47	41
Some college	50	45
Bachelors degree or more	50	51

questions. That is there was not much of a decline in performance from 2002 to 2003. These results are inconsistent with previous results with respect to flashbulb memory (Schmolck et al., 2000; Talarico & Rubin, 2003). Possible explanations for these discrepancies are addressed in the Discussion Section.

In an attempt to find a cohort that might be more or less likely to reveal consistent flashbulb memory, we calculated the percentage of respondents who revealed evidence for consistent flashbulb memory as a function of gender, geographical region, age and education. As revealed in Table 3, the percentage of respondents who revealed evidence for consistent flashbulb memory was remarkably similar across these cohorts. For each demographic variable at each time point (pre-9/11/02, post-9/11/02 or 8/03), likelihood ratio χ^2 tests were conducted to determine if the frequency of consistent flashbulb memory was different across groups (for all demographic variables at each time point, the χ^2 values were not significant, for all $p > .05$).

Conditional probability of flashbulb memory

For the above analyses, consistency for an individual question was judged with respect to the response given in 2001. That is if the response given at a subsequent time point (pre-9/11/02, post-9/11/02 or 8/03) matched the response given in 2001 then the response was considered consistent. With this criterion, 48 and 45% of respondents revealed evidence for consistent flashbulb memory in 2002 and 2003, respectively. However, given that we tested the *same participants* in 2002 and 2003 we can also examine the likelihood that participants revealed evidence for consistent flashbulb memory in 2003 as a function of whether they revealed evidence for consistent flashbulb memory in 2002. That is we can test the probability of a consistent flashbulb memory in 2003, conditional on an consistent flashbulb memory in 2002, that is $P(\text{FB}(2003)|\text{FB}(2002))$. For example if the same participants are represented in the 48 and 45% groups reported above then $P(\text{FB}(2003)|\text{FB}(2002))$ should approach 1. However, if different participants make up the 48 and 45% then $P(\text{FB}(2003)|\text{FB}(2002))$ should approach 0. The results of this analysis are as follows: $P(\text{FB}(2003)|\text{FB}(2002)) = .73$ and $P(\text{FB}(2003)|\sim\text{FB}(2002)) = .18$. Thus, participants were much more likely to reveal evidence for consistent flashbulb memory in 2003 if they had previously revealed evidence for consistent flashbulb memory in 2002.

A slightly different way to illustrate this result is to examine consistency from 2002 to 2003 for all participants. After all, it is possible that participants who were inconsistent in 2002 (relative to 2001) would nevertheless maintain their consistency from 2002 to 2003. In all, 54% of participants had consistent flashbulb memory from 2002 to 2003. The majority of these however (66% of the 54%) were participants who were consistent from 2001 to 2002. This result supports the conditional probability analyses presented above, demonstrating that participants who were consistent from 2001 to 2002 were more likely to be consistent than inconsistent from 2002 to 2003 and were more likely to be consistent than those who were inconsistent from 2001 to 2002.

Emotional reaction to the initial event

Mean ratings to the emotional reaction questions from the initial survey are reported in Table 4. The strongest emotion was clearly sadness ($M = 4.58$ on a five-point scale), followed by outrage ($M = 4.04$), anger ($M = 3.79$), a desire to fight back ($M = 3.74$) and a desire to give or help ($M = 3.71$). As a data reduction technique, the emotional response

Table 4. Emotional reaction to the initial event. Mean and standard deviation for ratings on a scale of 1–5 with 1 being ‘not at all’ and 5 being ‘extremely’. F1 and F2 refer to the factor loadings of each measure from an exploratory factor analysis ($N = 678$)

Emotion	Mean	SD	Anxiety	Rage
Frightened	3.03	1.48	.833	
Need to be with others	3.10	1.36	.760	
Confused	3.36	1.48	.732	
Vulnerable	3.01	1.32	.705	
Need to talk with others	3.22	1.31	.622	
Helplessness	3.52	1.34	.559	
Distracted	3.17	1.44	.519	
Desire to fight back	3.74	1.37		.860
Anger	3.79	1.35		.806
Outrage	4.04	1.23		.790
Hatred	2.91	1.43		.733
Strong	2.93	1.29		.497
A need to give/help	3.71	1.19	.348	.379
Sad	4.58	.82	.364	.373
Indifferent	1.70	1.08		.305

Note: The two factors were correlated, $r = .57$. Only factor loadings greater than .30 are included in the table.

data were submitted to an exploratory factor analysis using principal factor extraction and promax rotation. Inspection of the scree plot and eigenvalues suggested a two-factor solution, which we refer to as ‘anxiety’ and ‘rage’ (factor loadings are presented in Table 4). The correlation between anxiety and rage was strong ($r = .57$), but sufficiently uncorrelated to treat these as discrete emotional reactions to 9/11.

Determinants of flashbulb memory consistency

To gain some insight into factors that are associated with consistent long-term memory, we compared those respondents who revealed evidence for consistent flashbulb memory in both 2002 and 2003 ($N = 113$) to those who did not reveal evidence for consistent flashbulb memory in either 2002 or 2003 ($N = 77$). As in previous analyses, classification of ‘consistent flashbulb memory’ required that participants were consistent in answering questions about where they were, what they were doing, how they heard and who they were with. The results of these analyses are presented in Table 5 and indicate that there were significant differences between groups in the amount of anxiety experienced in response to the event ($p < .05$) and in the amount of covert rehearsal reported in 2003 ($p < .05$). The groups did not differ in the amount of rage experienced in response to the event, overt rehearsal in 2002 or 2003, covert rehearsal in 2002 or perceived consequentiality in 2002 or 2003 (for all, $p > .05$).

Although confidence ratings to the four main questions were uniformly high (most participants responded ‘very’ or ‘extremely’ confident), a significant difference between the groups was observed, such that the consistent flashbulb group reported higher confidence ratings than the inconsistent flashbulb group in both 2002 and 2003 ($p < .05$ for

Table 5. Mean ratings (and standard error) for consistent and inconsistent respondents

	Consistent	Inconsistent	<i>F</i>	<i>p</i>	η^2
2001					
Anxiety	3.20 (.10)	2.74 (.13)	6.42	.01	.03
Rage	3.35 (.13)	3.36 (.17)	.10	.76	.00
2002					
Overt rehearsal	2.18 (.09)	2.12 (.08)	.22	.64	.00
Covert rehearsal	2.55 (.09)	2.66 (.09)	.56	.45	.00
Consequentiality	3.00 (.08)	2.86 (.10)	1.28	.26	.01
Confidence	4.65 (.06)	4.34 (.10)	7.46	.01	.04
2003					
Overt rehearsal	2.49 (.07)	2.32 (.10)	2.10	.15	.01
Covert rehearsal	2.98 (.08)	2.61 (.13)	6.64	.01	.03
Consequentiality	2.99 (.08)	2.81 (.10)	2.01	.16	.01
Confidence	4.62 (.06)	4.32 (.09)	8.15	.01	.04

Note: Overt rehearsal, covert rehearsal, consequentiality and confidence were each assessed with multiple questions (see Materials Subsection). The average response across questions is reported here. Consistent respondents are those who revealed evidence for consistent flashbulb memory both 1 and 2 years after the event ($N = 113$). Inconsistent respondents are those who did not reveal evidence for consistent flashbulb memory at either year 1 or 2 ($N = 77$).

both years). Interestingly, confidence did not change for either group from 2002 to 2003 and the inconsistent group still reported confidence ratings in the 'very' to 'extremely' confident range.

DISCUSSION

The purpose of this project was to provide another perspective on autobiographical memory of 9/11 while making three relatively novel contributions. First, the analysis of different cohorts suggests that there is no simple demographic variable that predicts flashbulb memory consistency. The likelihood of revealing evidence for a consistent flashbulb memory was equivalent regardless of gender, age, geographical location or education. At first glance, our geographical data may seem incompatible with recent findings reported by Pezdek (2003). She found that respondents from Manhattan had better event memory but worse autobiographical memory than respondents from either California or Hawaii. In contrast, we did not find geographical location to be a predictor of memory performance. The key difference of course is that Pezdek purposely obtained a large sample of respondents from Manhattan, whereas our northeast group, for example consisted of respondents from areas across the northeast region of the United States. Pezdek's findings are interesting and suggest that people who were very close to the event exhibit different memory patterns than others. Unfortunately, we had too few respondents from the New York metropolitan area to provide a sufficient follow-up to Pezdek's findings. Also, our lack of an age effect on memory is inconsistent with previous results reported by Cohen et al. (1994) and Tekcan and Peynircioglu (2002). Cohen et al. found that 90% of their young respondents but only 42% of their elderly respondents revealed evidence for consistent flashbulb memory for Margaret Thatcher's resignation. Similarly, Tekcan and

Peynircioglu found that 90% of their young respondents but only 72% of their elderly respondents revealed evidence for flashbulb memory for the 1993 death of the President of Turkey.² In contrast, for our eldest group (age 60+), 48 and 45% revealed evidence for consistent flashbulb memory in 2002 and 2003, respectively, which are the same exact percentages as the entire sample (48 and 45%). It is important to note that the mean and range of age of our eldest group ($M = 71.0$, range 60–87) was similar to the mean and range of Cohen et al.'s elderly group ($M = 71.6$, range 64–84) and Tekcan and Peynircioglu's elderly group ($M = 71.5$, range 64–90). So why the discrepant results? One possible explanation is that there is a selection bias in the current study. That is, perhaps only the more vigilant elderly adults in our elder sample completed the follow-up surveys in 2002 and 2003. This idea is supported by data presented in Table 1, showing that the sample in 2003 was older and more educated than the sample in 2001.

The second novel contribution of the research presented here was the manipulation to assess the impact of the anniversary of 9/11 on memory. Interestingly, whether we assessed people's memories before or after the anniversary of 9/11 had no effect, suggesting that the media coverage surrounding the anniversary did not distort the consistency of responses. Of course, 50% of respondents' memory was already distorted by late summer 2002, perhaps due to the intense media coverage in the days and weeks following 9/11 itself, so we are hesitant to conclude on the basis of this null effect that media coverage in general has no impact on memory for events like 9/11. Indeed, the intense media coverage in the days immediately following the attacks may have affected the *accuracy* of participants' *initial* responses since they were taken at least 1 week after 9/11 (*cf.*, Winningham et al., 2000).

Perhaps the most intriguing results of the current study concern the stability of performance from 2002 to 2003. To recap, there was very little decline in consistency to individual questions from 2002 to 2003 and the percentage of participants who revealed evidence for a consistent flashbulb memory dropped only three percentage points from 48% in 2002 to 45% in 2003. Also, the probability of revealing evidence for a consistent flashbulb memory in 2003 given that one revealed evidence for an consistent flashbulb memory in 2002 was $p = .78$. In contrast, in a study of memory for the O. J. Simpson verdict, Schmolck et al. (2000) reported a decline from 50% revealing evidence for consistent flashbulb memory at 15 months to 29% at 32 months. Of course there are at least three glaring differences between these two studies. One is that the events of 11 September most likely remained in the public discourse much longer than the O. J. Simpson verdict, which might result in more rehearsal of memory for 9/11 than for the Simpson verdict. Second, the participants here responded to multiple-choice questions on a survey whereas the participants in Schmolck et al. provided written narratives. The multiple-choice format may have cued people's memory, and therefore improved performance in our study. Third, the same participants were tested in the present study in 2002 and 2003, whereas Schmolck et al. used a between subjects design. It is possible that, for our participants, completing the follow-up survey in 2002 served to strengthen memory for 9/11 in 2003.

The current results also dovetail nicely with other studies of the reaction to the events of 11 September 2001 and autobiographical memory in general. For instance, initial emotional reaction to the terrorist attacks was accounted for by two factors, which we labelled anxiety and rage. Moreover, these two factors had differential effects on memory

²Tekcan and Peynircioglu's study was not a test/re-test design so true accuracy cannot be evaluated.

consistency such that anxiety was related to memory performance but rage was not. These results are consistent with research by Lerner et al. on the differential effects of fear and anger on cognitive processing. More specifically, Lerner, Gonzalez, Small, and Fischhoff (2003) found that, in response to the 11 September terrorist attacks, a greater fear response was related to greater perceived risk in the future whereas a greater anger response was related to more optimism about future events in the United States. Thus, it is possible that participants who experienced a stronger anxiety/fear response after the attacks also perceived greater future risk, which may have resulted in more rehearsal and better memory performance (*cf.*, Conway, 1995; Er, 2003; Finkenauer et al., 1998).

Indeed, our comparison of consistent responders to inconsistent responders revealed that consistent responders had a stronger anxiety reaction to the event and they covertly rehearsed the event more often than inconsistent responders. These results are mainly compatible with the structural model of flashbulb memory suggested by Finkenauer et al. (1998) (except for the effect of consequentiality, but see below for a possible explanation of this null result). According to their model, flashbulb memories occur as the result of a strong emotional reaction and perceived consequentiality to the initial event, which in turn promotes rehearsal of the event, which leads to greater consistency of memory for the event. We were able to provide a partial test of this model with respect to emotional reaction, covert rehearsal and memory performance (we could not include personal consequentiality because it did not correlate with memory performance). In our model, the indirect effect of anxiety in 2001 on memory consistency in 2003, mediated by covert rehearsal in 2002, was not significant (Sobel test, $z = 1.23, p > .05$). We do not want to draw a strong conclusion from this null result, however, because rehearsal (and consequentiality) was measured in 2002, rather than immediately after the event.

We also found that consistent responders were more confident in their responses than inconsistent responders, in both 2002 and 2003. This result is somewhat inconsistent with previous studies revealing a disconnect between memory consistency and belief in memory consistency (Neisser & Harsch, 1992; Talarico & Rubin, 2003). However, the current results are not entirely inconsistent with these previous claims because confidence ratings for inconsistent responders, although lower than for consistent responders, were still very high (on a five-point scale with 4 being 'very confident' and 5 being 'extremely confident', $M = 4.34$ and $M = 4.32$ in 2002 and 2003, respectively for inconsistent responders). Thus, the current results support Talarico and Rubin's recent claim that confidence rather than consistency is one of the key characteristics of flashbulb memory.

A few caveats with respect to the current study deserve discussion here. First, our initial assumption, and one that we find to be shared by most other cognitive scientists, was that 9/11 was ideal for testing the flashbulb memory hypothesis because the events of the day were so shocking and clearly consequential. However, unlike the assassination of President Kennedy, the events of 9/11 were multi-faceted. In total, there were at least seven shocking moments that day that spanned nearly 3 hours (the four plane crashes, the two building collapses and the evacuation of the White House) and there was a great deal of confusion surrounding the events; initially some thought the first plane was an accident, later it was unknown how many planes were hijacked, the whereabouts of the President were unknown for some time, etc. More personally, some communication channels were down (e.g. many mobile phones were inoperable, making communication with loved ones difficult), large public buildings across the country were evacuated, people's daily routines were altered. In sum, it was a day that involved a great deal of confusion and therefore when one attempts to

recollect a single moment in that day, it may in fact be more difficult than recollecting a more encapsulated event such as the assassination of President Kennedy.

Another caveat with respect to the current study is that the extent to which one found the initial event 'surprising' was assumed, rather than measured. That is we simply assumed that all potential respondents would have found the events extremely surprising and therefore that there would be a ceiling effect on any question to assess surprise such as 'How surprising did you find the events?' However, without this measure we were unable to test the hypothesis that the extent to which one finds the initial event surprising influences the consistency of long-term memory (Conway et al., 1994; Finkenauer et al., 1998).

Another limitation of the current study was the use of a multiple-choice format. Given the internet mode of data collection, this approach was easier than obtaining narratives. However, narratives provide a richer description of autobiographical memory surrounding the moment one learns about surprising events and follow-up narratives are less likely to be accurate/consistent due to chance. Thus, future research should attempt to combine the benefits of collecting data *via* the internet (e.g. large, representative samples) with the benefits of collecting detailed narratives immediately after a surprising or salient public event occurs.

A final limitation of the current study is that perceived consequentiality was assessed in 2002 and 2003, rather than immediately after the initial event. Again, we did this because we suspected ceiling effects on questions like 'How consequential do you think the events were?' The downside of our approach is that the consequentiality measure in 2002 and 2003 is open to the effect of social desirability. That is participants might say that they perceived the events of 9/11 to be consequential because of social pressure. Thus, the current study may not have properly assessed surprise and personal consequentiality, which have been shown to predict consistent long-term memory (Conway et al., 1994; Finkenauer et al., 1998).

In conclusion, the current results contribute three novel findings to the flashbulb memory literature. First, consistency of flashbulb memory for the events of 11 September 2001 is not related to simple demographic variables such as gender, education, geographical region or age. Second, there does not appear to be an 'anniversary effect' on memory. Third, the likelihood of revealing evidence for a consistent flashbulb memory 2 years after the event is much higher if one revealed evidence for a consistent flashbulb memory 1 year after the event. Finally, the current results support previous claims in the flashbulb memory literature, most notably that emotional reaction to the initial event and rehearsal of the event are related to more consistent long-term memory and that confidence in flashbulb memory remains high, regardless of consistency or accuracy.

ACKNOWLEDGEMENTS

Funding for this research was provided by grant #0139292 from the National Science Foundation. We would also like to thank all the people at Knowledge Networks, Inc. for assistance in data collection and preparation. We would also like to thank Nahrain Israel for her assistance in analysing the initial survey data.

REFERENCES

- Bohannon, J. N. (1988). Flashbulb memories for the space shuttle disaster: A tale of two theories. *Cognition*, *29*, 179–196.
- Bohannon, J. N., & Symons, V. L. (1992). Flashbulb memories: Confidence, consistency, and quantity. In E. Winograd, & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of “flashbulb” memories* (Vol. 4, pp. 65–91). New York: Cambridge University Press.
- Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition*, *5*, 73–79.
- Christianson, S. A. (1989). Flashbulb memories: Special, but not so special. *Memory & Cognition*, *17*, 435–443.
- Cohen, G., Conway, M. A., & Maylor, E. A. (1994). Flashbulb memories in older adults. *Psychology and Aging*, *9*, 454–463.
- Conway, M. A. (1995). *Flashbulb memories*. Brighton, Sussex: LEA.
- Conway, M. A., Anderson, S. J., Larsen, S. F., Donnelly, C. M., McDaniel, M. A., McClelland, A. G. R., et al. (1994). The formation of flashbulb memories. *Memory & Cognition*, *22*, 326–343.
- Ebbinghaus, H. (1885). *Über das Gedächtnis*. Leipzig: Dunker. (Translated by H. Ruyer and C. E. Bussenius (1993), *Memory*, New York: Teachers College, Columbia University).
- Er, N. (2003). A new flashbulb memory model applied to the Marmara earthquake. *Applied Cognitive Psychology*, *17*, 503–517.
- Finkenauer, C., Luminet, O., Gisle, L., El-Ahmadi, A., Van der Linden, M., & Philippot, P. (1998). Flashbulb memories and the underlying mechanisms of their formation: Toward an emotional-integrative model. *Memory & Cognition*, *26*, 516–531.
- Greenberg, D. L. (2004). President Bush’s false “flashbulb” memory of 9/11/01. *Applied Cognitive Psychology*, *18*, 363–370.
- Kvavilashvili, L., Mirani, J., Schlagman, S., & Kornbrot, D. E. (2003). Comparing flashbulb memories of September 11 and the death of Princess Diana: Effects of time delays and nationality. *Applied Cognitive Psychology*, *17*, 1017–1031.
- Lee, P. J., & Brown, N. R. (2003). Delay related changes in personal memories for September 11, 2001. *Applied Cognitive Psychology*, *17*, 1007–1015.
- Lerner, J. S., Gonzalez, R. M., Small, D. A., & Fischhoff, B. (2003). Effects of fear and anger on perceived risks of terrorism: A national field experiment. *Psychological Science*, *14*, 144–150.
- McCloskey, M., Wible, C. G., & Cohen, N. J. (1988). Is there a special flashbulb-memory mechanism? *Journal of Experimental Psychology: General*, *117*, 171–181.
- Neisser, U., & Harsch, N. (1992). Phantom flashbulbs: False recollections about hearing the news about Challenger. In E. Winograd, & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of flashbulb memories* (pp. 9–31). Cambridge, England: Cambridge University Press.
- Pezdek, K. (2003). Event memory and autobiographical memory for the events of September 11, 2001. *Applied Cognitive Psychology*, *17*, 1033–1045.
- Pillemer, D. B. (1984). Flashbulb memories of the assassination attempt on President Reagan. *Cognition*, *16*, 63–80.
- Rubin, D. C., & Kozin, M. (1984). Vivid memories. *Cognition*, *16*, 81–95.
- Schmolck, H., Buffalo, E. A., & Squire, L. R. (2000). Memory distortions develop over time: Recollections of the O.J. Simpson trial verdict after 15 and 32 months. *Psychological Science*, *11*, 39–45.
- Talarico, J. M., & Rubin, D. C. (2003). Confidence, not consistency, characterizes flashbulb memories. *Psychological Science*, *14*, 455–461.
- Tekcan, A. I., Ece, B., Gulgoz, S., & Er, N. (2003). Autobiographical and event memory for 9/11: Changes across one year. *Applied Cognitive Psychology*, *17*, 1057–1066.
- Tekcan, A. I., & Peynircioglu, Z. F. (2002). Effects of age on flashbulb memories. *Psychology and Aging*, *17*, 416–422.
- Weaver, C. A. III, (1993). Do you need a “flash” to form a flashbulb memory? *Journal of Experimental Psychology: General*, *122*, 39–46.
- Winningham, R. G., Hyman, E., & Dinnel, D. L. (2000). Flashbulb memories? The effects of when the initial memory report was obtained. *Memory*, *8*, 209–216.

APPENDIX

Intro Screen

We are going to ask you for your memory about where you were, and what you were doing and feeling, when you learned that terrorists had attacked targets in the United States, and how confident you are in those memories.

We understand that this is a very painful subject for many people. We understand if you do not participate in this survey.

1a. Where were you when you first learned about the terrorist attack on targets in the United States, September 11, 2001?

- Home Work School Restaurant Outside
 In transit Store Gym Church Other _____

1b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

2a. To the best of your memory, when did you learn about these events? (Pick the closest option)

- Tuesday, September 11 Wednesday, September 12 Other date: _____

2b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

3a. What time did you learn about these events?

- 12:30 AM
 1:00 AM
 1:30 AM
 2:00 AM
..... (fill in all 24 hours, on the ½ hour)
 12:00 PM

3b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

4a. How did you first learn about these events?

- Radio TV Co-worker Friend Stranger
 Newspaper Sibling Parent Spouse Child
 Internet news Other _____

4b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

5a. What were you doing when you first heard the news of these events?

- Working Driving or riding in a car Eating Exercising
 Riding a bus Riding a train Riding a plane Walking
 Watching TV Shopping Other _____

5b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

6a. Were you alone or with others with when you first learned the news of the terrorist attack? (Check only one)

- Alone With others

6b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

[IF 6a="With others" THEN ASK 7a AND 7b, OTHERWISE SKIP TO 8a]

7a. Who were you with when you first learned the news of these events?

- Spouse Co-worker(s) Children Sibling(s)
 Other extended family Friend(s) Stranger(s)

[Note that there was not an option to check all that apply]

7b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

8a. What events had taken place when you first learned about this series of events? (Check all that apply)

- The first plane had hit one of the towers of the World Trade Center
 The second plane had hit the towers of the World Trade Center
 The plane had crashed in Pennsylvania
 The plane had hit the Pentagon
 The White House had been evacuated
 President Bush had made a statement in Florida

8b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

9a. Did you donate blood within the first few days after these events?

- Yes No

9b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

10a. Did you go to church or other form of memorial service within the first few days of these events?

- Yes No

10b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

11a. Who was the first person YOU called on the telephone after you learned of these events?

- Spouse Co-worker Children Sibling(s)
 Other extended family Friend(s) Stranger(s) Other _____

11b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

12a. Who was the first person WHO CALLED YOU on the telephone after you learned of these events?

- Spouse Co-worker Children Sibling(s)
 Other extended family Friend(s) Stranger(s) Other _____

12b. How confident are you in this memory?

- Not at all Slightly Moderately Very Extremely

13. How did you feel during the first few hours after learning the news about the terrorist attacks?

	Not at all	Slightly	Moderately	Much	Very Much
Angry	<input type="radio"/>				
Sad	<input type="radio"/>				
Confused	<input type="radio"/>				
Frightened	<input type="radio"/>				
Vulnerable	<input type="radio"/>				
Strong	<input type="radio"/>				
Indifferent	<input type="radio"/>				
Desire to fight back	<input type="radio"/>				
Hatred	<input type="radio"/>				
Outrage	<input type="radio"/>				
Helplessness	<input type="radio"/>				
A need to give/help	<input type="radio"/>				
Distracted	<input type="radio"/>				
Need to talk	<input type="radio"/>				
Need to be with others	<input type="radio"/>				

14. Do you have any other memories of where you were, who you were with, or how you felt that you would like to share with us?

ADDITIONAL QUESTIONS ASKED IN 2002 AND 2003

15_1. How often do you think about each of the following with respect to the terrorist attacks on September 11, 2001? [Where you were...]

Never Rarely Sometimes Frequently All the time

15_2. How often do you think about each of the following with respect to the terrorist attacks on September 11, 2001? [What you were doing...]

Never Rarely Sometimes Frequently All the time

15_3. How often do you think about each of the following with respect to the terrorist attacks on September 11, 2001? [How you felt...]

Never Rarely Sometimes Frequently All the time

16_1. How often have you told other people about the following with respect to the terrorist attacks on September 11, 2001? [Where you were...]

Never Rarely Sometimes Frequently All the time

16_2. How often have you told other people about the following with respect to the terrorist attacks on September 11, 2001? [What you were doing...]

Never Rarely Sometimes Frequently All the time

16_3. How often have you told other people about the following with respect to the terrorist attacks on September 11, 2001? [How you felt...]

Never Rarely Sometimes Frequently All the time

17. How much do you think your own life has changed because of September 11, 2001?

Not at all Slightly Moderately Very Extremely

18. How much has your perception of the world changed since September 11, 2001?

Not at all Slightly Moderately Very Extremely