Running head: Effects of Age on Flashbulb and Non-Flashbulb Memories

# Effects of age on phenomenology and consistency of flashbulb memories of September 11 and a staged control event

Lia Kvavilashvili[1], Jennifer Mirani[1], Simone Schlagman[2], James A. K. Erskine[3], and Diana E. Kornbrot[1]

[1] University of Hertfordshire, UK

[2] Inter Science Research, Germany

[3] St.George's, University of London, UK

Address for correspondence:

Lia Kvavilashvili

School of Psychology

University of Hertfordshire

College Lane

Hatfield, Herts, AL10 9AB

United Kingdom

Tel. +44 (0) 1707 285121

*Email: L.Kvavilashvili@herts.ac.uk*

Abstract

The special status of flashbulb memories was investigated by contrasting the effects of age on the phenomenology and consistency of flashbulb memories of September 11 over a 2-year delay period with those of a mundane staged control event, learning that one had not won a small prize. Flashbulb memories produced no significant age effects for either phenomenological characteristics or test-retest consistency, as predicted by Mather's (2004) emotional compensation hypothesis. By contrast, the control event resulted in significant age effects for phenomenological characteristics (e.g., specificity and the amount of detail recalled), but not for test-retest consistency. Furthermore, in both age groups, memories of September 11 were significantly more vivid, detailed and consistent than control memories even though the test-retest interval was twice as long for flashbulb memories. In addition, correlations between consistency scores and ratings of rehearsal were positive for control memories, but negative for flashbulb memories. The theoretical implications of these findings for research on cognitive aging and flashbulb memories are discussed.

*Keywords*: Flashbulb memories, non-flashbulb control memories, flashbulb memories and aging, source memory

Effects of age on phenomenology and consistency of flashbulb memories of September 11 and a staged control event

Memories of personally important and emotionally arousing events are often remembered with great clarity and detail for many years (e.g., winning a competition or having a car accident) while memories of other, more mundane events, fade over time and are easily forgotten. These vivid and long lasting memories are called *flashbulb memories*, and cognitive psychologists have studied them by asking people to remember their personal circumstances at the time when they first heard of an unexpected and dramatic public event.[1] A seminal study by Brown and Kulik (1977) showed that 13 years after the assassination of John F Kennedy, 99% of north American participants were still able to recall at least one of the six basic elements or 'canonical categories' of the context in which they heard the news (the place, activity one was engaged in, source of news or informant, own emotion, others emotion and immediate aftermath). In order to explain these findings, Brown and Kulik (1977) postulated the existence of a special brain mechanism (adopted from Livingston, 1967), which switches on automatically whenever the levels of surprise and importance or consequentiality exceed a certain "threshold'. This results in a fairly detailed and permanent memory trace that is immune to forgetting for many years.

However, the existence of a 'special' flashbulb memory mechanism remains controversial (M.A. Conway, 1995; Luminet & Curci, 2009; Pezdek, 2003b; Winograd & Neisser, 1992). The studies that have addressed this issue have concentrated on two separate aspects of flashbulb memories. The first refers to the long-term retention of quantity, specificity and vividness of flashbulb memories, irrespective of their accuracy (all of which are termed *phenomenology* in this paper). Research on these phenomenological aspects of memory has replicated and substantially extended Brown and Kulik's (1977) original findings by showing that people have vivid and detailed recollections of the reception context even several decades after the event (Berntsen & Thomsen, 2005; Bohannon, Gratz, & Symons Cross, 2007; Tekcan & Peynircioglu, 2002; see also Kvavilashvili, Mirani, Schlagman & Kornbrot, 2003; Talarico & Rubin, 2007). The second aspect is the *consistency* of flashbulb memories, usually assessed by comparing participants' memories soon after the event with those obtained after a delay of several months or years. Research on test-retest consistency of flashbulb memories has been more conflicting with some studies showing fairly good (but not 100%) consistency (e.g., M.A. Conway, Anderson, Larsen, Donnely, & McDaniel, et al., 1994; Tekcan, Ece & Gülgöz, 2003), and others substantial forgetting and distortions (e.g., Neisser & Harsch, 1992; Schmolck, Buffalo & Squire, 2000).

In the light of these findings, some researchers have argued that flashbulb memories are just ordinary memories that have been preserved by frequent rehearsal and media coverage of the event (Neisser, 1982; McCloskey, Wilbe, & Cohen, 1988; Talarico & Rubin, 2003; 2007; Wright, 1993). Others believe that for a special status, "memories of the personal circumstances of news need neither be complete nor immune to forgetting" (p. 56, Larsen, 1992). Instead, one needs to show that flashbulb memories are more vivid, detailed and consistent over long time delays than autobiographical memories of mundane non-flashbulb events.

Another important, and equally valid, way of addressing this issue is to examine the effects of age. If flashbulb memories are encoded automatically (possibly via a 'special' brain mechanism) and do not require attentionally demanding strategic processes, that are known to diminish with aging (Grady & Craik, 2000; Zacks, Hasher & Li, 2000), then there should be no age effects in either phenomenological aspects or the test-retest scores of young and old adults. The present investigation examines the issue of special status by comparing the effects of age on the phenomenology and consistency of memory, over long delay periods, for a flashbulb event of September 11 (Study 1) and a staged non-flashbulb control event (Study 2).

*Effects of age on flashbulb memories*

The few existing studies on phenomenological aspects of flashbulb memories and aging have resulted in conflicting findings. Some studies show reliable age effects in the number and/or specificity of the recalled details (Kensinger, Krendl, & Corkin, 2006; Tekcan & Penircioglu, 2002; Yarmey & Bull, 1978), while others report no age effects (Wolters & Goudsmit, 2005; Wright, Gaskell, & O'Muircheartaigh, 1998). Research on test-retest consistency has also been mixed. An early study by Cohen, Conway and Maylor (1994) found significant forgetting and distortion in older British participants for their memories of the resignation of Margaret Thatcher, after a delay of 11 months. However, other studies have failed to replicate this finding (A.R.A. Conway, Skitka, Hemmerich, & Kershaw, 2009; Davidson, Cook, & Glisky, 2006; Davidson & Glisky, 2002; Otani, et al., 2005; but see Kensinger et al., 2006). A study by Davidson et al. (2006) is particularly interesting as it used the same test-retest delay of 11 months but found no age related deficit in remembering personal circumstances of hearing the news of September 11. The authors therefore suggest that "flashbulb memories may be different from usual cases of source memory because of their emotional content, personal importance, or social relevance" (p. 19).

Inconsistent findings could be due to a variety of methodological factors such as differences in flashbulb events, sample sizes, scoring methods. For example, the resignation of Margaret Thatcher and the explosion of space shuttle Columbia were probably not as emotionally arousing/personally significant as the 9/11 terrorist attack, hence the significant age effects in the studies of Cohen et al. (1994) and Kensinger et al. (2006) but no age effects in Davidson et al. (2006). Furthermore, several studies did not screen older participants and the reported age effects could be due to the inclusion of older adults with early stages of dementia (e.g., Kensinger et al., 2006; Tekcan & Penircioglu, 2002). Most importantly, all previous test-retest studies have used fairly short delay intervals of 6 to 12 months. To assess whether flashbulb memories are similar to usual cases of source memory it may be necessary to examine age effects with longer delay intervals (*cf*. Tekcan & Peynircioglu, 2002). To address these issues, the current study examined flashbulb memories of September 11 (possibly the most tragic event in flashbulb research so far), used a long delay of almost two years and thoroughly assessed the cognitive status of participants.

*Comparing flashbulb and non-flashbulb control memories*

In order to properly understand age effects on flashbulb memories, it is also crucial to have a truly comparable non-flashbulb control event (*cf*. Kensinger et al., 2006). Although there are a growing number of studies that have used control events, none are totally satisfactory. Comparisons of reception context to memories of the actual event (e.g., factual details of the terrorist attack) are interesting but not entirely appropriate as they confound a type of memory (autobiographical vs. semantic) (Bohannon, 1988; Bohannon & Symons, 1992; Bohannon, et al., 2007; Er, 2003; Nachson & Zelig, 2003; Pezdek, 2003a; Shapiro, 2006; Smith, Bibi & Sheard, 2003; Tekcan, Ece, Gülgöz & Er, 2003; Wolters & Goudsmit, 2005). [2] The most relevant studies have compared flashbulb memories to personal autobiographical memories (usually, a self-selected salient event from the week preceding the flashbulb event) with mixed results. Some studies show superior consistency of flashbulb memories (Christianson, 1989; Curci & Luminet, 2006; Davidson et al., 2006; Tekcan &

Peynircioglu, 2002), while others report no reliable differences (Davidson & Glisky, 2002; Talarico & Rubin, 2003; 2007; see also Kensinger et al., 2006; Weaver, 1993).

The control events used in these studies have been criticized (Brewer, 1992; Larsen, 1992), and Wright and Gaskell (1995) have complained about the lack of clarity as to what can count as a good control event in these studies. Personal events chosen by participants are different for each participant, both in terms of the event contents and its emotional impact. Moreover, these self-selected memories are not about the context of hearing the personal news. They are the event itself. Hence, one of the major canonical categories of ‘source’ (a defining feature of all flashbulb memory descriptions, see Neisser & Harsch, 1992, Shapiro, 2006) is not applicable.

Consequently, Brewer (1992) suggested that a proper comparison should (a) involve a control event that asks participants to recall their personal circumstances of hearing some mundane personal news, and (b) be the same for all participants. This will ensure that the two events are comparable in terms of canonical categories, including the source. The present study, to our knowledge, is the first to have used such a control event and compared it with a flashbulb event.

*Strategy for this study*

The present investigation comprises two studies with nearly identical designs. The first used a dramatic flashbulb event - the terrorist attack in New York on September 11, 2001. The second used a staged non-flashbulb control event from participants’ own personal past. This event was same for all participants and involved receiving the news by mobile phone that the participant was not a winner in a prize draw run by the experimenter. Using mobile phones ensured that participants would be in a variety of locations, as with flashbulb memories.

In both studies, young and old British participants were initially tested either 1-2 days after the target event (short delay) or 10-11 days after the event (long delay). Half of all participants were first re-tested two weeks after their initial test. This allowed us to assess the amount of forgetting and age effects, if any, that may have occurred between this initial re-test (when memories were fresh) and subsequent re-test after a long delay. In Study 1 (flashbulb memory) all participants were finally re-tested after a delay of 23-24 months. In Study 2 (control memory) all participants were re-tested after a shorter delay of 11-12 months.

Memory was assessed by telephone interview (see Christiansen, 1989; Davidson & Glisky, 2002, Davidson, et al., 2006, for a similar procedure), using an instrument based on the Flashbulb Memory Questionnaire of M.A. Conway et al. (1994). The interview protocol is shown in Table 1. Participants' memories were tested via both free recall (memory description of personal circumstances) and probed recall (answers to canonical questions about *time*, *location*, *activity*, *others present* and *source)*. Consistency of probed recall was assessed by a coding scheme of Neisser and Harsch (1992) and their Weighted Attribute Score (WAS) to enable comparisons with a large number of previous studies (e.g., M.A. Conway et al., 1994; Cohen et al., 1994; Curci & Luminet, 2006; Davidson & Glisky, 2002; Hornstein, Brown , & Mulligan, 2003; Shapiro, 2006; Schmolk et al., 2000; Smith et al., 2003; Tekcan et al., 2003).

*Hypotheses*

If flashbulb memories are different from ordinary autobiographical memories, then the retention of memories of the control event after a shorter delay of 11-12 months would still be worse than those of flashbulb memories after a longer delay of 23-24 months. In addition, according to Mather's (2004) *emotional compensation hypothesis* "age differences in forgetting and distortion should be greater for the control events than for the shocking events" (p. 289). Therefore, it was predicted that age effects, for both phenomenological aspects and test-retest consistency, would be obtained for the control event in Study 2, but not for the flashbulb event in Study 1.

## *Method*

### *Overall design*

The design was between subjects with four independent factors: (1) age of participants (young, old); (2) the type of event (flashbulb, control); (3) delay between the event and initial testing (short, long), and (4) number of initial tests (one, two). Thus, half of the participants were tested only once and half were tested again after two weeks from their initial test. All participants were contacted again for a final re-test after a delay of two years (flashbulb event) or of one year (control event). Since none of the ANOVAs reported in this paper resulted in main effects of *delay between the event and initial testing* and *number of initial tests* (for details, see Kvavilashvili, Mirani, Schlagman, Foley & Kornbrot, in press), or any interactions involving these factors (for an exception see Footnote 8), the results will be reported only for the variables of age (young, old) and type of event (flashbulb, control).

There were three sets of dependent variables (see Table 1): (1) self-rated background measures of encoding and rehearsal (surprise, emotion, rehearsal, confidence, etc.); (2) phenomenological characteristics of memories irrespective of their consistency (the number of canonical items mentioned in free recall, specificity of the response to the 5 canonical items in probed recall and vividness on a 10-point scale); and (3) memory consistency score (WAS) derived from participants' answers to the five canonical questions in probed recall at test and re-test.

*Materials*

The interview protocols for initial tests and a final re-test are shown in Table 1. The free recall and probed recall items were identical to those in the FMQ of M.A. Conway et al. (1994; see also Neisser & Harsch, 1992). Background ratings of emotion, stress and surprise relevant to encoding were obtained on a 10-point scale on all test occasions. Further measures relevant to post encoding, comprising confidence for probed and free recall and rehearsal items (also on a 10-point scale) were obtained at final re-test.[3] The FMQ used in Study 2 was identical to that in Study 1 except differences in the wording that described the reception event. In addition, the question about national importance was dropped as obviously irrelevant.

*Cognitive functioning of participants*

Participants were screened for cognitive functioning using three tests. The first was the Telephone Interview for Cognitive Status (TICS) comprising 11 items with a maximum score of 41 and cut off score of 30. TICS correlates highly with the Mini Mental Sate Examination (MMSE; Folstein, Folstein, & McHugh, 1975), and has 94% sensitivity and 100% specificity in discriminating patients with Alzheimer's disease from normal controls (Brandt, Spencer, & Folstein, 1988). The second was the Isaacs Set Test (IST) of verbal (category) fluency with a maximum score of 40 (Isaacs & Kennie, 1973). The third was a short version of Wechsler Similarities Test (WST) (Wechsler, 1981), which requires participants to explain similarities between word pairs (e.g., orange–banana) (with maximum score of 10).[4] As a result of this screening, the data of four old participants in Study 1 and two old participants in Study 2 were excluded. Furthermore, none of the participants reported any hearing problems, experience of serious head injury, stroke, mental health and/or memory problems diagnosed by a physician. All participants had English as a first language.

The characteristics of participants retained in the final sample are presented in Table 2. Old participants had reliably lower scores on at least two cognitive tests than young participants, and had spent significantly fewer years in full time education.

*Study 1 (flashbulb memories of September 11)*

*Participants*. A total of 168 British participants were tested in September 2001. Old participants were recruited from a subject pool of healthy community dwelling retired older adults. Young participants were recruited by contacting colleagues, relatives and friends of four researchers (first author and 3 research students). Of these, 135 (80%) were re-tested in summer 2003. After excluding four old participants with low scores on cognitive tests, the final sample consisted of 64 young (30 males, 34 females) and 67 old participants (31 males, 36 females), with the mean ages of 33.41 years (range 20-56) and 71.31 years (range 61-82), respectively.

*Procedure*. Participants were individually contacted by one of four researchers by telephone on 12th and 13th of September or on 21st and 22nd of September, 2001. They were invited to take part in a study examining people's memories of how they first heard the news of a major public event such as the terrorist attack in New York. It was explained that participation was voluntary and that a few more interviews could follow in subsequent years. After obtaining oral consent, the Flashbulb Memory Questionnaire was administered over the telephone (see Table 1). Participants were asked to talk slowly and clearly into the phone, which ensured answers could be recorded verbatim by the researcher. Each interview lasted between 10 and 20 minutes. Half of the participants were re-tested after 2 weeks from this initial interview. They were asked to recall the reception event as they remembered it on that day rather than trying to remember the answers they gave in the previous interview. All participants were finally re-tested, after a delay of 23-24 months, in July/August of 2003. At the end of this interview participants completed three tests measuring their cognitive functioning (TICS, IST and WST).

*Study 2 (control memories of a staged event)*

*Participants.* A total of 185 participants were recruited and tested in summer 2003 (89 young and 96 old) through advertising in a local and one national newspaper as well as by door-to-door distribution of leaflets. After the exclusion of two old participants with low scores on TICS and WST, the final sample in summer 2003 consisted of 89 young (24 males, 65 females) and 94 old (28 males, 66 females) participants with mean ages of 37.72 years (*SD*=8.08, range 22-50) and 67.3 years (SD=5.35, range 60-82), respectively. Of these 183 participants, 170 (93%) were re-tested after a period of 11-12 months in summer 2004 (79 young and 91 old).

*Procedure.* The study was advertised as a project on memory and aging, which required participants to take part in several telephone interviews on their memories of personally experienced events. During an initial screening interview, conducted by one of the three interviewers (two females and one male), participants were informed that in order to take part, they had to own and be familiar with using a mobile phone as they would be contacted via their mobile on one or two occasions. They were also informed that they had a good chance to win £100 (about $160) within their age group in a prize draw that would be shortly run by the research team. To make this prize draw more salient, participants were asked if they were happy for their name to be disclosed to other participants if they won the draw. This was followed by the three tests assessing their cognitive status (TICS, IST, WST). At the end of the interview participants were informed that the second interview would be conducted fairly soon (e.g., early next week), and were asked to keep their mobiles switched on. They were not informed of the exact day and time of this call.

The following week participants were contacted on their mobile by another researcher who informed them that the interview they were expecting had to be cancelled, and that the researcher who conducted the initial interview would get in touch again soon. Finally, participants were told that the prize draw had taken place and that unfortunately they did not win the prize. It was not possible to reveal the names of the two winners as they wished to remain anonymous.[5]

As in Study 1, half of the participants were contacted after a short delay (1-2 days) from receiving the news about the prize draw and half after a longer delay of 10 and 11 days. Within each group, half of the participants were re-tested after two weeks from their initial test. During these interviews the FMQ was used, but participants were asked to recall their personal circumstances in which they first heard the news that they did not win the prize. All participants were finally re-tested for their memories of the control event in summer 2004, approximately 12 months after their initial interview in summer 2003.[6]

*Coding the phenomenological characteristics of memories*

*Quantity of details in free recall.* The quantity of information provided in memory descriptions was assessed in terms of whether participants mentioned any of the following categories, out of a possible 10: time, location, activity, others present, source of the news, own emotion, others emotion, any preceding events, aftermath and any irrelevant/additional detail (*cf*. Warren & Starwood, 1992). A score of ‘1’ was assigned if a particular category was mentioned (for example, ‘in the morning’, ‘at 2:00 p.m.’ in case of time), and a score of ‘0’ if it was not mentioned. Participants were only awarded a point for a category if it was explicitly mentioned in the memory description, even if they later recalled it as part of a probed recall. The scores could range from ‘0’ (i.e., no memory of the reception event) to a maximum of ‘10’.

*Specificity of answers in probed recall.* Following Kvavilashvili et al. (2003) and Tekcan and Peynircioglu (2002), we used a 3-point scoring system (from '0' to '2') to code the specificity of participants' answers to canonical questions about *time*, *location*, activity, *source* and *others present*. A score of '2' was assigned when the response contained specific information, for example, a particular radio station (Capital FM) in response to a question about the *source*. A score of '1' was assigned to a general, vague response, e.g., "at home" in response to the *location* question. A more specific response (e.g., in my bedroom) was required to get 2 points. 'Cannot remember' or responses preceded by 'maybe' and 'probably', were scored as '0'. Hence, the maximum possible score for probed recall specificity was 10.

*Coding of test-retest consistency of probed recall (WAS)*

Following Neisser and Harsch (1992), participants' answers to each of the five probe questions at a re-test were assigned a score of '0', '1', or '2' depending on how *consistent* they were with the answers provided at the initial test. A score of '0' was given if participants could not remember or if they recalled information that was completely different from the initial test (e.g., 'my father' instead of 'my friend'). A score of '1' was assigned if participants provided either less specific information ('my friend' instead of 'my friend Jon') or slightly incorrect information (e.g., 'my friend Sam' instead of 'my friend Jon'). A score of '2' was assigned if participants provided either the same information at both tests (e.g., 'my friend') or the same information plus additional detail at the re-test (initially 'my friend' and then 'my friend Jon').[7]

The total consistency score, derived from this coding scheme varies from 0 to 10. However, according to Neisser and Harsch (1992), *location*, *activity* and *source* are the core canonical categories (if one remembers all three one has got a basic story of hearing the news), whereas *time* and *others present* are the less important attributes of flashbulb memories (see Tekcan et al., 2003 for providing direct empirical support for this idea). The Weighted Attribute Score (WAS) reflects this by assigning a maximum score of '2' for *place, activity* and *source*, and giving one bonus point if a participant's cumulative score for *time* and *others present* is 3 or more (out of a total possible 4). The WAS ranges from 0 to 7, with higher scores reflecting better consistency. Although identical results were obtained for total consistency (0 to 10) and WAS (0 to 7), only the latter is reported here.

All coding of memory consistency and phenomenological qualities was carried out by several pairs of independent coders; the percentage of agreement varied from 85% to 100%, and discrepancies were solved by discussion.

## Results

### *Background variables*

Table 3 shows the mean ratings of background variables for young and old participants. The upper panel shows initial reactions to the flashbulb and control events. The lower panel has post-encoding variables (confidence and rehearsal) at the final re-test (delay of 23-24 months for flashbulb and 11-12 months for control event).

The data for each variable were entered separately into 2 event (flashbulb, control) x 2 age (young, old) between subject ANOVAs. All analyses resulted in a significant main effect of event with the flashbulb event being consistently rated as more surprising/emotional/important, etc. than the control event. The effect sizes of event ranged from medium ($\eta^2$=.12) for the ratings of confidence in the free recall at final re-test ($F$(1,282)=38.23, $MSE$=5.08, $p$<.0001) to very large ($\eta^2$=.86) for ratings of surprise at initial test ($F$(1,296)=1766.27, $MSE$=2.21 , $p$<.0000001).

The only other significant effect was a main effect of age for the ratings of personal importance, $F$(1,297)=4.62, $MSE$=4.46, $p$=.03, $\eta^2$=.015, with ratings being higher in young (*M*=3.76, *SD*=3.06) than in older adults (*M*=3.14, *SD*=3.07). There was a marginally significant age by event interaction for the ratings of confidence in the accuracy of memory descriptions, *F*(1,282)=3.40, *MSE*=5.07, *p*=.066, $\eta^2$=.01. Thus, there was no age effect for the flashbulb event (F<1), but there was a significant effect for the control event (*F*(1,282)=7.75, *MSE*=5.07, *p*=.006, $\eta^2$=.027) with older adults being more confident (*M*=7.28, *SD*=2.71) than younger adults (*M*=6.28, *SD*=2.68). All other effects were not significant (largest *F*=2.97). In sum, young and old participants did not differ in their ratings of either flashbulb or control event for the majority of variables. Also, relative to the terrorist attack in New York, the control event satisfies the criteria for being a fairly mundane and trivial event.

*Phenomenological characteristics of memories*

Table 4 shows the means for the three phenomenological variables (quantity of recalled information, specificity of participants' answers to five questions and vividness for the memory of the reception context) which were entered separately into a 2 age (young, old) x 2 event (flashbulb, control) x 2 time of testing (initial test, final re-test) mixed ANOVAs with the repeated measures on the last factor.

*Quantity of recalled information*. The analysis on the number of canonical categories mentioned in free recall resulted in main effects of both event and time of testing, which were qualified by a significant event by time of testing interaction, *F*(1,297)=60.20, *MSE*=1.64, *p*=0001, $\eta^2$=.17. Tests of simple main effects showed that for the control event, the quantity of free recall dropped significantly from the initial test (*M*=3.44, *SD*=1.46) to re-test (*M*=2.33, *SD*=1.38) (*F*(1,297)=65.18, *p*<.000001, $\eta^2$=.18). By contrast, for flashbulb memories they actually increased from *M*=3.76 (*SD*=1.51) to *M*=4.27 (*SD*=1.72), *F*(1,297)=10.45, *p*=.001, $\eta^2$=.03 (for similar results see Smith et al., 2003). Importantly, the predicted event by age interaction was also present $F(1,129)=4.44$, $p=.04$, $\eta^2=.02$, with no age effect in flashbulb memories ($F<1$), but older adults recalling fewer categories for the control event ($M=2.64$, $SD=1.49$) than young adults ($M=3.15$, $SD=1.28$), $F(1,297)=7.71$, $MSE=1.42$, $p=.006$, $\eta^2=.03$.

*Specificity of responses to five questions*. The ANOVA on the mean specificity scores resulted in main effects of event and time of testing, which were again qualified by a significant interaction, $F(1,297)=73.71$, $MSE=2.52$, $p=.0001$, $\eta^2=.20$. Tests of simple main effects showed that for control memories, there was a very large drop in specificity from initial test ($M=8.41$, $SD=1.47$) to final re-test ($M=5.76$, $SD=2.52$), $F(1,297)=233.75$, $p<.0000001$, $\eta^2=.44$. For flashbulb memories, the drop was much smaller (from $M=8.84$, $SD=1.04$ to $M=8.44$, $SD=1.54$), explaining only 1% of the variance, $F(1,297)=4.06$, $p=.045$, $\eta^2=.01$.[8] The main effect of age was also significant ($F(1,297)=8.29$, $MSE=3.67$; $p=.004$, $\eta^2=.03$) but was qualified by a marginally significant age by event interaction, $F(1,297)=3.68$, $MSE=3.67$, $p=.056$, $\eta^2=.01$. Thus, there was no effect of age in the specificity of flashbulb memories ($F<1$) but older participants' memories of the control event were less specific ($M=6.73$, $SD=2.18$) than those of young participants ($M=7.48$, $SD=1.21$), $F(1,297)=13.19$, $MSE=1.84$, $p<.001$, $\eta^2=.04$.

*Vividness of memories*. The ANOVA on ratings of vividness resulted in main effects of event and time of testing which were qualified by a significant event by time of testing interaction, $F(1,291)=33.13$, $MSE=3.68$, $p<.00001$, $\eta^2=.10$. For control memories there was a significant drop in vividness from initial test ($M=6.63$, $SD=2.74$) to subsequent re-test ($M=4.72$, $SD=2.96$) after a delay of only one year ($F(1,129)=81.02$, $p<.00001$, $\eta^2=.22$), while the vividness ratings of flashbulb memories were very high at initial test (*M*=8.31, *SD*=1.98) and did not change over a delay of two years (*M*=8.22, *SD*=1.83) ($F<1$). No other effects were significant.

In summary, there were no age effects on the phenomenological characteristics of flashbulb memories. All three remained stable over a two-year delay. By contrast, there was a reliable drop in phenomenological characteristics of the control event. In addition, older adults' control memories were less specific and contained fewer canonical categories than younger adults' memories.

*Test-retest consistency of memories*

To assess the consistency of probed recall, the mean WAS were calculated for flashbulb and control events using the scoring system described in the method section. These means were entered into a 2 age (young, old) x 2 event (flashbulb, control) between subjects ANOVA (see Table 5). There was a significant main effect of event, $F(1,297)=99.46$, $MSE=2.79$, $p<.000001$, $\eta^2=.25$. As predicted, the consistency scores were significantly higher for the flashbulb (*M*=5.15, *SD*=1.60) than for the control event (*M*=3.20, *SD*=1.73). There was no significant overall effect of age ($F(1,297)=2.32$, MSE=2.79, p=.129, $\eta^2=.01$) or event by age interaction ($F<1$). Thus, contrary to predictions, older adults' memories of control event were not reliably less consistent (*M*=3.08, *SD*=1.88) than those of younger adults (*M*=3.34, *SD*=1.53).

However, consistency scores obtained after delays of 23-24 and 11-12 months for flashbulb and control events, respectively, do not allow us to assess the amount of forgetting occurring from initial test to final re-test. To address this question we calculated additional 2-week WAS consistency measures for the half of the samples who were re-tested two weeks from their initial test. The 2-week WAS were calculated by comparing responses to five probe questions at initial test with those obtained after two weeks. These '2-week' WAS consistency measures and the 'final' WAS measures obtained after a delay of 23-24 and 11-12 months were entered into 2 age (young, old) x 2 event (flashbulb, control) x 2 time of re-test (2-week, final) mixed ANOVA with repeated measures on the last factor. As expected there was a significant main effect of event, $F(1,140)=33.87$, $MSE=2.36$, $p<.00001$, $\eta^2=.20$, with the flashbulb event having overall higher mean consistency scores than the control event. There was also a highly significant effect of time of re-test, $F(1,140)=191.59$, $MSE=1.15$, $p<.0000001$, $\eta^2=.58$, with consistency scores being markedly higher two weeks after initial test ($M=6.01$, $SD=1.07$) than after a delay of 23-24 or 11-12 months (flashbulb and control events, respectively) ($M=4.22$, $SD=1.76$). Most important, there was a significant event by time of re-test interaction (Figure 1), $F(1,140)=14.07$, $MSE=1.15$, $p=.0002$, $\eta^2=.09$. Although consistency of the control event was lower overall than for the flashbulb event, the tests of simple main effects showed that this difference was more pronounced at the time of final re-test, after a long delay ($F(1,140)=34.32$, $p<.000001$, $\eta^2=.20$) than after two weeks from the initial test ($F(1,140)=11.51$, $p=.001$, $\eta^2=.075$). Alternatively, the drop in consistency from initial to final re-test was much sharper for the control event ($F(1,140)=161.18$, $p<.0000001$, $\eta^2=.54$) than for the flashbulb event ($F(1,140)=48.96$, $p<.000001$, $\eta^2=.26$). There were no other significant main or interaction effects (all *F*s<2.61).

*Correlation analyses*

Table 6 shows that none of the encoding variables obtained during initial testing were correlated with the test-retest consistency scores (WAS) (for similar results see Hirst et al., 2009). However, reliable (albeit small) correlations were obtained for some post-encoding, background variables at re-test (see lower panel of Table 6). In young adults ratings of vividness were positively associated with consistency for both flashbulb ($r=.25$, $p<.05$) and control events ($r=.26$, $p<.05$), and in old adults for the control event (*r*=.51, p<.001) but not for the flashbulb event (r=.18, p=.145). A particularly interesting dissociation emerged between flashbulb and control memories for ratings of rehearsal (remembering and/or thinking about one's personal circumstances). Specifically, while rehearsal was positively correlated with the test-retest consistency of control memories in both young (*r* =.26, p<.05) and old participants (*r* =.27, p<.01), this correlation was negative for flashbulb memories of old participants (*r* = –.25, *p*<.05). In young participants it was also negative (*r* = –.24) but fell just short of significance (*p*=.059). This means that those who reported rehearsing their personal circumstances of hearing the news of September 11 were actually less consistent after a delay of two years than those participants who thought about it less frequently (see Bohannon & Symons, 1992, who also obtained negative correlations in participants who reported being emotionally affected by the news).

## Discussion

### *Effects of age on flashbulb and control memories*

Despite a growing number of studies on flashbulb memories in young adults (mainly undergraduate students), there are less than a dozen published studies on the effects of age on flashbulb memories (see introduction). While some have examined only the phenomenological characteristics of memories, others have mainly focused on test-retest consistency with delay intervals of 6 to 12 months.[9] The present aging study, to our knowledge, is the first to use a delay as long as 23-24 months and obtain both phenomenological and consistency measures for both young and old adults.

Another key feature of this study is the comparison of age effects on flashbulb memories and those of a staged control event that was the same for all participants. In a previous aging study with a comparison control event, Davidson et al. (2006) used an unspecified (personal) event of participants' own choice in the week before the flashbulb event (September 11). They obtained a significant age affect in the consistency of memories for the control event but no age effect for September 11. In line with this finding, and the emotional compensation hypothesis of Mather (2004), it was predicted that significant age effects would be obtained only for memories of the control event but not for the flashbulb event.

Results concerning the flashbulb memories were in line with these predictions. Thus, older adults' flashbulb memories were as vivid, detailed and specific after a delay of two years as those of young adults. In addition, their answers to canonical questions were not less consistent over time than those of young adults. This absence of age effects in the phenomenology and consistency of flashbulb memories was not due to older adults being more affected by the attack, as there were no reliable age differences in any of the background variables (see Table 3). Also, the consistency scores were by no means at ceiling, which might have masked the presence of age effects (Uttl, 2005). Most importantly, the absence of age effects was not due to having 16 (25%) middle-aged adults (in their 40s and 50s) in the sample of young participants in Study 1. Indeed, a separate regression analysis on the flashbulb memory consistency scores with chronological age as a predictor did not result in a significant effect of age ($F(1,129)=1.12$, $p=.29$) (see also A.R.A. Conway et al., 2009).

Our results conflict with those of Cohen et al. (1994), and Kensinger et al. (2006) who found significant age effects for memories of the resignation of Margaret Thatcher and the explosion of space shuttle Columbia, respectively. However, they do replicate and extend the results of Davidson et al. (2006), who also did not find age effects on flashbulb memories of September 11 over a one-year delay period. Non-significant findings were also obtained in a recent study by A.R.A. Conway et al. (2009) that re-tested a large national random sample (N=319) after delays of both one year and two years from September 11. Taken together, these results suggest that if a flashbulb event is of sufficient magnitude and importance (as September 11 clearly was) then there will be no age effects in the phenomenology and the consistency of flashbulb memories over long delays of at least two years. In fact, all our participants were re-tested one more time in summer 2004, almost 3 years from September 11, and still no age effects emerged either for phenomenological characteristics or test-retest consistency (see Kvavilashvili et al., in press).

By contrast, findings for the control memories were only partially in line with the emotional compensation hypothesis. Thus, as predicted, significant age effects were obtained for all phenomenological characteristics of memories except vividness. In particular, older adults provided fewer canonical categories in their free recall and were less specific in their answers to five probe questions than young adults.[10] However, no effects of age emerged for the *consistency of probed recall* – older adults' control memories (albeit less detailed and specific) were nevertheless as consistent after a delay of one year as those of young adults. This finding was unexpected. Indeed, laboratory studies of source memory would predict significant age effects in the recall of the context of hearing the news of fairly unimportant and non-emotional news (see Spencer & Raz, 1995). The absence of age effects for the consistency of the control event also contradicts earlier findings of Davidson et al. (2006) who showed significant age effects in the consistency of recall of participants' self-nominated event from the week preceding the flashbulb event. One possible explanation for the absence of age effect in the consistency of control memories is that older adults' control memories were of poorer quality (i.e., less specific and fewer details), so it was easier for them to maintain the consistency between poor reports than for younger adults whose reports were more detailed and specific.

Laboratory research on episodic memory has also shown that age effects can be eliminated when older adults have to focus on emotional or socially relevant information about the source (e.g., whether it is truthful or not, good or bad) (see May, Rahhal, Berry & Leighton, 2005; Rahhal, May & Hasher, 2002) or when they consider information as relevant either to them (i.e., self reference effect, see Gutchess, Kensinger, Yoon, & Schacter, 2007) or to their everyday knowledge (e.g., Castel, 2005). It is, therefore, possible that hearing the news of not winning the prize was perceived as a self-relevant and somewhat distinctive (albeit unimportant) event, which eliminated age effects. Clearly, more research needs to be conducted on laboratory source memory tasks with self or social relevance and memories of staged control events outside the laboratory. It is particularly important to compare both types of tasks in one sample of young and old adults to examine the extent to which the findings from laboratory tasks of episodic source memory can be generalized to memories of personal autobiographical events (*cf*. Davidson et al., 2006).

*Are flashbulb memories different from control non-flashbulb memories?*

For both age groups, the consistency was significantly better for September 11 than for the control event, even though the flashbulb test-retest interval was almost twice as long than that for the control event. Moreover, this superior consistency was present even after only two weeks from the initial test as shown by the results of those participants who were tested twice shortly after the event (see Figure 1). In addition, the drop in consistency over a 1-year period was much more dramatic for control memories ($\eta^2$=.54) than for flashbulb memories over a 2-year period ($\eta^2$=.26). All these findings support the idea that flashbulb memories are indeed different from ordinary non-flashbulb memories.

Further evidence that flashbulb and control memories are qualitatively different comes from the comparison of their phenomenological aspects and the results of correlational analyses. Thus, irrespective of their consistency, flashbulb memories contained more details and were more specific than control memories both at the time of initial and final re-tests. Perhaps, the most important finding in this respect refers to the ratings of vividness (see Table 4). For flashbulb memories these were very high at the initial test and did not reliably decrease after a delay of 2 years (for similar findings see Kvavilashvili et al., 2003; Talarico & Rubin, 2003; 2007; Weaver & Krug, 2004). For control memories, the ratings were reliably lower than in flashbulbs at initial test and substantially decreased after a delay of only 1 year.

Furthermore, an intriguing and discrepant pattern of correlations emerged in flashbulb and control memories for self-rated rehearsal (remembering and/or thinking of the reception context). While rehearsal was positively correlated with consistency scores in control memories, an opposite trend was present in flashbulb memories – the higher the self-rated rehearsal of personal circumstances, the lower the test-retest consistency scores. A possible explanation for this negative correlation is that public events, such as September 11, are constantly televised and discussed so that each person would hear the news several times from different sources (Neisser & Harsch, 1992). It is possible that over time, people will remember or rehearse several different occasions of hearing the news on that day, and this may negatively affect their consistency scores for the first reception context. This cannot, by definition, happen with the personal control event, hence the positive correlations obtained in Study 2.

The superior consistency of flashbulb memories, compared with control memories, replicates previous findings of Davidson et al. (2006), Christianson (1989) and Curci and Luminet (2006), but contradicts the results of Talarico and Rubin (2003;

2007) and Kensinger et al. (2006) who did not find reliable differences between the consistency of flashbulb and control memories. In most of these studies, control memories were of self-selected memorable personal events that happened in the week before the flashbulb event. However, in Davidson et al. (2006) participants were simply asked to recall this event whereas in studies by Talarico and Rubin participants were asked to provide key words which would act as reminders when recalling the same event in the future. It is, therefore, possible that participants deliberately committed this event to memory for future retrieval, and they were quite successful in doing so (see also Weaver, 1993). By contrast, participants in Davidson et al. (2006) often could not remember what the personal event was that they described at the initial testing. Even when given explicit reminders (e.g., “a party” or “a movie”), their recall was poor and reliably worse than for flashbulb memories. There is no doubt that people can remember certain events accurately if they deliberately decide to. However, flashbulb memories as well as most everyday autobiographical memories are encoded incidentally, without any deliberate intention to remember anything. Therefore, comparing flashbulb memories with deliberately encoded personal episodes may not be an appropriate comparison (for a discussion of this point, see Pillemer, 2009).

*Theoretical implications for cognitive aging research*

Our results showed no age effects in the consistency of either flashbulb or control memories. The absence of age effects cannot be attributed to insufficient power or ceiling effects in the WAS. The importance of this finding for cognitive aging research is emphasized by the reliable age effects, obtained in both studies, in a standard laboratory test of immediate free recall of ten words (see Table 2). Table 2 also shows that older adults had fewer years of education than young adults and scored lower on all other cognitive tasks in Study 1 and on category fluency task (IST) in

Study 2. In other words, we did not have unusually well-functioning older adults who would not display any age effects in other cognitive tasks including a simple episodic memory task.

For flashbulb memories, the findings were predicted from Mather's (2004) emotional compensation hypothesis and are generally consistent with recent aging research on emotional memory showing reduced or no age effects for emotionally arousing material (for a review see Kensinger, 2009). Although the absence of age effects in the consistency of a staged control event was unexpected, this finding is in line with some laboratory studies of episodic memory that have also failed to obtain age effects with self-relevant or naturalistic materials (Castel, 2005; Gutchess et al., 2007). Overall, however, older adults' autobiographical memories (whether flashbulb or ordinary) appear to be much better retained and more consistent than one would predict from numerous laboratory studies of explicit episodic memory including source memory tasks (Grady & Craik, 2000; Light, 1991; Zacks, Hasher, & Li, 2000).

In this respect, interesting parallels can be drawn with developmental research on children's memory in and outside of the laboratory. For example, Warren and Starwood (1992) failed to obtain age effects in the test-retest consistency of 5-to 13-year old children's flashbulb memories of Challenger explosion over a delay of 2 years. A recent series of test-retest studies of children's autobiographical memories of traumatic events (an injury and treatment in emergency room), conducted by Peterson and her colleagues, also showed few differences between 5- and 13-year old children in the consistency of their recall over delays of 6 months to 5 years (see Peterson, 2002, for a review). The absence of age effects in these studies is in stark contrast to very large effects between the ages of 5 and 13 documented in numerous laboratory studies with a variety of explicit episodic memory tasks (see Kurtz-Costes, Schneider, & Rupp, 1995; also Gathercole, 1998 for a review).

Following Rendell and Craik (2000), this contrasting pattern of results in and outside the laboratory can be termed the “real-life/laboratory paradox”. In the research of these authors on prospective memory (e.g., remembering to do things in the future), young adults performed better on typical laboratory tasks – a consistent finding in research on prospective memory and aging (see Henry, MacLeod, Phillips, & Crawford, 2004). In contrast, older adults outperformed young participants in everyday prospective memory tasks and this advantage was not due to differences in using external aids or rehearsal strategies (see also Rendell & Thompson, 1999). In terms of their emotional significance the everyday prospective memory tasks were probably similar to memories of a staged control event used in the present study. The reasons behind the “real-life/laboratory paradox” are not entirely clear (see McDaniel, Einstein, & Rendell, 2008). It is possible that studying age effects in flashbulb and staged control events will shed some light on mechanisms underlying this intriguing paradox.

*Theoretical implications for flashbulb memory research*

Results of our study appear to contradict the currently popular theory, held by Neisser and several other researchers, that flashbulb memories are prone to distortions and forgetting like ordinary, non-flashbulb memories (Neisser, 1982; Neisser & Harsch, 1992; McCloskey, 1992; Smith et al., 2003; Talarico & Rubin, 2003; 2007; Winograd, 1992; Wright, 1993). According to this view, the encoding of flashbulb memories is mediated by the operation of the same variables that are responsible for preferential encoding of ordinary memories (e.g., novelty, distinctiveness). In addition, the long-term retention of these memories is primarily due to high levels of rehearsal of the event and of one's personal circumstances that inevitably take place in the delay period through extensive media coverage and social sharing of the news.

However, the superior consistency of flashbulb memories obtained in the present study cannot be explained by increased rehearsal. Indeed, the rates of rehearsal (thinking about personal circumstances) were fairly low for both flashbulb and control memories on a 10-point scale ($M$=3.05 and $M$=1.21, respectively). In addition, while rehearsal correlated positively with the consistency scores of control memories, this correlation was negative for flashbulb memories (see Table 6). Further evidence in support of the idea that retention is not mediated by rehearsal comes from the finding that there was no effect of number of initial tests on final consistency scores. Those who were tested twice in September 2001 were no more consistent than those who were tested only once (see design in method section; for similar results see Hirst et al., 2009; Hornstein et al., 2003; Shapiro, 2006; Tizzard-Drover & Peterson, 2004; Warren & Starwood, 1992). Together, these results suggest that the long-term retention and consistency of flashbulb memories are mediated by processes that occur at encoding (*cf*. Kvavilashvili et al., in press). It is, however, unclear whether these involve primarily novelty/distinctiveness (Neisser, 1982) or emotional arousal/consequentiality (Brown and Kulik, 1977). Normally, the novelty and arousal co-occur in any dramatic flashbulb event so it is possible that the superior encoding of flashbulb memories is a product of both types of processes.

*Conclusions and future directions*

Research on aging and autobiographical memory has been based primarily on a method in which participants recall their memories in response to word cues or time periods suggested by a researcher. Like laboratory studies of episodic memory, this research has resulted in significant age effects both in terms of the specificity of recalled memories and their retrieval times (Piolino, et al., 2006; Rubin & Schulkind, 1997; Schlagman et al., 2009). However, very little is known about age effects in long-term retention and consistency of individual autobiographical memories (whether emotional or mundane). Results of the present study begin to fill this gap by showing that there are definitely no age effects in the specificity and consistency of autobiographical memories of emotionally arousing events over delay intervals as long as two or even three years (see also Kvavilashvili et al., in press). The next stage would be to examine even longer delays of 5 to 10 years. Findings concerning memories of a staged control event are also novel and theoretically informative. Although older adults had less detailed and specific memories for the control event than young participants after a delay of one year, their performance was not at floor and there were no age effects in the consistency of these memories. Thus, the effects of aging on source memory for control as well as flashbulb events merits further investigation.

The absence of age effects in the consistency of flashbulb and control memories also suggest that, in everyday life, most autobiographical memories are probably encoded automatically without one deliberately trying to encode or remember them. However, while memories of ordinary events are forgotten relatively quickly, flashbulb memories can be retained and show fairly good consistency for at least 2 to 3 years (present study; Kvavilashvili et al., in press). Various models of flashbulb memories have suggested that the emotional impact and personal importance of the event are crucial factors that contribute to the encoding and retention of flashbulb memories (see Luminet, 2009, for overview). However, correlations between these variables and flashbulb memory measures are usually fairly modest and several studies, including the present one, have failed to obtain reliable correlations (e.g., Curci & Luminet, 2006; Davidson & Glisky, 2002; Hirst et al., 2009; Neisser & Harsch, 1992; Otani et al., 2005; Shapiro, 2006; Smith et al., 2003). This could be due to ceiling effects in participants' ratings and/or the unreliability of measurement scales ratings. Future research might adopt an experimental approach by manipulating the emotional impact and personal importance of a staged control event and studying their effects on consistency over long delays. Whatever the outcome of these studies, one thing that is clear from the results of the present study is that "it would be premature to equate them [*flashbulb memories*] with memories of the multitude of mundane and recurring events in our lives" (p. 137; Pillemer, 2009).

References

Berntsen, D., & Thomsen, D. K. (2005). Personal memories for remote historical events: Accuracy and clarity of flashbulb memories related to World War II. *Journal of Experimental Psychology: General*, 134, 242-257.

Bohannon, J. N. (1988). Flashbulb memories for the Space Shuttle disaster: A tale of two theories. *Cognition, 29*, 179-196.

Bohannon, J. N., Gratz, S., & Symons Cross, V. (2007). The effects of affect and input source on flashbulb memories. *Applied Cognitive Psychology, 21*, 1023-1036.

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* (pp. 65-91). Cambridge: Cambridge University Press.

Brandt, J., Spencer, M., & Folstein, M. (1988). The telephone interview of cognitive status. *Neuropsychiatry, Neuropsychology, & Behavioral Neurology, 1,* 111-117.

Brewer, W. F. (1992). The theoretical and empirical status of the flashbulb memory hypothesis. In E. Winograd & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb" memories* (pp. 274-305). Cambridge: Cambridge University Press.

Brown, R., & Kulik, J. (1977). Flashbulb memories. *Cognition, 5*, 73-99.

Castel, A. D. (2005). Memory for grocery prices in younger and older adults: The role of schematic support. *Psychology & Aging, 20*, 718-721.

Christianson, S. -Å. (1989). Flashbulb memories: Special, but not so special. *Memory & Cognition, 17*, 443.

Cohen, G., Conway, M. A., & Maylor, E. A. (1994). Flashbulb memories in older adults. *Psychology & Aging, 9*, 454-463.

Conway, A. R. A., Skitka, L. J., Hemmerich, J. A., & Kershaw, T. C. (2009). Flashbulb memories for September 11, 2001. *Applied Cognitive Psychology, 23,* 605-623.

Conway, M. A. (1995). *Flashbulb memories*. Hillsdale: Lawrence Erlbaum Associates.

Conway, M. A., Anderson, S. J., Larsen, S., Donnely, C. M., McDaniel, M. A., McClelland, A. G. R, Rawles, R. E., & Logie, R. H. (1994). The formation of flashbulb memories. *Memory & Cognition, 22,* 326-343.

Curci, A., & Luminet, O. (2006). Follow-up of a cross-national comparison on flashbulb and event memory for September 11th attacks. *Memory, 14*, 329-344.

Davidson, P. S. R., Cook, S. P. & Glisky, E. L. (2006). Flashbulb memories for September 11th can be preserved in older adults. *Aging, Neuropsychology, and Cognition, 13,* 196-206.

Davidson, P. S. R., & Glisky, E. L. (2002). Is flashbulb memory a special instance of source memory? Evidence from older adults. *Memory, 10*, 99-111.

Er, N. (2003). A new flashbulb memory model applied to the Marmara earthquake. *Applied Cognitive Psychology, 17*, 503-517.

Folstein, M. F., Folstein, S. E., & McHugh, P. R. (1975). "Mini-Mental State": a practical method for grading the cognitive state of patients for the clinician. *Journal of Psychiatric Research, 12,* 189-198.

Gathercole, S. E. (1998). The development of memory. *Journal of Child Psychology and Psychiatry, 39,* 3-27.

Grady, C. L. & Craik, F. I. M. (2000). Changes in memory processing with age. *Current Opinion in Neurobiology, 10*, 224-231.

Gutchess, A. H., Kensinger, E. A., Yoon, C., & Schacter, D. L. (2007). Aging and the self-reference effect in memory. *Memory, 15,* 822-837.

Henry, J. D., MacLeod, M. S., Phillips, L. H., & Crawford, J. R. (2004). A meta-analytic review of prospective memory and aging. *Psychology & Aging, 19*, 27-39.

Hirst, W., Phelps, E. A., Buckner, R. L., Budson, A. E., Cuc, A., et al. (2009). Long-term memory for the terrorist attack of September 11: Flashbulb Memories, event memories, and the factors that influence their retention. *Journal of Experimental Psychology: General, 138*, 161-176.

Hornstein, S. L., Brown, A. S., & Mulligan, N. W. (2003). Long-term flashbulb memory for learning of Princess Diana's death. *Memory, 11*, 293-306.

Isaacs, B., & Kennie, A. (1973). The Set Test as an aid to the detection of dementia in old people. *Journal of Psychiatry, 123,* 467-470.

Kensinger, E. A. (2009). *Emotional memory across the adult lifespan*. New York: Psychology Press.

Kensinger, E. A., Krendl, A. C., & Corkin, S. (2006). Memories of an emotional and non-emotional event: Effects of aging and delay interval. *Experimental Aging Research, 32,* 23-45.

Kurtz-Costes, B., Schneider, W., & Rupp, S. (1995). Is there evidence for intraindividual consistency in performance across memory tasks? New evidence on an old question. In F. E. Weinert & W. Schneider (Eds.), *Memory performance and competencies: Issues in growth and development* (pp. 245-262). Mahwah, NJ: Lawrence Erlbaum Associates.

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.

Kvavilashvili, L., Mirani, J., Schlagman, S., Foley, K., & Kornbrot, D. E. (in press). Consistency of flashbulb memories of September 11 over long delays:

Implications for consolidation and wrong time slice hypotheses. *Journal of Memory and Language.*

Larsen, S. F. (1992). Potential flashbulbs: Memories of ordinary news as the baseline. In E. Winograd, & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb memories"* (pp. 32-63). Cambridge: Cambridge University Press.

Light, L. (1991). Memory and aging: Four hypotheses in search of data. *Annual Review of Psychology, 42*, 333-376.

Livingston, R.B. (1967). Brain circuitry relating to complex behavior. In G. C. Quarton, T. Melnechuk , & F. O. Schmitt (Eds.), *The neurosciences: A study program* (pp. 499-514). New York: Rockefeller University Press.

Luminet, O. (2009). Models for the formation of flashbulb memories. In O. Luminet & A. Curci (Eds.), *Flashbulb memories: New issues and new perspectives* (pp. 51-76). Hove and New York: Psychology Press.

Luminet, O., & Curci, A. (2009). *Flashbulb memories: New issues and new perspectives*. Hove and New York: Psychology Press.

May, C. P., Rahhal, T., Berry, E. M., & Leighton, E. A. (2005). Aging, source memory, and emotion. *Psychology & Aging, 20*, 571-578.

Mather, M. (2004). Aging and emotional memory. In D. Reisberg & P. Hertel (Eds.), *Memory and emotion* (pp. 272-307). New York: Oxford University Press.

McCloskey, M. (1992). Special versus ordinary memory mechanisms in the genesis of flashbulb memories. In E. Winograd, & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb memories"* (pp. 227-235). Cambridge: Cambridge University Press.

McCloskey, M., Wible, C. G., & Cohen, N. J. (1988). Is there a special flashbulb memory mechanism? *Journal of Experimental Psychology: General, 117,* 171-181.

McDaniel, M. A., Einstein, G. O., & Rendell, P. G. (2008). The puzzle of inconsistent age-related declines in prospective memory: A multiprocess explanation. In M. Kliegel, M. A. McDaniel, and G. O. Einstein (Eds.), *Prospective memory: Cognitive, neuroscience, developmental, and applied perspectives* (pp. 141-160). Mahwah, NJ: Erlbaum.

Nachson, I., & Zelig, A. (2003). Flashbulb and factual memories: The case of Rabin's assassination. *Applied Cognitive Psychology, 17,* 519-531.

Neisser, U. (1982). Snapshots or benchmarks? In U. Neisser (Ed.), *Memory observed: Remembering in natural contexts* (pp. 43-48). New York: W. H. Freeman.

Neisser, U., & Harsch, N. (1992). Phantom flashbulbs: False recollections of hearing the news about Challenger. In E. Winograd, & U. Neisser (Eds.), *Affect and accuracy in recall: Studies of "flashbulb memories"* (pp. 9-31). Cambridge: Cambridge University Press.

Otani, H., Kusumi, T., Kato, K., Matsuda, K., Kern, R. P., Widner, W. Jr., & Ohta, N. (2005). Remembering a nuclear accident in Japan: Did it trigger flashbulb memories? *Memory, 13,* 6-20.

Peterson, C. (2002). Children's long-term memory for autobiographical events. *Developmental Review, 22,* 370-402.

Pezdek, K. (2003a). Event memory and the autobiographical memory for the events of September 11, 2001. *Applied Cognitive psychology, 17,* 1033-1045.

Pezdek, K. (Ed.) (2003b). Memory and cognition for the events of September 11, 2001. *Applied Cognitive Psychology, 17* (A Special Issue).

Pillemer, D. B. (2009). "Hearing the news" versus "being there": Comparing flashbulb memories and recall of first-hand experiences. In O. Luminet & A. Curci

(Eds.), *Flashbulb memories: New issues and new perspectives* (pp. 125-140). Hove and New York: Psychology Press.

Piolino, P., Desgranges, B., Clarys, D., Guillery-Girard, B., Taconnat, L., Isingrini, M., & Eustache, F. (2006). Autobiographical memory, autonoetic consciousness, and self-perspective in aging. *Psychology & Aging, 21,* 510-525.

Rahhal, T., May, C. P., & Hasher, L. (2002). Truth and character: Sources that older adults can remember. *Psychological Science, 13*, 101-105.

Rendell, P.G., & Craik, F. I. M. (2000). Virtual week and actual week: Age-related differences in prospective memory. *Applied Cognitive Psychology, 14,* S43-62.

Rendell, P. G., & Thompson, D. M. (1999). Aging and prospective memory: Differences between naturalistic and laboratory tests. *Journal of Gerontology: Psychological Sciences, 54B*, 256-269.

Rouch-Leroyer, I., Fabrigoule, C., Letteneur, L., Commenges, D., Orgogozo, J., & Dartigues, J. F. (1998). A practical psychometric approach to detect preclinical stage of dementia. *Journal of American Geriatrics Society, 46*, 394-395.

Rubin, D. C. & Schulkind, M. D. (1997a). Distribution of important and word-cued autobiographical memories in 20-, 35-, and 70-year old adults. *Psychology & Aging, 12*, 524-535.

Schlagman, S., Kliegel, M., Schulz, J., & Kvavilashvili, L. (2009). Differential effects of age on involuntary and voluntary autobiographical memory. *Psychology & Aging, 24*, 397-411.

Schmolck, H., Buffalo, E. A., & Squire, L. R. (2000). Memory distortions develop over time: Recollections of the O.J. Simpson’s trial verdict after 15 and 32 months. *Psychological Science, 11*, 39-45.

Shapiro, L. R. (2006). Remembering September 11th: The role of the retention interval and rehearsal on flashbulb and event memory. *Memory*, *14*, 129-147.

Smith, M. C., Bibi, U., & Sheard, D. E. (2003). Evidence for the differential impact of time and emotion on personal and event memories for September11, 2001. *Applied Cognitive Psychology*, *17*, 1047-1055.

Spencer, W. D., & Raz, N. (1994). Memory for facts, source and context: Can frontal lobe dysfunction explain age-related differences? *Psychology & Aging, 9,* 149-159.

Talarico, J. M., & Rubin, D. C. (2003). Confidence, not consistency characterizes flashbulb memories. *Psychological Science, 14*, 455-461.

Talarico, J. M., & Rubin, D. C. (2007). Flashbulb memories are special after all; in phenomenology, not accuracy. *Applied Cognitive Psychology*, *21*, 557-578.

Tekcan, A. I., Ece, B., Gülgöz, 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 & Aging*, *17*, 416-422.

Tizzard-Drover, T., & Peterson, C. (2004). The influence of an early interview on long-term recall: A comparative analysis. *Applied Cognitive Psychology, 18*, 727-743.

Uttl, B. (2005). Measurement of individual differences: Lessons from memory assessment in research and clinical practice. *Psychological Science, 16*, 460-467.

Walters, G., & Goudsmit, J. (2005). Flashbulb and event memory of September 11, 2001: Consistency, confidence and age effects. *Psychological Reports*, *96*, 605-619.

Warren, A. R., & Starwood, J. N. (1992). Developmental issues in flashbulb memory research: Children recall the *Challenger* event. In E. Winograd and U. Neisser (Eds.), *Affect and accuracy in recall: Studies in "flashbulb" memories* (pp. 95-120), New York: Cambridge University Press.

Weaver, C. A. (1993). Do you need a "flash" to form a flashbulb memory? *Journal of Experimental Psychology: General, 122*, 39-46.

Weaver, C. A., & Krug, K.S. (2004). Consolidation-like effects in flashbulb memories: Evidence from September 11, 2001. *American Journal of Psychology, 117*, 517-530.

Wechsler, D. (1981). *Wechsler Adult Intelligence Scale-Revisited*. New York: The Psychological Corporation.

Winograd, E. (1992). Introduction. In E. Winograd and U. Neisser (Eds.), *Affect and accuracy in recall: Studies in "flashbulb" memories* (pp. 1-5), New York: Cambridge University Press.

Winograd, E., & Neisser, U. (Eds.) (1992). *Affect and accuracy in recall: Studies in "flashbulb" memories*. New York: Cambridge University Press.

Wright, D. B. (1993). Recall of the Hillsborough disaster over time: Systematic biases of "flashbulb" memories. *Applied Cognitive Psychology, 7*, 129-138.

Wright, D. B., & Gaskell, G. D. (1995). Flashbulb memories: Conceptual and methodological issues. *Memory, 3*, 67-80.

Wright, D. B., Gaskell, G. D., & O'Muircheartaigh, C. A. (1998). Flashbulb memory assumptions: Using national surveys to explore cognitive phenomena. *British Journal of Psychology, 89*, 103-122.

Yarmey, A. D., & Bull, M. P. (1978). Where were you when President Kennedy was assassinated? *Bulletin of the Psychonomic Society, 11*, 133-135.

Zacks, R. T., Hasher, L., & Li, H. (2000). Human Memory. In F. I. M. Craik & T. A. Salthouse (Eds.), *The handbook of aging and cognition* (pp. 293-357). London: Lawrence Erlbaum Associates.

Author Note

Lia Kvavilashvili, Jennifer Mirani, and Diana Kornbrot, University of Hertfordshire, UK; Simone Schlagman, Inter-Research Science Centre, Oldendorf/Luhe, Germany; James Erskine, St. George's, University of London, UK.

Research presented in this paper was supported by a research grant to Lia Kvavilashvili and Diana Kornbrot from the Economic and Social Research Council (UK), and a British Academy/Leverhulme Trust (UK) senior research fellowship awarded to Lia Kvavilashvili. We are grateful to Laura Fisher, David Wellsted and Rebecca Macham for conducting telephone interviews at various stages of the project, and to Jenna Garner for helping us out with coding the data. We are particularly indebted to Kerry Foley for both conducting interviews and coding. Portions of research described in this paper were presented at the British Psychological Society Cognitive Section Conference in September 2005 (University of Leeds), Psychonomic Meeting in November 2005 (Toronto), Bial Foundation meeting in April 2006 (Porto) and the 4th International Conference on Memory in July, 2006 (University of New South Wales, Sydney).

Correspondence concerning this article should be addressed to Lia Kvavilashvili, School of Psychology, University of Hertfordshire, College Lane, Hatfield, Herts, AL10 9AB, UK. Email: *L.Kvavilashvili@herts.ac.uk*

Footnotes

[1] This ensures some control over a flashbulb inducing event (i.e., same for all participants) even though the reception context in which the news was first heard varies across participants (Wright, 1993).

[2] Interestingly, the majority of these studies have found that retention levels of flashbulb memories are reliably better than for the factual details of the event memory (but see Er, 2003, Nachson & Zelig, 2003, and Bohannon et al., 2007, who obtained different results).

[3] Due to experimenter error, ratings of personal and national importance of terrorist attack in New York were obtained only at final retest in summer 2003.

[4] The IST and WST were used as screening tests because in the study of Rouch-Leroyer, Fabrigoule, Lettenneur, Commenges, Orgogozo and Dartigues (1998), 18.5% of older adults, who scored below the cut off points on both of these tests (less than 25 on IST and less than 6 on WST), were diagnosed with dementia after two years.

[5] In reality, the prize draw could not be run at this early stage of the project, while we were still in the process of recruiting participants. However, this bogus information was crucial for the design of the study as it allowed us to create a situation in which all participants received the same personal news about a less surprising and unimportant mundane event (i.e., not winning the prize). The real prize draw was run only after the entire study was completed in summer 2004.

[6] Participants also had an additional interview on their memories of September 11 and the death of Princess Diana in summer 2003 and in summer 2004. Results from these interviews are not reported in this study.

[7] Method of scoring was identical for flashbulb and control memories except for participants' answers to a question about *source*. Because most participants in Study 2

remembered correctly that they heard it from the phone conversation, we also asked them to tell us whether the informant was male or female. Only when they could answer this question correctly at re-test would they be assigned a maximum score of '2'.

[8] It is important to note that this effect for flashbulb memories was in fact due to a statistically reliable decrease in specificity scores in only one of the eight original experimental groups - older adults who were initially tested 10-11 days after the event (long delay condition) and were not re-tested after two weeks (tested once) (see design section in method).

[9] A.R.A. Conway et al. (2009), is the only aging study that used a 2-year delay interval but they also had an initial re-test after 11 months. In addition, the study used a somewhat unusual methodology, an internet survey with fixed response options, which could have inflated the consistency scores, and makes the comparisons with other studies difficult.

[10] This is in line with the research on aging and autobiographical memory which shows that older adults recall less specific and detailed memories in response to time-period or word cues (e.g., Piolino et al., 2006; Schlagman, Kliegel, Schulz & Kvavilashvili, 2009).

Table 1

*Telephone Interview Protocol*

**Flashbulb Memory Questionnaire at initial test (all participants) and at initial re-test (half the participants)**

| Question | Measure | Classification | Type of Variable |
|---|---|---|---|
| Please give a brief but detailed description of the personal circumstances in which you first heard the news<br>**Flashbulb:** of the terrorists' attack in New York on 11 September<br>**Control:** of not winning a prize | Number of *canonical* categories mentioned | Phenomenology | Free Recall[1] |
| When did you first hear the news?<br>Where were you when you heard the news?<br>Were there other people with you? If yes, then provide their names. | Specificity of the response | Phenomenology | Probed Recall[1] |
| What were you doing at the time when you heard the news?<br>Who or where did you hear the news from? | Consistency of the response | WAS consistency | |
| How emotional was your first reaction to the news?<br>Please answer on a 10- point rating scale where 1 is "Very calm, not emotional at all" and 10 is "Extremely emotional". | Emotion | Encoding | Background[2] |
| How surprised were you to hear this news?<br>Please answer on a rating scale where 1 is "Not surprised at all" and 10 is "Extremely surprised". | Surprise | Encoding | |
| How stressed did you feel later on in the day after you heard the news?<br>Please answer on a rating scale where 1 is "Not stresses at all" and 10 is "Extremely stressed". | Stress | Encoding | Background[3] |
| How often have you been thinking about<br>**Flashbulb:** the terrorists' attack in New York on 11 September?<br>**Control:** not winning a prize?<br>Please answer on a rating scale where 1 is "Not at all" and 10 is "all the time". | Rehearsal | Post-encoding | |
| How vivid is your memory of circumstances in which you first heard the news?<br>Please provide an answer on a rating scale on which 1 is "no image at all" and 10 is "extremely vivid image, almost like normal vision". | Vividness | Phenomenology | |

**Table 1 (continued) Additional questions asked at final re-test (all participants)**

| Question | Measure | Classification | Type of Variable |
|---|---|---|---|
| How confident are you that you remember this correctly? Please answer on a rating scale where 1 is "Merely guessing, not confident" and 10 is "Extremely confident".[3] | Confidence | Post encoding | Background[4] |
| When you first heard the news how important was if for you personally? Please answer on a rating scale where 1 is "Not important at all" and 10 is "Extremely important". | Personal Importance | Encoding | Background[5] |
| How important was the news of the terrorist attack considered in the UK? Please answer on a rating scale where 1 is "Not important at all" and 10 is "Extremely important". | National Importance (flashbulb event only) | Encoding | |
| How often have you been thinking or being reminded of **Flashbulb:** the terrorist attack in New York in the past two years? **Control:** not winning the prize in the past year? Please answer on a rating scale where 1 is "Never" and 10 is "Very often, at least once a day". | Rehearsal of Event | Post encoding | Background[6] |
| How often have you been remembering or thinking of your personal circumstances in which you heard the news of **Flashbulb:** the terrorist attack in the past two years? **Control:** not winning the prize in the past year? Please answer on a rating scale where 1 is "Never" and 10 is "Very often, at least once a day". | Rehearsal of Personal Circumstances | | |

Note 1. Memory questions, as in M.A. Conway et al. (1994).
Note 2. Background questions, as in M.A. Conway et al. (1994), but 10-point not 3-point scales.
Note 3. Additional background questions, not presented in M.A. Conway et al. (1994).
Note 4. Confidence rating was asked after free recall and after all 5 probe questions.
Note 5. Importance questions asked at initial test by M.A. Conway et al. (1994) but in final re-test interview here.
Note 6. Post encoding rehearsal questions modified from M. A. Conway et al. (1994).

Table 2

*Mean Scores (Standard Deviations) on Tests of Cognitive Functioning and Mean Number of Years of Education as a Function of Age in Study 1 and Study 2. Right Hand Columns Present Results of One-Way ANOVAS with Age Group as Independent Variable (F Values and Effect Sizes).*

| | Age Group | | | |
|---|---|---|---|---|
| | Young | Old | F value | Partial $\eta^2$ (eta-squared) |
| (a) Study 1 | N=64 | N=67 | (1,129) | |
| TICS | 35.63 (1.98) | 34.79 (1.88) | 6.12* | .04 |
| Recall of 10 words (TICS – Item 5) | 6.02 (1.28) | 5.12 (1.88) | 15.70*** | .11 |
| IST | 36.86 (2.84) | 34.39 (4.06) | 16.12*** | .11 |
| WST | 7.70 (.61) | 6.96 (1.55) | 12.96*** | .09 |
| Education | 17.60 (4.26) | 13.29 (3.61) | 38.93**** | .23 |
| (b) Study 2 | N=79 | N=91 | (1,168) | |
| TICS | 35.47 (2.25) | 35.08 (1.96) | 1.47 | .01 |
| Recall of 10 words (TICS – Item 5) | 6.03 (1.38) | 5.20 (1.42) | 14.73*** | .08 |
| IST | 37.62 (2.37) | 36.77 (3.18) | 3.83* | .02 |
| WST | 7.66 (.89) | 7.47 (.96) | 1.70 | .01 |
| Education | 16.46 (2.83) | 14.89 (3.40) | 10.45** | .06 |

* $p \leq .05$; ** $p < .01$; *** $p < .001$; **** $p < .0001$

Note. TICS – Telephone Interview of Cognitive Status (Brandt, et al., 1988); IST – Isaacs Set Test (Isaacs & Kenny, 1973); WST – Wechsler Similarities Test (Wechsler, 1981).

Table 3

*Mean Ratings of Young and Old Participants' Initial Reactions to the Event (Panel A) and Post-Encoding Variables at Re-Test (Panel B) as a Function of Event (flashbulb vs. Control). Standard Deviations in Brackets.*

| | Flashbulb Event | | Control Event | |
|---|---|---|---|---|
| | Young | Old | Young | Old |
| | Ratings of initial reactions | | | |
| Surprise | 8.50 (1.87) | 8.77 (2.07) | 1.37 (.75) | 1.32 (1.11) |
| Emotion | 4.79 (2.32) | 4.95 (2.71) | 1.42 (.79) | 1.09 (.32) |
| Stress | 6.13 (2.54) | 6.02 (2.57) | 1.10 (.52) | 1.04 (.33) |
| Rehearsal of event itself | 7.34 (1.98) | 7.27 (1.81) | 1.47 (.64) | 1.43 (.67) |
| Importance (personal) | 6.30 (2.52) | 5.66 (3.21) | 1.70 (1.54) | 1.29 (.82) |
| Importance (national) | 8.91 (1.19) | 8.54 (1.43) | N/A | N/A |
| | Ratings of post-encoding variables | | | |
| Confidence in free recall | 8.43 (1.46) | 8.45 (1.64) | 6.28 (2.68) | 7.28 (2.71) |
| Confidence in probed recall | 8.84 (.86) | 9.05 (.99) | 7.60 (1.59) | 7.82 (1.66) |
| Rehearsal of event itself | 5.73 (1.89) | 5.69 (1.78) | 1.12 (.40) | 1.17 (.49) |
| Rehearsal of personal circumstances | 2.81 (1.46) | 3.28 (1.94) | 1.20 (.65) | 1.23 (.60) |

Note. All ratings were made on 10-point rating scales (see Table 1).

Table 4

*Means of Phenomenological Variables as a Function of Age (Young, Old), Type of Memory (Flashbulb vs. Control) and Testing Occasion (Initial Test vs. Final Re-Test) (Standard Deviations in Brackets).*

| | Type of memory | | | |
|---|---|---|---|---|
| | Flashbulb | | Control | |
| | Young | Old | Young | Old |
| | Number of categories in free recall | | | |
| At initial test | 3.55 (1.28) | 3.97 (1.68) | 3.63 (1.31) | 3.27 (1.56) |
| At final re-test | 4.41 (1.50) | 4.13 (1.91) | 2.66 (1.25) | 2.00 (1.42) |
| | Specificity of probed recall | | | |
| At initial test | 8.89 (1.04) | 8.79 (1.05) | 8.76 (1.19) | 8.10 (1.63) |
| At final re-test | 8.55 (1.39) | 8.34 (1.66) | 6.22 (2.19) | 5.36 (2.73) |
| | Ratings of vividness of reception context | | | |
| At initial test | 8.05 (1.97) | 8.55 (1.97) | 6.86 (2.41) | 6.43 (2.99) |
| At final re-test | 8.16 (1.62) | 8.28 (2.01) | 4.96 (2.82) | 4.51 (3.08) |

Table 5

*Mean Probed Recall Consistency Scores (Weighted Attribute Scores) at Re-Test as a Function of Age (Young, Old) and Type of Memory (Flashbulb vs. Control). Standard Deviations in Brackets.*

| | Age Group | |
|---|---|---|
| | Young | Old |
| Flashbulb memories | 5.31 (1.43) | 4.99 (1.74) |
| Control memories | 3.34 (1.53) | 3.08 (1.88) |

Note. Weighted Attribute Scores range from 0 to 7.

Table 6

*Pearson Product Moment Correlations Between Memory Consistency (Weighted Attribute Scores) and Self-Rated Background Variables at Initial Test and at Final Re-Test as Function of Age (Young vs. Old) and Type of Memory (Flashbulb vs. Control).*

| | Study 1 (Flashbulb) | | Study 2 (Control) | |
|---|---|---|---|---|
| | Young (N=64) | Old (N=67) | Young (N=79) | Old (N=91) |
| Correlation betweens WAS and variables at initial test | | | | |
| Surprise | -.14 | -.16 | .03 | .07 |
| Emotion | .16 | .00 | .00 | .03 |
| Stress | .15 | .12 | .04 | -.08 |
| Rehearsal of event itself | -.06 | .00 | .15 | .18 |
| Correlation between WAS and variables at final re-test | | | | |
| Importance (personal) | -.08 | -.24 | .09 | .14 |
| Importance (national) | -.02 | -.16 | – | – |
| Confidence in probed recall | .08 | .22 | .07 | .21 |
| Vividness of memory | .25* | .18 | .26* | .51*** |
| Rehearsal of event itself | .09 | -.16 | .04 | .23* |
| Rehearsal of personal circumstances | -.24 | -.25* | .26* | .27** |

Note. * P <.05, ** P <.01, *** P <.001

## Figure Captions

*Figure 1.* Mean Consistency Scores (WAS) as a Function of Event (Flashbulb vs. Control) and Time of Re-Test (2-Week vs. Final) in Participants Who Were Initially Tested Twice Shortly After the Target Event. The WAS Ranged From 0 to 7.

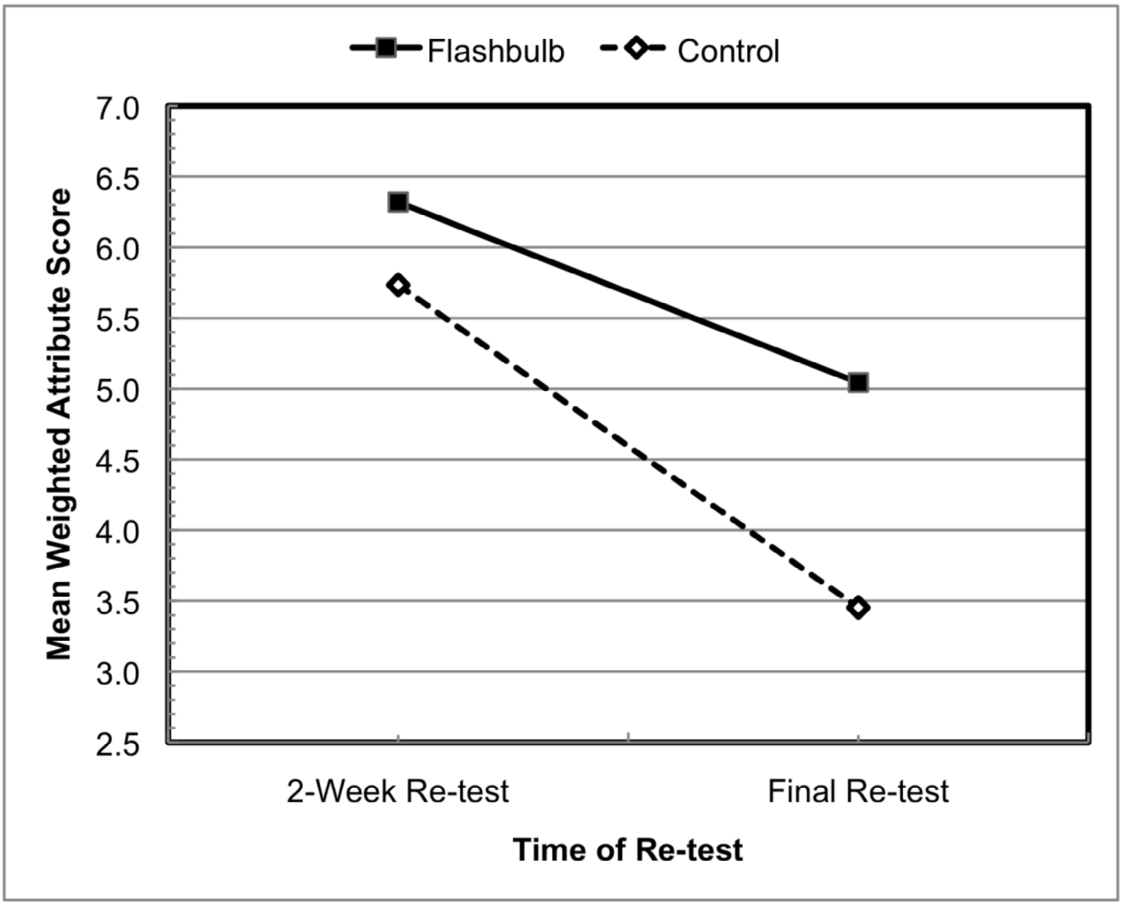
Flashbulb
Control
Mean Weighted Attribute Score
7.0
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2-Week Re-test
Final Re-test
Time of Re-test

Figure 1