On the morning of September 11, 2001, a series of events transpired that changed the world. As first one passenger airliner, and then another, and then a third crashed into significant landmarks of US prosperity and security, it became clear that the United States was the victim of the most deadly terrorist attack ever to have occurred. Further, the fact that this level of destruction could occur so easily and so successfully made it clear that life as we know it in a free democratic country was forever changed. The implications of the terrorist bombing on September 11 were vast, they were unparalleled and they were immediate.

In the aftermath of September 11, like most Americans, I was coping with my own depression over the loss of human life and the loss of my general sense of security and well being as a US citizen. Even when I was not reading about the attacks or talking about the attacks, I was – day and night – experiencing intrusive thoughts about these events. Although I was not watching the television coverage of the events in the days after September 11 – I found it too overwhelming – most people in my world were glued to the television during this period, literally obsessed with what was occurring. In light of this devotion of our consciousness to the events of September 11 and our reactions to these, one might imagine that these events would provide the “flashbulb memories” that cognitive psychologists have been hunting for since Brown and Kulik (1977) first introduced the concept 25 years ago. The events of September 11 provided an opportunity for testing the accuracy and the persistence of memory for a salient life event that simultaneously shocked a wide cross-section of the US population. Counter-intuitively, however, based on what I knew about memory, my prediction was that although most Americans would never forget the horrific events of September 11, few would remember the events as clearly as they probably thought they would.

Seven weeks after September 11, I had five samples of people complete a questionnaire on (a) memory for the events of September 11 and (b) their autobiographical memory for September 11. These five samples were: (1) 275 college students from Manhattan, New York; (2) 167 college students from California; (3) 127 college students from Hawaii; (4) 53 United and
American Airlines flight attendants and pilots; and (5) 68 fire fighters from California. This chapter focuses on the first wave of this longitudinal study. These results primarily involve comparisons among the three college samples who, because of differences in time zones, first heard of the terrorists’ attack at different time intervals after the first World Trade Center tower had been struck.

The North Tower of the World Trade Center was struck by a 767 passenger airliner at 8:45 Eastern Standard Time (EST). The South Tower of the World Trade Center was struck 18 minutes later by a second 767. At 9:50 the South Tower began to collapse. At 10:28 the North Tower began to collapse. The entire event transpired over an hour and 48 minutes. In the midst of this, in Washington, DC, a third passenger airliner crashed into the Pentagon at 9:41, and at 10:06, in Shanksville, Pennsylvania, a fourth passenger airliner crashed to the ground.

People in New York City experienced the events in real time, and they experienced the events as a disjointed sequence of terrifying and incomprehensible incidents. It took some time for them to realize that the events of September 11 constituted a coordinated terrorists’ attack. People in California and Hawaii, on the other hand, were more likely to have first learned of the events of September 11 after they had transpired, and consequently these people were more likely to have heard of the events in a coherent narrative describing a coordinated terrorists’ attack. It was predicted that people would remember the events quite differently as a function of how the events were perceived. Comparisons across time zones avail a test of this prediction.

Episodic memory for a traumatic event

The primary motivation for this study was to assess the accuracy of episodic memory for a traumatic event. It is important for each of us to believe that our memory for past events is reasonably accurate. In some very central way, our sense of self relies on our memory for our past experiences. To the extent that these episodic memories are inaccurate, our sense of self is a distortion of reality. Our everyday interactions with people also rely on shared beliefs about past experiences. These transactions usually go smoothly because our episodic memories for past experiences are usually “accurate enough.” However, there are some conditions under which episodic memories are predictably less reliable.

The literature on eyewitness memory is replete with research supporting the role of specific factors affecting the accuracy of eyewitness memory. (See Cutler & Perrod, 1995, for a review of this research.) Also, dating back to the early research by Bartlett (1932), cognitive psychologists have known that story recall is a highly constructive process. People do not simply copy in memory stories or events that they experience in the world. People, for example, use schemas to comprehend events and consequently remember along with the event experienced, the embellishments and inferences that
they derived from the schema. Although this constructive characteristic of memory aids in our comprehension, it is often the basis for memory flaws and distortions including suggestive influences (Holtz & Pezdek, 1992) and confabulations (Mazzoni, Loftus, Seitz, & Lynn, 1999).

What about memory for traumatic and highly emotional events? Are these memories subjected to the same type of distortions that everyday memories suffer from? The early research on “flashbulb memories” suggested that highly emotional events “leave a scar upon the cerebral tissues” (James, 1890/1950, p. 670). Brown and Kulik (1977) discussed their data on memory for the assassination of President Kennedy by postulating that “all ongoing brain patterns are subject to the order, ‘Now print!’” (p. 96). Although a debate has ensued for the past two decades regarding whether it is necessary to postulate a special memory mechanism to explain the processing of traumatic events (McCloskey, Wible, & Cohen, 1988; Nadel & Jacobs, 1998; Neisser, 1982), in fact, many characteristics of memory for non-traumatic events apply to memory for traumatic events as well (Pezdek & Taylor, 2002).

Specific aims

At the most global level, this study on memory for the events of September 11 assesses the accuracy of episodic memory for a traumatic event. More specifically, this study was designed to examine whether episodic memory for a traumatic event is constructive in nature and whether the errors in episodic memory for a traumatic event follow predictable patterns. The results of this study will also allow a comparison of the accuracy of memory for the external events of September 11 (i.e., event memory) with memory for the personal circumstances in which one first learned of the events (i.e., autobiographical memory). Although Brown and Kulik (1977) first attributed the term “flashbulb memory” to the latter of these two types of memory, the concept is frequently assumed to characterize event memory as well. This is one of the few studies that separately examines event memories and autobiographical memories that were derived from the same event.

This study is also unique in that the events of September 11 were experienced to be more traumatic with more significant and widespread consequences, than were perhaps any other events that have been the focus of previous research on this topic, including memory for the 1986 explosion of the space shuttle Challenger (Neisser & Harsch, 1992), memory for the 1989 Loma Prieta earthquake (Neisser, Winograd, Bergman, Schreiber, Palmer, & Weldon, 1996), and even memory for the 1963 assassination of President Kennedy (Brown & Kulik, 1977). Because the “arousal hypothesis” is often proposed to explain why experiencing an event directly is more memorable than just hearing about it (Christianson, 1992; Gold, 1992), it is important to examine memory for events that were highly arousing and truly traumatic.
Methodology

The three principal samples were undergraduate college students at: (1) Baruch College at City University of New York in lower Manhattan \( (n = 275) \); (2) Pomona College in Claremont, California \( (n = 167) \); and (3) the University of Hawaii, Manoa and Hilo \( (n = 127) \). Questionnaires were completed by the college students in the seventh week after September 11. This was the earliest date possible given the time required to obtain an expedited IRB approval from each of the four participating universities. Faculty members or graduate students at each site recruited volunteers to complete the questionnaire from Introductory Psychology courses. Questionnaires were completed on site and were collected immediately.

The percentage of females \( (M = 62\%) \) exceeded the percentage of males \( (M = 38\%) \) at each site. The three groups were ethnically diverse. The dominant ethnic groups in New York were Caucasian \( (35\%) \) and Asian \( (34\%) \). The dominant ethnic group in California was Caucasian \( (73\%) \). In Hawaii, the dominant ethnic group was Asian \( (52\%) \), and 26% of this sample was Caucasian. As can be seen on the last page of the questionnaire in the appendix, the mean age of the three college samples was quite similar \( (\text{NY: 18.91 years}; \text{CA: 19.15 years}; \text{HI: 20.78 years}) \).

In addition to the three college samples, two other groups of participants were included. These were 53 pilots and flight attendants from United and American Airlines (the airliners that crashed were United and American Airlines flights) and 68 Californian fire fighters (the New York fire fighters were national heroes on September 11). Participants in these two groups were recruited by coworkers who were acquaintances of the author. Participants volunteered to complete the questionnaire at work and return it to their coworker. These were samples of convenience that in many ways were not comparable to the college samples, however, they were included because of the relevance of the events of September 11 to them. As can be seen on the last page of the questionnaire in the appendix, the pilots and flight attendants \( (M = 42.02 \text{ years}) \) and the fire fighters \( (M = 39.37 \text{ years}) \) were older than the college students, and they completed the questionnaires after a shorter time delay following September 11 (between five and six weeks following September 11 as compared to seven weeks for the college students). Nonetheless, these data are included because they provide interesting points of comparison with the college samples, and because they increase the generalizability of the findings.

A copy of the questionnaire is included as an appendix with the mean response per group indicated for each question. The significance level indicated for each item in the appendix is for statistical comparisons made across all five groups. The multiple components of question 1 probed autobiographical memory for the events of September 11. In addition to prompting open ended free recall, this question prompted for information regarding location, activity, informant, time, and others present — the five attributes
focused on in previous research on flashbulb memory (cf. Neisser & Harsch, 1992). The remaining questions probed event memory for September 11. Accuracy and confidence for the event memory questions were obtained.

Results

The three college samples were selected because they spanned different time zones, and consequently were predicted to have heard of the attacks at different time intervals after the first World Trade Center tower had been struck. In fact, this was true. As can be seen in the responses to question 1 in the appendix, the mean time that the participants first heard of the terrorists’ attack after the first World Trade Center tower had been struck was 0.99 hour in New York, 2.50 hours in California, and 4.10 hours in Hawaii. The difference among these three groups was highly significant, \( F(2, 520) = 253.85, p < .001 \). Correspondingly, as predicted, in response to question 3, “When you first heard of the attack on New York, did you know that it was a terrorists’ attack?” 55% of the Californian sample and 59% of the Hawaiian sample responded affirmatively compared to only 39% of the New York sample, \( X^2 (2, N = 569) = 19.43, p < .01 \).

We also know that the participants in the New York sample were highly involved in the incident; they were on average 27 blocks from the World Trade Center when they learned of the terrorists’ attack. Further, 12% of the New York sample were within 10 blocks, and 40% were within 20 blocks of the World Trade Center. In response to question 12, 28% of the New Yorkers had friends or family members in the World Trade Center or on one of the four hijacked airplanes, compared to only 9% of the Californians and 4% of the Hawaiians. In addition, in response to question 11, “Please circle the number indicating how you felt when you first realized that this was a terrorist attack on New York”, (range = 1–7), the New Yorkers rated this event as more distressing \( (M = 5.49, SD = 1.46) \) than the Californians \( (M = 4.96, SD = 1.49) \) or the Hawaiians \( (M = 5.17, SD = 1.41) \). The difference among these three groups was significant, \( F(2, 564) = 7.12, p < .001 \).

Interestingly, the flight attendants and pilots reported high levels of distress (question 11) that were comparable to those of the New Yorkers \( (M = 5.70, SD = 1.31) \), and 25% of them had a friend or family member in the World Trade Center or on one of the hijacked airplanes (question 12). Further, for the flight attendants and pilots who knew someone involved in the event, 21% of these acquaintances did not survive, compared to 9% of the New York sample.

Event memory

The results are reported separately for event memory and autobiographical memory. Regarding how participants first heard about the terrorists’ attack, as indicated at the bottom of Table 4.2, whereas the large majority of the
college students first heard the news from some form of media (i.e., television, radio, online news, etc.), the large majority of the fire fighters and the flight attendants and pilots first heard the news from an individual (either live or by telephone). Regardless of how they first heard of the terrorists’ attack, throughout the day on September 11 the primary source of information regarding the events was television. Although there were significant differences in the amount of television watched across the five samples, the mean number of hours watched (question 14) was 6.00 (SD = 3.81). In the week following September 11, the mean number of hours that people in the five groups reported that they watched television coverage of the events of September 11 (question 15) was 19.55 hours (SD = 19.63), to be compared with a mean of 6.85 hours (SD = 9.84) that people reported that they read about the events of September 11 in print and electronic news sources (question 16). For each of these three questions, the two most involved groups, the New Yorkers and the flight attendants and pilots, reported the highest levels of watching television and reading about these events. In light of this excessive exposure to information it would be predicted that memory for the details of the events of September 11 would be quite good.

Regarding event memory, one of the most interesting questions in the questionnaire was question 4, “On September 11, did you see the videotape on television of the first plane striking the first tower?” In fact, the video recording of the first plane striking the first tower was not available on September 11 and was not broadcast until the next day. Thus, responses to this question assess the extent to which memory is a constructive process. That is, the first plane flying into the first tower was the first event in the sequence of terrorists’ events that occurred, and most participants did see the televised segment of this event. Therefore, in reconstructing their memory they retained memory for the televised segment presenting this event as having occurred first, that is, on September 11.

Across the five samples, the majority of the respondents (overall $M = 73\%$) incorrectly reported “yes” that on September 11 they did see the videotape on television of the first plane striking the first tower, and this pattern was evident in each of the five samples. This finding is made even more compelling by the fact that across all five samples, the mean confidence rating was significantly higher (indicating more confidence in their response) for people who incorrectly reported “yes” to question 4 (overall $M = 6.56, SD = 1.13$) than to those who correctly reported “no” to question 4 (overall $M = 5.59, SD = 1.77$), $t(664) = 8.38, p < .001$. Question 4 was the only question for which the correlation between accuracy and confidence was significant and negative, $r = -.31, (N = 666), p < .001$. Even among the New York participants, the majority (76%) incorrectly responded “yes” to question 4, and those who incorrectly responded “yes” were significantly more confident ($M = 6.59$) than those who correctly responded “no” ($M = 5.48$), $t(267) = 5.82, p < .001$. It is also interesting to note that the correlation between accuracy on this question and the amount of television watched on September 11 (ques-
action 14) was not significant, \( r = -0.02, (N = 627) \). The effect is thus not simply a consequence of the amount of media exposure to the event. Together these findings support the constructive nature of memory, even memory for a salient traumatic event to which people had excessive amounts of exposure.

The responses to question 5, “Was the Pentagon struck before the first tower collapsed?” also support the constructive nature of memory for the events of September 11. Across the five samples, only 62% of the participants responded correctly “yes” and the pattern of responding did not differ significantly across groups, \( X^2 (4) = 5.76, p > .05 \). The first tower was struck at 8:45 and it began to collapse at 10:28. The Pentagon was struck at 9:41. One explanation for the low accuracy rate on this question (given that the chance accuracy rate was 50%) is that the participants experienced the attack on New York first and more intensely than they experienced the attack on the Pentagon. Consequently, the events in New York were clustered in memory and reconstructed as having occurred prior to the attack on the Pentagon. This interpretation is supported by the finding that accuracy on this question was significantly negatively correlated with the mean time that the participants first heard of the terrorists’ attack after the first World Trade Center tower had been struck (question 1), \( r = -0.14, (N = 616), p < .001 \). Thus, participants who first heard of the events later, were less likely to correctly sequence the events in memory.

Responses to question 7, “How much time passed between when the first tower was struck and when it collapsed?” indicate memory for the duration of the complete event in New York. The correct answer to this question was 1 hour and 48 minutes (or 108 minutes). The mean response across the five groups was 61.86 minutes (\( SD = 18.16 \)), substantially less than the correct response, and the responses did not differ significantly across the five samples, \( F(4, 599) = 0.05 \). It is interesting to note that by seven weeks after September 11, for participants in all five samples, already memory for the events had been temporally compressed. This pattern was consistent across the five samples despite significant differences in (a) the degree of media exposure regarding the events (questions 14 and 15), (b) self-reports of the level of distress experienced (question 11), and (c) the mean time that the participants first heard of the terrorists’ attack after the first tower was struck (question 1). Perhaps this result occurred because so few participants actually experienced the event – from the first airliner crashing into the North Tower to the collapse of this tower – in real time. The temporal compression might thus reflect that the resulting memory preserved the event as it was perceived (primarily on television) rather than as it occurred.

In terms of temporal memory for the more specific details of the events of September 11, response accuracy did significantly differ across the five samples. The mean response to question 8, “How much time passed between when the first tower was struck and when the second tower was struck?” was 23.25 minutes (\( SD = 21.65 \)), slightly more than the correct response of 18 minutes. As can be seen in the appendix, responses differed significantly across
the five samples, $F(4, 623) = 14.26, p < .01$, with the Californian and Hawaiian samples being least accurate, exaggerating the duration. Responses to question 9, “How much time passed between when the first tower was struck and when the second tower collapsed?” followed the same pattern.

The responses to questions 6 and 10 probe memory for specific details of the events of September 11. In response to question 6, “The point of impact, where the first plane hit the North Tower, was between what floors?” there was a significant difference in accuracy across the five samples, $F(4, 512) = 14.42, p < .001$, with the Californian and Hawaiian samples being the least accurate. In response to question 10, “The New York Stock Exchange was closed for how many business days following September 11?” there was also a significant difference in accuracy across the five samples, $F(4, 633) = 6.35, p < .001$. However, for question 10, although again the Hawaiian sample was the least accurate, exaggerating the number of days from the correct response of 3 to an average of 5.15, the Californian sample was most accurate ($M = 3.69$ days). Responses to this question most likely reflect the familiarity of each sample with the functioning of the stock market.

**Autobiographical memory**

Autobiographical memory was assessed from the responses to the first question in the questionnaire. In coding these data, we followed the procedure of Neisser and Harsch (1992) to obtain *Weighted Attribute Scores* (WAS). The five most salient attributes of autobiographical memory typically include location, informant, activity, day and time, and others present. For each participant, each of the five attributes was coded 0, 1, or 2 to reflect how much detail was included in the response regarding that attribute. A score of 0 reflected that no information or incorrect information was provided; a score of 2 reflected that accurate detailed information was provided. The author and one graduate student together read and coded the responses of all participants. Any differences in ratings were reconciled by discussion. Location, informant and activity were considered major attributes. Day and time and others present were considered minor attributes. The WAS is the sum of the scores on the three major attributes, plus a bonus point if the subject scored 3 or more (of 4 possible) on the minor attributes. The WAS thus ranged from 0 to 7.

Mean WAS and mean scores on each of the five attributes of autobiographical memory are presented for each of the five groups in Table 4.1. Although the WAS were generally very high (overall mean = 6.63) analyses revealed significant differences both among the three college samples, $F(2, 568) = 38.79, p < .001$, and among all five samples, $F(4, 689) = 22.14, p < .001$. The autobiographical memory data present a pattern of results that is quite different from that reported with the event memory data. As can be seen in Table 4.1, the WAS were lowest for the New York sample. This finding was consistent for each of the five attributes that composed the WAS. The finding that autobiographical memory was lower for the New York participants than for
participants in the other samples is inconsistent with the results reported by Neisser et al. (1996) that level of involvement was associated with better memory for participants’ personal experience upon hearing of the Loma Prieta earthquake.

To assess whether autobiographical memory was significantly related to the degree of self-reported arousal, the correlation was computed between the WAS and degree of distress indicated in responses to question 11. Computed across all participants, this correlation was not significant, $r = .04, (N = 686)$, nor was the correlation significant within any of the five samples except for the fire fighters, $r = .27, (N = 66), p < .05$. Although this result may be an artifact of ceiling effects with both measures, a consistent relationship between arousal and memory was also reported by Neisser et al. (1996).

In addition to the WAS, responses to the autobiographical memory questions were also coded from 0 (no information provided) to 2 (specific information provided) for (a) memory of the first thing said to you, (b) memory of the first thing that you said, (c) degree of emotional reaction noted, (d) degree of disbelief noted (i.e., “I couldn’t believe it had happened”; “I thought I was watching a movie”), and (e) the extent to which the respondent indicated that they went about their regularly scheduled day after hearing of the terrorists’ attacks. The mean rating per group, with the significance level for each indicated, are reported in Table 4.2. One way Analyses of Variance (ANOVA) across all five groups revealed significant differences among groups on each item. More specifically, the New York participants, along with the fire fighters, were less likely to remember the specific thing first said to them and the specific thing they first said upon hearing of the terrorists’ attack. Also, the New York sample, along with the flight attendants and pilots, was more likely to express disbelief, more likely to express an emotional reaction and less likely to have gone about their regularly scheduled day after hearing of the terrorists’ attacks than were the other three groups.

**Discussion**

This research extends the findings of other studies of memory for traumatic events and specifically compares event memory and autobiographical mem-
Table 4.2. Mean rating for qualities indicated in autobiographical memory responses (range = 0-2) and percentages indicated regarding source of first information for each of the five groups

<table>
<thead>
<tr>
<th></th>
<th>NY</th>
<th>CA</th>
<th>HI</th>
<th>Air</th>
<th>Fire</th>
<th>F(4, 689)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>First thing said to you</td>
<td>1.67</td>
<td>1.9</td>
<td>1.8</td>
<td>1.87</td>
<td>1.68</td>
<td>F(4, 689) = 6.62, p &lt; .001</td>
<td></td>
</tr>
<tr>
<td>First thing you said</td>
<td>1.8</td>
<td>1.95</td>
<td>1.87</td>
<td>1.96</td>
<td>1.76</td>
<td>F(4, 689) = 3.93, p &lt; .01</td>
<td></td>
</tr>
<tr>
<td>Disbelief expressed?</td>
<td>0.39</td>
<td>0.22</td>
<td>0.42</td>
<td>0.51</td>
<td>0.26</td>
<td>F(4, 689) = 34.52, p &lt; .001</td>
<td></td>
</tr>
<tr>
<td>Emotion expressed?</td>
<td>0.59</td>
<td>0.36</td>
<td>0.46</td>
<td>0.75</td>
<td>0.24</td>
<td>F(4, 689) = 6.32, p &lt; .001</td>
<td></td>
</tr>
<tr>
<td>Go about your day?</td>
<td>1.44</td>
<td>0.84</td>
<td>0.72</td>
<td>1.32</td>
<td>0.87</td>
<td>F(4, 689) = 29.20, p &lt; .001</td>
<td></td>
</tr>
<tr>
<td>First heard from media</td>
<td>82%</td>
<td>87%</td>
<td>72%</td>
<td>34%</td>
<td>29%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>First heard from a person</td>
<td>18%</td>
<td>13%</td>
<td>28%</td>
<td>66%</td>
<td>71%</td>
<td>$\chi^2 (4) = 132, p &lt; .001$</td>
<td></td>
</tr>
</tbody>
</table>

Memory for an event that was experienced to be more traumatic, with more significant and widespread consequences, than was perhaps any other event that has been the focus of previous research on this topic. The most interesting finding in this study is the result that whereas event memory was most accurate in the sample most directly affected and the most distressed by the events of September 11, autobiographical memory was least accurately reported in this sample. This finding is a novel one because this is one of the few studies that has separately examined event memory and autobiographical memory for the same event. The discussion will focus first on an explanation for this finding and second on patterns of errors that occurred in event memory.

The effect of arousal on event memory and autobiographical memory

The landmark studies of “flashbulb memory” include memory for the 1986 explosion of the space shuttle Challenger (Neisser & Harsch, 1992), memory for the 1989 Loma Prieta earthquake (Neisser et al., 1996), and memory for the 1963 assassination of President Kennedy (Brown & Kulik, 1977). From these studies it has been concluded that “personal involvement . . . led to greatly improved recall” (Neisser et al., 1996, p. 337). That is, that people more aroused by a traumatic event will remember their experience of the event better than will people less aroused by the event. The results of the present study suggest that this conclusion is too simple.

I propose that in these studies, as well as in the present study, the traumatic event and people’s experience of it were perceived and processed separately, resulting in separate memories. Accordingly, the emotions produced by the events could be attached to either the external event or to one’s personal experience of the event, whichever is more vivid. As a consequence, it is the more vivid and emotionally arousing aspect of the experience – either event memory or autobiographical memory – that will receive more narrative
rehearsal and be more accurately retained. In this way, it is the synergy of arousal and rehearsal that affects memory.

In the present study, 73% of the participants first heard of the terrorists’ attack from the media, primarily from television, and on September 11, the participants watched an average of six hours of television coverage of the attacks. Even in New York, although many of the participants experienced the events directly, they too watched a tremendous amount of television on September 11 – an average of more than seven hours. The televised images of the airliner crashing into the World Trade Center and the subsequent collapse of two of the tallest buildings in the world in one of the most densely populated areas of the world were vivid and horrifying. By comparison, participants' personal experience upon hearing of the terrorists’ attack was relatively minor.

It is thus proposed that the emotional response to the experience was more likely to be attached to the external event than to an individual’s personal experience, and the external event was more likely to be narratively rehearsal and subsequently more accurately recalled, especially by participants in the more involved samples. According to this interpretation of the results, participants in the college sample reporting the highest levels of distress, specifically those in New York, were more likely to narratively rehearse the events of September 11 and the focus of their narration was more likely to be the external event itself rather than their experience upon hearing of the event. This would explain why event memory was most accurate (as reflected in the responses to questions 6, 8, 9, and 10) and autobiographical memory was least accurate (as reflected in the results reported in Tables 4.1 and 4.2) in the New York sample.

What type of narrative rehearsal occurred for the events of September 11? A remarkable observation was the finding that the large majority of the participants sought out social contact upon first hearing of the terrorists’ attack, and the social contact extended well beyond the individuals in their immediate environment. Students in New York phoned friends and relatives for updates on what had transpired and to see if they were all right. The fact that the cell phone service in New York was disrupted by the collapse of the World Trade Center was reported to be extremely upsetting to most New Yorkers. Students in California and Hawaii were on the phone, primarily with their parents, as if needing to be assured that some aspect of life was unchanged. The process of talking about the terrorists’ attack seemed to serve to make the events more comprehensible by providing a coherent narrative. It was this narrative rehearsal that shaped their memory for the events.

Keep in mind that in the present study, the terrorists’ attack on September 11 was experienced to be highly distressing to participants (mean response to question 11 was 5.21, $SD = 1.51$, on a 7-point scale). In addition, autobiographical memory was recalled with a high level of detail (mean WAS, range = 0–7, was 6.63, $SD = .66$) and except for the suggestibility questions,
event memory was quite accurate as well. By comparison, the mean emotionality rating by the Californian participants in the Neisser et al. (1996) study of memory for the Loma Prieta earthquake was around 4, the middle of a 7-point scale, and the WAS reported by Neisser and Harsch (1992) in the study of memory for the Challenger disaster was about 3 (range = 0–7). The terrorists’ attack on September 11 was, in fact, more distressing than were the events focused on in other studies of “flashbulb memory”. Nonetheless, even in the New York sample in the present study, autobiographical memory and event memory were quite accurately retained. However, errors in event memory did occur, and they followed a predictable pattern.

Patterns of errors in event memory

This study afforded the opportunity to see if memory for a salient traumatic event is subjected to the same type of distortions that everyday memories suffer from. In a recent review of the literature, Pezdek and Taylor (2002) reported that many characteristics of memory for non-traumatic events apply to memory for traumatic events as well. Specifically, I wanted to see if constructive features of memory were observable in memories for the events of September 11. Two questions were included to address this issue, question 4, “On September 11, did you see the videotape on television of the first plane striking the first tower?” and question 5, “Was the Pentagon struck before the first tower collapsed?” Regarding question 4, 72% of the participants incorrectly reported “yes” that on September 11 they did see the videotape on television of the first plane striking the first tower. Even more compelling is the finding that across all five samples, the mean confidence rating was significantly higher for people who incorrectly reported “yes” to question 4 than to those who correctly reported “no”.

Regarding question 5, 38% of the participants incorrectly reported “yes” that the Pentagon was struck before the first tower collapsed. One explanation for the low accuracy rate on this question is that the participants experienced the attack on New York first and more intensely than they experienced the attack on the Pentagon. Consequently, the events in New York were clustered in memory and reconstructed as having occurred prior to the attack on the Pentagon. Together, these findings suggest that memory for at least some aspects of the events of September 11 were constructed rather than being retained as they had in fact occurred.

Memory for the temporal duration of the events of September 11 also suggests that memory is a constructive process and events are not retained in memory as they in fact occur. Relevant are responses to question 7, “How much time passed between when the first tower was struck and when it collapsed?” The terrorists’ attack began with the first airliner striking the North Tower of the World Trade Center and ended when this tower collapsed. Thus, answers to this question reflect the duration of the entire incident in the participants’ memory. The correct answer to this question was 108 minutes.
The mean response across the five groups was about 62 minutes, substantially less than the correct response, and responses did not differ across groups. Although several researchers have reported that witnesses' estimates of the duration of a stressful event tend to be exaggerated (Buckhout, 1974; Loftus, Schooler, Boone, & Kline, 1987), the current finding of compressed memory for the events of September 11 does not necessarily contradict these results. In the previous research, the events focused on were experienced in real time, and it was the duration of these events that was temporally expanded. In contrast, few participants actually experienced the events of September 11 in real time. The temporal compression might thus reflect that the resulting memory preserved the events as they were perceived (primarily on television) rather than as they occurred.

These findings are likely to generalize to eyewitness memory. If the emotions produced by a stressful and traumatic event are attached to the witness's autobiographical experience, then memory for this aspect of event is more likely to be rehearsed and consequently will be well retained in memory. On the other hand, if the emotions produced by an event are attached to the witness's experience of the event itself, then details of the event itself are more likely to be rehearsed and consequently will be well retained. Future research is necessary to understand the conditions under which the emotions produced by an event become attached to memory for the event itself or the autobiographical memory. The next wave of this study will address changes in event memory and autobiographical memory over time to assess whether the patterns of results reported here are also apparent in participants' memories one year after September 11, 2001.

Acknowledgements

Several people made it possible to conduct this study in a timely manner, and I am grateful to each of them for their generosity. I am indebted to Melanie Rogers at Baruch College at City University of New York, Joie Acosta at the University of Hawaii, Manoa and Mark Runco at the University of Hawaii, Hilo, for their assistance in collecting data at their institutions. I also appreciate Robbin Hutchison's willingness to distribute questionnaires to the flight attendants and pilots. Finally, I thank Aris Karagiorakis and Anne Schimmelbusch for their help with data coding and analysis, and Dani Hodge for suggesting question 4.

References

APPENDIX

Questionnaire with mean response per group indicated along with the results of the corresponding significance test conducted across the five groups

---

Questionnaire Regarding Your Memory for The Terrorists' Attack on New York, September 11, 2001

Thank you for participating in this study. Please answer the following questions from memory without consulting print material or anyone else.

Your responses will remain confidential.

1. Please describe what you remember about where you were and what you were doing at the time that you first heard of the attack on New York.

Day and time:

Mean ' hours after first impact @ 8:45 EST:

NY: 0.99  CA: 2.50  HI: 4.10  Air: 1.17  Fire: 1.05

Sig: $F(4, 621) = 152.38, p < .001$
Where you were:

What were you doing:

Who told you (if TV/radio, what program/newscaster; if person, who?)

Specify as precisely as you remember, what was the first thing said to you regarding the attack:

Specify as precisely as you remember, what was the first thing that you said upon hearing of the attack:

Specify who else was present when you first heard of the attack:

Please describe in as much detail as possible, everything you remember about where you were and what you were doing when you first heard of the attack on New York and in the hour or so thereafter. (Please continue on to back of page.)

2. When you first viewed the television reports of the attack on New York, what had already occurred at the World Trade Center? (Check all that apply.)
   a. The first tower (North Tower) had been struck
   b. The second tower (South Tower) had been struck
   c. The first tower had collapsed
   d. The second tower had collapsed
   e. You did not view this incident on television on September 11

3. When you first heard of the attack on New York, did you know that it was a terrorists' attack? Yes  No

   Indicate your confidence in this response: 1 2 3 4 5 6 7
   (uncertain)  (absolutely certain)

**Responded “yes”:**
NY: 39%  CA: 55%  HI: 59%  Air: 32%  Fire: 29%
Sig: $X^2(4) = 31.90, p < .001$

**Confidence ratings:**
NY: 5.63  CA: 5.58  HI: 5.88  Air: 6.52  Fire: 5.82
Sig: $F(4, 668) = 4.5, p < .001$

4. On September 11, did you see the videotape on television of the first plane striking the first tower? Yes  No

   Indicate your confidence in this response: 1 2 3 4 5 6 7
   (uncertain)  (absolutely certain)

**Responded incorrectly “Yes”:**
NY: 76%  CA: 61%  HI: 84%  Air: 62%  Fire: 73%
Sig: $X^2(4) = 23.88, p < .001$

5. Was the Pentagon struck before the first tower collapsed?  Yes  No

   Indicate your confidence in this response: 1 2 3 4 5 6 7
   (uncertain)  (absolutely certain)

**Responded correctly, “Yes”:**
NY: 62%  CA: 62%  HI: 56%  Air: 68%  Fire: 73%
Sig: $X^2(4) = 5.76, p > .05$

**Confidence ratings:**
NY: 4.40  CA: 3.76  HI: 4.08  Air: 4.90  Fire: 5.25
Sig: $F(4, 657) = 9.25, p < .001$
6. The point of impact, where the first plane hit the North Tower, was between what floors? __________
   Indicate your confidence in this response: 1 2 3 4 5 6 7
   (uncertain) (absolutely certain)

Response (correct: ~90th):
NY: 88.89  CA: 71.72  HI: 78.03  Air: 86.20  Fire: 83.67
Sig: F(4, 512) = 14.42, p < .001

Confidence ratings:
NY: 3.68  CA: 2.78  HI: 2.74  Air: 3.66  Fire: 4.21
Sig: F(4, 509) = 11.72, p < .001

7. How much time passed between when the first tower was struck and when it collapsed?
   Indicate your confidence in this response: 1 2 3 4 5 6 7
   (uncertain) (absolutely certain)

Response (correct: 108 min):
NY: 62.21  CA: 61.51  HI: 63.33  Air: 62.56  Fire: 57.21
Sig: F(4, 599) = .05, p > .05

Confidence ratings:
NY: 3.97  CA: 3.07  HI: 3.00  Air: 4.23  Fire: 4.30
Sig: F(4, 590) = 16.94, p < .001

8. How much time passed between when the first tower was struck and when the second tower was struck?
   Indicate your confidence in this response: 1 2 3 4 5 6 7
   (uncertain) (absolutely certain)

Response (correct: 18 min):
Sig: F(4, 623) = 4.26, p < .01

Confidence ratings:
NY: 4.65  CA: 3.48  HI: 3.46  Air: 4.76  Fire: 4.55
Sig: F(4, 614) = 19.56, p < .001

9. How much time passed between when the first tower was struck and when the second tower collapsed?
   Indicate your confidence in this response: 1 2 3 4 5 6 7
   (uncertain) (absolutely certain)

Response (correct: 65 min):
NY: 76.61  CA: 107.46  HI: 87.03  Air: 70.65  Fire: 56.76
Sig: F(4, 559) = 3.50, p < .01

Confidence ratings:
NY: 3.75  CA: 2.65  HI: 2.76  Air: 3.89  Fire: 4.10
Sig: F(4, 548) = 18.48, p < .001

10. The New York Stock Exchange was closed for how many business days following September 11?
    Indicate your confidence in this response: 1 2 3 4 5 6 7
    (uncertain) (absolutely certain)
Response (correct: 3 days)
NY: 4.26  CA: 3.69  HI: 5.15  Air: 3.70  Fire: 4.16
Sig: $F(4, 633) = 6.35, p < .001$

Confidence Ratings:
NY: 4.67  CA: 3.36  HI: 3.40  Air: 5.20  Fire: 4.86
Sig: $F(4, 620) = 27.55, p < .001$

11. Please circle the number indicating how you felt when you first realized that this
was a terrorist attack on New York:

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>very calm</td>
<td>as distressed as I have ever felt</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Mean response:
NY: 5.49  CA: 4.96  HI: 5.17  Air: 5.70  Fire: 4.35
Sig: $F(4, 681) = 10.80, p < .001$

12. On September 11, 2001, did you have any friends or family members in the
World Trade Center or on any of the four airplanes that were hijacked?
Yes ________ No ________

Responded “yes”:
NY: 28%  CA: 9%  HI: 4%  Air: 25%  Fire: 2%
If yes, did they survive? Yes ________ No ________

Responded “no”:
NY: 9%  CA: 4%  HI: 2%  Air: 21%  Fire: 0%

13. On September 11, 2001, did you have any friends or family members in New
York City?
Yes ________ No ________

Responded “yes”:
NY: 99%  CA: 72%  HI: 44%  Air: 55%  Fire: 22%
Sig: $X^2(4) = 234.58, p < .001$

14. On the day of September 11, estimate how many hours you watched the
television coverage of the attack on New York.

Mean response:
NY: 7.31  CA: 3.89  HI: 5.46  Air: 8.00  Fire: 6.11
Sig: $F(4, 622) = 27.27, p < .001$

15. In the week following September 11, how extensively did you watch television
coverage of the attack on New York?
For about ____ days, I watched about ____ hours of television per day.

Response in total hours:
Sig: $F(4, 663) = 30.96, p < .001$

16. In the week following September 11, how extensively did you read about the
attack on New York in print and electronic news sources?
For about ____ days, I spent about ____ hours per day.

Response in total hours:
NY: 7.67  CA: 6.70  HI: 5.35  Air: 8.82  Fire: 5.12
Sig: $F(4, 664) = 2.22, p > .05$
17. Check which one of the following applied to you on September 11, 2001
   ___ You were a college student on the East Coast.
   What college? ___ What year in college? ___
   *If you were in NY City when the World Trade Center was struck, how many blocks
   were you from the World Trade Center? ___
   ___ You were a college student in California.
   What college? ___ What year in college? ___
   ___ You were a college student in Hawaii.
   What college? ___ What year in college? ___

18. Gender: _________

19. Ethnicity: _________

20. What is your primary language? _________

21. What country were you born in? _________

22. If you were not born in the US, how long have you lived in the US? _________

23. Your age (in years) on September 11, 2001 _________

Mean age:
   NY: 18.91  CA: 19.15  HI: 20.78  Air: 42.02  Fire: 39.37
   Sig: F(4, 666) = 387.99, p < .001

24. Today's date _________

Mean days after 9/11:
   NY: 49.98  CA: 50.86  HI: 50.07  Air: 35.80  Fire: 40.48
   Sig: F(4, 666) = 154.66, p < .001