

Memory Fragments as Components of Autobiographical Knowledge

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SUMMARY

Adults described and dated two kinds of personal remembrances: a fragment—a memory moment that is largely bereft of context—and an episodic, personal event memory—a narrative that consists of a number of related events. In Experiment 1 subjects reported memories from when they were 0–8 years of age and in Experiment 2, from when they were 0–16 years of age. Fragments were judged to be older than event memories, especially in Experiment 2 where the estimated ages of most fragments were from 0 to 8 years and of most episodic memories, from 8 to 16 years. Ratings of various features of the two kinds of memories also differed. We conclude that isolated memory moments possess validity and that although they are most likely to arise when the autobiographical memory system is not fully developed, they can also originate during a time when it is. Copyright © 2006 John Wiley & Sons, Ltd.

Despite the highly variable nature of personal recollections, psychologists interested in autobiographical memory have typically investigated memory for experienced events or what Tulving (2002) has called episodic memory and Brewer (1986, 1996), personal or recollective memory. Brewer (1996) described recollective memory as

memory for a specific episode from an individual's past... these memories typically contain information about place, actions, persons, objects, thoughts, and affect... They are accompanied by a belief that the remembered episode was personally experienced by the individual in that individual's past. (pp. 60–61)

An episodic memory, then, ordinarily contains a substantial amount of information, a point that has been well documented (e.g. Barsalou, 1988; Dudycha & Dudycha, 1933a, 1933b). In addition, such memories generally involve a sequence of related events that occurred in a

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well-defined context, setting or background. In sum, recounting a personal memory usually amounts to a narrative or a story about a set of contextualized events from one's life.

Not always is this the case, however. A personal memory may sometimes consist of nothing more than a brief experience. It may be simply the recollection of a fleeting sensation (a visual, auditory, olfactory or other sensory image), a transient feeling or emotion, or a momentary behaviour or action. And, too, the memory may have little or no context. Some autobiographical memories, then, are basically stand-alone snippets of one's past. Salaman (1970) described them as 'fragment memories' (p. 40) and as 'memories of particular moments' (p. 31). Each, she claims, is like 'an island without a background' (p. 33). Schacter and Tulving (1982) labelled them free fragments. Tulving's (1983) term for them is free radicals, by which he means 'the rudimentary units of remembered experiences... that have become detached from episodic memory' (p. 112). Robinson (1992) characterized such recollections as moments that 'are isolated from a temporal sequence of related events' (p. 228). Elsewhere (Bruce et al., 2005), we have called them fragment memories, memory fragments or, simply, fragments.

A theory proposed by Conway and his associates (Conway, 1992, 1996; Conway & Pleydell-Pearce, 2000; Conway & Rubin, 1993) offers a particular elaboration of the distinction between fragment and episodic memories. The theory holds that autobiographical memories are constructed from a knowledge store having three levels. At the highest level are lifetime periods that are thematic in nature and typically span years. Lifetime periods can be described by phrases such as 'when I lived with Olivia' and 'when I worked for the government'. At an intermediate level are general events. They usually extend over hours, days or weeks and are nested under one or more lifetime periods. Examples of general events are a dinner with friends, a day at the beach and a stay in the hospital. At the base level of the structure is event-specific knowledge (ESK as Conway calls it)—the fine grain of higher-level knowledge—with time intervals most often on the order of seconds or minutes. Each event-specific detail, for instance, a remark, a feeling or a look, is linked to a single general event.

According to Conway's model, recollection of an autobiographical experience is a reconstruction that can involve information stored at all three levels. We will focus on general events and event-specific knowledge, for it is the content at these levels that is akin to what we are here calling episodes and fragments. Remembering an episodic memory in Conway's terms is recalling a general event and its associated lower-level details, whereas retrieving a fragment memory is remembering specific information not contextualized within a general event. As it currently stands, the theory appears to admit only of the former. Remembering an isolated fragment is precluded by the model's assumption that if event-specific information is to be retained, it must normally be embedded in a general event: 'Information in this [event-specific knowledge] representation is rapidly lost unless it becomes linked to a general event. . . .' (Conway & Pleydell-Pearce, 2000, p. 272). In short, event-specific details do not ordinarily have a life independent of a general event. We say 'ordinarily' because fragments appear to be present in the memories of amnesic patients (Schacter & Tulving, 1982; Tulving, 1983) and those suffering from posttraumatic stress disorder (Conway & Pleydell-Pearce, 2000; Conway, Singer, & Tagini, 2004). But when it comes to *normal* individuals remembering personal memories, the clear implication of Conway's theory is that the retrieval of a noncontextualized memory fragment is a nonentity.

To our knowledge, only two studies have reported data that bear directly on this implication. Both investigations examined adults' recall of their earliest memories. Bruce et al. (2005) asked subjects to describe their first fragment memories and their first episodic

memories and to estimate how old they were at the time of each experience. They were also asked to rate various characteristics of the two kinds of memories. Fragments were given earlier datings than episodes—approximately 3 1/3 versus 4 years of age, respectively—and they differed from event memories on a number of dimensions. The other investigation was conducted by Mullen (1994). Of her subjects' earliest recollections, 15% were memory fragments (she called them images) and the remainder were event memories. She too found that fragment remembrances came from earlier in life than event memories. In brief, what evidence there is suggests that normal individuals are capable of retrieving free-standing memory fragments.

Although the findings of Bruce et al. (2005) and Mullen (1994) support the reality of decontextualized event-specific personal knowledge, the support may apply only to our earliest experiences, for those were the ones that Bruce et al. and Mullen asked their subjects to report. At the time of such experiences (about 3 years of age on average), language, narrative skills, social-interaction abilities, a full sense of the past, knowledge of the self, and other cognitive skills such as reminiscing may not have developed sufficiently to provide a context in which event-specific information might ordinarily reside (see Fivush & Nelson, 2004, for a discussion of these issues). But as these cognitive abilities develop, episodic details may be less and less likely to persist as free fragments and more and more likely to become bound up with general events. It turns out that in principle, Conway and Pleydell-Pearce (2000) adopt just such a stance: 'Infant (pre-2-year old) autobiographical memory comprises mainly ESK stored nonconceptually. . . . [With development] the basis gradually emerges for representing more abstract autobiographical knowledge (general events) that acts, at retrieval, to contextualize ESK' (p. 278). Although we may differ from Convey and Pleydell-Pearce in details (e.g. the likely age range for the prepotency of fragment memories—0–2 years in their view and roughly 0–3 years in ours), the implication of our two positions is the same: The fragment memories reported in the Bruce et al. and Mullen studies were likely to have been recollected from a period when a fully functioning autobiographical memory system was not entirely in place. Had it been, free-standing fragments may not have arisen. To test this idea, we asked subjects in the present experiments to report fragment and event memories but not necessarily the earliest ones from their lives.

EXPERIMENT 1

Experiment 1 was similar to our earlier study (Bruce et al., 2005) in which subjects described their first fragment and event remembrances. This time, however, we asked for recollections from any point during the initial 8 years of life. Our thinking was that if memory fragments arise only when language, narrative, social interaction, and other cognitive skills are not well developed, they should continue to be retrieved from earlier in life than story-like episodic memories, indeed, from an age comparable to that observed in our prior study, specifically, around 3 1/3 years. On the other hand, if stand-alone memory moments can arise even when a fully functional autobiographical memory system is in place, the estimated ages of fragments and event memories should be similar.

Method

Subjects

The subjects were 203 students enrolled in introductory psychology courses at Saint Mary's University. They received course bonus points for participating in the study.

Procedure and Design

Testing was entirely a paper-and-pencil affair. Participants provided some biographical information and then described a personal event memory and a memory fragment from the first 8 years of their lives. After each report they provided estimates of how old they were at the time of the experience, confidence judgements of their estimates, and assessments of the memory on 20 seven-point scales.

In recalling an episodic memory, a subject was asked to 'give a brief description of a personal event from the first 8 years of your life. This should be something that happened to you or that you experienced in some place at some time. In other words, it is a personal recollection that is a story. So it has a beginning and an end and you will be able to recall some specific details about what happened'.

For a fragment memory, the instructions were to 'give a brief description of a personal experience from the first 8 years of your life that is a memory fragment. In other words, it is not a complete story with a beginning and an end, it is simply a disconnected piece of memory. It lacks the continuity, background information, and details associated with an event or story. Perhaps you remember it as an image (visual, auditory or of a smell or taste), a behaviour or an emotion. In short, it is nothing more than an isolated fragment that sticks in your mind'.

The instructions included two examples of each kind of memory. They are shown in Appendix A. Subjects were cautioned that each experience they described should be something that they could actually remember and not something that they had been told about by their parents or observed in a photo, and further, that it should be a one-time occurrence and not something that had happened repeatedly.

To designate when a remembered experience had occurred, a subject drew a vertical line through a horizontal time scale. Major divisions of the scale were in years and had the numbers 0 through 8 arrayed below them. Each 1-year interval was divided by minor tick marks into six 2-month periods. If a subject drew a vertical line between two tick marks, it was taken as going through the lower one. Otherwise, the age was given directly by the tick mark through which the line was drawn. In sum, age estimates were recorded in years and sixths of years. The label below each time scale was 'age (in years) at time of personal event' or 'age (in years) at time of memory fragment' depending on the kind of memory being queried. After dating their memories, participants gave confidence judgements in their estimates by checking one of five graded statements ranging from 'certain of my age at the time' (5) to 'not at all sure of my age at the time' (1).

The memories were rated on the 20 seven-point scales listed in Appendix B: 18 were slight modifications of items developed by Johnson, Foley, Suengas, and Raye (1988) and two (items 6 and 20) were specifically generated for purposes of the present study. The intent was to secure a subject's assessment of a variety of characteristics of each event or fragment memory, for example, sensory aspects (visual, sound, smell and taste properties), activity, vividness, degree of detail, location, duration, affect, memory for what happened before and after the experience, amount of rehearsal of the memory, and the participant's perspective of the recollected experience. The 20 scales were always listed in the same order and were headed by a lead-in statement that said either 'the memory for the personal event that I have just described' or 'the memory fragment I have just described'. Each item stated a memory characteristic with the numbers 1 through 7 arrayed below it as well as verbal descriptions of the two end points. Participants circled the number that best indicated how the characteristic squared with the memory in question.

Some subjects were tested individually or in pairs in a laboratory room while others were tested in one of four similar-sized groups in a classroom setting. Laboratory subjects heard a tape recording of the instructions at each point along the way and paraphrased them to ensure that they had been understood. In-group testing, instructions were presented on Power Point slides and were read aloud by the investigator. In both settings, the appropriate response form was provided as each step in the procedure was reached. When a subject in the laboratory completed a form, it was collected by the experimenter; in the classroom situation, the forms were collected when testing was completed. For laboratory subjects, order of report (event-fragment or the reverse) alternated from one experiment session to the next. For classroom subjects, two groups were tested in one report order and two in the other.

Memory reports and final sample of subjects

The 406 memory reports were subjected to a validity check. They were typed, randomly numbered, and arranged in ascending numerical sequence. Two of the authors (DB and JAR) independently examined each report and evaluated it in light of the instructions given to participants. Each description was classified as a personal event, a memory fragment, or neither. The judges agreed on 94.6% of their assessments and were able to reconcile their differences in all but seven instances. These seven reports were removed from the data sample along with 28 others for the following reasons: 13 fragment submissions were judged to be events; 12 experiences were considered to be repetitive or generic (e.g. 'smell of salt water or the ocean'); and 3 memories were deemed to be autobiographical facts. The 35 rejected reports were provided by 33 subjects. Thus, the final sample of data was furnished by 170 participants—122 females and 48 males—whose median age was 20.6 years, with a range from 18.3 to 34.8 years. Subjects tested individually or in pairs numbered 58; those tested in a classroom setting totalled 112. Approximately half the subjects ($n = 90$) reported an event memory first and a memory fragment second and the other half ($n = 80$) gave their reports in the reverse order

Results

We first determined whether there were substantial differences in the results due to testing individuals singly or in pairs versus in large groups. There were no statistically significant main or interaction effects of this factor on estimated ages at the time of the memory experience or on confidence judgements in age estimates. Significant main and interaction effects of test setting occurred with respect to the 20 memory scales, but they were unsystematic and their proportion was low relative to the number of times that such effects could have occurred, 0.075 to be exact. Accordingly, data from the two sets of subjects were combined in the analyses to be reported.

Age estimates and confidence judgements

The mean estimated age of a memory fragment, 5.07 years ($SD = 1.65$), was significantly lower than that of a personal event, 5.99 years ($SD = 1.40$), $F(1, 168) = 34.83$, $MSE = 2.12$, $p < 0.001$. There were no reliable effects due to order of report, $F(1, 168) < 1$, or the interaction between type of memory and report order, $F(1, 168) = 2.61$, $MSE = 2.12$, $p > 0.05$.

Subjects were significantly less confident in estimating how old they were at the time of a fragment experience, $M = 3.26$ ($SD = 1.15$), as compared with an event, $M = 4.02$

($SD = 1.04$), $F(1, 168) = 54.32$, $MSE = 0.82$, $p < 0.001$. Order of report had no significant main effect, $F(1, 168) = 1.93$, $MSE = 1.46$, $p > 0.05$, but did interact with the type of memory. Specifically, subjects expressed greater confidence in age estimates for personal events under both test orders, but analyses of simple effects indicated that only when events were reported first was the effect reliable, $F(1, 168) = 79.06$, $MSE = 0.82$, $p < 0.001$. Otherwise, it was not, $F(1, 171) = 3.05$, $MSE = 0.82$, $p > 0.05$.

Characteristics of fragment and personal event memories

A word count of the memory reports revealed that fragment recollections were significantly briefer than event remembrances, means of 27.2 ($SD = 13.7$) and 84.6 ($SD = 33.8$) words, respectively, $F(1, 168) = 510.66$, $MSE = 535.33$, $p < 0.001$.

Before describing the ratings of the memories on the 20 different scales, we review the effects attributable to the order in which the reports were provided and the interaction of report order and type of memory. There was a main effect of order in 8 of 20 instances (when this occurred, it was almost always the fragment-event order that produced higher ratings). A significant interaction of order and memory type occurred on 10 of 20 occasions. However, in no case was the interaction disordinal, that is, the direction of the difference between the ratings of fragment and event memories was the same for both report orders. In sum, the order effects do not qualify the differences that were observed between the characteristics of the two kinds of memories.

Table 1 presents the results of the ratings. The left-most column contains the number and a capsule description of each scale. The first two data columns provide mean ratings for the two kinds of memory. The final column lists means of the differences between the ratings (events – fragments) and the statistical significance of the differences. We have divided the scales into two categories: ratings of instructed and noninstructed features. The instructed category consists of 12 characteristics that were stated or strongly implied in the memory retrieval instructions given to subjects. The noninstructed category is made up of 8 features that were not stated or implied in the instructions.

Fragment and event memories differed significantly on 10 of the 12 instructed characteristics, $F(1, 168) \geq 20.41$, $MSE \leq 3.44$, $p < 0.001$. As compared with fragments, event recollections were rated as more detailed (especially concerning vision, sound, touch and activity) and the underlying experiences were seen as longer and better contextualized as to location, general setting, and what preceded and followed them. In short, ratings on the instructed dimensions indicated that subjects were following the directions in reporting the two kinds of memories.

Reliable differences were obtained on 6 of the 8 noninstructed dimensions. In comparison with fragment memories, participants rated event memories higher in overall vividness, judged that they remembered to a greater degree how they felt and the intensity of their feelings at the time the event memories were established, and indicated that they talked and thought about them more frequently, $F(1, 168) \geq 39.42$, $MSE \leq 2.30$, $p < 0.001$. They also saw their event remembrances more often from the perspective of a spectator, $F(1, 168) = 10.23$, $MSE = 3.18$, $p < 0.01$.

Content analysis of fragment memories

To obtain a better understanding of the nature of an autobiographical memory fragment, we carried out a content analysis of the reports. We identified three categories or core qualities: (1) the memory report contained information about an action, an activity, or something that happened; (2) it described a scene, setting, or sensory impression; (3) it involved an

Table 1. Experiment 1: Mean ratings and differences in ratings (events – fragments) of instructed and noninstructed characteristics of event and fragment memories

Scale Number and Description	Event	Fragment	Difference
Instructed characteristics:			
1. Involves visual detail	5.90	5.32	0.58*
2. Involves sound	3.55	2.55	1.00*
3. Involves smell	2.00	1.89	0.11
4. Involves touch	4.07	2.95	1.12*
5. Involves taste	1.61	1.70	-0.09
6. Involves activity	5.98	4.27	1.71*
8. Amount of detail	5.35	3.86	1.49*
9. Location of the experience	6.66	5.48	1.18*
10. Familiarity of general setting	6.03	5.05	0.98*
11. Length of experience	4.42	2.34	2.08*
16. Remember what took place before	3.01	1.53	1.48*
17. Remember what took place after	3.88	1.87	2.01*
Noninstructed characteristics:			
7. Overall vividness	5.87	4.68	1.19*
12. Overall tone of the memory	4.03	4.24	-0.21
13. Remember how I felt	5.92	4.64	1.28*
14. Negative/positive feelings at the time	3.49	3.85	-0.36
15. Intensity of feelings	5.45	4.41	1.04*
18. Times thought about the memory	4.56	3.64	0.92*
19. Times talked about the memory	3.61	2.49	1.12*
20. Perspective in seeing the memory	5.51	4.92	0.59**

* $p < 0.001$.** $p < 0.01$.

emotion or feeling. We note that these qualities correspond to the three kinds of memories—behaviours, images and emotions—that Pillemer and White (e.g. Pillemer & White, 1989) hypothesize are represented in a primitive memory system that is present from birth. Two of the authors (DB and JAR) independently evaluated the 170 fragment reports. We were able to assign the great majority of them to one of the three core categories. When more than one quality was present, we made a decision as to which one was primary. We agreed 80.6% of the time in our initial assessments and were able to reconcile our disagreements over the remaining instances.

Before proceeding further, it may be helpful to provide two examples of the memory fragment reports and to note the content category to which each was assigned: (1) 'I remember sitting in my Aunt's kitchen, hiding in the corner. I remember the colours of her floor and the wood smell along the frame of the wall. But I don't know why I was ducked down or why I was there at all' (subject's estimated age at the time: 5.50 years). (2) 'I remember being really muddy and my grandmother washing me off with a hose before she would take me inside. I don't remember how or why I was dirty or going inside to get better cleaned off' (subject's estimated age at the time: 3.83 years). The first example was judged to belong to the category of a scene or sensory impression and the second, to the category of an activity or something that happened.

The content analysis disclosed that 35.3% of the fragment memory reports were mainly about actions or something that happened, 54.7% described scenes or sensory impressions, and 10.0% were largely concerned with emotions or feelings. Because emotion fragments were relatively infrequent, we examined only whether fragments involving actions differed

from those involving scenes on any of the dependent variables previously considered, that is, age estimates, confidence in age estimates and scale ratings. Reliable differences showed up only in the scale ratings. Not surprisingly, action fragments rated higher in activity than sensory fragments, $F(1, 151) = 18.89$, $MSE = 3.30$, $p < 0.001$. As well, activity as compared with sensory fragments were more often seen from the perspective of a spectator, $F(1, 151) = 14.44$, $MSE = 4.84$, $p < 0.001$, were associated with general settings that were more familiar and with feelings that were more negative, $F(1, 151) \geq 8.39$, $MSE \leq 4.13$, $p < 0.01$, and involved touch to a greater degree, $F(1, 151) = 4.27$, $MSE = 3.99$, $p < 0.05$.

Discussion

Consistent with our earlier findings (Bruce et al., 2005), the present study affirmed the reality of memory fragments. Of particular interest is the mean of the fragment datings, 5.07 years. At first glance, such an advanced age appears at odds with the possibility that memory moments persist only from a period of life when language, narrative and other cognitive abilities that underlie the autobiographical memory system are not fully developed. On that view, fragments should have arisen from experiences that occurred around age 3 1/2—approximately the mean estimated age of fragments in our previous investigation (Bruce et al.). That they were judged to have been retrieved mainly from about age 5 indicates that they were established at a time when memory processes are available that permit the creation of long-lasting episodic memories and hence the contexts in which event details are usually nested (e.g. Conway & Pleydell-Pearce, 2000; Fivush & Nelson, 2004; Pillemer, 1992).

Nevertheless, age assessments of fragments in Experiment 1 were still on average well below the upper bound of the range of years over which childhood amnesia may extend—up to about the end of age 6 (Winograd & Killinger, 1983). So many, and possibly a majority, of our subjects may yet have been fishing for fragments in a pool of experiences that occurred when it was difficult to form enduring autobiographical contexts for event-specific information. Consider also that the average age of event memories in Experiment 1 was 5.99 years, significantly higher than for fragments. If stand-alone memory moments are not due to an inability to create event contexts, there seems to us no obvious reason why such moments should not have been retrieved from the same time as event memories. But clearly they were not.

In sum, the outcome of Experiment 1 has two messages. First, it provides further evidence for the validity of fragment memories. Second, it leaves us on the fence as to whether such memories are restricted to that period of life when the cognitive abilities necessary for establishing event contexts are underdeveloped or whether fragments can arise irrespective of whether one has the capacity to establish a durable context for them.

EXPERIMENT 2

The 0–8 year retrieval window in Experiment 1 may not have been wide enough to determine whether fragment memories can come from a stage of life when the autobiographical memory system is firmly in place. In Experiment 2, therefore, we repeated our first study but increased the upper bound of the retrieval period to 16 years. Because one is more likely to remember episodic memories that are more recent (e.g.

Rubin, 1982), we anticipated that personal event memories should be recollected more often from later in the 0–16 year period than earlier. As for memory fragments, if they are restricted to the childhood years, we would expect them to continue to come from the earlier years of this expanded interval. On the other hand, if fragments are not the result of an inability to establish general event memories, we would expect their retrievability to be similarly influenced by recency and their estimated ages to be comparable to those of episodic memories.

Method

Subjects

The subjects were 118 students enrolled in introductory psychology courses at Saint Mary's University. They were awarded course bonus points for participating in the study.

Procedure and design

Participants were tested singly or in pairs in a laboratory setting or in a group in a classroom situation. They furnished descriptions of two kinds of memories—a personal event memory and a memory fragment. After each one, they estimated how old they were when the experience occurred, indicated their confidence in their estimates, and evaluated the characteristics of their memories according to 20 seven-point scales. The details of the procedure were identical to those of Experiment 1 except for the following: (1) Participants were asked to report memories from any time during the first 16 years of their lives. (2) The horizontal time scale on which subjects marked their ages ranged from 0 to 16 years. (3) The memory examples used to illustrate the two types of memories were changed (see Appendix A). For each type, one example was replaced and the other was slightly revised. The modifications of the fragment examples were intended in part to convey a clearer indication of the decontextualized nature of a fragment memory.

Memory reports and final sample of subjects

The validity of the memory reports was assessed. They were typed, concealed as to the kind of report, and arranged in a random sequence. Two of the authors (DB and JAR) independently examined each report and decided whether it was an event memory, a memory fragment or neither. They agreed on 95.3% of their assessments and were able to reconcile all their disagreements. In the end, 32 reports were rejected for the following reasons: 18 fragments were judged to be personal events; 1 event memory was considered to be a fragment; 6 descriptions were autobiographical facts; 1 recollected experience had occurred repeatedly; 2 events were deemed to be unduly extended in time; and four reports contained too little information to decide one way or the other. The 32 rejected reports came from 31 subjects. The final set of data, then, was provided by 87 participants, 56 females and 31 males. Their ages ranged from 18.1 to 35.3 years with a median of 21.3 years. The number of subjects tested in a laboratory setting was 45 and in a classroom setting, 42. Order of report was counterbalanced with 49 participants describing a personal event first and 38 describing a memory fragment first.

Results

We first determined whether there were any significant differences attributable to the setting (laboratory vs. classroom) in which the data were collected. There were no reliable

effects of this variable on age estimates and confidence judgements. For the 20 rating scales, there were 80 possible significant effects of test setting itself or in interaction with memory type and order of report, but only four were observed, in short, about what would be expected by chance alone. Accordingly, all of the following statistics are based on data from the two test situations combined.

Age estimates and confidence judgements

The mean of participants' estimates of their ages at the time of a fragment experience was 6.66 years ($SD = 3.02$) and of a personal event experience, 9.61 years ($SD = 4.00$), a highly significant difference, $F(1, 85) = 42.67$, $MSE = 8.36$, $p < 0.001$. Order of report, either alone or in interaction with type of memory, had no reliable influence on the dating of a memory, $F(1, 85) < 1$ in both instances.

Subjects were markedly less confident in their estimates of the ages of fragments, $M = 2.91$ ($SD = 1.10$), as compared with events, $M = 4.16$ ($SD = 1.91$), $F(1, 85) = 73.15$, $MSE = 0.87$, $p < 0.001$. There was no main effect of report order, $F(1, 85) < 1$. Report order and memory type interacted, but simple effects analyses disclosed that confidence in the datings of fragment memories was significantly lower for both test orders, $F(1, 85) \geq 18.64$, $MSE = 0.87$, $p < 0.001$.

Characteristics of fragment and personal event memories

Accounts of fragments were again significantly briefer than accounts of events, means of 34.0 ($SD = 11.6$) and 86.9 ($SD = 33.0$) words, respectively, $F(1, 85) = 283.49$, $MSE = 397.84$, $p < 0.001$. Turning to the 20 scales used to assess the characteristics of fragment and personal event memories, we first determined whether the ratings were influenced substantially by the order in which participants gave their reports. On five occasions, there was a main effect of order—ratings were generally higher when fragment descriptions were provided first. More important is that in five instances, test order and type of memory interacted significantly. The interactions were never disordinal, however: Differences between ratings of the two kinds of memories were always in the same direction for both test orders. Thus, order effects do not qualify the picture that emerged from the ratings of the two kinds of memories.

Table 2 presents the mean ratings of personal events and memory fragments on each of the 20 scales as well as means of the differences in the ratings (events – fragments). The scales are again divided into two groups: those that inquired into the instructed features of the two kinds of memories and those that probed noninstructed features. For the instructed dimensions, 11 of the 12 differences were statistically significant, $F(1, 85) = 4.53$, $MSE = 3.19$, $p < 0.05$ for smell, $F(1, 85) = 11.52$, $MSE = 4.52$, $p < 0.01$ for touch, and $F(1, 85) \geq 22.43$, $MSE \leq 3.18$, $p < 0.001$ for the nine remaining instructed characteristics. Once more, then, subjects appear to have adhered to our directions in reporting the two kinds of memory.

The eight sets of ratings of noninstructed features contained reliable differences between fragment and event memories in six instances, $F(1, 85) \geq 15.62$, $MSE \leq 3.38$, $p < 0.001$. As compared with fragment memories, participants judged their event memories to be higher in overall vividness, they thought and talked about them more often, they had better memory for event-associated feelings and evaluated them as more intense, and they saw their event recollections more often from the perspective of a spectator.

Content analysis of fragment memories

Two of us (DB and JAR) performed a content analysis of the fragment memories using the same three core categories as in Experiment 1. We agreed on 87.4% of our initial

Table 2. Experiment 2: Mean ratings and differences in ratings (events – fragments) of instructed and noninstructed characteristics of event and fragment memories

Scale Number and Description	Event	Fragment	Difference
Instructed characteristics:			
1. Involves visual detail	6.33	5.33	1.00*
2. Involves sound	3.97	2.41	1.56*
3. Involves smell	2.52	1.97	0.55***
4. Involves touch	4.03	2.91	1.12**
5. Involves taste	1.85	1.64	0.21
6. Involves activity	5.84	4.32	1.52*
8. Amount of detail	5.72	3.67	2.05*
9. Location of the experience	6.55	4.32	2.23*
10. Familiarity of general setting	5.76	4.22	1.54*
11. Length of experience	4.63	2.16	2.47*
16. Remember what took place before	3.72	1.39	2.33*
17. Remember what took place after	4.00	1.71	2.29*
Noninstructed characteristics:			
7. Overall vividness	6.09	4.37	1.72*
12. Overall tone of the memory	4.94	4.43	0.51
13. Remember how I felt	6.21	4.41	1.80*
14. Negative/positive feelings at the time	4.47	4.38	0.09
15. Intensity of feelings	5.30	3.98	1.32*
18. Times thought about the memory	4.68	3.16	1.52*
19. Times talked about the memory	3.70	1.89	1.81*
20. Perspective in seeing the memory	5.85	4.77	1.08*

* $p < 0.001$.** $p < 0.01$.*** $p < 0.05$.

classifications and were able to reconcile our differences for the remaining cases. The classifications were as follows: 48.3% of the fragments were actions or things that happened, 49.4% were scenes or sensory impressions, and 2.3% were emotions or feelings. In view of the negligible number of fragments that were principally about emotions, we excluded them from further analysis and examined only the action and the sensory or perceptual fragments to determine whether they differed with respect to estimated ages, confidence in age estimates, and scale ratings. Statistically significant effects were found only in the scale ratings, and then, only for two of them. As would be expected, action fragments were rated higher in activity than scene or sensory fragments, $F(1, 83) = 9.10$, $MSE = 3.67$, $p < 0.01$. They also involved touch to a greater extent than sensory fragments, $F(1, 83) = 5.10$, $MSE = 4.65$, $p < 0.05$.

Discussion

Experiment 2 provided further evidence that stand-alone event details are part of an individual's autobiographical knowledge. Especially salient is that fragments, though not from as young an age as in Experiment 1, were still more likely to be about experiences that happened much earlier in life than those that were the content of episodic memories.

GENERAL DISCUSSION

On the emergence of memory fragments

Figure 1 summarizes the age findings of the present research in a way that may make some of our conclusions more persuasive. It shows cumulative relative frequency distributions of the estimated ages of fragment and event memories. The two distributions on the left, labelled Fragment 0–8 and Event 0–8, describe the datings from Experiment 1 and the two on the right, labelled Fragment 0–16 and Event 0–16, describe the datings from Experiment 2. In graphing each function, the estimated ages were cumulated in quarter-year intervals and each data point was plotted at the top of an interval. For example, the percentage of age estimates in the interval 5.00 up to but not including 5.25 was added to the percentage of all estimates less than 5.00. The resulting cumulative percentage was plotted at 5.25. For purposes of Figure 1, then, the extent of the retrieval period (which includes 100% of the cases) was 8.25 years for Experiment 1 and 16.25 years for Experiment 2. Figure 1 also contains a vertical line that divides the age range into two halves, halves that in the text we refer to simply as 0–8 years and 8–16 years.

Because subjects in Experiment 1 were constrained to report memories from the first 8 years of their lives, the distributions of estimated ages of memories in that study lie entirely within the 0–8 year range. In Experiment 2, the upper limit of the retrieval period was 16 years. Yet as Figure 1 indicates, a sizeable majority of the fragment memories in our second study were still retrieved from the years 0 to 8—75.9% of them to be exact. By comparison, only 39.1% of the episodic event memories came from the 0–8 year period.

The substantial proportion of fragment memories in Experiment 2 that were recollected from the 0–8 year interval suggests that there is something about that period that is conducive to the occurrence of isolated memory moments. To reiterate our previous conjecture, it is that during the early years of life—and it might be up to age 8 for some

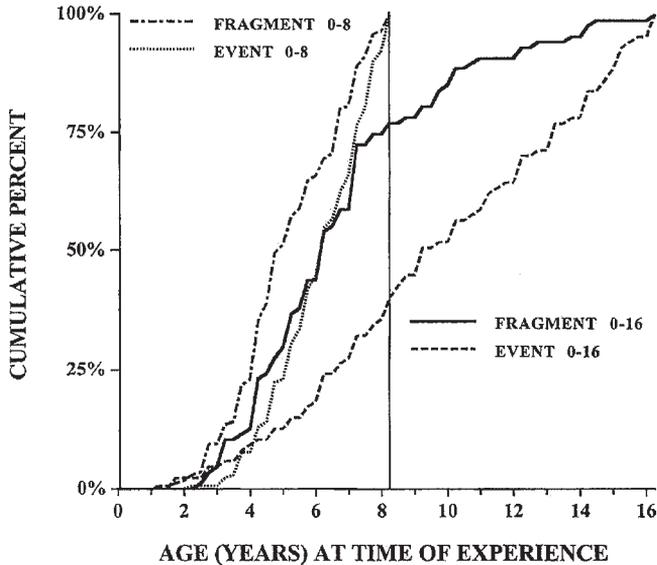


Figure 1. Cumulative relative frequency distributions for the ages of fragments and personal events remembered in Experiment 1 (Fragment 0–8 and Event 0–8) and Experiment 2 (Fragment 0–16 and Event 0–16)

individuals—language, narrative and other cognitive skills are not sufficiently developed to permit the creation of a lasting context as a carrier for event-specific knowledge. Fivush and Nelson (2004) have reviewed the developmental course of the components of a fully functioning autobiographical memory system. Some come on stream early in life, for example, recognition of the cognitive self around the age of 2 (e.g. Howe & Courage, 1993). Others mature considerably later. For instance, a secure knowledge of temporal patterns (e.g. season, month, day, etc.) appears not be present before 6 years of age (Friedman, 1991), and when individual differences are taken into account, it may in some cases be later than that. In sum, absent the full range of autobiographical memory skills, enduring personal memories may be more likely to have the character of fragments rather than story-like event memories. Why such memories should persist is, of course, another question, one that we have no convincing answer to. As Salaman (1970) observed, they seem largely unremarkable.

Although memory fragments may arise because the autobiographical memory system has not reached full stature, Figure 1 shows that a nonnegligible proportion of the fragments in Experiment 2—almost a quarter of them—were about experiences that were estimated to have occurred during the period 8–16 years, in other words, when autobiographical memory capacities are well developed. Evidently retrievable memory fragments need not always be contextualized within general events, even when that is possible. The recollection of these later occurring fragments thus argues against the position of Conway and Pleydell-Pearce (2000) that noncontextualized, event-specific knowledge is unlikely to be a part of the autobiographical knowledge of normal subjects.

Our interpretation of why fragment memories arise has emphasized encoding processes. Either the requisite autobiographical memory skills have not come on line (early fragments) or are not fully employed (later fragments). Another possibility is that fragment memories are merely what remain of general event memories after a good deal of forgetting has taken place. The chief problem we see with a forgetting interpretation concerns differences in the characteristics of the two kinds of memories. The ratings indicate that it is not just that fragments have fewer details than event memories, it is also that they constitute a qualitatively different and far less diverse set of memories. Forgetting may result in less detailed fragments, but is it a plausible explanation of their reduced diversity and of the ways in which they are qualitatively different from event memories? We think not.

Estimating the ages of autobiographical memories

We turn now to concerns about the dating accuracy of the reported autobiographical memories. Over and above the problem that age estimates are just that—estimates—how is it that such estimates are made, especially when it comes to fragments? Contextual information is frequently a cue. Thus, individuals may recollect the details associated with their fifth birthday or that they did such and such during a vacation at a remembered time and place. With a fragment, however, context may in large measure be lacking and subjects may take that as a sign of an early memory. Another potential cue is the amount of detail that a memory contains, with less detail indicating an older memory (Friedman, 1993). Certainly the rating data of the present experiments revealed that there was less contextual information and fewer details associated with fragments as compared with episodic memories. Could this be why fragments were judged to have occurred at an earlier age on average than events?

To evaluate this possibility, we performed a number of analyses. One—and it is the only one we will describe because the results of all the analyses pointed to the same conclusion—explored the differences between the fragment data of Experiments 1 and 2. The mean estimated age of fragment memories in Experiment 1 was 5.07 years and in Experiment 2, 6.67 years. The difference between the means was statistically significant, $F(1, 255) = 30.01$, $MSE = 4.90$, $p < 0.001$.

We next investigated whether the earlier datings of fragments in Experiment 1 could be attributed to the fact that they were more impoverished as to context and details than in Experiment 2. The number of words used to describe the fragments suggested as much. In Experiment 1, fragment reports averaged 27.2 words and in Experiment 2, 34.0 words, $F(1, 255) = 15.82$, $MSE = 170.21$, $p < 0.001$. Scale ratings told a different story, however. Statistical tests disclosed that ratings of fragments differed significantly across the two experiments on only 4 of the 20 scales. Moreover, in two of these instances, ratings of the earlier fragments of Experiment 1 indicated that they actually contained *more* contextual information than the later fragments of Experiment 2. Specifically, subjects in Experiment 1 relative to those in Experiment 2 judged that they had a better sense of both the location and the general setting of their fragment memory experiences, $F(1, 255) \geq 8.98$, $MSE \leq 4.40$, $p < 0.01$. The other two reliable differences had nothing to do with the details or context associated with remembered fragments but indicated only that subjects in Experiment 1 thought and talked more about their fragment memories than did subjects in Experiment 2. Overall, then, comparisons of the fragment data across the two experiments provided no compelling evidence that the earlier estimated ages of the fragments in Experiment 1 versus those in Experiment 2 were due to their possessing fewer details or less contextual information. This outcome together with the fact that the same conclusion can be drawn from our other analyses inclines us to reject the hypothesis that fragment memories in the current studies were dated from an earlier time of life than episodes because they were more meager in context and details.

The nature of autobiographical memory fragments

What do the investigations reported here tell us about the nature of memory fragments and how they differ from personal event memories? The reported fragment and event memories certainly conformed in large measure to the descriptions of the two kinds of memory contained in the initial instructions and examples that subjects received. But the differences go beyond that. Consider the ratings of what we have called noninstructed features of the memories. In both experiments, they indicated that in comparison with event memories, subjects perceived fragments as lower in overall vividness, judged the feelings accompanying them to be neither as intense nor as well remembered, and declared that they were not as often talked or thought about. The mode of re-experiencing also tended to be different: Fragments were less often seen from the perspective of a spectator than were event memories. Such variations lend confidence to the conclusion that fragment and event memories are both genuine and different.

A prominent qualitative difference between the two kinds of memories bears mention. Fragment memories lacked one of the key features of a narrative event memory, namely, a purpose, a goal, a reason or a rationale. Respondents often explicitly noted this lack. The two samples of the fragment memories quoted in the results section of Experiment 1 illustrate the point. In each case, the rememberer mentioned the absence of a reason or a purpose behind the experience. It is also worth noting that the fragment memories used as

examples in the instructions given to subjects in Experiment 1 (see Appendix A) implied nothing about the absence of a goal, a purpose or a reason. Thus, although the instructional examples may have served to some extent as a response model, there is enough information in the ratings and the qualitative nature of the fragment memories to suggest that they reflect more than simply the demand characteristics of the instructions and the fragment memory illustrations given to the participants.

The content analyses of the fragment memories are especially revealing and suggest two conclusions: First, fragment memories appear to be primarily of two kinds. Here they were mainly about activities, actions or something that happened or they were about scenes, settings or sensory impressions. Some fragments were focused largely on emotions or feelings, but they were clearly in the minority. The second suggestion is that fragments from earlier in life are more about sensory or perceptual experiences than about activities or happenings. Thus, 54.7% of the fragments from the 0–8 year period in Experiment 1 were sensory or perceptual in nature whereas only 35.3% were activity fragments. With the wider retrieval window of 0–16 years in Experiment 2, the percentages for sensory and activity fragments were about the same—roughly 49% for both of them.

CONCLUSIONS

The results of the present studies strengthen and expand our earlier findings (Bruce et al., 2005). They strengthen them because they again demonstrate that isolated memory moments possess validity and are distinguishable from event memories. They expand them in two respects. First, they suggest that many fragments, perhaps the majority of them, arise because the full complement of capabilities that make up the autobiographical memory system—language, social-interaction skills, narrative competence, self-knowledge and the like (Fivush & Nelson, 2004)—is lacking and thus unable to provide a context for such memories. Another way of putting it is that momentary experiences of early life are retained by a primitive, non-narrative memory system that is present from birth or that emerges early on and whose representations are images, behaviours or emotions (Conway & Pleydell-Pearce, 2000; Pillemer, 1998; Pillemer & White, 1989; White & Pillemer, 1979). The current data expand the implications of our earlier results in a second way: They indicate that free fragments can also be created and persist when normal autobiographical memory processes have come into operation. We are unable to offer a secure explanation of this observation, although we suspect that at least some of the processes involved operate at encoding. In any case, the current evidence for fragments from the post-childhood years contravenes one aspect of the theory of autobiographical knowledge proposed by Conway and his associates (e.g. Conway & Pleydell-Pearce, 2000), namely, that the existence and retrieval of event-specific knowledge depends on its being linked to a general event. That seems not to be necessary, even in normal subjects.

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APPENDIX A

EPISODIC AND FRAGMENT MEMORY EXAMPLES USED IN EXPERIMENT 1

1. Episodic memory examples
 - a. My family and I went to a ranch to go horseback riding. My sister and I were too young. So we had to stay in a small enclosed circle and sit on the horse as it slowly walked around while in the meantime, my parents rode off down a trail.
 - b. One Christmas morning, my sister, brother and I got up around 3 a.m. to see if Santa had come. There were lots of presents and one big one for the family. Later in the morning, my father got to open it. It was an Atari video system, still one of the best Christmases ever.
2. Fragment memory examples
 - a. I remember sitting in a sleigh in the winter and eating red licorice.
 - b. I remember going into my back yard when I was very young and I found my mother crying.

EPISODIC AND FRAGMENT MEMORY EXAMPLES USED IN EXPERIMENT 2

3. Episodic memory examples
 - a. I remember that my family and I went to a ranch to go horseback riding. My sister and I had no experience riding. So we had to stay in a small enclosed circle and sit on the horse as it slowly walked around while in the meantime, my parents rode off down a trail.
 - b. I remember going to the beach one summer. I went with my family and my best friend Mike. It was a beautiful day and we had a picnic. We all spent most of the day making a gigantic sand snake. It curled every which way for about 20 feet from the edge of the water. Eventually the tide came in and destroyed it, but it looked great while it lasted.
4. Fragment memory examples
 - a. I remember sitting in a sleigh in the winter and eating red licorice. I don't remember where it was or how I got the licorice.
 - b. I remember swimming at a beach one time and how cold the water was. I don't remember anything other than that.

APPENDIX B

THE 20 RATING SCALES USED TO ASSESS CHARACTERISTICS OF PERSONAL EVENT MEMORIES (THE ASSESSMENT FORM USED FOR MEMORY FRAGMENTS WAS THE SAME EXCEPT FOR THE WORDING CHANGES INDICATED IN PARENTHESES). EACH ITEM IS FOLLOWED BY THE DESCRIPTIONS OF THE END POINTS OF THE SCALE; THE NUMBERS 1–7 SEPARATING THE END POINTS HAVE BEEN OMITTED

The memory for the personal event that I have just described (The memory fragment that I have just described):

1. involves visual detail: *little or none-a lot*
2. involves sound: *little or none-a lot*
3. involves smell: *little or none-a lot*
4. involves touch: *little or none-a lot*
5. involves taste: *little or none-a lot*
6. involves activity: *little or none-a lot*
7. the overall vividness of the memory (memory fragment) is: *vague-very vivid*
8. the details of the personal event (memory fragment experience) are: *sketchy-very detailed*
9. the location of the personal event (memory fragment experience) is: *vague-clear/distinct*
10. the general setting is: *unfamiliar-familiar*
11. the personal event (memory fragment experience) seems: *short-long*
12. the overall tone of the memory (memory fragment) is: *negative-positive*
13. I remember how I felt at the time of the personal event (memory fragment experience): *not at all-definitely*
14. my feelings at the time were: *negative-positive*
15. my feelings at the time were: *not intense-very intense*
16. I remember things that took place immediately before the personal event (experience): *not at all-very clearly*
17. I remember things that took place immediately after the personal event (experience): *not at all-very clearly*
18. since this personal event (experience) occurred, I have thought about it: *not at all-many times*
19. since this personal event (experience) occurred, I have talked about it: *not at all-many times*
20. I see my memory of the personal event (memory fragment experience) from the perspective of: *a participant-a spectator*