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Differential Effects of Age on Involuntary and Voluntary Autobiographical Memory

Simone Schlagman
University of Hertfordshire

Matthias Kliegel
Technische Universität Dresden

Jörg Schulz and Lia Kvavilashvili
University of Hertfordshire

Research on aging and autobiographical memory has focused almost exclusively on voluntary autobiographical memory. However, in everyday life, autobiographical memories often come to mind spontaneously without deliberate attempt to retrieve anything. In the present study, diary and word-cue methods were used to compare the involuntary and voluntary memories of 44 young and 38 older adults. The results showed that older adults reported fewer involuntary and voluntary memories than did younger adults. Additionally, the life span distribution of involuntary and voluntary memories did not differ in young adults (a clear recency effect) or in older adults (a recency effect and a reminiscence bump). Despite these similarities between involuntary and voluntary memories, there were also important differences in terms of the effects of age on some memory characteristics. Thus, older adults' voluntary memories were less specific and were recalled more slowly than those of young adults, but there were no reliable age differences in the specificity of involuntary memories. Moreover, older adults rated their involuntary memories as more positive than did young adults, but this positivity effect was not found for voluntary memories. Theoretical implications of these findings for research on autobiographical memory and cognitive aging are discussed.

Keywords: autobiographical memory, involuntary memory, positivity effect, reminiscence bump, aging

Autobiographical memories are memories of events from one's own personal past and are crucial for developing and maintaining personal identity across the life span (Brewer, 1986; Conway & Pleydell-Pearce, 2000; Rubin, 1986). They are distinguished from autobiographical facts, which refer to autobiographical knowledge without recalling any particular episode (e.g., knowing that Mr. Smith was your primary school teacher), and can vary along several dimensions, such as specificity, vividness, and perspective. Autobiographical memories can also differ in terms of whether they are recalled deliberately or spontaneously; hence the distinction between voluntary and involuntary autobiographical memory (Ball, 2007; Berntsen, 1996, 1998; Mace, 2007; Schlagman & Kvavilashvili, 2008).

Although research on voluntary autobiographical memory is long-standing and includes a growing number of studies on older adults, there is only one diary study, published in two parts, on the effects of age on involuntary memories (Schlagman, Kvavilashvili, & Schulz, 2007; Schlagman, Schulz, & Kvavilashvili, 2006).[1] Moreover, several findings from this study did not replicate the results from research on voluntary autobiographical memories; this indicates that age effects obtained on voluntary autobiographical memories cannot be automatically generalized to involuntary memories. The aim in the present study was to fill this gap in research by further examining the effects of age on involuntary autobiographical memory and—for the first time—to directly compare voluntary and involuntary autobiographical memory in young and older adults. The primary focus was on those variables that have been fairly well investigated for voluntary autobiographical memories, such as the specificity of memories, their emotional valence (pleasantness), and the distribution of memories across the life span.

Conceptual Rationale of the Study

One consistent pattern of results in cognitive aging research concerns robust age-related decrements in laboratory tasks of

Simone Schlagman, Jörg Schulz, and Lia Kvavilashvili, School of Psychology, University of Hertfordshire, Hatfield, United Kingdom; Matthias Kliegel, Department of Psychology, Technische Universität Dresden, Dresden, Germany.

Simone Schlagman is now at the Inter-Research Science Center, Oldendorf/Luhe, Germany.

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Correspondence concerning this article should be addressed to Lia Kvavilashvili, School of Psychology, University of Hertfordshire, College Lane, Hatfield, Hertsfordshire AL10 9AB, United Kingdom. E-mail: L.Kvavilashvili@herts.ac.uk

[1] There is also one unpublished diary study by Mace (2003) and a questionnaire study by Berntsen and Rubin (2002) in which participants had to retrospectively recall the most recent involuntary memory that they had experienced in their everyday life.

explicit memory (e.g., free recall, cued recall) but small or no age effects in tasks of implicit memory (e.g., priming, word fragment completion; Grady & Craik, 2000; Light, Prull, La Voie, & Healy, 2000; Zacks, Hasher, & Lee, 2000). This pattern is explained by differential involvement of effortful versus automatic processes in these tasks. Whereas in the former retrieval is mediated by resource-demanding strategic processes, in the latter it is mediated by nonconscious automatic processes that do not require one to travel back mentally to an encoding episode (Tulving, 2002).

An important challenge for cognitive aging research is to identify and investigate the nature of those explicit memory tasks that do involve conscious recollection of the past episode but nevertheless are mediated by automatic processes and hence produce minimal or no age effects. There are at least two classes of explicit memory tasks that may fall into this category. One is prospective memory, which involves a conscious recollection of intended action at an appropriate moment (e.g., making a phone call at 2:00 pm), and another is involuntary autobiographical memory (cf. Ball, 2007). Although there is an ongoing debate about the extent to which prospective memory is mediated by automatic processes (see Kliegel, McDaniel, & Einstein, 2008), there seems to be unanimous agreement about the spontaneous nature of involuntary autobiographical memories (Berntsen, 1996, 2007; Linton, 1986; Mace, 2007; Mandler, 1994, 2007). Thus, at the time of retrieval, people usually are engaged in some fairly mundane activity. Then, all of a sudden, a memory of a past event pops to mind, often in response to some cue in the environment or their thoughts (e.g., Berntsen, 1996; Kvavilashvili & Mandler, 2004). Because there is no previous intent or decision to recall a memory, involuntary autobiographical memories, by definition, are not mediated by strategic retrieval processes. This makes them ideally suited for studying the effects of age on automatic processes in explicit memory tasks. Of particular conceptual importance is comparison of involuntary and voluntary autobiographical memories to see if the pattern of differential age effects is similar to findings obtained in laboratory tasks of implicit and explicit memory.

Effects of Age on Voluntary Autobiographical Memories

Despite the prevalence of involuntary memories in everyday life, research on autobiographical memory has concentrated almost exclusively on voluntary memories that are deliberately retrieved in response to specific cues provided by the experimenter (the so-called word-cue method; see Rubin, 2005). This research has been instrumental in addressing a variety of theoretical issues, such as the nature and organization of autobiographical memories, their functions, and their accuracy (e.g., Bluck, 2003; Brewer, 1988; Conway & Bekerian, 1987; Haque & Conway, 2001). According to Conway and Pleydell-Pearce (2000), autobiographical memory contains information that varies in specificity and has a hierarchical structure, with abstract knowledge about lifetime periods (e.g., when I lived in London) at the top and specific details of a particular event (e.g., meeting Sarah on the bus for the first time) at the bottom. General memories of repetitive events (e.g., traveling to work every morning) or extended events that lasted longer than a day (e.g., Christmas break in Devon) are in the middle and represent the preferred level of specificity, as people often recall general memories even when asked to recall specific memories (Barsalou, 1988; Linton, 1986; Williams & Dritschel, 1992). Most important, specific memories are not stored as whole memories but are constructed by combining sensory information of specific events, such as images, feelings, and actions, with knowledge from higher levels of the hierarchy (i.e., general events and lifetime periods) to form detailed and specific memories. Several lines of research support this model, among them recent neuroimaging studies (Cabeza & St. Jacques, 2007) and findings that the deliberate retrieval of autobiographical memories is a slow and effortful process that can take, on average, up to 10 s (Conway, 1990; Conway & Rubin, 1993).

Further evidence in support of the model comes from research on aging and autobiographical memory. Thus, older adults take significantly longer to retrieve autobiographical memories in response to word cues than do younger adults (Dijkstra & Kaup, 2005; Rubin & Schulkind, 1997a, 1997b). In addition, the autobiographical memories of older adults lack specific sensory and contextual details, and, in comparison with young adults, older adults are more likely to recall general than specific events from their past (Anderson, Cohen, & Taylor, 2000; B. Levine, Svoboda, Hay, Winocur, & Moscovitch, 2002; Piolino, Desgranges, Benali, & Eustache, 2002; Piolino et al., 2006). Furthermore, Cohen and Faulkner (1988) found that the specificity of older adults' voluntary memories was related to the number of times these memories had been previously recalled (i.e., rehearsed); they argued that frequent rehearsal might be a necessary prerequisite to preserve specific memories in old age. If these memories are not deliberately retrieved on a regular basis, the connections deteriorate and the details are lost (Cohen, 1998; Cohen & Faulkner, 1988; Rabbit & Winthorpe, 1988).

Despite these difficulties, the recall of voluntary memories is important in old age, as it may aid emotional regulation and the maintenance of a positive self-concept (e.g., Fernandes, Ross, Wiegand, & Schryer, 2008; Pasupathi & Carstensen, 2003). For example, several longitudinal studies have shown that evaluations of past events become more positive with age (e.g., Field, 1981; Kennedy, Mather, & Carstensen, 2004; L. J. Levine & Bluck, 1997), and in some cross-sectional studies older adults have rated their voluntary memories as more pleasant than have younger adults (e.g., Dijkstra & Kaup, 2005; Rubin & Schulkind, 1997b). These findings are important for research in cognitive aging, in particular for the socioemotional selectivity theory (see Carstensen, Isaacowitz, & Charles, 1999; Mather & Carstensen, 2005), which explains increased positivity in old age as being due to robust motivational shifts in response to a realization that time is running out. Thus, in search of emotional meaning and satisfaction, older adults focus on positive memories and ignore negative information.

Another set of important findings in this context concerns the distribution of memories across the life span. Thus, regardless of age, people tend to recall recent memories more often than older memories (Janssen, Chessa, & Murre, 2005; Rubin, 1999, 2000). However, in older adults, in addition to a clear recency effect, there is another (albeit smaller) peak in the recall of memories of events that occurred when participants were between approximately 10 and 30 years of age (Rubin, 1999, 2000). Although the exact age frame of this reminiscence bump varies (e.g., Chu & Downes, 2000), the phenomenon has been repeatedly reported in the literature and has been found with different retrieval methods that include the standard word-cue method, recall of most vivid and

important memories, and life narratives (e.g., Cohen & Faulkner, 1988; Fitzgerald, 1988; Fitzgerald & Lawrence, 1984; Fromholt et al., 2003; Rubin & Schulkind, 1997a, 1997b). However, the ubiquitous nature of the reminiscence bump has recently been questioned by a study of Berntsen and Rubin (2002), in which the reminiscence bump was obtained for participants' happiest and most important memories but not for the saddest and most traumatic memories (see also Glück & Bluck, 2007).

Effects of Age on Involuntary Autobiographical Memories

Very little is known about the effects of age on involuntary autobiographical memories. In an initial diary study by Schlagman et al. (2007), a small group of young and older participants (ages 20–28 and 64–80) recorded their involuntary memories for 7 consecutive days. Several novel findings emerged from this study. The first and most important finding was that there was no age effect in the proportion of specific memories (which was equally high in both age-groups), and older adults did not report rehearsing their specific memories more frequently than their general memories. Thus, older adults appear to have involuntary access to specific memories that have not been maintained by frequent prior rehearsal, in contrast to voluntary autobiographical memories. Second, older adults showed a clear reminiscence bump with a greatly reduced recency effect. The absence of a recency effect was also reported in an unpublished diary study by Mace (2003). According to Schlagman et al. (2007), its absence could be indicative of further differences between voluntary and involuntary autobiographical memories.

Third, Schlagman et al. (2006) examined emotional qualities of involuntary memories and found that older participants rated their memories as more positive than did young participants. In addition, a content analysis of memory descriptions showed that although 29% of young adults' involuntary memories were of typically negative events (e.g., accidents/illnesses, stressful situations and deaths/funerals), only 7% of older adults' memories fell into these categories. These findings may have important conceptual implications in that they suggest that the positivity effect in old age is stronger for involuntary than voluntary memories. Indeed, for voluntary autobiographical memories, a positivity effect has been obtained in some cross-sectional studies (e.g., Dijkstra & Kaup, 2005; Rubin & Schulkind, 1997b) but not in others (e.g., Anderson et al., 2000; Fernandes et al., 2008). One possible explanation for these contradictory findings is that participants provided only one rating of how pleasant their memory was, and it is not clear whether participants rated the emotional valence of their memories, the original event, or a mixture of both. Therefore, in the present study we included pleasantness ratings for both memory (now) and original event (then).

Finally, Schlagman et al. (2007) also showed that, irrespective of age, involuntary memories were reported predominantly in response to some external triggers and during undemanding habitual activities, such as walking, washing up, or getting dressed (cf.Berntsen, 1998; Kvavilashvili & Mandler, 2004). Interestingly, older adults found the execution of these automatic tasks more difficult, as they reported higher levels of concentration on these tasks (cf. Kvavilashvili & Fisher, 2007, Study 2; Lindenberger, Marsiske, & Baltes, 2000). Increased concentration would then leave them with less cognitive capacity to experience additional task-unrelated thoughts or memories, and, indeed, older adults reported fewer involuntary memories than did young adults.

Taken together, results concerning age effects on involuntary autobiographical memories appear to be at odds with research examining voluntary memories both in terms of memory characteristics (e.g., specificity) and their distribution across the life span. However, the initial study by Schlagman et al. (2007) has several limitations that bring into question the generalizability and validity of their findings, as only 11 young and 10 older adults were tested and no comparison was made with voluntary memories.

Present Study: Aims and Hypotheses

In the present study, we used larger samples of young and older adults who kept a diary of involuntary memories for 7 days and recalled voluntary memories with the standard word-cue method. The primary goal was to see if different patterns of aging emerged for voluntary and involuntary memories. From a more general cognitive aging perspective, this is an important comparison, as it can shed some light on the effects of age on automatic and controlled processes in autobiographical memory and provide evidence for different mechanisms involved in these memories.

Our first aim was to examine several memory characteristics (e.g., specificity, pleasantness, vividness) as a function of age and memory type. On the basis of previous research, conducted separately on voluntary and involuntary autobiographical memories (see above), it was hypothesized that Age × Memory Type interactions would be obtained for at least two of these characteristics. For example, it was expected that the positivity effect in old age (higher pleasantness ratings) would be stronger for involuntary than voluntary memories. Similarly, for the specificity of memories the prediction was that young and older adults would not differ in the proportion of specific involuntary memories but that older adults would report reliably fewer specific voluntary memories. We also explored the frequency of prior recall (rehearsal) to assess Cohen and Faulkner's (1988) claim that older adults maintain specific memories only by frequent rehearsal. In this case, one would expect involuntary memories to have higher rates of prior rehearsal than would voluntary memories.

Our second aim was to compare the distribution of voluntary and involuntary memories across the life span. For the young group, a clear recency effect was expected for both types of memory (see, e.g., Berntsen, 1996; Schlagman et al., 2007). The prediction for the older group was that voluntary memories would exhibit a typical distribution with a pronounced recency component and a smaller increase of memories from the reminiscence bump period (10–30 years). An opposite pattern was expected for involuntary memories: a pronounced reminiscence bump with greatly reduced recency effect. We also examined the distribution of memories in older adults for positive, negative, and neutral memories to assess a recent claim that the reminiscence bump does not occur for negative memories (Berntsen & Rubin, 2002).

Additional predictions concerned the number of involuntary and voluntary memories and retrieval times of voluntary memories. It was expected, in line with Schlagman et al. (2007), that older adults would report fewer involuntary memories than would young adults (see also Berntsen & Rubin, 2002). Given their general difficulties with voluntary retrieval (e.g., a lack of specificity),

older adults were also expected to recall fewer voluntary memories. Significant age effects were also predicted for retrieval times of voluntary memories (Rubin & Schulkind, 1997a, 1997b).

Method

Participants

Thirty-eight older adults (19 men, 19 women) with a mean age of 74.61 years (*SD* = 3.19, range = 69–80) and 44 psychology undergraduates (19 men, 25 women) with a mean age of 21.02 years (*SD* = 2.41, range = 18–28) took part in the study. The young group participated for course credit. Older adults were community residing and retired and were recruited from a subject pool or by advertising in the local area. They did not report any serious head injury, stroke, or mental health/memory problems diagnosed by a physician. English was the first language of all participants.

Table 1 shows mean scores of background variables as a function of age and the results of several one-way analyses of variance (ANOVAs). Older adults were in good health and did not differ from the young adults in terms their ratings of health in general (1 = *poor* to 5 = *excellent*), health in relation to their peers (1 = *worse,* 3 = *same,* 5 = *significantly better*), and ratings of mood recorded in the diary (1 = *very negative,* 3 = *neutral,* 5 = *very positive*). Members of the older group were cognitively well functioning, as indicated by their scores on two subtests of the Speed and Capacity of Language-Processing test (SCOLP; Baddeley, Emslie, & Nimmo-Smith, 1992). They had reliably higher scores on the Language Capacity test (i.e., Spot-the-Word), and there were no age differences on the Speed of Comprehension test. However, older adults had spent less time in education and scored lower on a simple free recall task than did young adults.

Materials and Procedure

Initial (screening) telephone interviews were conducted to assess participants' health status and to obtain background information. The researcher also administered a free recall test by reading aloud 10 words (*cabin, pipe, elephant, chest, silk, theatre, watch, whip, pillow,* and *giant*) and asking participants to recall as many words as they could, in any order. Participants were informed that they were taking part in a research project on aging and cognition; they were invited to attend two 1-hr experimental sessions 8 days apart and to keep a diary of their everyday memory processes between the two sessions. All participants were tested individually in a quiet room, either at the university (mainly young adults) or at their home (mainly older adults).

Session 1 and instructions for the diary. In this session, participants received detailed instructions about the nature of involuntary autobiographical memories and were asked to record any involuntary memories that occurred during a simple vigilance task (see Schlagman & Kvavilashvili, 2008, for a detailed description of methodology). Performance on this task was part of another study and is reported elsewhere (Schlagman, Kliegel, Schulz, & Kvavilashvili, 2009). Then they were administered the Speed of Comprehension Test (see below). At the end of the session, participants were informed about their next task: recording involuntary memories in a diary for 7 consecutive days. The nature of involuntary autobiographical memories was explained again (see Appendix A), and participants received verbal and written instructions about how to keep the diary (see Appendix B). A copy of the instructions was on the inside cover sheet of the diary. Participants began recording their involuntary memories the next morning.

Diary phase (involuntary memory recall). Participants carried the diaries with them for a period of 7 days and recorded their involuntary autobiographical memories immediately, or as soon as possible, after occurrence. If they could not complete the recording immediately but later felt they had forgotten key characteristics, a space was provided for them to record this in the form of a tally (tick). There were no restrictions on the type (e.g., memories could be specific or general, recent or remote) or number of memories recorded each day.

Participants recorded each memory using a two-page questionnaire. On page 1, they recorded the time and date when the memory occurred and when the questionnaire was filled out and rated their mood immediately before the memory (1 = *very negative,* 3 = *neutral,* 5 = *very positive*). Then, participants briefly described their memory and indicated whether or not it was triggered. If the memory was triggered, they indicated if the trigger was in their thoughts or in the environment and wrote a description of it. Finally, they gave a rating of memory vividness on a 7-point scale (1 = *very vague, almost no image at all* to 7 = *very vivid, almost like normal vision*). On page 2, participants described what activity they were involved in at the time they had the memory and

Table 1
Mean Scores (Standard Deviations in Parentheses) of Background Variables as a Function of Age (Young vs. Older)

Variable	Group		$F(1, 80)$	Effect size (η_p^2)
	Young, $n = 44$	Older, $n = 38$		
General health	3.70 (0.58)	3.92 (0.54)	3.01	.036
Health (self vs. peers)	3.50 (0.73)	3.79 (0.74)	3.16	.038
Mood	3.31 (0.48)	3.39 (0.56)	0.49	.00
SCOLP, Language Capacity	45.64 (5.27)	54.79 (8.10)	37.73**	.32
SCOLP, Speed of Comprehension	63.45 (16.62)	67.45 (14.10)	1.54	.02
Immediate free recall test	5.95 (1.14)	5.08 (1.56)	8.49*	.10
Years in education	14.73 (1.25)	12.74 (3.28)	13.84**	.15

Note. Right-hand columns present results of one-way analyses of variance on means with age-group as the independent variable (*F* values and effect sizes). SCOLP = Speed and Capacity of Language-Processing test.
* $p < .05$. ** $p < .001$.

rated how much they were concentrating on this activity on a 5-point scale (1 = *not at all* to 5 = *fully concentrating*). This was followed by further evaluations of memory characteristics, such as how unusual or common the remembered event was (1 = *very common* to 5 = *very unusual*), how pleasant or unpleasant was the memory per se and the remembered event at the time it was experienced (1 = *very unpleasant,* 3 = *neutral,* 5 = *very pleasant*), and whether the remembered event was general or specific. Participants also indicated their age in the memory and how often the memory had been thought of or rehearsed before (1 = *never,* 2 = *once or twice,* 3 = *a few times,* 4 = *several times,* 5 = *many times*).

Voluntary memory recall phase. Session 2 took place 1 week after Session 1, in the same location and at about the same time. After completing the Language Capacity test of SCOLP, participants took part in a voluntary memory task in which 30 word cues (10 negative, 10 neutral, and 10 positive; see Appendix C), in size 18 Arial font, were presented in a fixed random order on an iMac laptop with SuperLab software (for more details of the stimuli, see Schlagman & Kvavilashvili, 2008).

Participants were told that they should deliberately recall an autobiographical memory associated with each of the 30 word cues presented. Each word cue would stay on the screen for 1 min, and they had to recall a memory as quickly as possible. If they were unable to do so, the computer would automatically move to the next word cue. It was reiterated that past memories could be general or specific in nature and could be very recent or remote. As soon as participants had retrieved a memory they were to click the mouse to pause the computer program and complete the first page of the same autobiographical memory questionnaire used in the diary phase (questions about triggers, ongoing activity, and concentration rating were omitted). Once all word cues had been presented, participants completed page 2 of the questionnaire for each memory (i.e., questions on pleasantness, rehearsal, unusualness, specificity, age of memory).

Additional measures of cognitive functioning. The Speed of Comprehension test was taken from SCOLP (Baddeley et al., 1992) and consisted of 100 sentences. Participants were given 2 min to decide whether each sentence was true or false (e.g., "Haddocks are fish" and "Desks wear clothes"). Performance was measured by the number of correct true/false judgments out of 100.

Spot-the-Word. This test from the SCOLP measures verbal crystallized intelligence (Baddeley, Emslie, & Nimmo-Smith, 1993) and consists of 60 pairs of words (e.g., *plorinum–levity* or *thrash–listid*). Participants had to indicate which of the two was a real word, as accurately as possible and with no time limit. Performance was measured by the number of correctly rated word pairs out of 60.

Coding of Autobiographical Memories

Before any analyses were conducted, two independent raters coded each memory as autobiographical or nonautobiographical (for details, see Schlagman et al., 2006, 2007). Interrater reliability, calculated for each memory type and age-group, was high and ranged from $\kappa = .64$ ($SE = .05$) to $\kappa = .84$ ($SE = .06$). Involuntary memories were discarded either because they were deliberately recalled in response to a question (e.g., *do you remember when we went to Camden*?) or because they were not autobiographical and were examples of current thoughts (*thought about having my own personal house*), contents of general knowledge (*Monica from* Friends! *One particular episode where she cooks Thanksgiving dinner*), prospective memory (*I remembered I needed to renew a library book*), or tip-of-the-tongue states (*suddenly the surname popped into my head—I had been trying for weeks to remember*). Voluntary memories were discarded because they referred either to general knowledge or to autobiographical facts in the form of general statements without recalling any contextual details (e.g., *can't read my wife's handwriting; we are lucky to have a warm fire; always proud of my lovely family and their achievements*). Total numbers of discarded and valid autobiographical memories are presented in Table 2. Although more memories were discarded for older adults, this age effect was much stronger for voluntary memories, $\chi^2(1, N = 1{,}922) = 82.38$, $p < .00001$, than for involuntary memories, $\chi^2(1, N = 808) = 3.83$, $p = .05$.

Results

Although all participants made at least one entry in their diary, 2 older participants, with only one memory each, had to be excluded because their memories were discarded as not autobiographical. Therefore, the analyses involving involuntary memories are based on the data for 36 older adults. In line with previous research in this area, the majority of analysis involved use of aggregated data (Berntsen & Hall, 2004; Schlagman & Kvavilashvili, 2008). For each participant, we calculated means (e.g., mean vividness or rehearsal rating) that were then entered into the ANOVA. When the data were dichotomous (i.e., specific vs. general), mean proportions of specific memories were calculated for each participant and then entered into the analysis in the same fashion. The rejection level was set at .05 and the effect size was measured by partial eta squared (η_p^2), with small, medium, and large effects defined as .01, .06, and .16, respectively (Cohen, 1977).

Number of Memories

The mean numbers of involuntary and voluntary memories as a function of age are presented in Table 3 along with the relevant one-way ANOVA results. Older adults recalled reliably fewer voluntary memories ($M = 18.89$) than did young

Table 2
Number (%) of Valid and Discarded Voluntary and Involuntary Autobiographical Memories as a Function of Age-Group (Young vs. Older)

	Autobiographical memories		
Variable	Valid	Discarded	Total
Voluntary memories			
Young	1,065 (97%)	28 (3%)	1,093 (100%)
Older	718 (87%)	111 (13%)	829 (100%)
Total	1,783 (93%)	139 (7%)	1,922 (100%)
Involuntary memories			
Young	437 (93%)	33 (7%)	470 (100%)
Older	301 (89%)	37 (11%)	338 (100%)
Total	738 (91%)	70 (9%)	808 (100%)

Table 3
Means, Standard Deviations, and Ranges of Valid Voluntary and Involuntary Memories as a Function of Age-Group (Young vs. Older)

Variable	Group		$F(1, 78)$	Effect size (η_p^2)
	Young, $n = 44$	Older, $n = 36$		
Valid voluntary memories[a]				
M	24.20	18.89	15.61**	.16
SD	5.88	6.28		
Range	8–30	5–30		
Valid recorded involuntary memories				
M	9.93	8.36	1.04	.01
SD	5.50	8.22		
Range	1–25	1–38		
Ticked involuntary memories				
M	7.16	1.42	9.62*	.11
SD	10.91	2.21		
Range	0–44	0–8		
Total involuntary memories (recorded plus ticked)				
M	17.16	9.78	7.99*	.09
SD	13.48	8.86		
Range	1–65	1–40		

Note. Right-hand columns present results of one-way analyses of variance on means with age-group as independent variable (*F* values and effect sizes).
[a] Degrees of freedom for voluntary memories were (1, 80), as the data of all 38 older participants were included into the analysis.
*$p < .01$. **$p < .001$.

adults ($M = 24.20$).[2] In addition, mean retrieval times for older adults ($M = 15.20$ s, $SD = 7.95$) were significantly longer than those for young adults ($M = 9.82$ s, $SD = 4.38$), $F(1, 80) = 14.94$, $p < .0003$, $\eta_p^2 = .16$.

Results for involuntary memories show that there were no age effects in the mean number of involuntary memories recorded in full. However, older adults had reliably fewer unrecorded memories (in the form of ticks) than did young adults ($M = 1.42$ and $M = 7.16$, respectively). A significant age effect also emerged for the total number of memories (recorded plus ticked memories). It appears that older adults recorded most of the involuntary memories that they had in full, whereas young adults had many more memories than they were able to record (see also Schlagman et al., 2007).

Retrieval Conditions of Involuntary Memories

Triggers. Participants recorded whether or not each involuntary memory was triggered and, if so, whether the trigger was internal or external. Although the majority of memories were reported to have been triggered by external cues (60%) rather than internal cues (23%) or no triggers (17%), this effect was stronger in older adults, $\chi^2(2, N = 738) = 35.60$, $p < .0001$ (see Table 4). Examination of the adjusted residuals (which were > 5.00) showed that in comparison to young adults, older adults were more likely to report external triggers and less likely to report no triggers.

Activities and concentration ratings. The examination of participants' descriptions of activities at the time of having a memory showed that older adults were more likely to report being engaged in habitual automatic tasks, such as having a cup of tea or tidying up (61% vs. 48%, respectively), and were less likely to be engaged in attentionally demanding activities, such as writing or reading, than were young adults (39% vs. 52%, respectively), $\chi^2(1, N = 738) = 12.46$, $p < .001$. Nevertheless, older adults reported marginally higher levels of concentration on these activities ($M = 3.43$, $SD = 0.81$) than did young adults ($M = 3.09$, $SD = 0.80$), $F(1, 78) = 3.45$, $p = .067$, $\eta_p^2 = .04$. This indicated that they found these simple, everyday tasks somewhat more difficult to perform than did young adults.

Testing the Main Hypotheses: Memory Characteristics

Unless otherwise stated, overall mean ratings for all memory characteristics were entered into 2 (Age: young, old) × 2 (Memory Type: involuntary, voluntary) mixed ANOVAs with the repeated measures on the last factor (see Table 5).

Specificity and prior rehearsal. For specificity, there was a main effect of memory type, $F(1, 78) = 90.77$, $p < .00001$, $\eta_p^2 = .54$, with the proportion of specific involuntary memories ($M = 0.78$) being greater than that of voluntary memories ($M = 0.60$). There was also a main effect of age, $F(1, 78) = 15.25$, $p < .001$,

[2] It is important that both young and older participants recalled equal numbers of memories in response to positive, negative, and neutral cues, as shown by a nonsignificant interaction ($F = 2.21$) obtained in an additional 2 (Age-Group) × 3 (Cue Valence) mixed ANOVA with the repeated measures on the last factor. In the young group, the number of recalled memories to positive, negative, and neutral cues was 8.02 ($SD = 2.23$), 8.02 ($SD = 2.12$), and 8.05 ($SD = 2.36$), respectively. In the older group, the respective means were 6.50 ($SD = 2.15$), 6.50 ($SD = 2.44$), and 5.79 ($SD = 2.48$).

Table 4
Percentages (Frequencies) of Involuntary Memories as a Function of Age-Group (Young vs. Older) and Type of Reported Trigger (External vs. Internal vs. None)

	Type of trigger			
Age-group	External	Internal	None	Total
Young	52% (229)	25% (107)	23% (101)	100% (437)
Old	72% (216)	20% (60)	8% (25)	100% (301)
Total	60% (445)	23% (167)	17% (126)	100% (738)

$\eta_p^2 = .16$. Overall, older adults reported fewer specific memories ($M = 0.63$) than did young adults ($M = 0.74$). However, as predicted, there was a significant Age-Group × Memory Type interaction, $F(1, 78) = 8.67$, $p = .004$, $\eta_p^2 = .10$. A test of simple main effects showed that although older adults reported fewer specific voluntary memories than did young adults, $F(1, 78) = 36.69$, $p < .00001$, $\eta_p^2 = .32$, no significant age effect was obtained for the proportion of specific involuntary memories ($F = 1.63$).

Examination of prior rehearsal showed a main affect of age, $F(1, 78) = 11.69$, $p = .001$, $\eta_p^2 = .13$, with older adults reporting higher levels of rehearsal ($M = 3.00$) than did young adults ($M = 2.52$). However, there was no main effect of memory type ($F = 1.18$) or Age × Memory Type interaction ($F = 2.59$). This indicated that older participants did not rehearse their (predominantly specific) involuntary memories more frequently than their (less specific/more general) voluntary memories.

Emotional characteristics of memories. For pleasantness of the memories and the original event, the additional factor of time (now vs. then) was added to the 2 (age) × 2 (memory type) mixed ANOVA. There was a main effect of time, $F(1, 78) = 9.38$, $p = .003$, $\eta_p^2 = .11$, with pleasantness ratings for memory (now; $M = 3.44$) being higher than for the original event (then; $M = 3.15$). Additionally, there was a main effect of memory type, $F(1, 78) = 12.43$, $p = .001$, $\eta_p^2 = .14$, which indicated that, overall, involuntary memories were more pleasant than voluntary memories. However, this main effect was qualified by a significant interaction with age, $F(1, 78) = 5.17$, $p < .03$, $\eta_p^2 = .06$ (see Figure 1). Tests of the simple main effects showed that, regardless of time, older adults rated their involuntary memories as more pleasant ($M = 3.62$) than did young adults ($M = 3.26$), $F(1, 78) = 4.61$, $p < .04$, $\eta_p^2 = .06$, but there was no difference between young and older adults in terms of pleasantness ratings for voluntary memories ($M = 3.16$ and $M = 3.14$ for young and older adults, respectively; $F < 1$). Alternatively, involuntary memories were rated as more pleasant ($M = 3.62$) than were voluntary memories ($M = 3.14$) by the older group, $F(1,78) = 15.30$, $p < .001$, $\eta_p^2 = .16$, but there was no difference in the young group ($F < 1$). A three-way interaction was not significant ($F < 1$).[3]

Other characteristics. The analyses of the remaining memory characteristics revealed main effects of age for vividness ratings, $F(1, 78) = 6.36$, $p = .01$, $\eta_p^2 = .075$; unusualness ratings, $F(1, 78) = 6.02$, $p = .02$, $\eta_p^2 = .07$; and age of memories, $F(1, 78) = 330.62$, $p < .000001$, $\eta_p^2 = .81$. No other main effects or interactions were significant. Thus, the involuntary and voluntary memories of older adults were considerably older ($M = 33.56$) than were those of young adults ($M = 3.87$). Moreover, both involuntary and voluntary memories were rated as being more vivid and more unusual by older adults than by young adults (see Table 5).

Testing the Main Hypotheses: The Life Span Distribution of Memories

The frequency distribution of voluntary and involuntary memories across the life span was examined separately for the two age-groups. To examine the distribution of memories, we calculated the age of each memory by subtracting the age of the participant in the memory from the current age of the participant. This would provide the retention time in years for each memory. If the memory was from the current year, retention time would be zero.

The young group. For the young group, the percentage of involuntary and voluntary memories decreased rapidly with an increase in retention time. The result was a clear recency effect, with 29% ($n = 128$) and 28% ($n = 294$) of involuntary and voluntary memories, respectively, coming from the most recent year (see Figure 2). A curve-fitting regression analysis conducted separately for each memory type on the young adults' number of memories confirmed that the shape of each frequency distribution resembled a decay function. The hyperbolic regression model accounted for 98% of the variance of the observed counts for voluntary memories and for 96% of the variance of the observed counts for involuntary memories.

The older group. The possible age range of older adults' memories was very large; therefore, the data were examined in decades (8 in total). Initially, we investigated the shape of the frequency distribution of memories as a function of their pleasantness (positive, negative, neutral), to see if negative memories were distributed differently than positive and neutral memories (see Berntsen & Rubin, 2002). However, there was no statistically reliable association between the 8 decades and the type of memory valence, either for involuntary memories, $\chi^2(14, N = 292) = 16.7$, $p = .27$, or for voluntary memories, $\chi^2(14, N = 684) = 15.1$, $p = .37$ (the corresponding effect size correlations were also very modest; contingency coefficient = .23 and .15, respectively). Therefore, the frequency distributions were examined irrespective of their valence (see Figure 3). There were similar distributions for

[3] An additional analysis was conducted on voluntary memories by calculating mean emotional valence ratings as a function of cue type (negative, neutral, positive) and entering these means into a 2 (Age-Group) × 3 (Cue Valence: negative, neutral, positive) mixed ANOVA with repeated measures on the last factor. This analysis resulted in the main effect of cue valence, $F(2, 158) = 250.16$, $p < .000001$, $\eta^2 = .76$, with memories retrieved to positive cues being rated significantly higher ($M = 4.14$, $SD = 0.50$) than were memories retrieved to neutral cues ($M = 3.22$, $SD = 0.53$, $p < .000001$) . These, in turn, were rated as more positive than those retrieved to negative cues ($M = 2.37$, $SD = 0.62$, $p < .000001$). The main effect of age was not significant ($F < 1$); however, there was a reliable Age × Cue Valence interaction, $F(2, 158) = 6.43$, $p = .002$, $\eta_p^2 = .08$. Tests of simple main effects showed that young and older participants did not differ in their ratings of memories recalled to neutral cues ($M = 3.22$, $SD = 0.47$ and $M = 3.23$, $SD = 0.60$, $F < 1$) and positive cues ($M = 4.05$, $SD = 0.52$ and $M = 4.25$, $SD = 0.47$), $F(1,79) = 3.12$, $p = .08$, $\eta_p^2 = .04$. However, older adults rated memories to negative cues more negatively ($M = 2.17$, $SD = 0.63$) than did young adults ($M = 2.54$, $SD = 0.59$), $F(1, 79) = 7.61$, $p = .007$, $\eta_p^2 = .09$.

Table 5
Overall Mean Ratings (Standard Deviations) of Memory Characteristics as a Function of Memory Type (Involuntary vs. Voluntary) and Age-Group (Young vs. Older)

	Involuntary memories		Voluntary memories	
Characteristic	Older	Young	Older	Young
Specificity[a]	0.75 (0.20)	0.80 (0.14)	0.51 (0.11)	0.67 (0.12)
Rehearsal[b]	2.98 (0.82)	2.63 (0.70)	3.02 (0.77)	2.41 (0.60)
Memory pleasantness[b]	3.65 (0.72)	3.32 (0.70)	3.22 (0.42)	3.20 (0.55)
Event pleasantness[b]	3.59 (0.82)	3.21 (0.79)	3.06 (0.46)	3.12 (0.29)
Unusualness[b]	3.86 (0.79)	3.44 (0.66)	3.57 (0.51)	3.47 (0.47)
Vividness[c]	5.48 (1.23)	4.91 (0.83)	5.48 (.94)	5.10 (0.76)
Age of memory[d]	35.69 (15.71)	3.66 (2.69)	31.45 (11.16)	4.08 (1.75)

Note. [a] Memories were rated as specific or general. Means represent mean proportions of specific memories averaged across participants. [b] Ratings were made on 5-point scales. For rehearsal, scale points were 1 = *never,* 2 = *once or twice,* 3 = *a few times,* 4 = *several times,* and 5 = *many times.* For memory and event pleasantness, scale points were 1 = *very unpleasant,* 3 = *neutral,* and 5 = *very pleasant.* For unusualness, scale points were 1 = *very common,* 5 = *very unusual.* [c] Ratings were made on a 7-point scale (1 = *very vague, almost no image at all* to 7 = *very vivid, almost like normal vision*). [d] For each memory, age was calculated by subtracting participant's age in memory from participant's current chronological age.

both types of memories: a somewhat reduced recency effect and a very clear reminiscence bump for the decades of 50–59 and 60–69 years (i.e., when participants were approximately 10–30 years of age). The reminiscence bump was slightly smaller than the recency component.

Several log-linear analyses were conducted on this data. First, a model of independence was tested; it predicted that the percentages of memories falling into each of the 8 decades would not differ according to type of memory (voluntary vs. involuntary). This model produced an excellent fit, likelihood ratio [*LR*] (7) = 5.98, $p = .54$, and indicated that age of memory and type of memory were not associated. Therefore, the frequencies were collapsed across memory type for the further analyses. The next model tested for an equal number of expected cell counts in each of the 8 decades but produced a poor fit and was rejected, $LR(8) = 167.95$, $p < .001$. Two additional models used generalized log-odds contrasts to test for differences between different decades. First, we tested for a difference between the frequencies in the most recent decade and the 2 decades in the bump period. The model had an excellent fit, $LR(2) = 0.08$, $p = .96$. Thus, there were significantly more memories from the most recent decade than from the bump period. Second, we tested whether there was a difference between the frequencies of memories in the bump period and the 4 decades between the most recent decade and the bump period. This model also produced an excellent fit, $LR(4) = 0.44$, $p = .98$, and showed that significantly more memories were

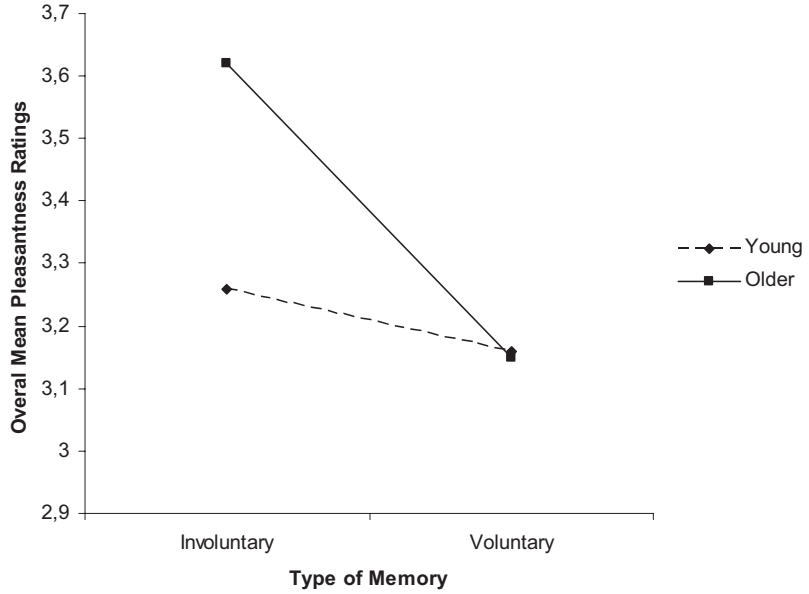

Figure 1. Overall mean pleasantness ratings as a function of memory type (involuntary vs. voluntary) and age-group (young vs. older).

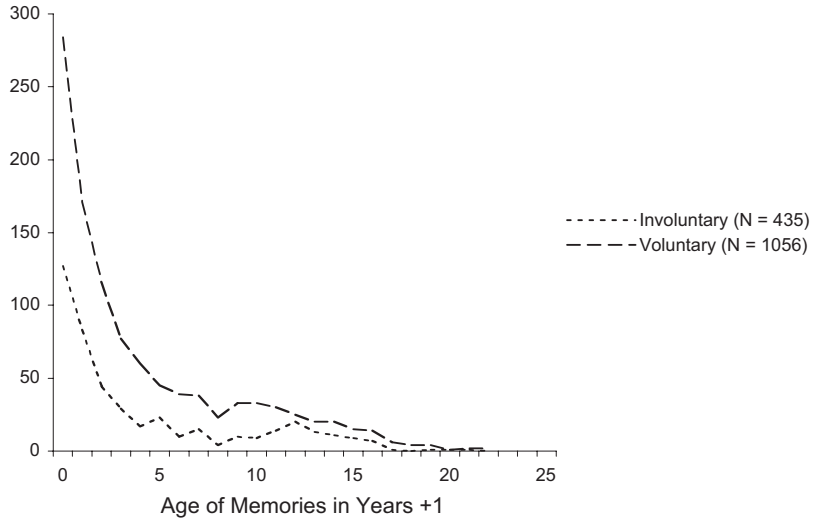

Figure 2. Numbers of involuntary and voluntary memories in the young group as a function of retention time (expressed in years +1 year).

in the bump period than in the other 4 decades before the most recent decade. In sum, the age distribution of involuntary and voluntary memories included both a recency effect and a reminiscence bump (see Figure 3).

Discussion

Our primary objective in the present investigation was to compare age effects on explicit (autobiographical) memory tasks that differed only in terms of whether their retrieval was mediated by automatic or strategic processes (involuntary and voluntary autobiographical memories, respectively). It was expected that some of the Age × Memory Task interactions would be similar to those obtained for laboratory tasks of explicit and implicit memory. Several variables were investigated, but the primary focus was on memory characteristics, such as specificity, pleasantness, and the life span distribution of memories. Below, we discuss findings and theoretical implications for these and other variables, methodological considerations, and conclusions.

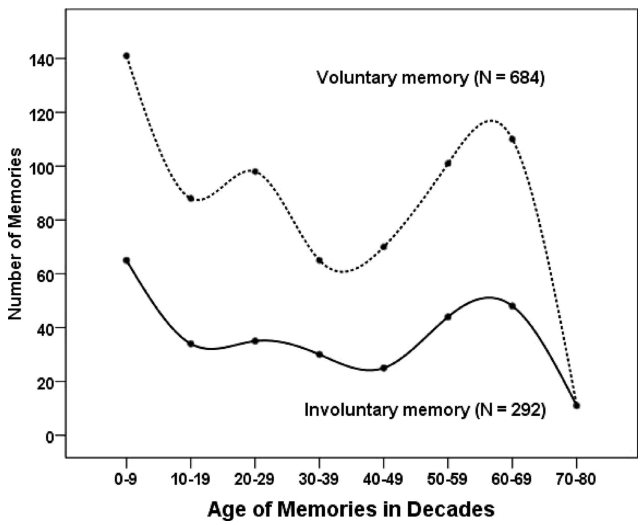

Figure 3. Numbers of involuntary and voluntary memories in the older group as a function of retention time (expressed in decades).

Age Effects on Specificity, Number of Memories, and Retrieval Times of Voluntary Memories

Large age effects obtained in our study for voluntary memories both replicate and extend the previous findings on aging and autobiographical memories. Thus, on average, older adults took 15 s to retrieve memories (5 s longer than young adults). Although these retrieval times appear very long, they are in line with previous studies that show that older adults can take up to 13–20 s to retrieve a memory (e.g., Fitzgerald & Lawrence, 1984; Rubin & Schulkind, 1997a, 1997b). Second, the older group recalled significantly fewer specific voluntary memories (51%) than did the young group (67%). This finding also is well documented (e.g., B. Levine et al., 2002; Piolino et al., 2002).

In contrast, older and young adults did not differ in the proportion of specific involuntary autobiographical memories, which was equally high in both age-groups (75% and 80%, respectively). This finding is particularly surprising, because, unlike instructions from previous studies on aging and autobiographical memory, our instructions did not request the recall of specific memories only (see Appendix A). Moreover, the high level of specificity in the memories of older adults was not maintained by frequent rehearsal (see Cohen, 1998), as they did not report rehearsing their involuntary memories more often than their voluntary memories. Thus, the older adults appeared to be able to effortlessly access specific details of one-off events. At the same time, they experienced considerable difficulties when trying to access these events via deliberate search processes.

In line with Craik's (1986) influential model of memory and aging, this contrasting pattern of findings should be indicative of different mechanisms involved in these two types of memory. According to this model, age effects will be larger for memory

tasks that are primarily mediated by self-initiated controlled processes (e.g., free recall) and smallest or nonexistent for tasks mediated by automatic processes (e.g., priming and implicit memory; see also Grady & Craik, 2000). It is interesting that both priming and implicit memory tasks involve nonconscious access of past information. The results of the present study are important because they show that age effects can also be absent in some explicit memory tasks that do require conscious retrieval and mental time travel to a previous episode.

Currently, there are contradictory conceptual views on how involuntary autobiographical memories are constructed and retrieved. According to Conway (2005), involuntary memories are directly retrieved from a separate pool of very recent memories that have not yet been consolidated into the autobiographical memory system (see also Berntsen, 1998). In contrast, Schlagman and Kvavilashvili (2008) have suggested that involuntary autobiographical memories are retrieved (and constructed) from the same autobiographical system as are voluntary memories. The only difference between the voluntary and involuntary memories lies in the nature of the retrieval process. In the former, one consciously directs the search process through the hierarchy (see, e.g., Haque & Conway, 2001),[4] whereas, in the latter, an incidental cue (internal or external) spontaneously activates the representation of this cue, which then spreads automatically through the autobiographical memory system. If there is a perfect match between key features of the representation of this cue and some already activated fragments of previous events at the bottom of the hierarchy, a specific autobiographical memory is formed and is automatically delivered to consciousness.

Initial support for this model comes from studies of Schlagman and Kvavilashvili (2008) on young adults that showed that involuntary memories were more specific and were recalled significantly faster than voluntary memories. Present findings concerning the absence of an age effect in the specificity of involuntary memories provide additional support for the idea that these memories are accessed automatically from the bottom of the autobiographical memory system. Of particular importance is the finding that (predominantly specific) involuntary memories recalled by older adults were not of very recent events, as proposed by Conway (2005). In fact, the average age of involuntary memories was 35.69 years and was not reliably different from that of voluntary memories (i.e., 31.45 years).

Effects of Age on the Pleasantness of Memories

The second set of important findings concerns a significant Age × Memory Type interaction for pleasantness ratings of autobiographical memories. In line with our predictions, older adults rated their involuntary memories as more pleasant than did younger adults. It is important that this finding was not due to a mood congruency effect, as older adults did not rate their mood as more positive than did young adults at the time involuntary memory occurred (see Table 1), and the correlations between the ratings of mood and emotional valence of memories were fairly modest in size in both young adults, $r(439) = .34$, $p < .0001$, and older adults, $r(299) = .28$, $p < .0001$.

In contrast, older adults' ratings of voluntary memories were not more positive than those of younger adults (for similar results, see Anderson et al., 2000; Fernandes et al., 2008). Also, there was no positivity effect for the number of voluntary memories as a function of cue valence, as equal numbers of memories were recalled to positive, negative, and neutral cues (see footnote 2). Moreover, when we examined participants' pleasantness ratings as a function of cue valence (positive, negative, neutral), there were no age effects in the ratings of memories for positive and neutral cues, but older adults' ratings of memories to negative cues were reliably more negative than those of younger adults (see footnote 3). Taken together, our findings do not demonstrate the positivity effect for voluntary autobiographical memories, at least with the word-cue method used here. However, we found a clear positivity effect for involuntary memories.

This contrasting pattern raises some important theoretical and methodological issues for research on the positivity effect and the socioemotional selectivity theory. Research in this area has often been conducted on nonautobiographical material, such as words, images, and faces (Mather & Carstensen, 2005), and recent findings have shown that the positivity effect is mediated by strategic rather than automatic processes. For example, in a study by Rösler et al. (2005), the attention of both older and young adults was initially captured by negative emotional scenes; however, older adults chose to disengage their attention from them. This tendency was not present in young adults. Moreover, in a study by Mather and Knight (2005, Experiment 3) older adults recalled a smaller proportion of negative pictures than did young adults in a full attention condition, but this effect disappeared (was even reversed) under a divided attention condition. It appears that older adults strategically diverted their attention away from negative stimuli, but this process was disrupted in a divided attention condition.

However, the results of the present study suggest that the positivity effect is not always due to strategic processes. In case of involuntary autobiographical memories it is clearly mediated by automatic processes, because the occurrence of involuntary memories is not under our conscious control; they simply pop into mind unexpectedly (see, e.g., Mandler, 2007). This is a novel finding that needs to be studied in more detail in the future. One possibility is that the positivity effect for involuntary memories occurs because older adults deliberately divert their attention from potentially negative stimuli or triggers, and this prevents them from experiencing negative involuntary memories. However, initial findings from a laboratory task of involuntary memories showed that older adults did not report fewer involuntary memories in response to negative cues than did young participants (see Schlagman et al., 2009). Clearly, more research needs to be conducted on this issue in the future. It is also important to compare positivity effect across various memory tasks (i.e., involuntary/voluntary autobiographical memory and laboratory tasks of recall and recognition of words and images) in a single sample to examine possible reasons for discrepant patterns of findings (see, e.g., Fernandes et al., 2008).

[4] In our study, for example, older adults took significantly longer to direct this search, and, in almost 50% of cases, they terminated it prematurely by recalling general memories instead of specific events.

Distribution of Involuntary and Voluntary Memories Across the Life Span

The third research question of this study concerned the life span distribution of involuntary and voluntary autobiographical memories. For the young group, the distribution of involuntary and voluntary memories was identical (see Figure 2). Most memories were retrieved from the last 5 years. The largest number of memories was from the most recent year, and then the number of memories clearly decreased each year until it evened out at about 5 retention years. This finding replicates that of previous work examining both involuntary and voluntary autobiographical memory in young participants (e.g., Berntsen, 1998; Rubin, 1999). It is important that the distributions of the older adults' involuntary and voluntary memories were also identical, as they included a clear recency effect and a reminiscence bump that fell between the ages of approximately 10 and 30 years (see Figure 3). These findings are in line with those of previous studies on voluntary autobiographical memories (see Rubin, 1999) but contradict the results of Schlagman et al. (2007) and Mace (2003), who did not obtain a strong recency effect for involuntary autobiographical memories. A possible reason for this discrepancy is a lack of power in the previous studies due to small samples.

The results of the present study are also important because they showed that the shape of the distribution of memories in older adults (i.e., the recency component and the reminiscence bump) did not depend on the type of memories (positive, negative, neutral). It appears that the absence of a reminiscence bump for negative autobiographical memories found by Berntsen and Rubin (2002) might be due to the particular method whereby participants were specifically asked to recall their most negative memories but that there is no such absence when memories simply pop to mind or when participants have to recall memories in response to word cues. This issue, however, requires further and more in-depth investigation in the future.

Additional Findings

Number of recalled/recorded memories. Older adults recalled reliably fewer voluntary memories in response to the word cues than did young adults. This is a novel finding that provides further support for the idea that deliberate retrieval of autobiographical memories in response to word cues is a fairly demanding task for older adults. However, there was also a significant age effect in the total number of recalled (recorded plus ticked) involuntary memories. Although this is in line with previous findings on involuntary autobiographical memories (see Berntsen & Rubin, 2002; Schlagman et al., 2007), it contains an apparent paradox. If involuntary memories are brought about by a process of spreading activation that is entirely automatic and nonconscious (see Schlagman & Kvavilashvili, 2008), why did the older adults record fewer involuntary memories than the young adults?

A possible explanation is that although the retrieval of involuntary memories per se is automatic and does not require attentional resources, its end product (i.e., thinking about the contents of involuntary memory) is not. Thus, for one to think about the contents of an involuntary memory and to process the stimuli as part of an ongoing activity, some spare working memory capacity is required. Because older adults may need to pay more attention to the execution of fairly automatic activities, as shown by the results of the present study (see also Kvavilashvili & Fisher, 2007; Schlagman et al., 2007) they will have less working memory resources available with which to become aware of and process task-unrelated thoughts and memories that may be automatically activated by incidental stimuli (see also Kvavilashvili & Mandler, 2004). An alternative but not mutually exclusive possibility is that, because they have to concentrate so much on the ongoing activity, they are less likely to notice the available cues in the environment.

Other memory characteristics. Significant effects of age were obtained for several memory characteristics in addition to specificity and pleasantness. Unsurprisingly, older adults' memories (both voluntary and involuntary) were older than young adults' memories. The memories of older adults were also more rehearsed, simply because they would have had more opportunities (or years) to think about their memories than would young adults. Older adults rated their involuntary and voluntary memories as more vivid and unusual than did young adults. Although this finding was unexpected, it is in line with several other studies of voluntary autobiographical memories that showed higher vividness ratings in older adults (Cohen & Faulkner, 1988; Comblain, D'Argembeau, & Vand der Linden, 2005; Rubin & Schulkind, 1997b). It appears that the increased vividness of older adults' autobiographical memories may be a general phenomenon that is worthy of more in-depth examination.

Methodological Issues

During the initial coding of voluntary and involuntary autobiographical memories, approximately 12% of older adults' memories had to be discarded because they were not autobiographical in nature. It is unlikely that this happened because older participants did not understand instructions and/or the concept of involuntary or voluntary autobiographical memories, as explanations were sufficiently detailed (see Appendixes A and B). A relatively large number of nonautobiographical voluntary memories ($n = 107$) may reflect the tendency of older adults to report general autobiographical facts and/or irrelevant, nonautobiographical information when they are asked to recall or reminisce about their past (see St. Jacques & Levine, 2007). Indeed, 71% ($n = 76$) of their discarded voluntary memories referred to general autobiographical facts without any reference to contextual details or events that happened at a particular time and place (see Method section).[5] Had we retained these memories, the age decrement in the specificity of voluntary memories would have been even stronger than currently reported. It is also important that there was almost no overlap in the contents of voluntary and involuntary memories, as this indicates that involuntary memories recorded in a diary did not affect participants' voluntary recall of memories in Session 2.

Another methodological issue concerns the finding that older adults' memories were significantly older than young adults' memories. This raises a possibility that age effects obtained in the present study were due to increased age of memories in older adults rather than group differences in chronological age. If this

[5] Only 8% of younger adults' discarded voluntary memories were autobiographical facts. The majority of these memories (21 out of 26) referred to contents of general knowledge.

was the case, there should be reliable positive correlations between the age of memories and memory characteristics in the group of older adults, especially for involuntary memories (i.e., older memories should be more specific, pleasant, vivid, etc.). However, most of these correlations were nonsignificant. If anything, small negative correlations were obtained for the vividness of involuntary memories, $r(291) = -.17$, $p = .003$, and voluntary memories, $r(689) = -.19$, $p < .0001$; this indicates that for older adults, recent memories were more vivid than older memories. A reliable positive correlation was obtained only for the rehearsal rating of involuntary memories, $r(291) = .23$, $p < .0001$. This indicates that for older adults, older memories were more rehearsed than recent memories. These results indicate that the pattern of findings obtained in the present study is unlikely to have been caused by group differences in age of memories.

Conclusions

The results of the present study show that age has similar effects on some characteristics of involuntary and voluntary autobiographical memories (e.g., the number of memories reported and the distribution of memories across the life span). On the other hand, differential effects of age on involuntary and voluntary memories were obtained for the specificity of memories and the positivity effect. These findings have important implications for current theories of autobiographical memory and the socioemotional selectivity theory, respectively. They also emphasize the necessity of distinguishing between involuntary and voluntary autobiographical memory and show that examining the effects of age can further enrich the research on memory and aging as well as provide important insights into the nature and functions of involuntary autobiographical memory.

References

Anderson, S. J., Cohen, G., & Taylor, S. (2000). Rewriting the past: Some factors affecting the variability of personal memories. *Applied Cognitive Psychology, 14,* 435–454.

Baddeley, A., Emslie, H., & Nimmo-Smith, I. (1992). *The Speed and Capacity of Language-Processing Test.* Bury St. Edmunds, England: Thames Valley Test Company.

Baddeley, A., Emslie, H., & Nimmo-Smith, I. (1993). The Spot-the-Word Test: A robust estimate of verbal intelligence based on lexical decision. *British Journal of Psychology, 32,* 55–65.

Ball, C. T. (2007). Can we elicit involuntary autobiographical memories in the laboratory? In J. H. Mace (Ed.), *Involuntary memory* (pp. 127–152). Malden, MA: Blackwell.

Barsalou, L. W. (1988). The content and organisation of autobiographical memories. In U. Neisser & W. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory* (pp. 193–243). Cambridge, England: Cambridge University Press.

Berntsen, D. (1996). Involuntary autobiographical memories. *Applied Cognitive Psychology, 10,* 455–460.

Berntsen, D. (1998). Voluntary and involuntary access to autobiographical memory. *Memory, 6,* 113–141.

Berntsen, D. (2007). Involuntary autobiographical memories: Speculations, findings, and an attempt to integrate them. In J. H. Mace (Ed.), *Involuntary memory* (pp. 1–19). Malden, MA: Blackwell.

Berntsen, D., & Hall, N. M. (2004). The episodic nature of involuntary autobiographical memories. *Memory & Cognition, 32,* 789–803.

Berntsen, D., & Rubin, D. C. (2002). Emotionally charged autobiographical memories across the life span: The recall of happy, sad, traumatic and involuntary memories. *Psychology and Aging, 17,* 636–652.

Bluck, S. (2003). Autobiographical memory: Exploring its functions in everyday life. *Memory, 11,* 113–123.

Brewer, W. F. (1986). What is autobiographical memory? In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 25–49). Cambridge, England: Cambridge University Press.

Brewer, W. F. (1988). Memory for randomly sampled autobiographical events. In U. Neisser & W. Winograd (Eds.), *Remembering reconsidered: Ecological and traditional approaches to the study of memory* (pp. 21–30). Cambridge, England: Cambridge University Press.

Cabeza, R., & St. Jacques, P. (2007). Functional neuroimaging of autobiographical memory. *Trends in Cognitive Sciences, 11,* 219–227.

Carstensen, L. L., Isaacowitz, D. M., & Charles, S. T. (1999). Taking time seriously: A theory of socioemotional selectivity. *American Psychologist, 54,* 165–181.

Chu, S., & Downes, J. J. (2000). Odor-evoked autobiographical memories: Psychological investigations of Proustian phenomena. *Chemical Senses, 25,* 111–116.

Cohen, G. (1998). The effects of ageing on autobiographical memory. In C. P. Thompson, D. J. Herrman, D. Bruce, J. G. Payne, & M. P. Toglia (Eds.), *Autobiographical memory, theoretical and applied perspectives* (pp. 105–123). London: Erlbaum.

Cohen, G., & Faulkner, D. (1988). Lifespan changes in autobiographical memory. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Eds.), *Practical aspects of memory: Current research and issues* (Vol. 1, pp. 277–282). Chichester, England: Wiley.

Cohen, J. (1977). *Statistical power analysis for the behavioral sciences.* New York: Academic Press.

Comblain, C., D'Argembeau, A., & Van der Linden, M. (2005). Phenomenal characteristics of autobiographical memories for emotional and neutral events in older and younger adults. *Experimental Aging Research, 31,* 173–189.

Conway, M. A. (1990). *Autobiographical memory: An introduction.* Milton Keynes, England: Open University Press.

Conway, M. A. (2005). Memory and the self. *Journal of Memory and Language, 53,* 597–628.

Conway, M. A., & Bekerian, D. A. (1987). Organization in autobiographical memory. *Memory & Cognition, 15,* 119–132.

Conway, M. A., & Pleydell-Pearce, C. W. (2000). The construction of autobiographical memories in the self-memory system. *Psychological Review, 107,* 261–288.

Conway, M. A., & Rubin, D. C. (1993). The structure of autobiographical memory. In A. E. Collins, S. E. Gathercole, M. A. Conway, & P. E. Morris (Eds.), *Theories of memory* (pp. 103–138). Hove, England: Erlbaum.

Craik, F. I. M. (1986). A functional account of age differences in memory. In F. Clix & H. Hagendorf (Eds.), *Human memory and cognitive capabilities: Mechanisms and performances* (pp. 409–422). Amsterdam: Elsevier.

Dijkstra, K., & Kaup, B. (2005). Mechanisms of autobiographical memory retrieval in younger and older adults. *Memory & Cognition, 33,* 811–820.

Fernandes, M., Ross, M., Wiegand, M., & Schryer, E. (2008). Are the memories of older adults positively biased? *Psychology and Aging, 23,* 297–306.

Field, D. (1981). Retrospective reports by healthy intelligent older people of personal events of their adult lives. *International Journal of Behavioural Development, 4,* 77–97.

Fitzgerald, J. M. (1988). Vivid memories and the reminiscence phenomenon: The role of the self-narrative. *Human Development, 31,* 261–273.

Fitzgerald, J. M., & Lawrence, R. (1984). Autobiographical memory across the lifespan. *Journal of Gerontology, 39,* 692–698.

Fromholt, P., Mortensen, D. B., Torpdahl, P., Bender, L., Larsen, P., &

Rubin, D. C. (2003). Life-narrative and word-cued autobiographical memories in centenarians: Comparisons with 80-year-old control, depressed and dementia groups. *Memory, 11,* 81–88.

Glück, J., & Bluck, S. (2007). Looking back across the life span: A life story account of the reminiscence bump. *Memory & Cognition, 35,* 1928–1939.

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

Haque, S., & Conway, M. A. (2001). Sampling the process of autobiographical memory construction. *European Journal of Cognitive Psychology, 13,* 529–547.

Janssen, S. M. J., Chessa, A. G., & Murre, J. M. J. (2005). The reminiscence bump in autobiographical memory: Effects of age, gender, education, and culture. *Memory, 13,* 658–668.

Kennedy, Q., Mather, M., & Carstensen, L. L. (2004). The role of motivation in the age-related positivity effect in autobiographical memory. *Psychological Science, 15,* 208–214.

Kliegel, M., McDaniel, M. A., & Einstein, G. O. (2008). (Eds.). *Prospective memory: Cognitive, neuroscience, developmental, and applied perspectives.* New York: Erlbaum.

Kvavilashvili, L., & Fisher, L. (2007). Is time-based prospective remembering mediated by self-initiated rehearsals? Role of cues, ongoing activity, age and motivation. *Journal of Experimental Psychology: General, 136,* 112–132.

Kvavilashvili, L., & Mandler, G. (2004). Out of one's mind: A study of involuntary semantic memories. *Cognitive Psychology, 48,* 47–94.

Levine, B., Svoboda, E., Hay, J. F., Winocur, G., & Moscovitch, M. (2002). Aging and autobiographical memory: Dissociating episodic from semantic retrieval. *Psychology and Aging, 17,* 677–689.

Levine, L. J., & Bluck, S. (1997). Experienced and remembered emotional intensity in older adults. *Psychology and Aging, 12,* 514–523.

Light, L., Prull, M. W., La Voie, D. J., & Healy, M. (2000). Dual process theories of memory in old age. In T. J. Perfect & E. A. Maylor (Eds.), *Models of cognitive aging* (pp. 238–300). Oxford, England: Oxford University Press.

Lindenberger, U., Marsiske, M., & Baltes, P. B. (2000). Memorizing while walking: Increase in dual-task costs for young adulthood to old age. *Psychology and Aging, 15,* 417–436.

Linton, M. (1986). Ways of searching and the contents of memory. In D. C. Rubin (Ed.), *Autobiographical memory* (pp. 50–66). Cambridge, England: Cambridge University Press.

Mace, J. H. (2003, July). *Involuntary autobiographical memory and the reminiscence effect.* Paper presented at the Fifth Biennial Meeting of the Society of Applied Research in Memory and Cognition, University of Aberdeen, Aberdeen, Scotland.

Mace, J. H. (2007). Involuntary memory: Concept and theory. In J. H. Mace (Ed.), *Involuntary memory* (pp. 1–19). Malden, MA: Blackwell.

Mandler, G. (1994). Hypermnesia, incubation, and mind popping: On remembering without really trying. In C. Umiltà & M. Moscovitch (Eds.), *Attention and performance XV: Conscious and nonconscious information processing* (pp. 3–33). Cambridge, MA: MIT Press.

Mandler, G. (2007). Involuntary memories: Variations on the unexpected. In J. H. Mace (Ed.), *Involuntary memory* (pp. 208–223). Malden, MA: Blackwell.

Mather, M., & Carstensen, L. L. (2005). Aging and motivated cognition: The positivity effect in attention and memory. *Trends in Cognitive Sciences, 9,* 496–502.

Mather, M., & Knight, M. (2005). Goal-directed memory: The role of cognitive control in older adults' emotional memory. *Psychology and Aging, 20,* 554–570.

Pasupathi, M., & Carstensen, L. L. (2003). Age and emotional experience during mutual reminiscing. *Psychology and Aging, 18,* 430–442.

Piolino, P., Desgranges, B., Benali, K., & Eustache, F. (2002). Episodic and semantic remote autobiographical memory in aging. *Memory, 10,* 239–257.

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

Rabbit, P., & Winthorpe, C. (1988). What do old people remember? The Galton paradigm reconsidered. In M. M. Gruneberg, P. E. Morris, & R. N. Sykes (Ed.), *Practical aspects of memory: Current research and issues* (Vol. 1, pp. 277–282). Chichester, England: Wiley.

Rösler, A., Ulrich, C., Billino, J., Sterzer, P., Weidauer, S., Bernhardt, T., et al. (2005). Effects of arousing emotional scenes on the distribution of visuospatial attention: Changes with aging and early subcortical vascular dementia. *Journal of the Neurological Sciences, 229–230,* 109–116.

Rubin, D. C. (1986). (Ed.) *Autobiographical memory.* Cambridge, England: Cambridge University Press.

Rubin, D. C. (1999). Autobiographical memory and aging: Distributions of memories across the life-span and their implications for survey research. In D. C. Park & N. Schwarz (Eds.), *Cognition, aging and self-reports* (pp. 163–183). Hove, England: Psychology Press.

Rubin, D. C. (2000). Autobiographical memory and aging. In D. Park and N. Schwarz (Eds.), *Cognitive aging: A primer* (pp. 131–149). Philadelphia: Psychology Press.

Rubin, D. C. (2005). Autobiographical memory tasks in cognitive research. In A. Wenzel & D. C. Rubin (Eds.), *Cognitive methods and their application to clinical research* (pp. 219–241). Washington: American Psychological Association.

Rubin, D. C., & Schulkind, M. D. (1997a). The distribution of autobiographical memories across the lifespan. *Memory & Cognition, 25,* 859–866.

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

Schlagman, S., Kliegel, M., Schulz, J., & Kvavilashvili, L. (2009). *Eliciting involuntary autobiographical memories in the laboratory: Examining the effects of age.* Manuscript submitted for publication.

Schlagman, S., & Kvavilashvili, L. (2008). Involuntary autobiographical memories in and outside the laboratory: How different are they from voluntary autobiographical memories? *Memory & Cognition, 36,* 920–932.

Schlagman, S., Kvavilashvili, L., & Schulz, J. (2007). Involuntary autobiographical memory and aging. In J. H. Mace (Ed.), *Involuntary memory* (pp. 87–112). Malden, MA: Blackwell.

Schlagman, S., Schulz, J., & Kvavilashvili, L. (2006). A content analysis of involuntary autobiographical memories: Examining the positivity effect in old age. *Memory, 17,* 161–175.

St. Jacques, P. L., & Levine, B. (2007). Ageing and autobiographical memory for emotional and neutral events. *Memory, 15,* 129–144.

Tulving, E. (2002). Episodic memory: From mind to brain. *Annual Review of Psychology, 53,* 1–25.

Williams, J. M. G., & Dritschel, B. H. (1992). Categoric and extended autobiographical memories. In M. A. Conway, D. C. Rubin, H. Spinnler, & W. A. Wagenaar (Eds.), *Theoretical perspectives on autobiographical memory* (pp. 391–410). Dordrecht, the Netherlands: Kluwer Academic.

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

(*Appendixes follow*)

Appendix A

Instructions Received by Participants Concerning the Nature of Involuntary Autobiographical Memories

An involuntary memory is a memory from your past that comes to you spontaneously all by itself (i.e., without any deliberate attempt to retrieve it). In other words, a memory that simply "pops" into your mind. Involuntary memories can sometimes be triggered by something (either in your thoughts or in your environment), or they may occur without any apparent trigger. Involuntary memories may be of an event, situation, or experience from your past.

Involuntary memories may vary in detail. Some may be specific and refer to a single episode that you experienced on a particular day (e.g., *the day you moved into a new house* or *how you passed your driving test*). Other memories may be more general and refer to events that lasted longer than 1 day. General memories can be of a single event that your experienced repeatedly over an extended period (i.e., *visits to the dentist* or *going to seaside every summer during your childhood*), or they can be of an extended event that lasted for more than a day (for example, *a trip to Paris*) and the memory is of the whole trip, not a specific day. Involuntary memories can be many years old or only a few days (or hours) old. Furthermore, it may be that you have thought of the memory many times before or never before.

The important thing to remember is to record only involuntary memories—memories that "pop" into your mind without your consciously trying to remember anything.

Appendix B

Written Instructions About How to Complete a Questionnaire for Each Recorded Autobiographical Memory (Appended at the End of Diary)

You will find 14 questions in each questionnaire. Some are structured (you should mark by a circle around the appropriate response). Other questions are open (you describe something in your own words). Each of these 14 questions is explained in detail below:

1. Indicate the time and date that you experienced the memory.

2. Indicate the time and date when you recorded the memory.

3. Indicate (by circling a number on the scale) what was your mood immediately before the memory came to mind. 1 indicates your mood was very negative, 5 indicates it was very positive, and 3 indicates neutral mood (i.e., you were neither happy nor unhappy).

4. Briefly describe the content of your memory (i.e., what your memory is about). Below are three examples given in a previous study in America:
   (a) "I was remembering how embarrassed I was at 13 to wear open-toed sandals and dresses."
   (b) "This sensation took me back to the summers when my sister and I would spend every day in the swimming pool. We used to do tricks, and often water would go up our noses. We were about 7 and 8 respectively when we were allowed to be out there alone."
   (c) "Seven years ago I was driving home in the rain to visit my parents in San Diego. Very heavy rain and the defrost didn't work on my 66 Mustang, which I drove at the time."

5. Evaluate how vivid your memory is (i.e., how clear is the image in your mind). Do you have a very vivid image which is almost like normal vision, or is the image very vague with almost no image at all? 1 indicates you had a very vague image in your mind, almost no image at all, and 7 indicates you have a very vivid image in your mind, almost like normal vision.

6. Indicate (by circling the relevant option) whether or not there was something that triggered the memory. This might be something in your environment or something in your thoughts. For example, remembering "driving home in rain to visit my parents in San Diego" was triggered by "heavy rain on freeway." Remembering "how embarrassed I was at 13 to wear open-toed sandals" was triggered by "the sight of the older lady's open toed sandals." Memories can be triggered by just about anything or sometimes by nothing at all. If there was no trigger, circle (c) and move on to question 7.

7. If there was a trigger, describe what it was that triggered your memory.

8. Indicate (by circling a number on the scale) to what extent you were concentrating on the activity when the memory came to mind. 1 indicates you were not concentrating at all on the activity, 5 indicates you were fully concentrating, and 3 indicates a medium level of concentration.

9. Evaluate whether your memory is about an unusual or common event/experience in your life. That is, is it a unique and surprising event or an everyday event and

like many others. 1 indicates a very common event, and 5 indicates the event/experience was very unusual. 3 indicates the event was neither common nor unusual.

10. Evaluate how pleasant or unpleasant your memory is. Is it positive and pleasant to remember, or is it negative and unpleasant to remember? Circling a 3 indicates your memory is neutral (i.e., neither pleasant nor unpleasant).

11. Evaluate how pleasant or unpleasant the original event was at the time you experienced it (i.e., was the event that you remembered positive and pleasant or negative and unpleasant at the time you experienced it in your life). Circling a 3 indicates that the event at the time you experienced it was neutral (i.e., neither pleasant nor unpleasant).

12. Indicate whether the memory is of a specific or general event/experience. A specific event refers to a single episode in your life (e.g., the day you moved into your new house or the day a family member was born). A general event may refer to an extended event (e.g., a trip to Paris) or a single event that occurred repeatedly over an extended period (e.g., traveling on the tube every morning when working in the City; going to seaside every summer during your childhood).

13. Write in years your age at that time (i.e., when the memory originally took place). If you do not remember how old you were, state an estimated age (e.g., 15–17 years).

14. Indicate (by circling the relevant number) whether you have had this memory before. It does not matter if the memory has come to mind involuntarily before, or that you have deliberately recalled the memory before—just indicate how often you have remembered the event/situation.

Appendix C

List of 30 Word Cues Used in Session 2 for Voluntary Autobiographical Memories

1. Warm fire (positive)
2. Ugly face (negative)
3. Phone box (neutral)
4. Friendly host (positive)
5. Feeling safe (positive)
6. Toothache (negative)
7. Lunch box (neutral)
8. Good genes (positive)
9. Terrible singing (negative)
10. Uncomfortable bed (negative)
11. Lucky find (positive)
12. Broken promise (negative)
13. Cleaning products (neutral)
14. Handwriting (neutral)
15. Seeing the sunset (positive)
16. Special place (positive)
17. Answering the telephone (neutral)
18. Giving directions (neutral)
19. Having a row (negative)
20. Pile of papers (neutral)
21. Tape recorder (neutral)
22. First date (positive)
23. Saying goodbye (negative)
24. Stressful day (negative)
25. Knocking on a door (neutral)
26. Sightseeing (positive)
27. Back pain (negative)
28. Being shouted at (negative)
29. Corner shop (neutral)
30. Feeling proud (positive)

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