Impairment of episodic and semantic autobiographical memory in patients with mild cognitive impairment and early Alzheimer's disease

Thomas Leyhe\textsuperscript{a,b,c}, Stephan Müller\textsuperscript{a}, Monika Milian\textsuperscript{a}, Gerhard W. Eschweiler\textsuperscript{a,b}, Ralf Saur\textsuperscript{a,c}

\textsuperscript{a} Department of Psychiatry and Psychotherapy, University of Tübingen, Osiannderstraße 24, 72076 Tübingen, Germany
\textsuperscript{b} Geriatric Center at the University Hospital of Tübingen, Osiannderstraße 24, 72076 Tübingen, Germany
\textsuperscript{c} Section of Experimental Magnetic Resonance of CNS, Department of Neuroradiology, University of Tübingen, Hoppe-Seyler-Straße 3, 72076 Tübingen, Germany

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A B S T R A C T

Autobiographical memory includes the retrieval of personal semantic data and the remembrance of incident or episodic memories. In retrograde amnesias, it has been observed that recall of autobiographical memories of recent events is poorer than recall of remote memories. Alzheimer’s disease (AD) may also be associated with a temporal gradient (TG) in memory decline, though studies have yielded inconsistent results on this point. They have also yielded inconsistent results on whether AD might differentially affect semantic and episodic remembrance. Here, we compared autobiographical memory of childhood, early adulthood, and recent life among healthy control (HC) subjects, patients with early AD, and patients with amnesic mild cognitive impairment (aMCI). Both the aMCI and AD patients exhibited declines in recall of autobiographical incidents and semantic information. In AD patients, both components of autobiographical memory had a clear TG, with better preservation of memories of childhood than those of early adulthood and recent life. The TG of autobiographical memory decline in AD patients is more compatible with the Cortical Reallocation Theory than with the Multiple Trace Theory of memory consolidation. In contrast to AD patients, aMCI patients exhibited impaired recall of personal facts and autobiographical incidents relating only to recent life. The significant decline in autobiographical memory for recent life that occurred in aMCI patients suggests that deterioration of consolidation of personal facts and events begins with commencement of functional impairment in the hippocampus.

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1. Introduction

Autobiographical memory is a mental representation of personal events and facts that allow for retrieval of both personal semantic data and remembrance of incident or episodic memories. For example, in recounting the childhood, remembering an autobiographical event, such as the time one first went to school, is episodic, while remembering the name of the first grade teacher is semantic. According to this phenomenological differentiation, it is suggested that episodic and semantic autobiographical memory can be dissociated anatomically. Episodic memory primarily involves structures of the medial temporal lobe, including the hippocampus, whereas semantic autobiographical memory mainly involves the lateral temporal cortex, particularly of the left hemisphere (Gilboa et al., 2005; Kapur, Thompson, Kartsounis, & Abbott, 1999; Maguire, 2001; Moscovitch et al., 2005; Svoboda, McKinnon, & Levine, 2006; Tulving, 2002; Wheeler, Stuss, & Tulving, 1997). Medial temporal lobe structures seem to play a time-limited role in semantic memory (Smith & Squire, 2009). Thus, semantic memory that has been consolidated for a long time becomes independent of the medial temporal lobe processes, while recently acquired semantic memory would be expected to depend upon the medial temporal lobe.

Clinical observations in patients with retrograde amnesias have revealed that the retrieval of autobiographical memories of recent events is often poorer than the retrieval of remote ones. This temporal gradient (TG) in memory decline, known as Ribot’s law (Ribot, 1881), has been explained along the lines of the main theories of memory consolidation.

The Cortical Reallocation Theory (Alvarez & Squire, 1994; Meeter & Murre, 2004; Squire, 2004) suggests a temporary role of the hippocampus for memory trace formation and consolidation for both semantic and episodic information (declarative memory). Observations of a TG in memory performance resulting from hippocampal damage or atrophy have led to the hypothesis that the hippocampus participates only in the consolidation processes. At the completion of these processes, the information itself is stored in the neocortex. Once memories have been stored in the neocortex, they
become resistant to hippocampal disruption. Therefore, a decline in the function of medial temporal lobe structures would affect only recent memories, leading to the TG.

The Multiple Trace Theory (Moscovitch et al., 2005; Nadel & Moscovitch, 1997) provides another explanation for the TG in amnesia. According to this theory, the hippocampal formation encodes all information and forms memory traces that include both hippocampal and neocortical neurons. In this model, each time a memory is retrieved, a new hippocampally mediated trace is created. Thus, frequently repeated remote memories are represented by more and stronger hippocampal–neocortical traces than recent memories, making them less susceptible to disruption by brain damage. As the memory traces for autobiographical episodes are spatially distributed in the hippocampus, the extent and severity of retrograde amnesia, as well as the slope of the TG, are related to the extent and location of damage to the hippocampal system.

Impairment in autobiographical memory is often the most apparent symptom of Alzheimer’s disease (AD). There have been different findings concerning the effects of AD on the TG, as well as on semantic and episodic remembrance in autobiographical memory. Using the Autobiographical Memory Interview (AMI), Kopelman and colleagues found significant deficits in AD patients. These deficits were more pronounced for recent time periods than for remote ones (Kopelman, Wilson, & Baddeley, 1989). Similar results have been reported by other authors (Hou, Bruce, Kramer, & Kramer, 2005; Nestor, Graham, Bozeat, Simons, & Hodges, 2002; Snowden, Griffiths, & Neary, 1996). Greene, Hodges, and Baddeley (1995) examined autobiographical memory in a cohort of patients with early AD and found a slight TG in the incident component, but not the personal semantic component of the AMI (Kopelman, Wilson, & Baddeley, 1990). Ivanou et al. (2004) compared semantic and episodic semantic memory in AD patients, and patients with semantic dementia, and healthy elderly individuals, and they could not show a clear TG for episodic autobiographical memory. There was, however, a modest gradient present for semantic autobiographical memory in the AD group. In contrast, other studies of AD patients have found no TG in autobiographical memory (Dall’Ora et al., 1989; Meeter, Eijssackers, & Mulder, 2006).

Patients with amnestic mild cognitive impairment (aMCI) have memory deficits, and in some cases, these are present in combination with other cognitive impairments. The presence of aMCI increases the risk for dementia, with rates of conversion to AD of 10–15% per year (Gauthier et al., 2006; Petersen et al., 2001). In a recent study, Murphy, Troyer, Levine, and Moscovitch (2008) evaluated patients with aMCI for deficits in autobiographical memory. Using the autobiographical interview of Levine, Svoboda, Hay, Winocur, and Moscovitch (2002), they found that episodic memory was reduced, but semantic memory retrieval was increased when compared to healthy controls. Moreover, a TG of autobiographical memory could not be detected in these aMCI patients.

Here, we compared autobiographical memory among patients with aMCI, patients with early AD, and healthy controls. We used the AMI of Kopelman et al. (1990) to determine whether aMCI or early AD impairs semantic or episodic autobiographical memory, and whether these impairments exhibit a TG.

2. Methods

2.1. Participants

Sixty subjects (32 females and 28 males) with a mean age of 73.1 ± 6.6 years participated in this study. Patients were recruited from the Memory Clinic of the Department of Psychiatry and Psychotherapy of the University Hospital of Tubingen. The study was approved by the Local Ethics Committee, and written informed consent was obtained from each individual.

The study population was divided into healthy control (HC) subjects (N = 20), patients with aMCI (N = 20), and patients with early AD (N = 20). The HC group consisted of relatives or friends of the patients. HC individuals did not have a history of neurological or psychiatric disease or any signs of cognitive decline, as confirmed by a clinical interview. AD and aMCI patients underwent physical, neurological, and psychiatric examinations. They also underwent electroencephalography and computed tomography or magnetic resonance imaging of the brain. Routine laboratory tests included Lues (syphilis) serology as well as analysis of vitamin B12, folate acid, and thyroid-stimulating hormone levels. In all patients, neuropsychological testing was performed using the “Consortium to Establish a Registry for Alzheimer’s Disease” test battery (CERAD, Morris et al., 1989).

The diagnosis of aMCI was based on the Mayo criteria (Petersen et al., 1999), which includes the presence of a memory complaint (corroborated by an informant), impaired memory function for age and education (delayed word recall score > 1 standard deviation below normal age- and education-matched mean for older adults), preserved general cognitive function, intact activities of daily living, and the absence of dementia. The threshold of > 1.5 standard deviation instead of > 1.5 for impairment was used by some authors (patients, a slight grade was used in executive function was detected. No other cognitive impairments were detected with neuropsychological testing.

All AD patients met the diagnostic criteria of probable AD according to the Diagnostic and Statistical Manual of Mental Disorders, fourth edition (American Psychiatric Association, 1994), the ICD-10 Classification of Mental and Behavioural Disorders (World Health Organization, 1992), and the criteria of the National Institute of Neurological and Communicative Disorders and Stroke and the Alzheimer’s Disease and Related Disorders Association (McKhann et al., 1984). All AD patients had a score of four on the Global Deterioration Scale (Resiberg, Ferris, De Leon, & Crook, 1982). A score of four implies clear-cut evidence of a memory deficit during an intensive interview with a clinician, including decreased memory of current and recent events, decreased ability to travel or handle finances, and an inability to perform complex tasks. The patient may also deny that there is any problem with his/her memory, even though it is evident to friends and family.

HCs included participants who had normal corrected visual acuity and sufficient hearing ability. None of the participants had a physical handicap that affected their ability to perform the required tasks or any indication of neurological or psychiatric disorders unrelated to their diagnosis.

2.2. AMI

All subjects took part in the AMI (Kopelman et al., 1990). The AMI is a semi-structured interview consisting of two parts that independently test recall for the three components of autobiographical memory: autobiographical incidents and personal semantic information. Questions about personal semantic content and autobiographical incidents are chosen to evoke memories from three periods (childhood, early adult life, and recent life) and to expose the pattern of autobiographical memory deficits. The personal semantic schedule requests facts from childhood (e.g., names of schools or teachers), early adult life (e.g., name of the first employer, date and place of wedding), and recent years (e.g., holidays, journeys, and previous hospitalizations). For each time period, a maximum of 21 points can be achieved.

The autobiographical incident questions contain items assessing the same three time periods. Subjects are required to recall three incidents from childhood, three incidents from early adult life, and three recent events. The amount of detail used to describe an event is rated. Three points are awarded for a correct autobiographical memory that is specific in time and place. Two points are given for a personal but non-specific event or a specific event for which time and place are not recalled. One point is awarded for a vague personal memory. Zero points are given for no response or a response based on semantic memory. For each time period, the maximum score is nine. Informants, such as spouses or life-long companions, were used to verify the accuracy and details of the responses.

2.3. Data analysis

The SPSS-14 statistical package for Windows was used for data analysis. Differences in age, education, and MMSE score were assessed using a one-way analysis of variance (ANOVA) followed by a post hoc Scheffé test. The chi-square test was used to detect differences in gender distribution. Two-way ANOVAs were used to examine the main effects of group and time periods as well as the interaction effect on the performance of semantic and episodic memory recall. A group–time interaction effect is indicative of a TG when the memory recall of a patient group becomes progressively worse with periods that are more recent, relative to that of HCs. Subsequent ANOVAs were used to test for TG separately in the two patient groups. Between-group differences within each time period were examined with a one-way ANOVA followed by a post hoc Scheffé test. To test for a substantial influence of age, two-way analyses of covariance (ANCOVA), with age as a covariate, were used to examine the main effects of group and time periods, as well as an interaction effect on the performance of semantic and episodic memory recall. To control for the influence of executive functions, correlations between the Trail Making Test (TMT) from the CERAD (Morris et al., 1989) and the results of the AMI in the patient groups were evaluated using the Spearman-rank correlation test.
3. Results

3.1. Characteristics of HCs, aMCI patients, and AD patients

The demographic data and the mean Mini Mental State Examination (MMSE; Folstein, Folstein, & McHugh, 1975) scores of the three groups are shown in Table 1. A one-way ANOVA of the mean age ($F_{2,57} = 3.601; P < .059$) and education ($F_{2,57} = .954; P = .391$) did not show any significant group differences. The three groups also did not differ in gender distribution (chi-square [3] = 5.27; $P = .152$), indicating no significant differences for the MMSE ($F_{2,57} = 38.60; P < .001$). HC subjects had higher mean MMSE scores than aMCI ($P < .001$) and AD patients ($P < .001$). Moreover, mean MMSE scores of aMCI patients were higher than those of AD patients ($P < .001$).

3.2. Autobiographical semantic memories

An analysis of semantic information retrieval revealed a significant main effect for group ($F_{2,57} = 19.63; P < .001$). Post hoc Scheffé tests showed that retrieval was poorer in AD patients than in HC subjects ($P < .001$) and aMCI patients ($P < .001$). No differences in retrieval were detected between the HC and aMCI groups ($P > .072$). The other main factor, time period, was also significant ($F_{2,56} = 18.092; P < .001$). To explore whether a TG existed in the recollection of memories, we tested the interaction between time period and group. We found that the interaction was significant ($F_{4,114} = 5.232; P < .001$), indicating the presence of a TG. Fig. 1 shows semantic autobiographical memory performance of the individual groups.

To control for a possible influence of age, we performed a two-way ANCOVA, with age as a covariate. We again found a significant main effect of group ($F_{2,56} = 15.56; P < .001$) and a significant interaction effect between time period and group ($F_{4,112} = 5.288; P < .001$). There was no main effect of the covariate factor age ($F_{1,57} = 1.26; P = .275$).

We also examined the possibility that executive function confounded the results. We correlated the results of the TMT from the CERAD (Morris et al., 1989) with the results of autobiographical semantic memory in the patient groups. We did not find any significant correlations ($r$ scores ranged from $−.295$ to $0.247$; all $P > .1$) between autobiographical semantic memory and either TMT A or TMT B. As TMT B scores reflect not only executive function but also attention, we computed TMT B–A scores by subtracting TMT A scores (indicating attentional speed) from TMT B scores (indicating the more executive aspect of divided attention). There were no significant correlations between autobiographical semantic memory and TMT B–A scores in the patient groups ($r$ scores ranged from $−0.152$ to $0.359$; all $P > .5$).

Subsequent analyses showed a TG over all time periods in AD patients compared to HC subjects ($F_{2,37} = 11.568; P < .001$). AD patients performed worse than the HC group in recall of autobiographical semantic information from childhood ($P < .05$), early adulthood ($P < .001$), and recent life ($P < .001$). Facts from childhood were recalled better than facts from early adulthood ($P < .01$) or recent life ($P < .001$). Moreover, facts from early adulthood were retrieved better than facts from recent life ($P < .01$).

No significant TG was found in the aMCI group compared to HC subjects, although a stable trend was observed ($F_{2,37} = 3.020; P = .06$). Retrieval of facts from recent life was significantly worse in aMCI patients than HC subjects ($P < .05$). However, these groups did not differ in the recall of childhood ($P = .66$) and early adulthood facts ($P = .15$). The aMCI patients performed better than the AD patients in recalling autobiographical semantic information from early adulthood ($P < .001$) and recent life ($P < .01$), but not from childhood ($P = .27$). In aMCI patients, recall of facts from childhood was similar to recall of those from early adulthood ($P < .40$). In contrast, these patients had more difficulty retrieving facts from recent life than from either childhood ($P < .01$) or early adulthood ($P < .01$).

In the HC group, recall of personal semantic information did not vary by time period. Table 2 summarizes AMI scores for autobiographical semantic memory.

3.3. Autobiographical incident (episodic) memories

Incident memory recall varied significantly according to group ($F_{2,57} = 31.65; P < .001$). Post hoc Scheffé tests showed that the HC group performed better in the recall of incident memories than the AD group ($P < .001$) or the aMCI group ($P < .05$). In addition, recall was better in aMCI patients than AD patients ($P < .001$). Both time period ($F_{2,56} = 18.905; P < .001$) and the group–time period interaction were also significant ($F_{4,114} = 4.002; P < .01$), indicating the presence of TG. Fig. 2 shows the incident autobiographical memory performance of the individual groups.

To exclude a confounding influence of age, we performed a two-way ANCOVA with age as a covariate. There was a significant main effect of group ($F_{2,56} = 26.53; P < .001$) and a significant interaction effect between time period and group ($F_{4,112} = 4.74; P < .001$), but there was no main effect of the covariate factor age ($F_{1,57} = 0.31; P = .581$).

We also examined the potentially confounding effect of executive function by performing a correlation analysis between autobiographical episodic memory scores and data from the TMT.
of the CERAD (Morris et al., 1989) in the patient groups. Neither for TMT A, nor for TMT B was there any significant correlation (r from −0.262 to 0.299; all P > .1) with autobiographical episodic memory. Since TMT B scores reflect not only executive function but also attention, we computed TMT B−A scores by subtracting TMT A scores (indicating attentional speed) from TMT B scores (indicating the more executive aspect of divided attention). There were no significant correlations between performances in autobiographical episodic memory and TMT B−A scores in the patient groups (r from −0.224 to 0.205; all P > .3).

The AD group showed a TG over all time periods relative to HC subjects (F[2,37] = 13.11; P < .001). AD patients performed worse than HC subjects in recall of autobiographical incident memories from childhood (P < .01), early adulthood (P < .01), and recent life (P < .001). Recall of incidents from childhood was better than recall of those from early adulthood (P < .05) or recent life (P < .001). Moreover, recall of incidents from early adulthood was better than recall of those from recent life (P < .001).

A memory decline could also be observed in the aMCI group (F[2,37] = 3.602; P < .05). Recall of autobiographical incidents from childhood (P = .77) and early adulthood (P = .42) was similar between the aMCI and HC subjects. However, recall of recent life events was significantly worse in aMCI patients (P < .05). For all time periods, aMCI patients scored higher than their AD counterparts (childhood P < .05, early adulthood P < .001, recent life P < .001). Although AMCI patients recalled incidents from childhood and early adulthood equally well (P = .19), retrieval of incidents from recent life was poor compared to retrieval of either childhood (P < .01) or early adulthood incidents (P < .05).

In HC subjects, personal incident recall did not differ by time period. Table 3 summarizes the AMI scores for autobiographical episodic memory.

### 4. Discussion

The data presented here are in agreement with those from previous studies showing that autobiographical memory is impaired in AD patients (Eustache et al., 2004; Meeter et al., 2006; Piolino et al., 2003; Starkstein, Boller, & Garau, 2005) and MCI patients (Murphy et al., 2008). We have found that AD-related declines in the memory of autobiographical incidents and semantic information have a clear TG, wherein remote memories are better preserved than ones that are more recent. These results were not significantly confounded by age or impairments in executive function.

These findings are in accordance with the Cortical Reallocation Theory (Alvarez & Squire, 1994; Meeter and Murre, 2004; Squire, 2004). As memory consolidation depends on hippocampal integrity (Maguire, 2001; Svoboda et al., 2006), disturbances in the consolidation of autobiographical incidents can occur at the beginning of hippocampal degeneration, which is associated with early AD (deToledo-Morrell, Goncharova, Dickerson, Wilson, & Bennett, 2000). As the disease typically starts late in life, degradation of autobiographical incident memory is most pronounced for recent events. According to the Cortical Reallocation Theory, episodic memory of early adulthood and childhood is better preserved, as these memories have been consolidated and stored in the neocortex, and have become independent of the hippocampus. However, our AD patients showed a slightly impaired ability to remember remote incidents. This finding might be due in part to the spreading of the neurodegenerative process to the neocortex, as had been shown in previous studies in early AD (Scheff & Price, 2006). Possibly retrieval deficits contribute to AD patients’ problems. As the disease develops gradually, they may retrieve recent memories less often and thereby forget them more. This could indirectly affect consolidation.

Our data are less compatible with the Multiple Trace Theory (Moscovitch et al., 2005; Nadel & Moscovitch, 1997), as a more balanced impairment of autobiographical incident memory over all life periods would be expected with that theory. Explaining our results in accordance with the Multiple Trace Theory would mean

### Table 2

<table>
<thead>
<tr>
<th>Subject group</th>
<th>Life period</th>
<th>Childhood</th>
<th>Early adulthood</th>
<th>Recent life</th>
<th>Significant differences between time periods</th>
</tr>
</thead>
<tbody>
<tr>
<td>HC</td>
<td></td>
<td>20.00 (1.86)</td>
<td>20.45 (1.94)</td>
<td>19.70 (1.86)</td>
<td>n.s.</td>
</tr>
<tr>
<td>aMCI</td>
<td></td>
<td>19.30 (1.49)</td>
<td>19.80 (1.97)</td>
<td>16.65 (3.68)</td>
<td>Childhood &gt; Recent life** Early adulthood &gt; Recent life** Childhood &gt; Early adulthood Childhood &gt; Recent life*** Early adulthood &gt; Recent life***</td>
</tr>
<tr>
<td>AD</td>
<td></td>
<td>18.05 (3.45)</td>
<td>15.35 (3.64)</td>
<td>12.75 (4.85)</td>
<td></td>
</tr>
</tbody>
</table>

Note: scores are expressed as mean (standard deviation). Maximum score = 21. HC, healthy controls; aMCI, patients with amnesic mild cognitive impairment; AD, patients with early Alzheimer’s disease.

* P < .05.
** P < .01.
*** P < .001.

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**Fig. 2.** Recall of personal incident memories across life periods in healthy controls (HC), patients with amnesic mild cognitive impairment (aMCI), and early Alzheimer’s disease (AD) patients. Means and standard errors of means (SEM) are given. Max. = maximum.
that older hippocampal–neocortical traces are generally stronger and thus less susceptible to partial hippocampal damage. The weakest traces of recent life are disrupted first, followed by the stronger traces of early adulthood and the strongest traces of childhood.

The pattern of autobiographical semantic memory decline resembled that of autobiographical incident memory decline in our study. Given that the lateral temporal cortex (mainly on the left) is particularly involved in the retrieval of semantic, autobiographical memory (Fujii, Moscovitch, & Nadel, 2000; Gilboa et al., 2005), the initial hippocampal damage associated with AD should not affect the memory of personal semantic facts. One possible explanation for our findings is an early spread of the disease to the lateral temporal cortex, as has been shown with neuroimaging (Whitwell et al., 2002; Snowden et al., 1996). With progression of AD, atrophy of patients with varying stages of AD (Dall'Ora et al., 1989; Greene et al., 2007). However, a more reasonable explanation would be that the initial consolidation of personal semantic facts depends on the hippocampus (Nadel & Moscovitch, 1997; Squire, 1992; Squire & Alvarez, 1995) and, thus, is also susceptible to early hippocampal damage.

Inconsistent results from previous studies with regard to TG as well as semantic and episodic memory in the autobiographical memory of AD patients might be attributable to the study of patients with varying stages of AD (Dall'Ora et al., 1989; Greene et al., 1995; Hou et al., 2005; Ivanou, Cooper, Shanks, & Venneri, 2004; Kopelman et al., 1989; Meeter et al., 2006; Nestor et al., 2002; Snowden et al., 1996). With progression of AD, atrophy of the hippocampus progresses (deFerriolo-Morrell et al., 2000), and the neurodegenerative process affects larger portions of the neocortex (Braak & Braak, 1999). Thus, as both the Cortical Reallocation Theory and Multiple Trace Theory would predict, patients with advanced cases of AD should exhibit no TG in autobiographical memory, because neuronal correlates of remote memory are also disrupted at this stage. Similarly, differences between semantic and episodic memory should disappear.

Previous studies have shown that the posterior cingulate cortex, a region anatomically connected with medial temporal cortex, plays a role in autobiographical memory retrieval (Maddock, Garrett, & Buonocore, 2001). PET imaging studies have found that amyloid accumulates in the posterior cingulate in early AD (Rowe et al., 2007). Functional imaging studies have detected the earliest metabolic changes of AD in this region (Salmon, Lekeu, Bastin, Garraux, & Collette, 2008). Thus, neuropathological changes in the posterior cingulate cortex may contribute to impaired autobiographical memory retrieval in patients with early AD.

While AD patients performed worse than HC subjects in remembering both remote and recent time periods, the aMCI group differed significantly from HC subjects only for recent memory. This decline occurred in the memory of both personal semantic information and incidents. In contrast, Murphy et al. (2008) did not detect any impairment in autobiographical semantic memory in aMCI patients. In this study, aMCI patients performed worse than HC subjects only in terms of incident recall. Moreover, fewer details were provided for earlier life periods than for later life periods in both patients and healthy controls. Differences between these previous findings and the findings of this study may be due to differences in the patient populations studied. Impairment of our aMCI group was possibly more pronounced, as we found that global cognitive function (assessed with the MMSE) was significantly lower in aMCI patients than in HC subjects. The aMCI and HC subject groups in the study by Murphy and colleagues were comparable in this measure.

Another reason for contradictory results between this study and previous reports may be that different memory tests were used. Murphy’s group used the autobiographical interview of Levine et al. (2002). In that interview method, one narrative for each of five life periods is given. These narratives are used to evaluate both episodic and semantic autobiographical memory. In contrast, the AMI of Kopelman et al. (1990) uses separate items to assess memory for episodic events and personal semantics. In this method, evaluation of autobiographical incident memory is based upon recall of three incidents from childhood, three from early adult life, and three recent events. Therefore, recall of only one event per time period, as requested in the autobiographical interview of Levine et al. (2002), might be easier. This event was presumably the most accessible and, therefore, the most likely to yield detailed recollection. Additional events may have been less accessible for recall. Differences between the results of Murphy et al. (2008) and the present study may also be due to the more complex scoring system used by Murphy et al.

Nevertheless, our findings in the aMCI group suggest that a decline in autobiographical memory starts as soon as consolidation of autobiographical information is disturbed by hippocampal damage. Previous studies have shown altered activation patterns in the hippocampus and medial temporal lobes in people without memory impairment who have an increased genetic risk of developing AD (Wermke, Sorg, Wohlschlager, & Drzezga, 2008). Thus, functional impairment of the hippocampus may precede the appearance of MCI. It can be hypothesized that the time of diminution of autobiographical memory in this group could mark the beginning of functional impairment in the medial temporal lobe.

A limitation of this study is the lack of neuroimaging results. Future investigations of autobiographical memory should involve an examination of the association between memory and a volumetric analysis of anatomical brain regions.

In summary, the present study shows that autobiographical memory is impaired in AD and aMCI patients. Deterioration was found for both autobiographical incident remembrance and autobiographical semantic remembrance. In AD patients, a TG was

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**Table 3**

Scores for autobiographical incident memory, as assessed using the Autobiographical Memory Interview (Kopelman et al., 1990).

<table>
<thead>
<tr>
<th>Subject group</th>
<th>Life period</th>
<th>Significant differences between time periods</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Childhood</td>
<td>Early adulthood</td>
</tr>
<tr>
<td>HC</td>
<td>8.30 (1.03)</td>
<td>8.05 (1.05)</td>
</tr>
<tr>
<td>aMCI</td>
<td>7.90 (1.25)</td>
<td>7.30 (1.45)</td>
</tr>
<tr>
<td>AD</td>
<td>6.15 (2.51)</td>
<td>5.05 (2.52)</td>
</tr>
</tbody>
</table>

Note: scores are expressed as mean (standard deviation). Maximum score = 9. HC, healthy controls; aMCI, patients with amnesic mild cognitive impairment; AD, patients with early Alzheimer’s disease.

- * P < .05.
- ** P < .01.
- *** P < .001.
detected, while in aMCI patients, a significant decline occurred only in autobiographical memory of recent life. This likely indicates that deterioration of consolidation of personal facts and events begins with the commencement of functional impairment in the hippocampus.

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