

## **Autobiographical Memory in Normal Ageing and Dementia**

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Autobiographical memories in young and elderly normal subjects are drawn mostly from the recent past but elderly subjects relate a second peak of memories from early adulthood. Memory for remote past public events is relatively preserved in dementia, possibly reflecting integrity of semantic relative to episodic memory. We examined recall of specific, consistent autobiographical episodes in Alzheimer's disease (AD) in response to cue words. Patients and control subjects drew most memories from the recent 20 years: episode age related to anterograde memory function but not subject age or dementia. Subjects also related a secondary peak of memories from early adulthood: episode age related to subject age and severity of dementia. The results suggest that preferential recall of memories from early adulthood is based on the salience of retrieval cues, altered by age and dementia, superimposed on a temporal gradient of semantic memory. Further, AD shows behavioural similarity to normal ageing.

### **Introduction**

Previous studies of remote memory function in normal subjects have shown that the ability to recall remote events is related to the age of the episode, the age of the subject, and the nature of the memory test. In young subjects, distant events are generally recalled less readily than recent ones, whether the test material concerns autobiographical events or public events. Thus, Crovitz and Schiffman (1974) demonstrated that the frequency of autobiographical episodes recalled by young college students was related to the age of the episode as a monotonic function when plotted on a log-log scale, a finding confirmed by others (Rubin, 1982; Squire, 1989). Similarly, in studies of memory for remote public events, performance of teenage subjects was best for the most recent events, and declined progressively across more distant decades (Sanders and Warrington, 1971; Squire, 1974). This failure of normal subjects to recall events from more remote time periods has been attributed to normal forgetting, that is, increased inaccessibility of memory traces that occurs with the passage of time.

In more elderly subjects, remote memory for public events generally shows a similar pattern of performance to that of the young subjects, but at an inferior

level (Sanders and Warrington, 1971; Squire, 1974; Squire and Slater, 1975; Squire *et al.*, 1975). For autobiographical memories, however, the relationship between memory function and the age of the memory is qualitatively different from that of the young subjects. Specifically, elderly subjects spontaneously relate a secondary peak of memories from the more remote past, corresponding approximately to the time when the subjects were 20 to 30 years of age (reviewed by Rubin *et al.*, 1986). The origin of this secondary peak is unclear but has been attributed to reminiscence effects operating upon retrieval as well as effects on encoding of the salience of the events at the time of their occurrence. One way of resolving this question is to examine the effects of memory disorder on the age of the secondary peak of remote memories encoded prior to the onset of the memory dysfunction.

The normal pattern of remote memory function is disrupted in memory-disordered patients in a way that depends on the aetiology of the memory disorder. For example, distinctions have been drawn between temporally-limited patterns of remote memory deficit, in which the retrograde loss spares more remote memories, and temporally-extensive deficits in which all remote memories are affected, although sometimes unevenly (reviewed by Squire and Cohen, 1984). The majority of these studies, however, have been performed using tests of memory for remote public events, which are particularly prone to artefact. Several observers, including Sanders and Warrington (1971, 1975) and Weiskrantz (1985), have drawn attention to two particular factors that may erroneously influence the results in tests of remote memory for public events. Firstly, selected items from the 1940s that remain memorable in the 1980s may be intrinsically more important than selected items from the 1980s that may be forgotten after an equivalent 40 year delay. Secondly, some remote events may become more memorable as a result of repeated exposure on television, in books and in magazines, this exposure necessarily being less for the more recent events. These criticisms apply less to memory for autobiographical events; however, few studies have studied autobiographical memory in memory-disordered patients.

Alzheimer's disease (AD) is often considered to represent an exaggeration of normal ageing so that studies of these patients may provide evidence on the origin of patterns of memory function in normal elderly subjects. Clinical observations of patients with AD suggest that memory for remote events is relatively preserved. Formal studies of remote memory in AD, however, have generally used public events as stimulus items and have shown controversial results. Some studies have found a temporally extensive deficit with no temporal gradient (Wilson *et al.*, 1981), while others have shown some preservation of remote events in the memory of these patients (Beatty *et al.*, 1988; Sagar *et al.*, 1988; Kopelman, 1989). Some of these differences may relate to differences in severity of dementia between the study groups of the various studies. In order to avoid the artefacts of public events tests, we examined memory for past autobiographical events in patients with AD. Our aims were to establish more reliably the pattern of remote memory deficit in these patients, and to obtain evidence on the origin of the secondary peak of autobiographical memories seen in normal subjects. This study represents an extension of that reported previously (Sagar *et al.*, 1988).

TABLE 1. *Characteristics of subject groups: mean, standard deviation, and range*

<i>Group</i>	<i>M:F</i>	<i>Disease age (years)</i>	<i>Education (years)</i>	<i>Duration (years)</i>
Normal control	9:11	60.2	15.0	—
		6.12	2.77	
		53–78	12–20	
Alzheimer	7:8	65.0	14.3	4.3
		7.57	2.77	2.91
		52–77	8–19	2.13

## Methods

### *Subjects*

The groups comprised 15 patients with AD and 20 normal, healthy control (NC) subjects (Table 1). The AD patients were recruited from the Memory Disorders Unit of the Massachusetts General Hospital. The diagnosis of AD was based on NINCDS inclusion and exclusion criteria (Khachaturian, 1985; McKhann *et al.*, 1984). No patient was receiving any primary psychoactive drug. The NC subjects were spouses or siblings of the patients, patients with traumatic peripheral nerve injury and nonacademic MIT personnel.

The groups were matched for age, sex and years of education (Table 1). On the memory and orientation section of the Blessed Dementia Scale (BDS; max. = 37, with higher scores indicating greater dementia severity) (Blessed *et al.*, 1968), the AD group scored 7.8 on average, with a standard deviation of 2.32 and range of 2 to 27; the NC group's range equalled 0 to 2.

### *Procedure*

*Autobiographical memory.* A thorough description of the personal remote memory test exists elsewhere (Sagar *et al.*, 1988) and is summarised here. Subjects were presented with each of 10 high-frequency noun cues (bird, flag, tree, car, ship, boy, arm, star, clock, table) and were given up to 4 min to relate an autobiographical memory from any period of their life involving those cues. After the first 2 min, nonspecific prompts were given when necessary.

Responses were scored on a 0 to 3 point scale, depending upon the degree of specificity to time and place. Twenty-four hours later, subjects were presented with the cue words and were asked to reproduce the day 1 memories. These responses were also scored on a 0 to 3 point scale, depending on specificity and consistency with the day 1 memories. All responses were scored by a single investigator on the day of the test. AD patients were impaired in their ability to recall autobiographical episodes (Sagar *et al.*, 1988); however, for all subject groups, only those memories that scored 3 on the two successive days were used in analyses concerning the age of the episodes related. The correlations between

estimated dates on day 1 and day 2 were 0.997 for NC subjects and 0.92 for AD patients ( $p < 0.001$ ). Thus, the dating analyses used only memories that were highly specific to time and place and showed consistency of content and date when examined repeatedly.

Free recall of the word cues was tested three times: at the end of the day 1 and day 2 test sessions and before the start of the day 2 session. Subjects were given 2 min for recall at each session.

*Standard neuropsychological tests.* Scores on other neuropsychological tests, performed within 1 week of the autobiographical memory test, were available for a single subset of 10 of the AD patients: all 10 patients received the Brown–Peterson Distractor Test (Brown 1958; Peterson and Peterson, 1959); 7 received the Depth of Processing Test ( Craik and Tulving, 1975), 7 immediate recall of the NYU stories (Randt $\textit{et al.}$ , 1977), 8 the Token Test (DeRenzi and Ferrari, 1978) and 8 the Reporter’s Test (DeRenzi and Faglioni, 1978). These tests were later used to correlate with autobiographical memory performance.

#### *Statistical analysis*

The ages of autobiographical episodes related by each subject group were not normally distributed. Accordingly, nonparametric statistics were used throughout. Comparisons between data sets were made using the Kruskal–Wallis ANOVA or, for paired comparisons, the Mann–Whitney U-test (two-tailed, unless otherwise stated). Correlations were examined using the Spearman Rank Correlation Coefficient, rho ( $\rho$ ).

## **Results**

### *Normal subjects*

The age distribution of autobiographical episodes related by normal control subjects showed significant differences in frequency related to the age of episodes. The majority of memories were derived from the most recent 5 years and showed a gradually decreasing frequency with episode age over the period up to 20 years ago. For more remote time periods, this gradually decreasing frequency with episode age was interrupted by a second cluster of high episode frequency for the time period 20 to 50 years ago with a peak at 35 to 40 years ago (Fig. 1).

The age distribution was not an artefact related to differential effects of the different cue words. Thus, Kruskal–Wallis ANOVA comparing the age of episodes for each of the 10 cue words showed no significant effects, whether taken across all time periods ( $H = 4.9$ ), confined to the most recent 20 years ( $H = 12.0$ ) or confined to time periods more than 20 years ago ( $H = 13.5$ ) (Table 2).

Subjects were divided into three age bands, 50 to 59, 60 to 69 and over 70 years. An analysis of age of episode produced by subjects from these three age groups showed that older subjects related significantly older memories ( $H = 6.55$ ,  $p < 0.05$ ) (Fig. 2). When the episodes 0 to 20 years ago and over 20 years ago were considered separately, the effect of age of subject was found to

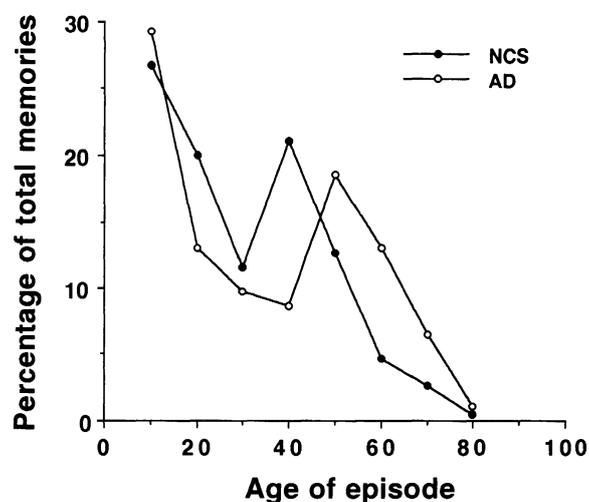


FIG. 1. Age distribution of autobiographical episodes related by control subjects and patients with AD. Age of episode is represented as number of years from the event to the time of the memory test. Frequency of episodes for each 10-year period is expressed as the percentage of all memories related by each subject. Normal subjects and AD patients draw most memories from the recent 20 years; a secondary peak occurs around early adulthood. In AD, this secondary peak is shifted into the more remote time periods.

TABLE 2. Item analysis of NC subjects' responses to each of the 10 cue words

Word cue	Response frequency	Mean age of episode
Bird	20	22.6
Flag	17	21.6
Tree	17	23.6
Car	20	28.7
Arm	18	24.1
Boy	20	24.6
Ship	20	27.2
Star	18	25.5
Clock	20	18.3
Table	20	21.8

influence only the remote memories (for memories 0 to 20 years ago,  $H = 2.76$ , n.s.; for memories 21 years or more,  $H = 14.9$ ,  $p < 0.001$ ).

*Patients with Alzheimer's disease*

The age distribution of episodes related by the AD group differed from that of the NC (Wald-Wolfowitz Runs Test,  $z = 2.64$ ,  $p < 0.01$ ). As in the NC group, the

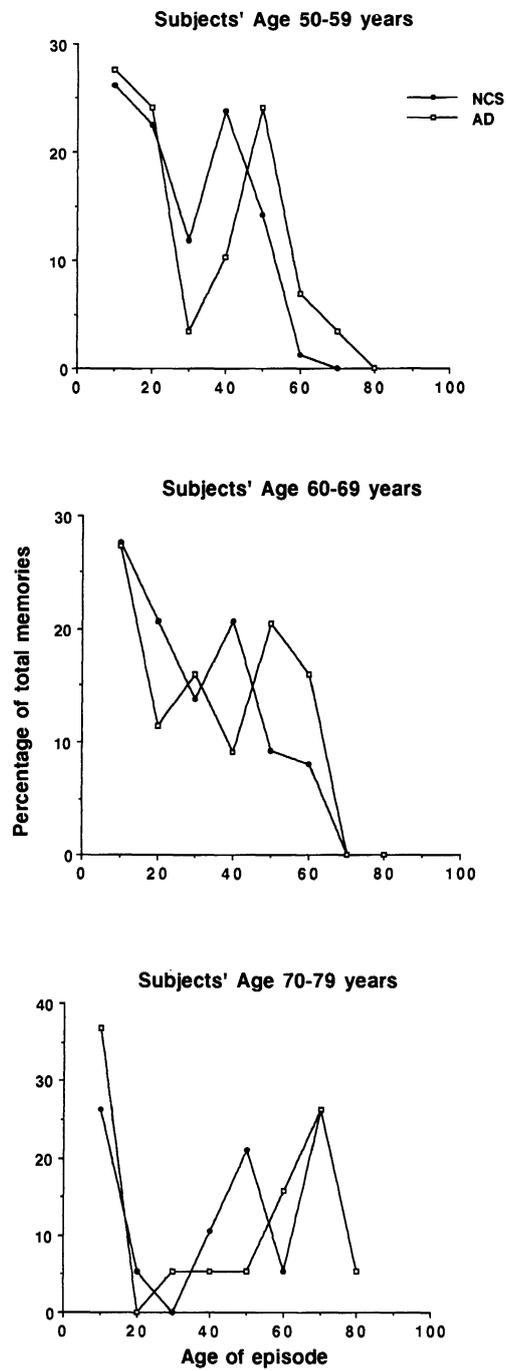


FIG. 2. Age of episode related to age of subject. In both groups, the age of the secondary peak of autobiographical episodes is greater in older subjects whereas the age of the recency peak is unrelated to subject age.

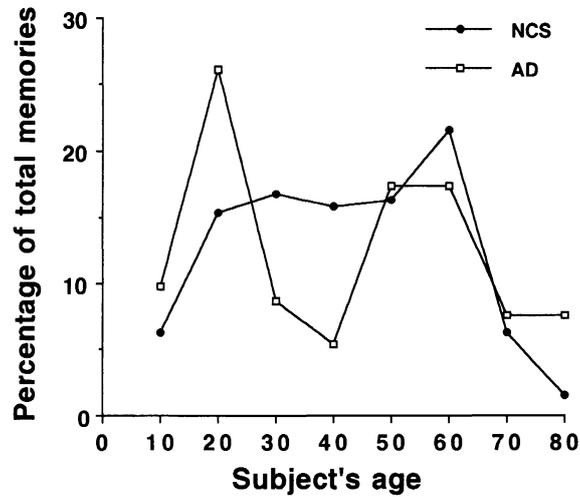


FIG. 3. Age distribution of autobiographical episodes expressed as the age of the subject at the time that the recalled event took place. Frequency of episodes for each 10-year period is expressed as the percentage of all memories related by each subject. The pattern of performance is similar to that shown in Fig. 1.

majority of episodes were drawn from the most recent 20 years and a second cluster of memories corresponded to the more remote time periods (Fig. 1). However, in the patients with AD, this secondary cluster was significantly older than in the NC subjects ( $U = 1537, z = -3.33, p = 0.001$ ) in contrast to the recent memories, which did not differ significantly in age ( $U = 1980.5, z = 0.30, n.s.$ ). Because of the slight albeit non-significant difference in mean age between the AD and NC groups, these analyses were repeated using the subject's age at the time of the event to define the age of the episode. Similar results were obtained: the age distribution of episodes differed between the groups ( $z = 1.97; p < 0.05$ ); the secondary cluster of memories (subjects' ages 0 to 40 years) was significantly older in the AD group than in the NC group ( $z = -3.21; p < 0.002$ ) whereas the age of recent memories (subjects' age  $> 40$  years) did not differ significantly between the groups ( $z = -1.62; p = 0.11$ ) (Fig. 3). Further analyses were continued using "number of years ago" as the measure of age of episode.

The age of episodes produced by patients with AD was related to the age of the subject as it was in NC subjects; older patients tended to produce older memories. When the subjects were divided into the three age bands, 50 to 59, 60 to 69, and over 70 years, the overall age of episodes did not differ significantly among them ( $H = 1.825$ ). However, recent and remote memories differed markedly in their relationship to the age of the subject. For recent memories (0 to 20 years), the age of episodes recalled was not related to the age of the subject ( $H = 2.454$  for difference among the three age groups). By contrast, for more remote memories, older subjects related older memories (for episodes 21 years of more,  $H = 15.1, p < 0.001$ ). Compared with NC subjects, patients aged 50 to 59 and 60 to 69

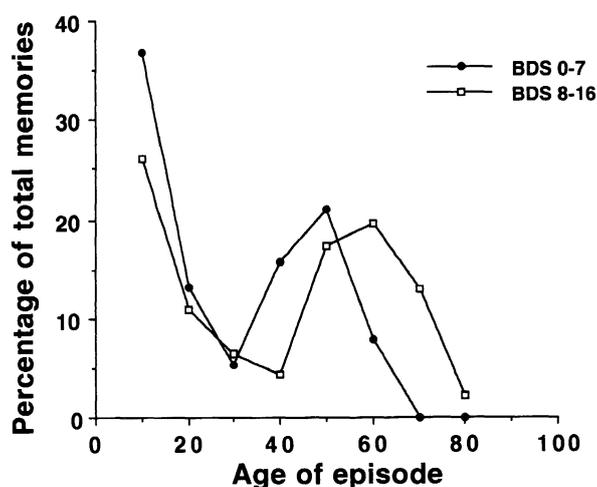


FIG. 4. Age of episode related to severity of dementia in AD. The age of memories constituting the secondary peak is greater in the more demented patients whereas the age of the recency peak is unrelated to dementia severity.

differed significantly from the age-matched, NC groups in the age of episode related (for 50 to 59 years,  $U = 203.5$ ,  $z = -1.824$ ,  $p < 0.05$ , one-tailed; for 60 to 69 years,  $U = 698$ ,  $z = -2.822$ ,  $p < 0.005$ , two-tailed), but no difference was found for patients aged 70 years or more ( $U = 48.5$ ,  $z = -0.667$ ).

The tendency of patients with AD to produce memories from the more remote past was related to severity of dementia and new learning capacity. Specifically, for memories 0 to 20 years ago, patients with higher scores on the BDS (8 to 16) did not differ from patients with lower BDS scores (7 or less) in the age of memory related ( $U = 135$ ,  $z = -1.33$ , n.s.). By contrast, for memories over 20 years old, the more demented patients related significantly older memories than did the less demented patients ( $U = 118$ ,  $z = -3.09$ ,  $p = 0.002$ ) (Fig. 4). Similarly, patients who were able to recall few cue words at the end of testing produced significantly older memories than did those who recalled more of the cue words (chi-square for comparison of number of memories in the age groups 0 to 20 years and 21 years and over between subjects with word list recall 0 to 3 and 4 to 6 = 3.23,  $p < 0.05$ , one-tailed). Furthermore, the ability to recall autobiographical episodes tended to relate to the median age of episodes recalled by each subject: the fewer episodes recalled, the older the median age of the memories related. However, this relationship between recall ability and age of episode was found only for the more remote memories (for memories > 20 years old, median age of episode vs number of memories recalled,  $r = -0.442$ ,  $z = -1.592$ ,  $p = 0.056$ ). The age of the more recent memories was not related to the ability to recall episodes (for memories 0 to 20 years,  $r = -0.129$ ,  $z = -0.465$ , n.s.).

The median age of episode produced by patients with AD was related to performance on other tests of memory and language function. Significant negative correlations were found between age of episode and total score on the Depth-of-

Processing Test ( $\rho = -0.85, p < 0.03$ ), such that subjects with poorer antero-grade memory related older autobiographical episodes. Nonsignificant negative correlations were found between age of episode and performance on the Brown–Peterson Distractor task ( $\rho = -0.10$ ) and immediate recall of the NYU stories ( $\rho = -0.56$ ), but no correlations were found between age of episode and scores on the Token Test ( $\rho = 0.01$ ) or Reporter’s Test ( $\rho = 0.02$ ).

When recent and remote memories were examined separately, the correlation of episode age with Depth-of-Processing Test performance was reflected in a correlation with recent ( $\rho = -0.42$ ) but not remote episodes ( $\rho = 0.03$ ), although neither correlation was now significant. Significant correlations were found between immediate recall of the NYU stories and the median age of episode for recent memories but the correlation with remote memories was weaker and not statistically significant (for episodes 0 to 20 years,  $\rho = -0.94, p < 0.025$ ; for 21 years and over,  $\rho = 0.51, p = 0.22$ ) and between performance on the Reporter’s Test and the age of remote but not recent memories (for 0 to 20 years,  $\rho = -0.32, p = 0.40$ ; for 21 years and over,  $\rho = 0.87, p < 0.025$ ). Performance on the Token Test showed a similar trend to that of the Reporter’s Test in its association with age of episode (for 0 to 20 years,  $\rho = -0.30, p = 0.43$ ; for 21 years and over,  $\rho = 0.58, p = 0.13$ ). Performance on the Brown–Peterson task did not correlate significantly with age of recent or remote memories (for 0 to 20 years,  $\rho = -0.3, p = 0.37$ ; for 21 years and over,  $\rho = 0.24, p = 0.47$ ).

### Discussion

The results of this study indicate that the age of autobiographical episodes related by normal elderly subjects and patients with dementia differs according to the age of the subject and the severity of dementia. The alteration in age distribution of episodes produced by dementia has qualitatively similar, but lesser, effects to those of advancing age in normal subjects. Moreover, the effects of age and dementia on the age of episodes related affects only those memories that stem from more remote time periods; neither age nor dementia affects the frequency of memories drawn from the most recent 20 years, which in both normal elderly subjects and patients with dementia resembles that of young normal subjects.

These results have been obtained by selection of highly specific and consistent memories in all subject groups. We did not attempt to corroborate the dates of the episodes by interviewing relatives or spouses because we had no indication that their accounts would necessarily be more reliable than those of the study subjects. Such attempts at corroboration assume that the corroborator has access to the same set of autobiographical memories as the subject and that the memories are of equal personal salience for both individuals; these assumptions must be highly questionable. If not, however, the corroborator is disadvantaged relative to the subject and the assumption that his assessment is more reliable is clearly unfounded. Accordingly, we chose to rely on selection of highly specific memories that were recalled and dated consistently on two separate occasions by AD patients as well as NC subjects; the results are unlikely to be artefacts of inaccurate dating or confabulation. Although patients with AD are impaired in their abil-

ity to recall autobiographical episodes and frequently relate memories of low specificity for which the date is uncertain (Sagar *et al.*, 1988), these factors are unlikely to be relevant to the results of this study because of the selected nature of the memories that have been analysed.

A potential criticism of the autobiographical memory test used in this study is that it assesses bias and not ability in recall (Rabbitt and Winthorpe, 1988). However, bias is unlikely to be a major factor in determining the results of this study for several reasons: First, the relationship between age of episode on the one hand and current subject age, severity of dementia and anterograde memory capacity on the other, indicate that any such bias must be systematic in its relationship to these variables. Second, the lack of influence of any of these variables on the age of recent memories indicates that the bias must be operative only on the remote secondary peak of memories. Third, the observation that AD subjects recall a normal proportion of their memories from the last 20 years indicates that the pattern of results is unlikely to result from environmental factors associated with the disease, such as lack of day-to-day stimulation, that would cause the subject to dwell in the past. Fourth, relative preservation of remote autobiographical memory in AD has also been shown using a structured interview paradigm (Kopelman, 1989). Finally, the influence of bias would not alter interpretation of the results, discussed below, that the secondary remote peak of memories is more related to retrieval factors at recall than to encoding factors at the time the event took place. Thus despite this criticism of the method, the findings have implications for the processes underlying autobiographical recall in normal ageing, for the dissociability of remote memory processes relating to the age of the memory and the nature of the recalled information and for the behavioural relationship between AD and normal ageing.

The pattern of performance shown by normal elderly control subjects in this study confirms earlier observations of different temporal distributions of autobiographical episodes in young and elderly normal subjects. The principal difference related to subject age involves the occurrence of a secondary cluster of memories from the more remote past, which is not a feature of the temporal distribution of memories in young subjects. The origin of this secondary peak in elderly subjects is unclear. One possible mechanism involves the salience of the events at the time of their occurrence. Memory for past public events in normal subjects is better if the individual was alive at the time of event, even for highly educated subjects who were presumed to be familiar with the relevant historical facts through reading and education (Squire, 1974; Sanders and Warrington, 1971). Thus, normal elderly subjects may show good memory for events of early adulthood because the personally experienced events were particularly salient and led to a richness of encoding at that time. However, the finding of this study that AD was associated with a systematic shift of the secondary peak into the more remote time periods argues strongly against this interpretation because disease could not plausibly affect, in any systematic way, the differential strength of encoding that related specifically to the salience of the events at the time of their occurrence. Thus, the change in the temporal distribution produced by the AD process is likely to result either from a systematic disruption of stored memories or in a change in factors that influence retrieval. Current memory theory does not

readily provide a mechanism that would lead to selective loss of stored memories specifically relating to early adulthood. In the context of present knowledge, it seems more likely that the shift in the age distribution of remote memories produced in AD results from a change in the cues that facilitate retrieval of memories from specific remote time periods.

These considerations of the way in which disease may alter retrieval processes leads to certain implications and speculations concerning the origin of the temporal distribution of autobiographical memories in normal subjects. Specifically, elderly subjects may preferentially recall a subset of memories from the remote past because normal ageing is associated with the development of a network of retrieval cues, not yet present in younger subjects, which specifically relate to early adulthood. Possibly, this network arises by the selective strengthening of certain memories that develops as a direct consequence of new experiences. One such example would be the strengthening of memories relating to the birth of one's own children by the experiences surrounding the birth of grandchildren. By this analysis, salience operates as a cumulative influence from the time the memory is initially laid down but is of variable effect depending upon subsequent experience. Hence, salience operates principally at the time of retrieval to facilitate access to stored memories.

AD was found to influence the age of memories relating to the secondary, more remote peak but had no effect on the age distribution of memories drawn from the most recent 20 years. Furthermore, the proportion of memories relating to the recency peak and the secondary peak did not differ from that of the normal control group, even though the absolute number of memories was overall fewer in the AD group. These observations are similar to the differences that have been reported between young and old normal subjects; ageing affected the age of the secondary peak but not the more recent cluster of memories (Franklin and Holding, 1977; Fitzgerald and Lawrence, 1984; Rubin *et al.*, 1986). These differential effects of ageing and disease on the subsets of remote memories suggests that different cognitive processes underlie the recent and remote clusters of autobiographical memories in normal elderly subjects, and that dementia has selective effects on those processes that contribute to the secondary peak.

The age of autobiographical episodes produced by patients with AD showed patchy correlations with performance on standard neuropsychological tests. Although interpretation of these findings is necessarily tentative, positive associations were found between anterograde memory capacity and the age of recent but not remote memory. By contrast, age of subjects and severity of dementia correlated significantly only with the age of remote memories. These dissociations support the concept of different cognitive processes underlying recent and remote autobiographical memory. Further, they are compatible with the hypothesis that recent memories are largely episodic in nature whilst more remote memories are more semantically organized (Cermak, 1984). Further evaluation of these trends is necessary using a larger group of subjects.

The significance of the positive correlation between age of remote memory and performance on the Reporter's and Token Tests is obscure. However, the greater preservation of language function in those subjects who relate older memories argues strongly against the possibility that the differential age distribution

of autobiographical episodes in dementia is an artefact of disordered language expression.

The pattern of performance on the autobiographical memory test differs qualitatively from that on public events tests. Similar results were shown by Beatty *et al.* (1988). The patients who participated in the study reported here were a subset of the patients reported by Sagar *et al.* (1988). In that study, the AD patients showed a gradient of deficit for recall of past public events in which remote memories were relatively preserved. Unlike the autobiographical test results, however, the public events test showed a progressive impairment from the most remote to the most recent time periods, with no selective preservation relating to the recent time period and no reminiscence peak relating to early adulthood. The temporal gradient on public events tests has been attributed to a gradual strengthening of memories, and loss of specific temporal reference, as a result of an increase of associative links resulting from new experiences, i.e. the development of semantic memory from episodic experiences (Cermak, 1984). The results of autobiographical memory tests suggest that the reminiscence peak is superimposed upon this gradient of memory strength. Thus, a shift of the reminiscence peak into the more remote time periods may result from a weakening of the reminiscence effect relative to the gradient of semantic memory. By this analysis, age and dementia have a predominant effect on reminiscence.

In conclusion, memory for past events comprises subprocesses relating to recency, semantic memory, and reminiscence. Memory for recent events may be related to anterograde processes whilst remote events are affected by reminiscence and the development of semantic memory. Observations of qualitatively similar effects on the reminiscence peak in dementia and normal ageing underline behavioural similarities between these two conditions.

#### Acknowledgements

This research was supported by grants from the National Institute of Health, USA, numbers RR 00088, MH 32724, and the Oxford Regional Health Authority, UK. Support during data analysis and manuscript preparation was provided by Special Trustees of the Former United Sheffield Hospitals, UK, Roche Products, UK, the Medical Research Service of the Department of Veterans Affairs, Palo Alto, California, USA and National Institute of Health, USA, numbers MH 30854 and 40041. We thank Dr John Growdon for referring the AD patients for study.

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