Semantic memory and frontal executive function during transient global amnesia

J R Hodges

Abstract
To assess semantic memory and frontal executive function, two patients underwent neuropsychological testing during transient global amnesia (TGA) and after an interval of 6–8 weeks. In spite of a profound deficit in anterograde verbal and non-verbal memory, semantic memory was normal, as judged by category fluency measures, picture naming, and picture-word and picture-picture matching, and reading ability was normal. Similarly, there were no deficits on a number of tests known to be sensitive to frontal executive dysfunction. A hexamethylpropyleneamine-oxime (HMPAO) single photon emission CT (SPECT) scan, obtained on one patient 24 hours post-TGA, showed focal left temporal lobe hypoperfusion which had resolved three months later. The observed dissociation between episodic and semantic memory is discussed in the light of contemporary cognitive theories of memory organisation.

(J Neurol Neurosurg Psychiatry 1994;57:605–608)

The term “transient global amnesia” (TGA) was first coined by Fisher and Adams to describe a clinical syndrome characterised by the abrupt onset of severe anterograde amnesia, usually accompanied by repetitive questioning occurring in the middle aged or elderly, and lasting a few hours. During the attack patients remain alert and communicative, and personal identity is preserved. More recently, research criteria for the diagnosis have been proposed which include the following: the attacks must be witnessed and information available from a capable observer who was present for most of the attack; there must be clear-cut anterograde amnesia during the attack; clouding of consciousness and loss of personal identity should be absent; there should be no accompanying focal neurological symptoms or signs; epileptic features must be absent; the attack must resolve within 24 hours; and patients with recent head injury or known active epilepsy are excluded.

Although several hundred patients who fulfil these criteria have been reported, there are still relatively few reports of neuropsychological testing during TGA. These studies have established that the pattern of memory impairment closely resembles that seen in patients with permanent amnesia, that is, there is preserved immediate or short-term memory (eg, digit span), but longer-term anterograde memory for verbal and non-verbal material is profoundly impaired. It is also apparent that most patients have a retrograde amnesia, although the extent of the deficit varies from fairly slight (ie, weeks or months) to very extensive (ie, many decades). However, a number of issues remain unsettled. In particular, the status of semantic memory and frontal “executive” function during TGA has been investigated very little.

‘Semantic memory’ is the term applied to the component of long-term memory responsible for the storage and integrity of knowledge about the world, including the meaning of words and objects. It is of considerable theoretical interest to know whether semantic memory is intact in TGA. First, it has been suggested that episodic (ie, memory for temporally specific events or episodes) and semantic memory are functionally separate systems which may dissociate; the degree of episodic memory impairment in TGA is clearly profound and it is therefore of interest to know whether semantic memory is impaired during TGA. Second, the temporal neocortex, especially on the left side, appears to be the area most critical for the maintenance of semantic memory. Cerebral perfusion studies using single photon emission CT (SPECT) have usually shown bilateral temporal lobe hypoperfusion extending beyond the structures involved in episodic memory (the hippocampal complex) during TGA.

Thus, it is possible that semantic memory may be impaired in patients with TGA, but the deficit has been overshadowed by profound changes in episodic memory.

The status of frontal “executive” function during TGA is also of interest. Patients with permanent amnesia secondary to diencephalic damage invariably have additional executive deficits, presumably secondary to functional frontal deactivation. By contrast, hippocampal amnesia executive function is unimpaired. As functional imaging studies by SPECT have usually shown pathological changes confined to the temporal regions, frontal executive function should also be normal during TGA. On the other hand, Goldenberg has recently argued, on the basis of a review of the literature, that there may well be a diffuse impairment in cognitive function, including frontal executive abilities during TGA.

The aim of the present study was to investigate semantic memory and executive function...
Table 1  Basic demographic and clinical details of the two patients

<table>
<thead>
<tr>
<th></th>
<th>Patient 1</th>
<th>Patient 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)/Sex</td>
<td>69/M</td>
<td>62/M</td>
</tr>
<tr>
<td>Cerebrovascular risk factors</td>
<td>Absent</td>
<td>Absent</td>
</tr>
<tr>
<td>Migraine</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Length of TGA (hours)</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Repetitive questioning</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Length of retrograde amnesia*</td>
<td>Months</td>
<td>Months</td>
</tr>
<tr>
<td>Fulfil research criteria for TGA</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>CT scan</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>EEG post attack</td>
<td>Normal</td>
<td>Normal</td>
</tr>
<tr>
<td>SPECT</td>
<td>Left temporal normal</td>
<td>Not performed</td>
</tr>
</tbody>
</table>

*As judged by informal assessment.

in TGA. Two patients were tested during the acute attack, and again after an interval of 6–8 weeks. As the features of the attack were virtually identical—and characteristic of TGA—both patients, only patient 1 will be described in detail. Basic demographic and clinical details of the two cases are summarised in table 1. Patient 1 also underwent SPECT scanning 24 hours after the attack and again after three months.

Case report

Patient 1, a 69-year-old man, presented on 14 February 1993 in the midst of his first attack of TGA. At approximately 11:00 he became acutely amnesic immediately after sexual intercourse with his wife. He exhibited the typical features of repetitive questioning and was disoriented in time. He rapidly forgot any new material and it was clear that he had a dense retrograde amnesia extending back for at least a week—he had forgotten an important dinner which had occurred a few days before. He complained of no other neurological symptoms. In the past he has suffered from benign coital cephalgia, but was generally fit and well. After assessment by his general practitioner, he was referred to Addenbrooke’s Hospital. General medical and neurological examination were normal. Neuropsychological assessment began at 18:00. At that time he was still clearly amnesic with virtually no retention of new information, such as a name and address. His retrograde amnesia, assessed informally with collaborative evidence from his wife, indicated a dense remote memory deficit of weeks with a patchy impairment extending over a period of months. By 21:00 the retrograde amnesia had shrunk to about 24 hours and he was beginning to retain new information. Testing was discontinued at that stage. After the attack he was left with an amnesic gap of 12 hours which encompassed the duration of the amnesic episode, plus two hours preceding it during which time his behaviour was normal.

The following day he underwent a CT scan, EEG, chest radiograph, and ECG, all of which were normal. A hexamethyl-propylene-amine-oxide (HMPAO) SPECT scan, performed on the day after the attack, showed an area of focally reduced perfusion in the left temporal lobe, involving predominantly the medial temporal area. Repeat examination three months later was normal.

NEUROPSYCHOLOGICAL ASSESSMENT

Both patients underwent testing during TGA and after an interval of 6–8 weeks; the results are shown in table 2. Anterograde episodic memory for verbal material, as judged by performance on the logical memory (story recall) part of the Wechsler memory scale—revised was profoundly impaired in both patients. Similarly, neither patient retained any elements of the Rey complex figure after a delay of approximately 30 minutes, despite normal copying of the figure. When re-tested both had improved very considerably. The first patient’s verbal memory was perhaps still slightly below that expected for his age and education. Patient 2 was considered to be entirely normal.

In contrast to their longer-term memory, immediate (short-term) memory, as judged by digit span, was normal in both patients and showed no change between the two test sessions.

Semantic memory was evaluated using components of a battery which has been described in detail elsewhere. In brief, the battery employs a consistent set of stimulus items designed to assess input to, and output from, central representational knowledge about the same group of items via different sensory modalities. It contains 48 items chosen to represent three categories of animals (land animals, sea creatures, and birds) and three categories of artefactual items (household items, vehicles, and musical instruments), matched for word frequency. The following sub-tests from the battery were
Assessment of functions during transient global amnesia

administered: category fluency for each of the main semantic categories in the battery, naming of all 48 line drawings, picture-pointing in response to the spoken name (each array consisting of eight items from the same semantic category, such as birds). On each sub-test, both patients performed normally during TGA as judged against 25 normal controls roughly matched for age and IQ. On category fluency both patients produced an adequate total number of exemplars, although, in keeping with the severe amnesic state, approximately 10% of the responses were perseverations. On reassessment, the total number of responses was almost identical, but now without perseverative errors.

In addition, a picture–picture matching test designed to assess non-verbal semantic knowledge was administered. In this test, subjects are asked to match conceptually related pictures. For instance, the target picture of an Egyptian pyramid is presented above two drawings depicting a palm tree and a fir tree, and the subject is asked to say which one goes with the pyramid. Both patients performed flawlessly on this test during TGA and were, therefore, not reassessed.

The ability to read aloud words with an exceptional or irregular spelling-to-sound correspondence (e.g., PINT, ISLAND, Celly) has been shown to depend upon intact semantic memory; patients with semantic memory impairment exhibit the features of surface dyslexia, that is, defective irregular word reading with predominant regularisation errors (PINT to rhyme with MINT). To assess reading, the two patients were given the surface reading list devised by Patterson and Hodges, consisting of 252 words divided equally into regular and exception words from a range of frequencies (high, medium, and low). Both patients performed normally during TGA producing six and eight errors, respectively, all on low frequency irregular words. There was no significant change in their reading accuracy when re-tested 6-8 weeks later.

Frontal executive abilities were assessed by means of Raven’s advanced progressive matrices (APM) part A+B and the trail matching test (parts A + B) and the Stroop test. Both patients performed normally during TGA, as judged against normative data for these tasks. There was some variability between the two test sessions, with slight decline on the Stroop test in patient 1, and on the trail matching test in patient 2. These relatively minor fluctuations can be considered within normal limits.

Discussion

The principal findings of normal semantic memory and frontal executive function during TGA confirm previous observations, which have suggested that TGA produces an unusually profound, yet pure, amnesic syndrome.

The distinction between episodic and semantic memory was first fully developed by Tulving. Since then, it has been repeatedly suggested that the amnesic syndrome repre-
mic region. In the present study, a SPECT scan obtained 24 hours post-TGA showed focally reduced perfusion confined to the left temporal lobe, involving predominantly medial temporal structures. It is probable that the deficit was resolving and that during TGA bilateral changes would have been present. The most parsimonious interpretation of these reports is that the site of pathology in TGA varies; most commonly, the medial temporal region is involved, but occasionally the midline thalamic structures may bear the brunt. This could explain the variable duration of retrograde amnesia during TGA. Hodges and Ward clearly demonstrated that, although all patients have a profound anterograde amnesia, the degree of retrograde memory impairment is extremely variable. It has recently been suggested, by Squire, that pathology limited to the hippocampus results in a pure anterograde amnesia, and only when other structures are also involved is there an accompanying retrograde amnesia.

Semantic memory and frontal executive function during transient global amnesia.

J R Hodges

*J Neural Neurosurg Psychiatry* 1994 57: 605-608
doi: 10.1136/jnnp.57.5.605

Updated information and services can be found at:
http://jnnp.bmj.com/content/57/5/605

**Email alerting service**
Receive free email alerts when new articles cite this article. Sign up in the box at the top right corner of the online article.

**Notes**

To request permissions go to:
http://group.bmj.com/group/rights-licensing/permissions

To order reprints go to:
http://journals.bmj.com/cgi/reprintform

To subscribe to BMJ go to:
http://group.bmj.com/subscribe/