Short report

Memory disorder related to coma duration after head injury

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SUMMARY The relationship of memory and intelligence test performances to coma duration was studied in 51 head injured patients who had not been operated on for intracranial haematoma. Memory defect was related to coma duration, and was not secondary to impaired perceptual or conceptual analysis of the material to be remembered.

The duration of post-traumatic amnesia is related to the severity of residual memory deficit,^{1,2} but less consistency is found in the relation of the duration of coma to the persisting memory defect after closed head injury (CHI),²⁻⁷ possibly because reversible secondary lesions may give rise to or prolong coma. CHI affects not only memory but also other aspects of cognition.^{2,8,9} Although memory tests are sensitive detectors of various cognitive deficits caused by CHI, the nature of these deficits is unclear.^{1,10} Deficient information analysis of the material to be remembered may be the reason for poor memory test performances after CHI.

The purpose of this study was to demonstrate that CHI creates a memory deficit which is not secondary to impaired conceptual or perceptual analysis of the material to be remembered and which is related to coma duration in patients who have not been operated on for intracranial haematoma. Memory was measured with modifications of two well known tests, which provided an estimate of the perceptual and conceptual analysis of the material to be remembered.¹¹ The Similarities of the Wechsler Adult Intelligence Scale¹² (WAIS) was used as an orienting task, which gave a score of the level of conceptual encoding in the incidental learning of the words.¹³ Luria's homogeneous interference procedure¹⁴ was included in the Benton Visual Retention Test (BVRT),¹⁵ in order to obtain an estimate of forgetting during interference.

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Patients and methods

The patients in this study were admitted to the Neurosurgical Clinic of Helsinki after CHI and referred for routine neuropsychological examination in 1978-81. Only patients who had been comatose immediately after injury and whose coma duration could be judged from hospital records were selected. Coma was defined as the absence of eye opening, the absence of comprehensible verbal response and the absence of response to command.¹⁶ As soon as any of these responses was recorded, the patient was considered to be out of coma. Patients who were confused, disoriented or unable to cooperate adequately in the psychological examination as well as patients who were operated on for intracranial haematoma were excluded.

The remaining 51 patients were subdivided into 25 patients with a coma of less than 6 hours (Short Coma Group = SCG) and 26 with a coma of more than 6 hours (Long Coma Group = LCG). The groups were similar in the proportion of men and women (20/5 in the SCG and 21/5 in the LCG) as well as mean age (28 years), education (9.7 years in the SCG and 10.5 in the LCG) and IQ (table).

The time lapse from injury to psychological examination varied from 5 days to 34 months, mean 83 days in the SCG and 151 days in the LCG. Patients examined *not* more than 40 days after injury, and those examined *more* than 40 days after injury were studied separately, but as the results of these subsamples were very similar, only the results of the total sample are reported.

Tests

Intelligence was studied with the Digit Span, Similarities and Block Design subtests of the WAIS. The raw scores and the IQ calculated from these subtests were used.

Free and Cued Recall of the Similarities. The first 10 questions of the Similarities of the WAIS were given to each subject irrespective of the number of incorrect answers. After this orienting task, the patient was asked, without previous warning, to recall as many of the word pairs as he could, in

Table Test results

	<i>Short coma</i>		<i>Long coma</i>		<i>t</i>	<i>p</i> <
	<i>(< 6 hours)</i>		<i>(> 6 hours)</i>			
	<i>M</i>	<i>SD</i>	<i>M</i>	<i>SD</i>		
WAIS						
IQ	96.6	17.7	99.1	16.4	0.52	NS
Digit Span*	9.9	2.0	10.6	2.0	1.28	NS
Similarities*	14.0	5.5	14.8	6.2	0.47	NS
Block Design*	29.5	9.3	30.3	9.1	0.34	NS
Free Recall of Similarities	9.6	4.2	6.5	3.4	2.93	0.006
Cued Recall of Similarities	8.0	1.6	6.8	1.9	2.31	0.03
Immediate Reproduction of BVRT	20.5	3.6	19.0	3.9	1.41	NS
Forgetting Percentage of BVRT	18.6	13.7	29.7	19.3	2.38	0.03

*Raw scores.

any order; the score was the number of words correctly recalled. Following this the first word of each of the 10 pairs was given as a cue, the score again being the number of correct responses.

*The Benton Visual Retention Test (BVRT)*¹⁵ with *homogeneous interference*. The 10 cards of form C were used, each card being shown for 10 seconds, with the subject instructed to draw the figure(s) on a piece of paper immediately after the removal of the card (reproduction I). Every second time the subject was requested to re-draw from memory the figure(s) of the next to last card followed by the last card (reproduction II). Benton's scoring method was used.¹⁵ The number of correct figures was totalled over the 10 cards separately for reproduction I and II, the maximum for each being 26. The difference of these totals considered as the percentage of the former score was the *Forgetting Percentage*, indicating the decline of memory from the *Immediate Reproduction* (I) to that following the interference (II).

Results

The table shows that the coma groups did not differ from each other on the WAIS subtests or on the Immediate Reproduction of the BVRT, but the Long Coma Group was significantly inferior to the Short Coma Group on the Free and Cued Recall of the Similarities as well as on the Forgetting Percentage of the BVRT. In the total sample the Similarities score was related to the Free and Cued Recall ($r = 0.31$ and 0.37 , $p < 0.05$ and 0.01 , respectively), the Immediate Reproduction of the BVRT being associated with the Forgetting Percentage ($r = -0.51$, $p < 0.001$). The correlations indicate that the memory performances were dependent on the information analysis of the material, but as the coma groups were equal in information analysis, its impairment was not the reason for the memory deficit related to coma duration.

Discussion

The results showed that CHI causes a disorder of

verbal and visual recent memory that is related to coma duration, but is not secondary to deficient conceptual or perceptual analysis of the material to be remembered. Contrary to some previous studies⁵⁻⁷ this result suggests that coma duration is a reliable indicator of the severity of diffuse brain damage, when patients with intracranial haematoma requiring surgical removal are excluded. In line with previous findings^{17,18} no impairment of immediate memory was associated with coma duration.

The patients of the present study were referred to neuropsychological assessment usually for the evaluation of working ability or rehabilitation possibilities. Such a group is of course a biased sample. Patients with severe CHI and obvious disability as well as those with mild CHI and complete recovery are seldom referred to this kind of neuropsychological examination. In all likelihood this bias attenuated the correlation between coma duration and the neuropsychological impairments. However, it does not invalidate the conclusion that CHI causes a memory disorder that is not reducible to impaired encoding, the degree of the memory disorder being related to coma duration, in all probability reflecting the severity of diffuse axonal lesion.

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