



Characterization of a Factual Knowledge–Associated Brain Memory Area by Functional Magnetic Resonance Imaging and Implementation in Tumor and Epilepsy Brain Surgery

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■ **BACKGROUND:** The role of the dominant hippocampus in verbal and episodic memory recall has been extensively investigated. However, there are categories of memory estimated independent of hippocampal function. In particular, factual knowledge is solely constituted from written or spoken input independent on undertaken experience, but the temporal structures involved are not well defined.

■ **METHODS:** In this retrospective study, we mapped the activity of factual knowledge recall using functional magnetic resonance imaging (fMRI) in 60 patients scheduled for tumor or epilepsy surgery and in 18 patients resected within or close to the left mesial temporal lobe. Memory tests were performed preoperatively and postoperatively to investigate deficit symptoms in factual knowledge retrieval.

■ **RESULTS:** We found a highly reproducible localized brain area within the parahippocampal gyrus, in the depth of the dorsal collateral sulcus, which was constantly involved in factual knowledge retrieval during fMRI tasks in 93% of patients (56/60) during recall of capital cities or multiplication tasks, in two thirds of the patients mainly on the dominant side. In addition, all 18 patients after surgery within this area showed postoperative factual knowledge deficits (56% permanent, 44% transitory), memory prognosis significantly correlating with the first day's factual knowledge retrieval task results.

■ **CONCLUSIONS:** Using fMRI, we visualized a circumscribed brain area within the parahippocampal gyrus during factual knowledge retrieval, the lesioning of which led to factual knowledge deficits. Thus, impairment of factual

knowledge retrieval may occur if resection is extended into the parahippocampal gyrus. Preoperative fMRI memory maps may contribute to avoiding such deficits.

INTRODUCTION

Various types of amnesia are observed in patients with temporomesial brain tumors, stroke, trauma, or after tumor resection or epilepsy surgery in the dominant temporomesial structures. Two types of amnesia have been classified: retrograde amnesia and anterograde amnesia, comprising loss of previously acquired memory and loss of the ability to build up or keep new memories. In patients with retrograde amnesia, different parts of memory content can be affected. This factor led to a classification of different memory subtypes. Besides episodic or autobiographic memory, which summarizes all experiences obtained in particular periods, factual knowledge, as part of semantic memory, is constituted from facts exclusively derived from written or spoken input (e.g., facts learned in school such as multiplication tables or capitals of countries). The distinction between episodic memory and semantic memory was introduced by Tulving.¹ Sometimes, the denotation of words is also considered as part of memory. The cortical representation of word meaning is confined to areas that have been previously described²⁻⁴ and its irritation was observed after surgery of tumors adjacent to these areas.

Numerous studies have described patients with lesions, who had amnesia caused by stroke or infection. However, in these cases, the extent of the lesion is usually large and its borders are often vague. Rempel-Clower et al.⁵ and Squire et al.⁶ described loss of factual knowledge as shown by tests involving public

Key words

- Dominant temporal lobe surgery
- Factual knowledge retrieval
- Functional MR imaging
- Parahippocampal gyrus

Abbreviations and Acronyms

fMRI: Functional magnetic resonance imaging

MRI: Magnetic resonance imaging

WHO: World Health Organization

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Citation: *World Neurosurg.* (2017) 107:291-301.

<http://dx.doi.org/10.1016/j.wneu.2017.07.176>

Journal homepage: www.WORLDNEUROSURGERY.org

Available online: www.sciencedirect.com

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Table 1. Patient Demographics: Cohort 1

Patient Number	Patient's Initials	Sex	Age (years)	Diagnosis	Localization	Lesion Volume (cm ³)	Preoperative Memory Deficiency	Functional Magnetic Resonance Imaging Gyrus Parahippocampalis Activity
1	KG1	F	44	GBM	Left temp	9.2	No	Weak
2	KY	M	44	AA	Right temp	21.7	No	Left
3	EK1	F	45	GBM	Left temp	26.1	No	Left
4	AC	M	40	GBM	Left temp	41.7	No	Left
5	GF	M	33	GBM	Left temp	45.6	Yes	Right
6	WH	F	66	GBM	Left temp	21.3	No	Right
7	HM1	F	26	AA	Left temp	25.6	No	Left
8	EA1	M	22	Me	Right temp	NA	No	Weak
9	KJ	M	53	GBM	Left temp	19.5	No	Weak
10	TG	F	44	All	Right temp	27.2	No	Weak
11	ZL	F	59	GBM	Left occip	15.1	No	Left
12	KW	F	49	GBM	Right temp	40.7	No	Right
13	HO	M	60	ANG	Left temp	NA	No	Right
14	SB	M	27	AA	Right temp	13.8	No	Left
15	GA	M	55	Me	Left temp	46	No	Left
16	KG2	F	47	GBM	Left temp	NA	No	Right
17	EK2	F	46	GBM	Left temp	26.7	No	Right
18	FA	M	54	GBM	Left tmp	16.4	No	Left
19	HC	F	63	HS	Left temp	NA	No	Left
20	BK1	M	52	GBM	Left temp	17.3	No	Left
21	HR	M	58	GBM	Left temp	16.5	No	Left
22	BE	F	52	GBM	Left temp	53.4	No	Left
23	HM2	F	48	AA	Left temp	25.6	No	Left/right
24	NKH	M	51	All	Left temp	NA	No	Left
25	RA	M	67	GBM	Left temp	36.5	No	Left
26	KA	M	49	GS	Left temp	31.2	No	Left/right
27	BEM	F	50	GBM	Left temp	12.8	No	Left
28	LJA	M	50	All	Left insular	10.6	No	Left
29	KH1	M	54	AA	Left temp	31.1	No	Left
30	SL	M	43	AA	Left temp	50.1	No	Right
31	PA	M	37	GBM	Left temp	34.7	Yes	Left
32	KV	F	55	GG	Left temp	1.6	No	Left
33	DM	F	42	AA	Left temp	19.5	No	Right
34	HR	M	59	GBM	Left temp	17.8	No	Left
35	BK2	M	53	GBM	Left temp	19.7	No	Right
36	KE1	M	60	GBM	Left temp	27	No	Right
37	MN	F	43	HS	Left temp	8.9	No	Right
38	BN	F	28	GG	Left temp	17.5	No	Right
39	GG	M	41	XA	Left temp	1.33	No	Left

Continues

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