Executive Cognitive Control and the Frontal Lobes

COLLEGE OF HUMAN SCIENCES AND EDUCATION
KIMEP UNIVERSITY

CLINICAL COGNITIVE SCIENCES LAB

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PERSPECTIVES OF INTEGRATIVE NEUROSCIENCE
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Instituto de Neurociencias
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The concept of ‘executive function’ originated in computer science. Programs that control other programs.

In 1956 a program called the *Automatic Supervisor* was developed for the IBM 702.

Shortly afterwards, *General Motors Executive System* was developed for the IBM 704

Moncreiff, B.: An automatic supervisor for the IBM 702. AIEE-IRE '56 Joint ACM-AIEE-IRE Western Computer Conference, pp. 21-25 (1956)

Several other top-down controllers, or operating systems were developed with similar ‘executive’ names.

This approach in computer science coincided with the development of cognitive science, starting in 1956.

Manufacturer	Computer	Year	Operating System
Honeywell	H800	1961	Executive Monitor
Univac	Univac 1107	1962	EXEC I
Burroughs	D825	1962	AOSP
Burroughs	B5000	1962	Master Control Program
Philco	Philco-2000	1962	SYS; BKS
GE	GE-215/225/235	1962	BRIDGE
IBM	IBM 7090/7094	1962	IBSYS
Bendix	G-20	1962	EXECUTIVE
CDC	CDC 1604	1962	CO-OP monitor system
CDC	CDC 3600	1963	SCOPE monitor system
Honeywell	Honeywell 1800	1963	ADMIRAL Master Monitor
GE	GE 625-635	1964	Comprehensive Operating Supervisor
RCA	RCA 3301	1964	Realcom system
SDS	SDS 9000	1964	MONARCH
DEC	PDP-6	1964	Supervisory Control Program

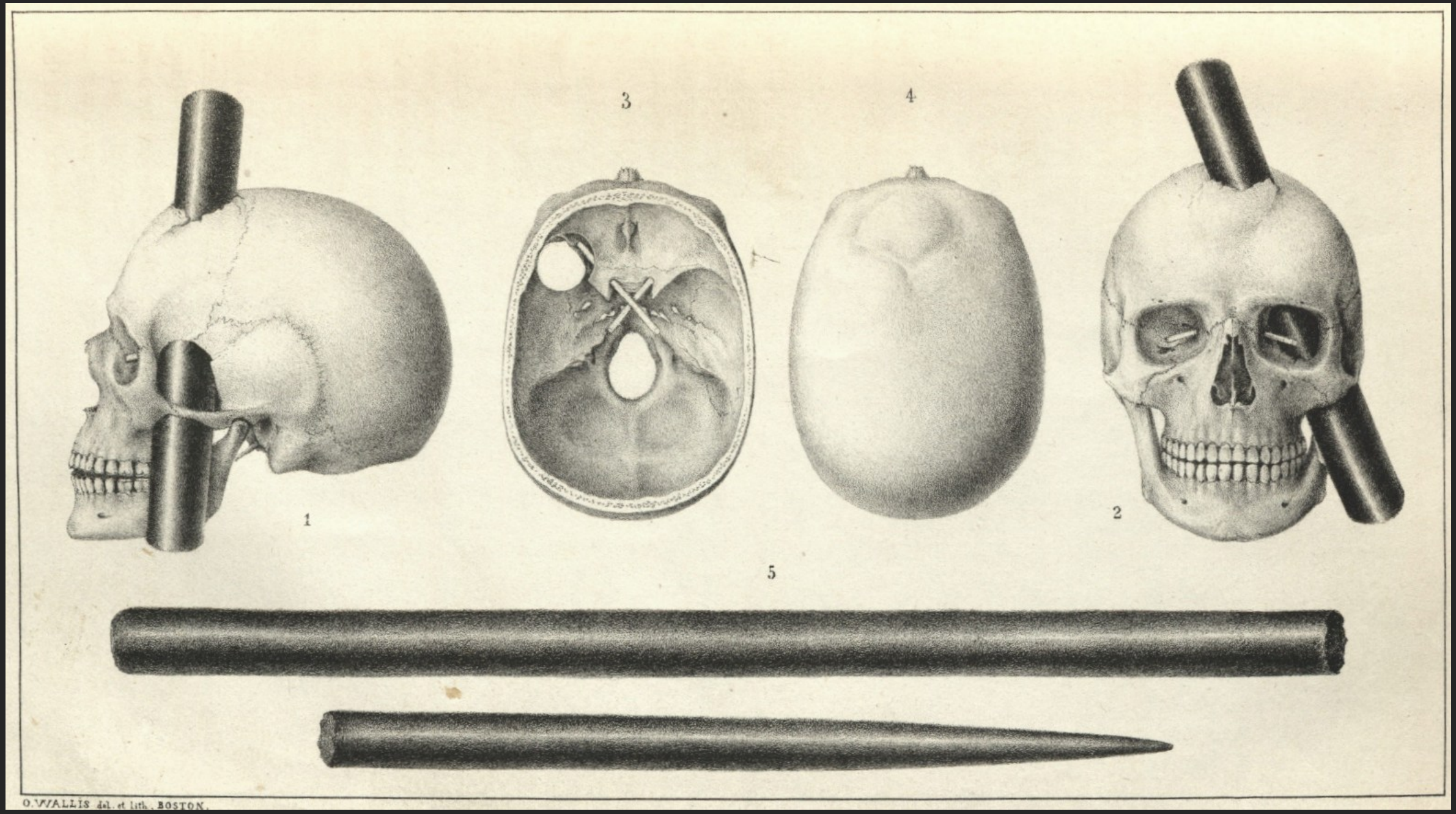
Table 1 An overview of the first operating systems offered by U.S. computer manufacturers 1960-1964

Bullynck, M.: What is an operating system? a historical investigation (1954–1964). In: De Mol, L., Primiero, G. (eds.) Reflections on Programming Systems: Historical and Philosophical Aspects. Springer, Cham (2018).

Pluck, G., Cerone, A., & Villagomez-Pacheco, D. (2023). Executive function and intelligent goal-directed behavior: perspectives from psychology, neurology, and computer science. In: Masci, P., Bernardeschi, C., Graziani, P., Koddenbrock, M., Palmieri, M. (eds) Software Engineering and Formal Methods. SEFM 2022 Collocated Workshops. SEFM 2022. Lecture Notes in Computer Science, vol 13765. Springer, Cham.

Minds, Brains & Computers

In 1973, drawing on computer science, Karl H. Pribram, working with cortical ablation of primate brains, proposed that the frontal lobes may function like the ‘executive controllers’



Bigalow, H.J. (1850). Dr. Harlow's case of recovery from the passage of an iron bar through the head. *American Journal of Medical Science*, *20*(39), 13-22.

- Acutely, he seemed to not lose consciousness.
  - He was able to talk, and to walk up a staircase to receive medical treatment.
- Chronically, no amnesia, aphasia, or other global or focal cognitive impairment reported.
  - Was able to continue paid employment.
- But he did show disorganized behavior and disinhibition.

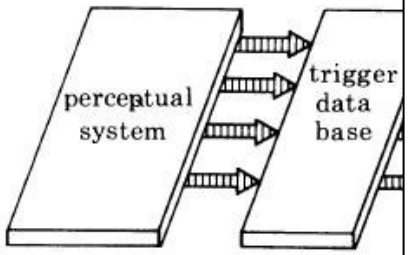


FIGURE 1. A simplified version of the Norman
The lines with arrows represent activati
function of contention scheduling. Th
involved in schema operation for both
involves placing information in short-t

Norman, D.A., Shallice, T.: Attention to ac
automatic control of behavior. Human Info
Processing Technical Report no. 99 (198

Baddeley, A., & Hitch, G. J. (1974). Workir
Bower (Ed.), Recent Advances in Learning
8, pp. 47-90). Academic Press.

BRAIN AND COGNITION 7, 212–230 (1988)

Frontal Amnesia and the Dysexecutive Syndrome

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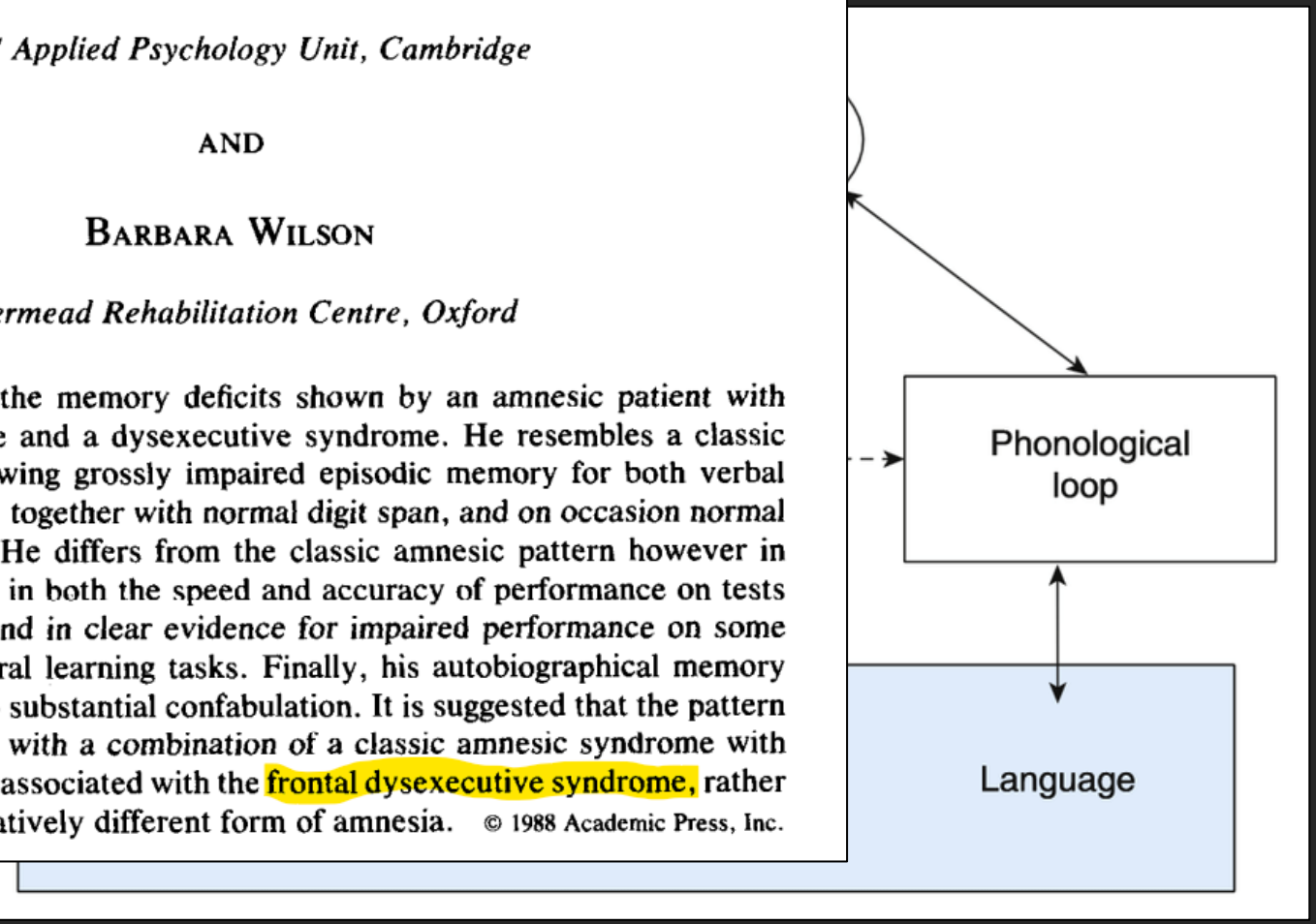
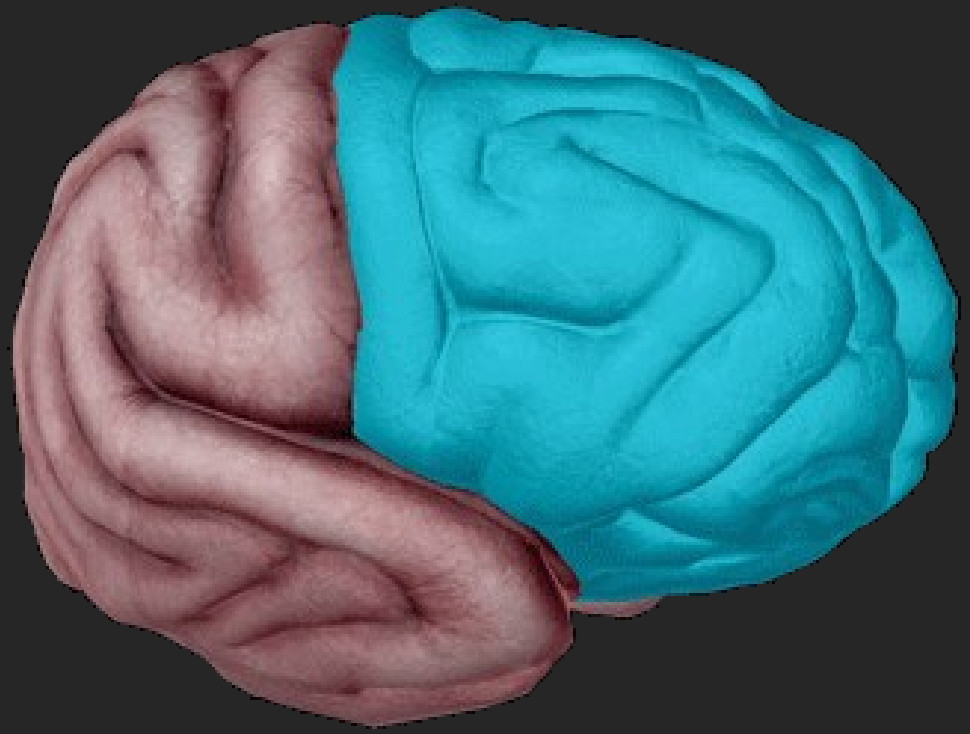
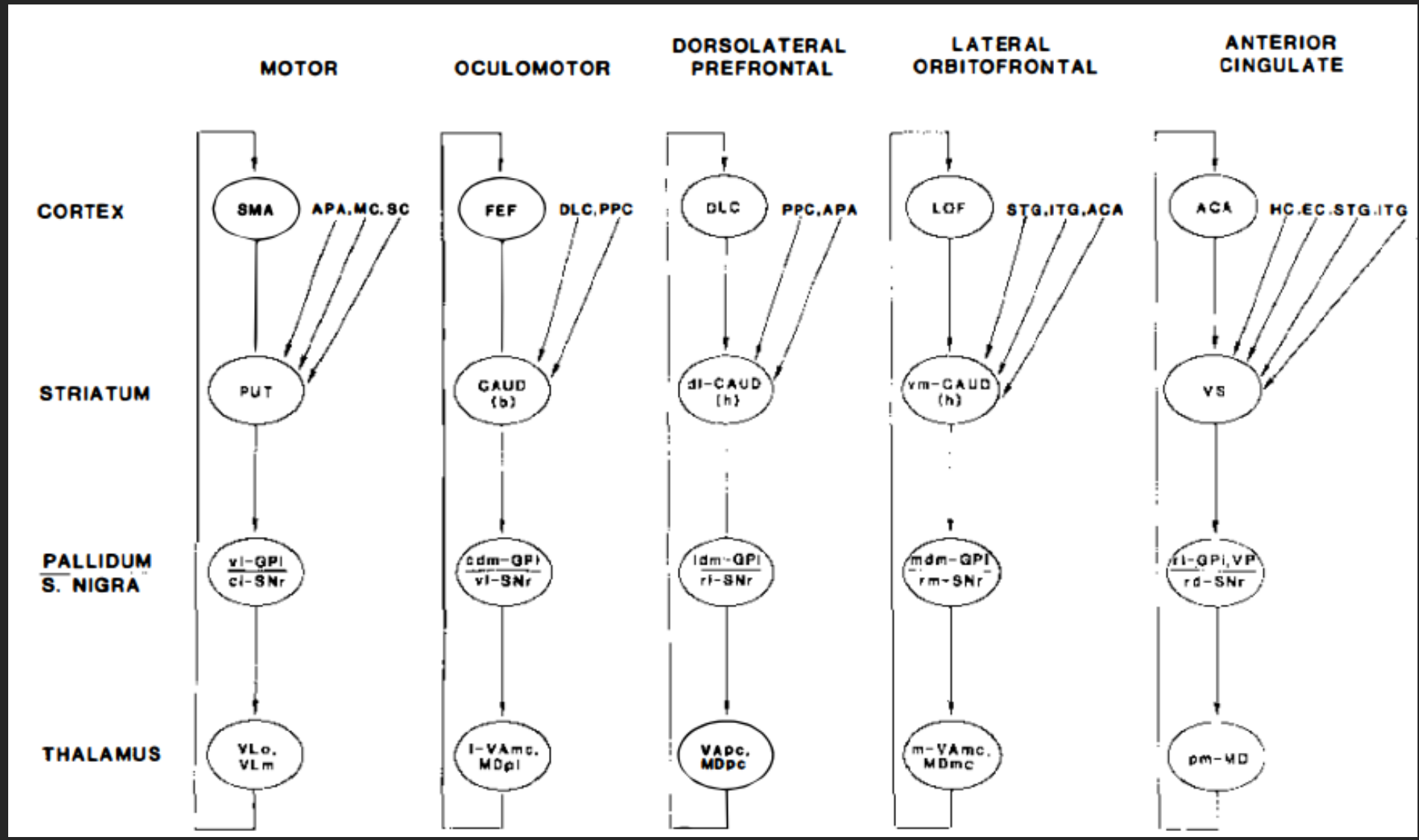
This study analyzes the memory deficits shown by an amnesic patient with bilateral frontal damage and a dysexecutive syndrome. He resembles a classic amnesic patient in showing grossly impaired episodic memory for both verbal and nonverbal material, together with normal digit span, and on occasion normal recency in free recall. He differs from the classic amnesic pattern however in showing an impairment in both the speed and accuracy of performance on tests of semantic memory, and in clear evidence for impaired performance on some though not all procedural learning tasks. Finally, his autobiographical memory was poor and subject to substantial confabulation. It is suggested that the pattern of deficits is consistent with a combination of a classic amnesic syndrome with the additional problems associated with the frontal dysexecutive syndrome, rather than exhibiting a qualitatively different form of amnesia.



The Frontal Lobes



Executive Function



Alexander, G. E., DeLong, M. R., & Strick, P. L. (1986). Parallel organization of functionally segregated circuits linking basal ganglia and cortex. *Annual Review of Neuroscience, 9(1)*, 357-381.

The frontal lobes comprise about 33% of the total tissue of the human brain

Describing a function as being in the frontal lobes is equivalent to describing a country as being in the Europe/Asia region

Semendeferi, K., & Damasio, H. (2000). The brain and its main anatomical subdivisions in living hominoids using magnetic resonance imaging. *Journal of Human Evolution, 38*(2), 317-332.

British Journal of Psychiatry (1992), **161**, 244–248

Point of View

Frontal Lobology – Psychiatry's New Pseudoscience

ANTHONY S. DAVID

The frontal lobes are the most evolutionarily advanced organ of the body. Here lies the seat of the highest human functions of thought, intellect, creativity, self-control and social interaction (Milner & Petrides, 1984; Lishman, 1987; Russell & Roxanas, 1990; Kolb & Wishaw, 1990). As one recent reviewer notes (Reading, 1991), it is hard to avoid 'sounding metaphysical' when going through such a list. It seems that, in accordance with psychiatry's own late phylogenesis, the frontal lobes have only just been discovered.

The disorders outlined below have been ascribed to frontal lobe dysfunction.

Personality disorders (Gorenstein, 1982): the lack of concern for others (psychopathy), the indifference, and the apathy are all reminiscent of frontal lesions.

Obsessions (Behar *et al*, 1983): the rigidity, lack of spontaneity, and perseveration are the hallmarks of frontal lobe dysfunction.

the highest levels of thought, so how does it help us to state that they are, by analogy and implication, the surface manifestations of frontal lobe neuropathology? Such a statement is a tautology. Rogers (1985) has argued in a different context, namely movement disorders, that the terminology with which phenomena are described brings with it prejudicial assumptions about the nature of the phenomena. Here is another conflict of paradigms where the glamour of neuroscience has displaced a humbler descriptive science, psychopathology. Does history help us understand how this stale impasse came about?

Much of the following discussion will concentrate on schizophrenia since this is where the frontal lobe hypothesis has its strongest allegiance.

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Executive function and adult homelessness, true impairment or frontal lobology?

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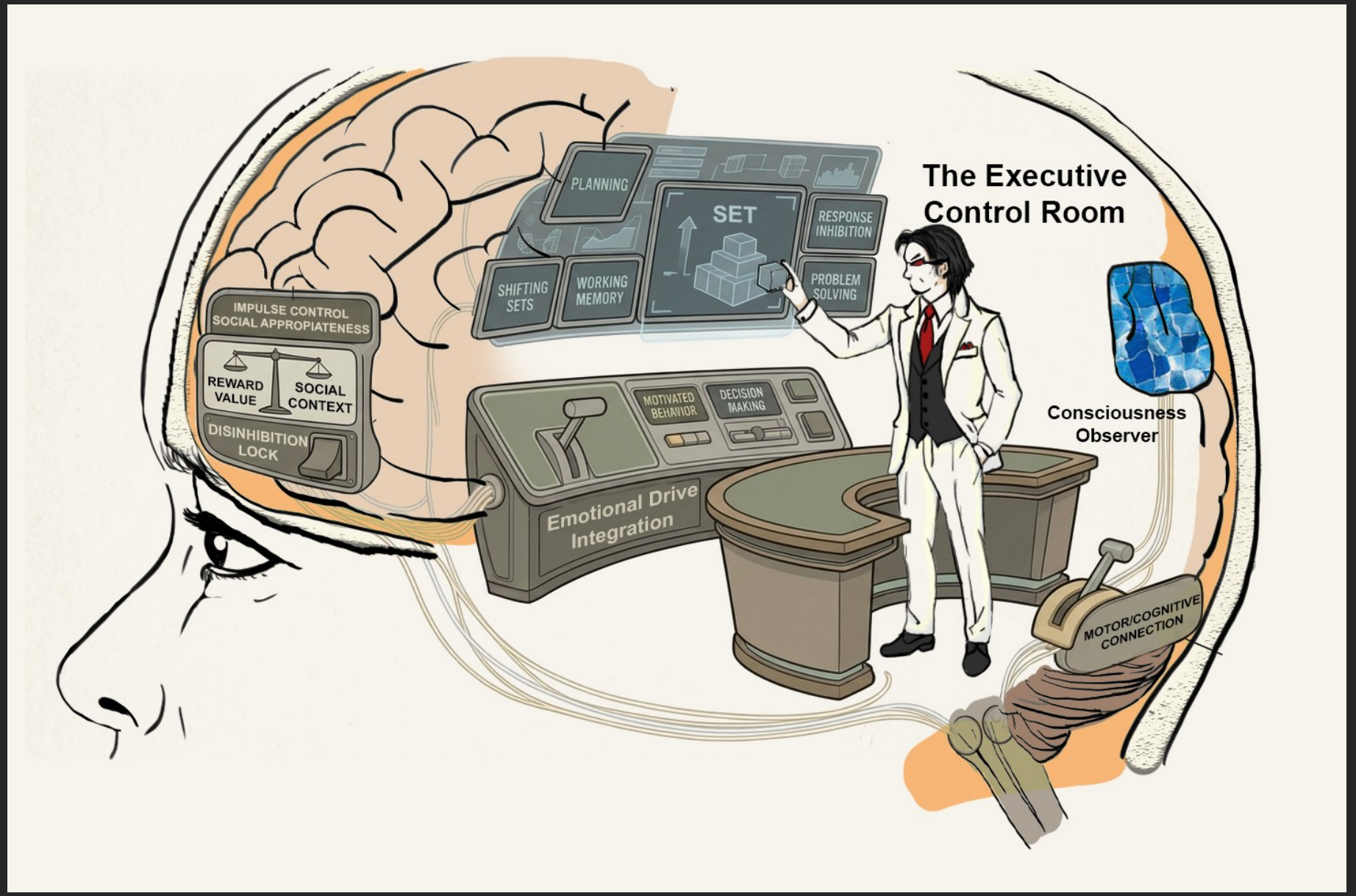
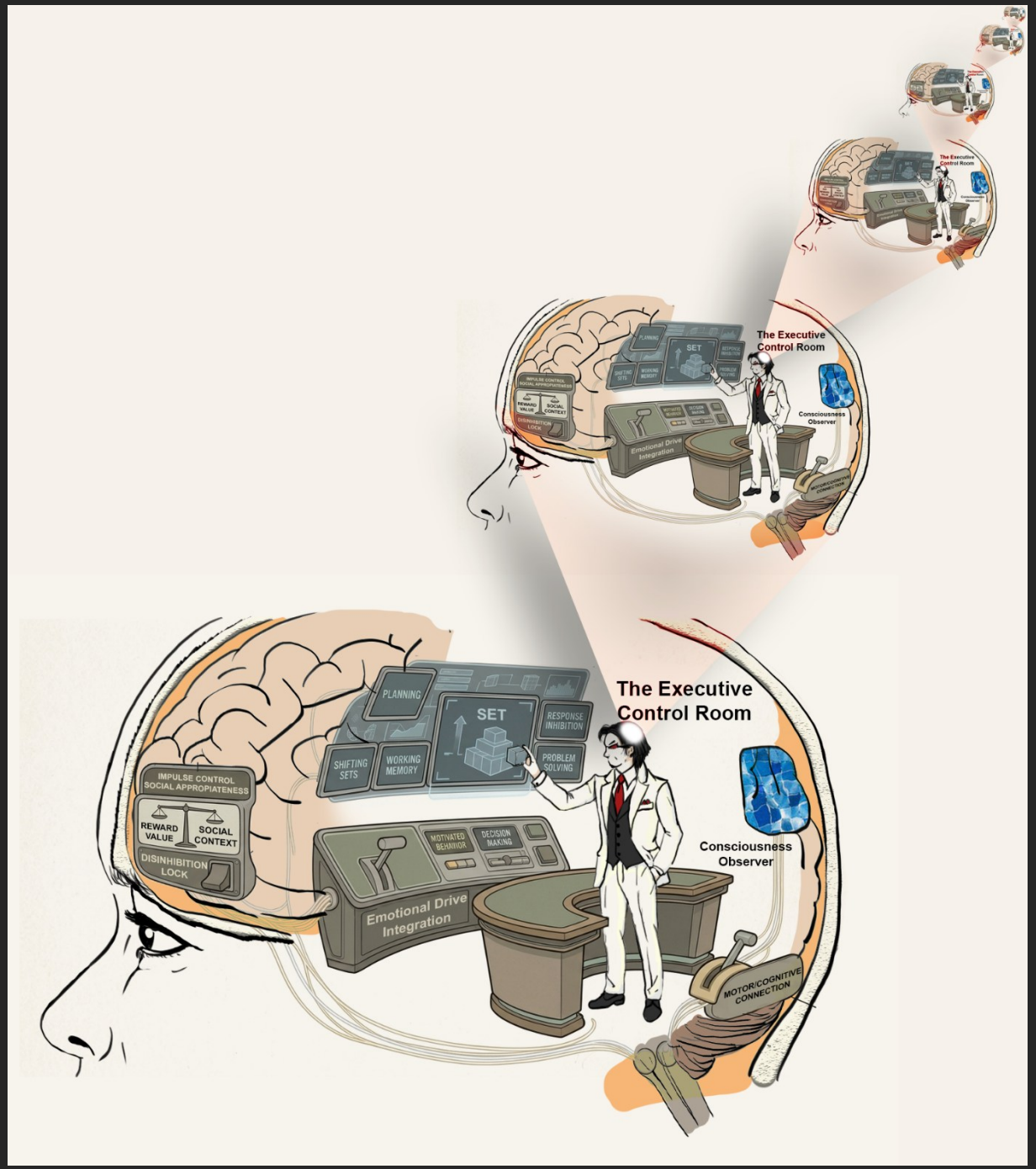
Homelessness is associated with multiple risk factors for neurocognitive impairment. Past research with people experiencing homelessness has described "frontal lobe" dysfunction including behavioral disorders and executive cognitive impairments. In the current study, 72 adults experiencing homelessness were assessed with a standardized assessment of executive function, and interviewed regarding neurological and psychiatric history. When compared to a control sample of 25 never-homeless participants, and controlling for level of education, there was little evidence for executive dysfunction in the sample of people experiencing homelessness. Levels of substance abuse, past head injury, and post-traumatic stress disorder were notably high. However, there were no statistically significant associations

Frontal lobology

Executivism


The Executive
Control Room
PLANNING
SET
RESPONSE INHIBITION
SHIFTING SETS
WORKING MEMORY
PROBLEM SOLVING
IMPULSE CONTROL
SOCIAL APPROPIATENESS
REWARD VALUE
SOCIAL CONTEXT
DISINHIBITION LOCK
MOTIVATED BEHAVIOR
DECISION MAKING
Emotional Drive
Integration
Consciousness
Observer
MOTOR/COGNITIVE
CONNECTION


The Executive Control Room
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DECISION MAKING
Emotional Drive Integration
Consciousness Observer
MOTOR/COGNITIVE CONNECTION

PROBLEMS

Frontal lobology & Executivism

SOLUTION

Frontal lobe ≠ Executive

Cognitive Control not Executive Function

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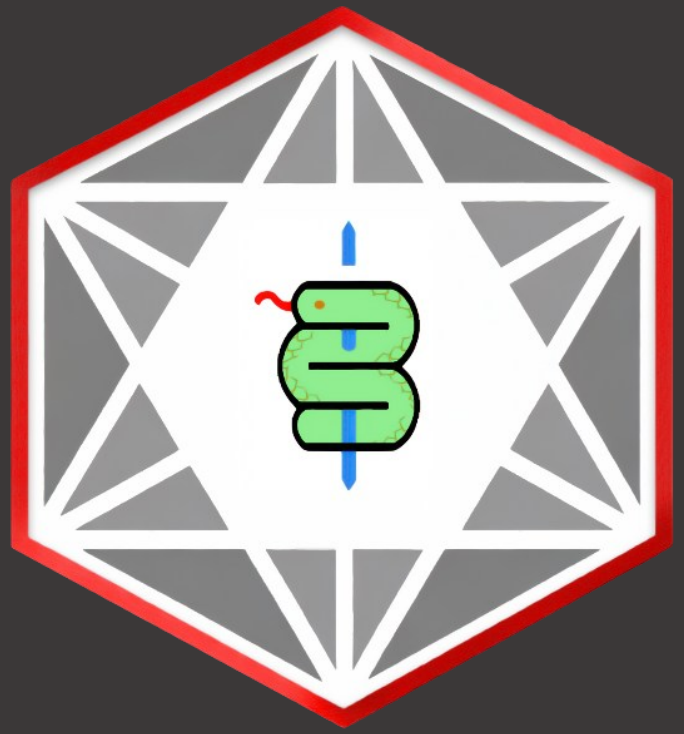

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