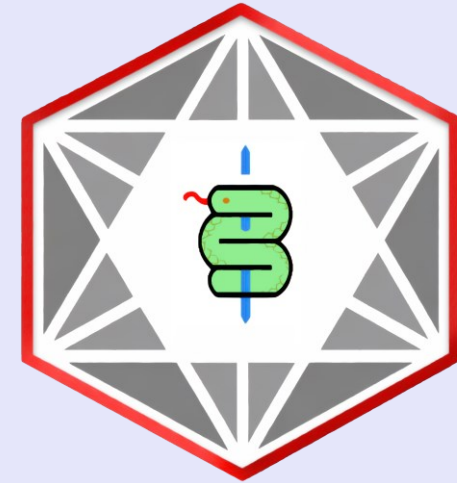


Cross-cultural Differences in Executive Functions



Chula
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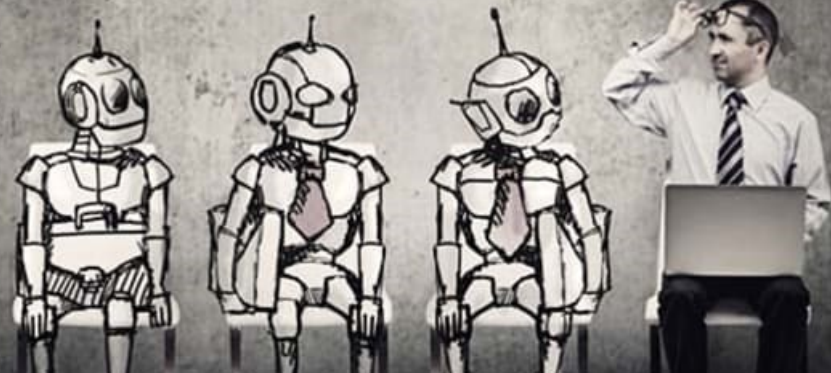
**CLINICAL
COGNITIVE
SCIENCES
LAB**

Dr Graham Pluck

Faculty of Psychology, Chulalongkorn University, Thailand

ART Conference, Goldsmiths, University of London, 1st November 2023

What does Executive Function mean?



Executive Function

‘Executive functions are high-level cognitive processes, often associated with the frontal lobes, that control lower-level processes in the service of goal-directed behavior’

Miyake, A., et al.: The unity and diversity of executive functions and their contributions to complex "Frontal Lobe" tasks: a latent variable analysis. *Cogn. Psychol.* **41**, 49-100 (2000)

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Top-down control

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.

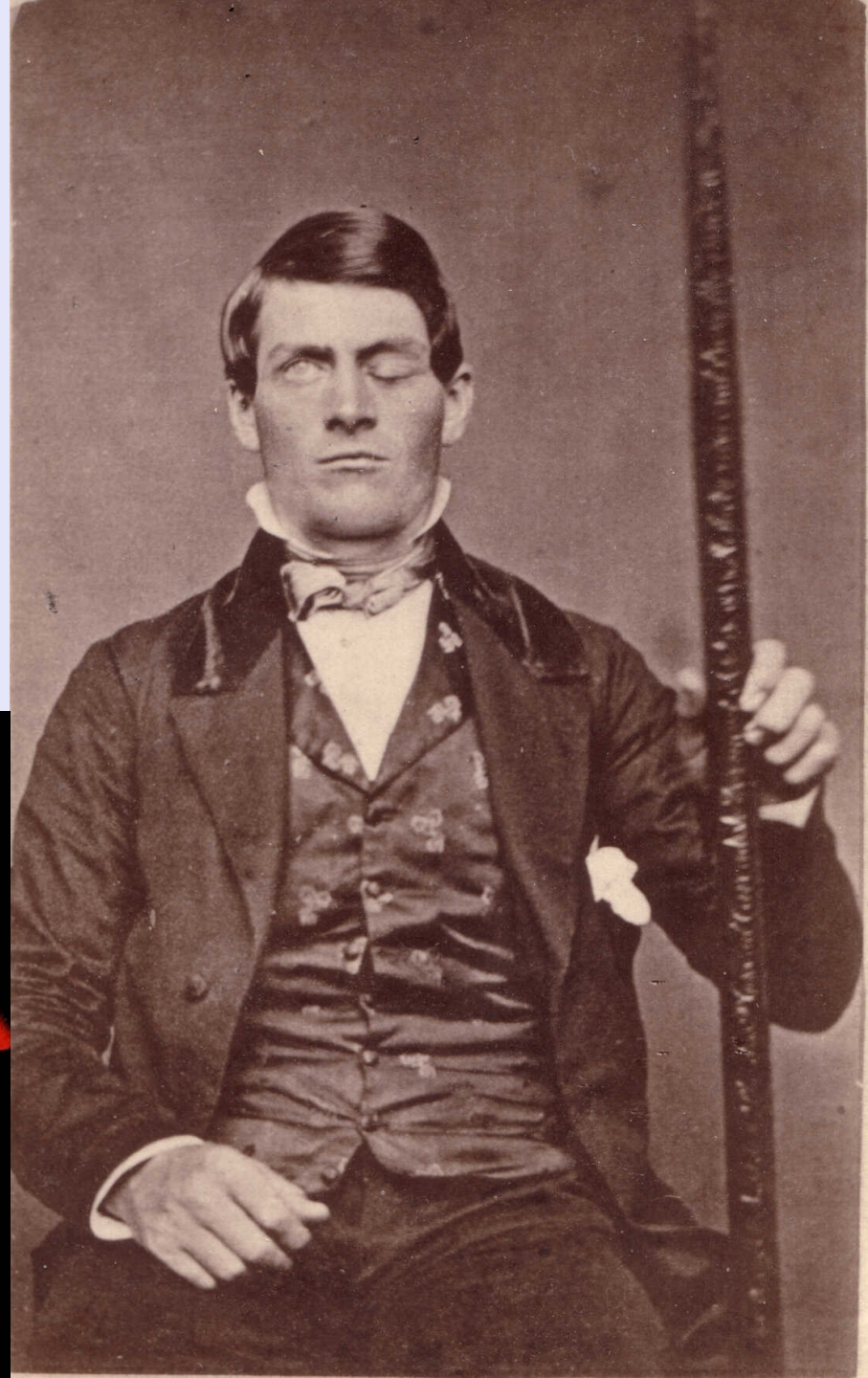
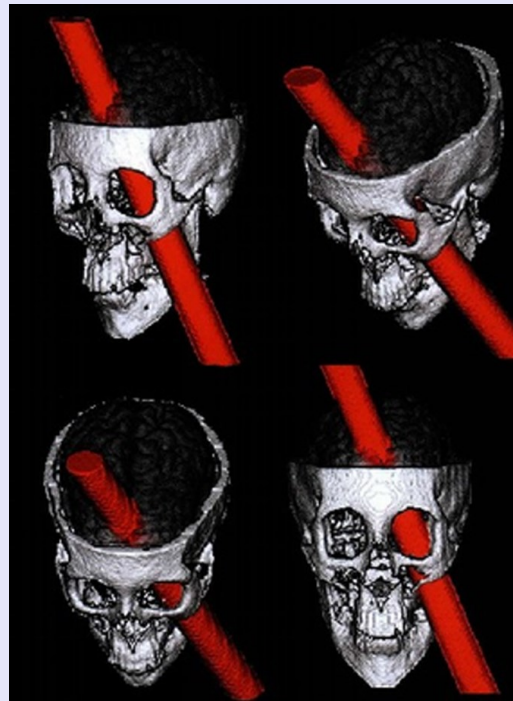
This approach in computer science coincided with the development of cognitive science, starting in 1956.

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

- Phineas Gage, after surviving a frontal lobe injury, became erratic, with difficulties in planning, decision making, and disinhibition.
- This pattern of symptoms is now known in neurology as the *dysexecutive syndrome*.
- Many similar cases have been reported of people with frontal lobe damage who become disorganized in the lives. Many maintain > average IQ.

Harlow, J.M.: Recovery from the passage of an iron bar through the head. *Hist. Psychiatry* 4, 274-281 (1993)



Minds, Brains & Computers

In 1973, drawing on computer science, neuroscientist Karl H. Pribram proposed that the frontal lobes may function like the 'executive controllers' in computers



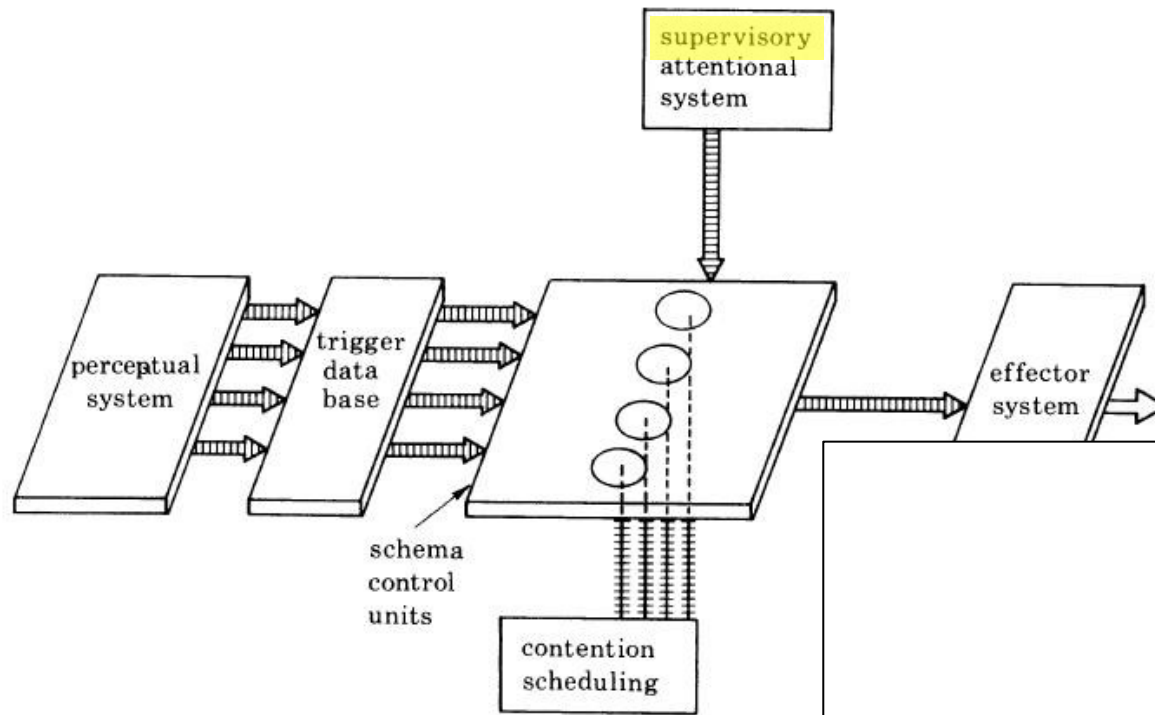
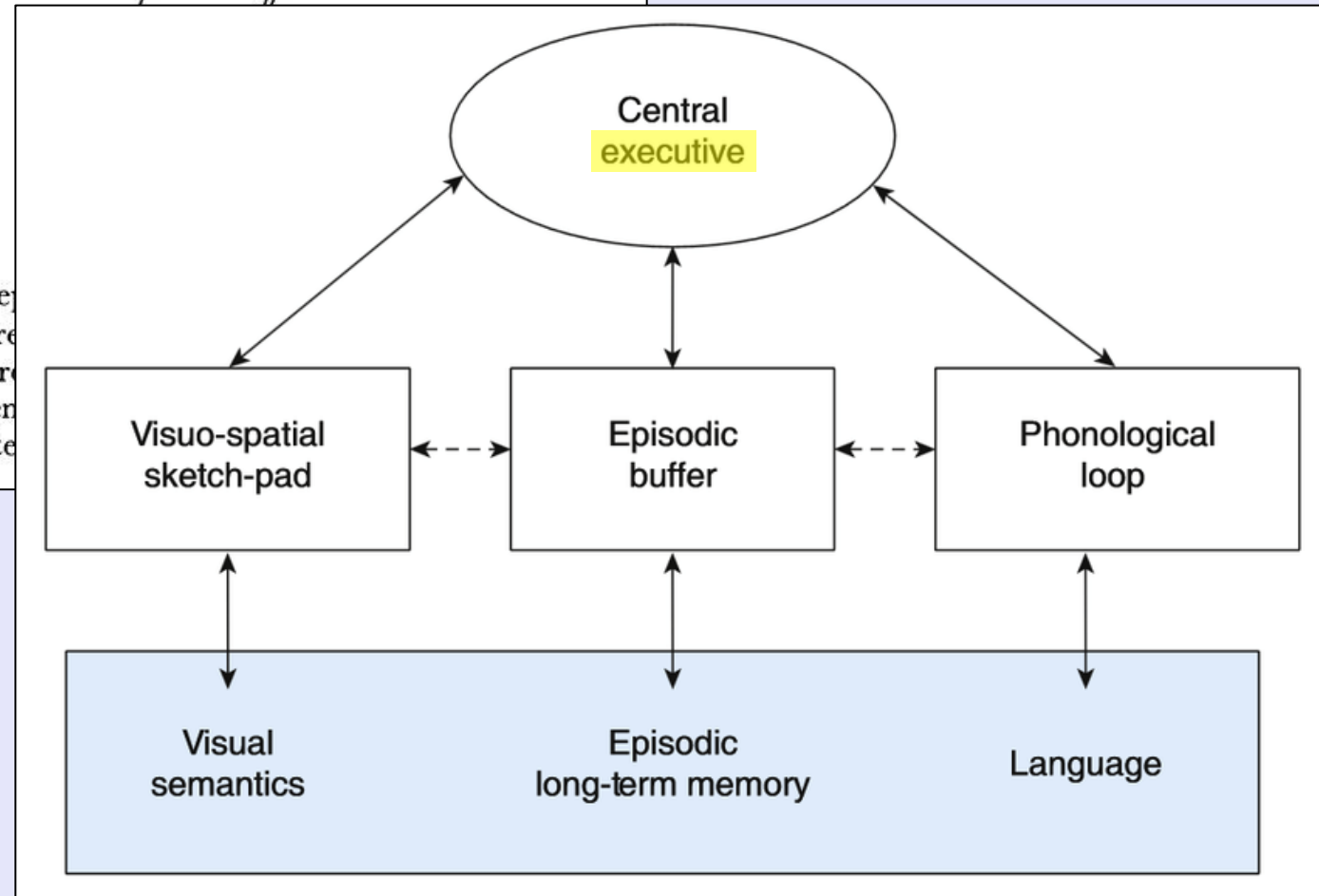


FIGURE 1. A simplified version of the Norman & Shallice (1980) model re...
 The lines with arrows represent activating input, the crossed lines re...
 function of contention scheduling. The term 'effector system' re...
 involved in schema operation for both action and thought schen...
 involves placing information in short-term stores that can activate



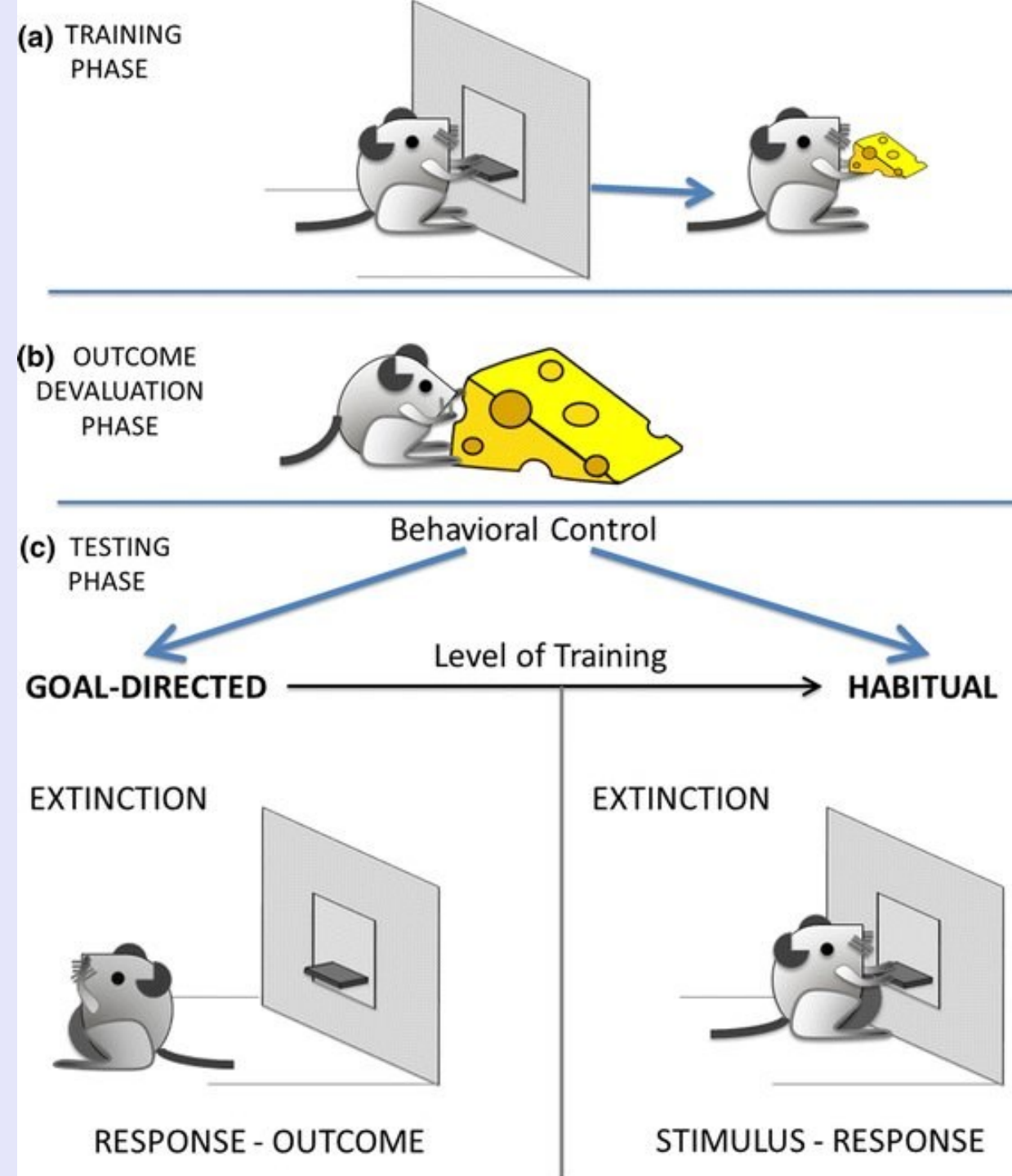
Norman, D.A., Shallice, T. (1980). Attention to action: willed and automatic control of behavior. Human Information Processing Technical Report no. 99.

Baddeley, A. (2000). The episodic buffer: a new component of working memory?. *Trends in Cognitive Sciences*, 4(11), 417-423.

Goal-directed behavior

- (a) A rat is trained to press a lever to obtain a reward (e.g., cheese)
- (b) The cheese is devalued (e.g., by letting the rat get sated)
- (c) The rat is now tested.
- If it doesn't press the lever. Its previous lever-pressing behavior was goal-directed.
 - If it continues to press the lever, its behavior is habitual.

This distinction is equivalent to *model-based* and *model-free* in computational reinforcement learning.



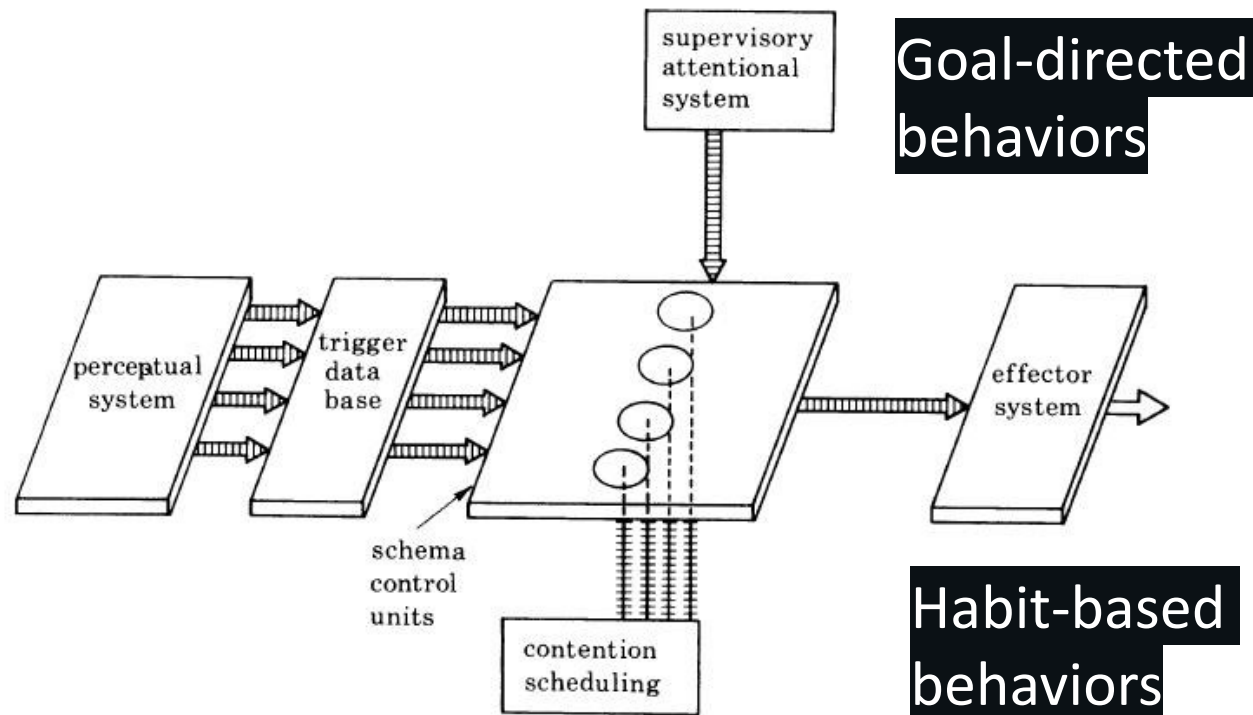


FIGURE 1. A simplified version of the Norman & Shallice (1980) model representing the flow of control information. The lines with arrows represent activating input, the crossed lines represent the primarily mutually inhibitory function of contention scheduling. The term 'effector system' refers to specific purpose-processing units involved in schema operation for both action and thought schemas. In the latter case schema operation involves placing information in short-term stores that can activate the trigger data base.

Norman, D.A., Shallice, T.: Attention to action: willed and automatic control of behavior. Human Information Processing Technical Report no. 99 (1980).

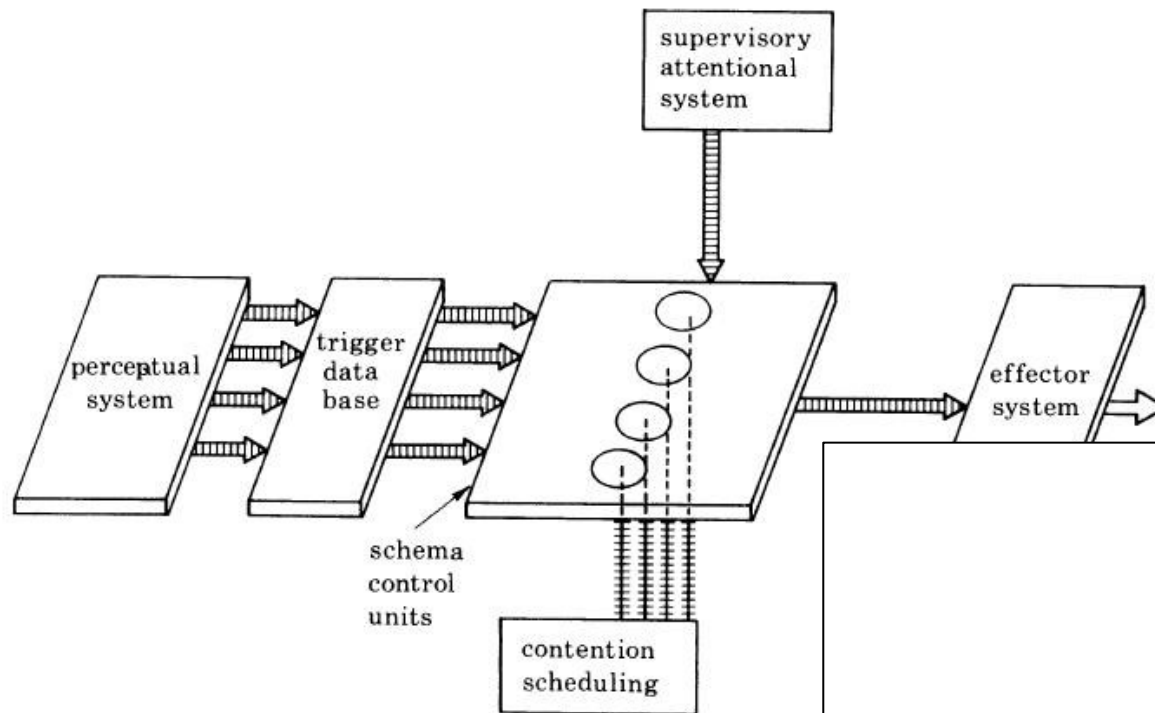
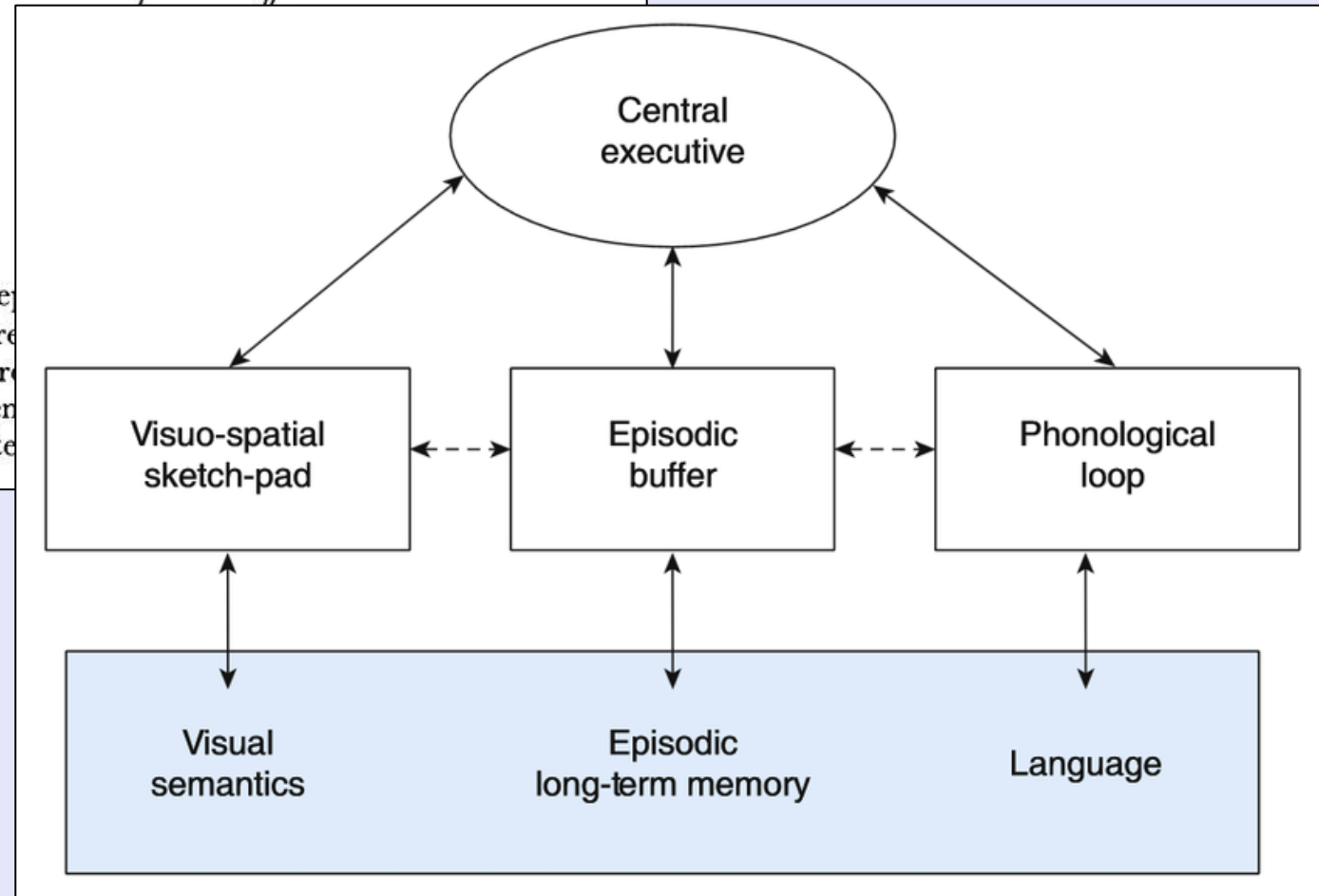


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 involves placing information in short-term stores that can activate

There is probably no single 'executive module'.

The executive component most likely fractionates into different parts.



DEFICITS IN STRATEGY APPLICATION FOLLOWING FRONTAL LOBE DAMAGE IN MAN

by TIM SHALLICE *and* PAUL W. BURGESS

(From the National Hospital, Queen Square, London and the MRC Applied Psychology Unit, Cambridge)

Shallice and Burgess gave three patients with dysexecutive syndrome the 'Multiple Errands Test'.

Sent to the Brunswick centre, London, with a list of tasks, such as:

- Buy a loaf of brown bread
- Be at a certain place 15 minutes after starting.
- Find the name of the shop likely to stock the most expensive item.

TABLE 5. ERRORS ON MULTIPLE ERRANDS

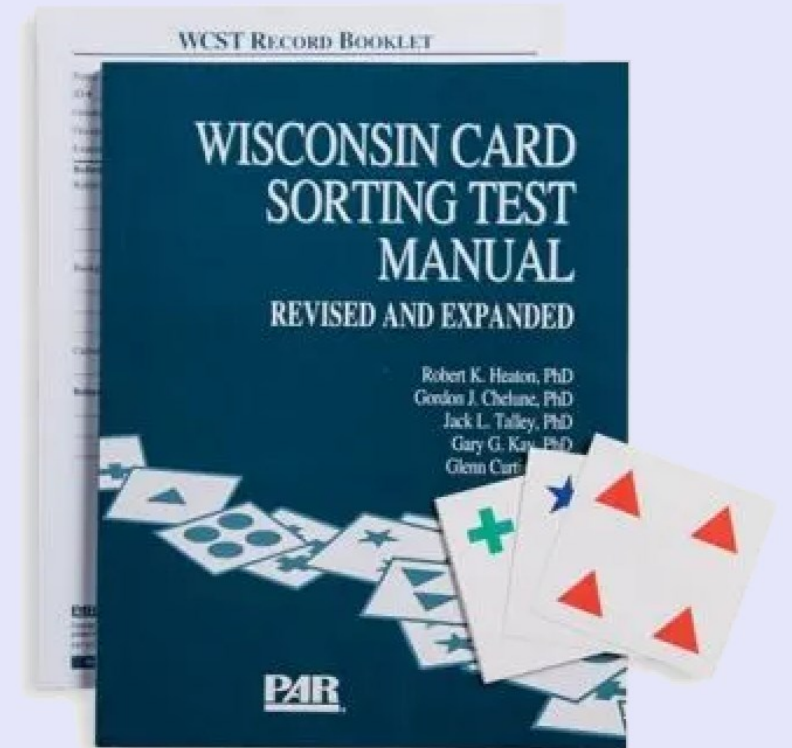
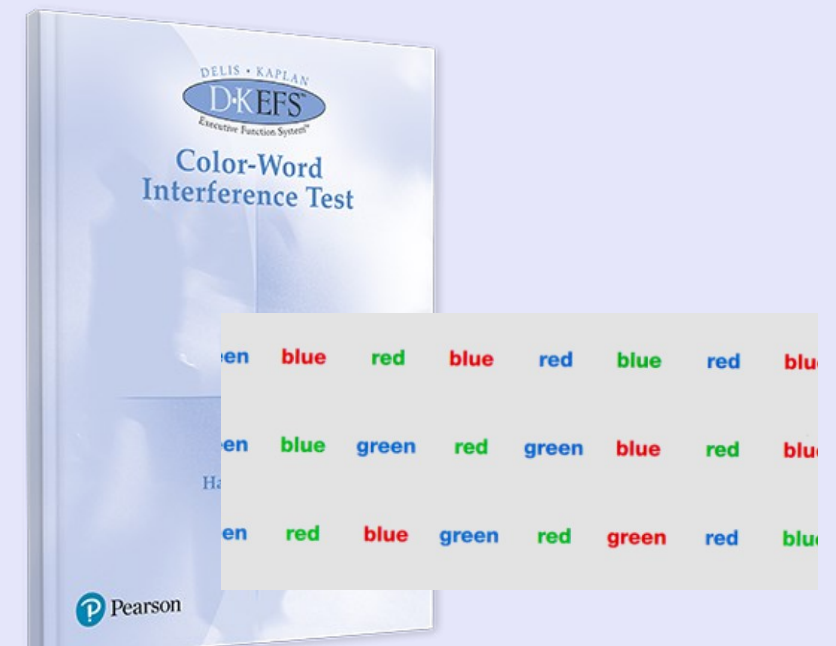
	<i>Cases</i>			<i>Control</i>
	<i>1</i>	<i>2</i>	<i>3</i>	
Inefficiencies	6*	9*	5*	1.4 (1.1)
Rule breaks	5*	8*	8*	1.6 (1.3)
Interpretation failures	1	1	1	0.4 (0.7)
Task failures	0	5*	4*	1.1 (1.4)
Total errors	12*	23*	17*	4.6 (2.1)

* More than 2 SD worse than the control subjects.

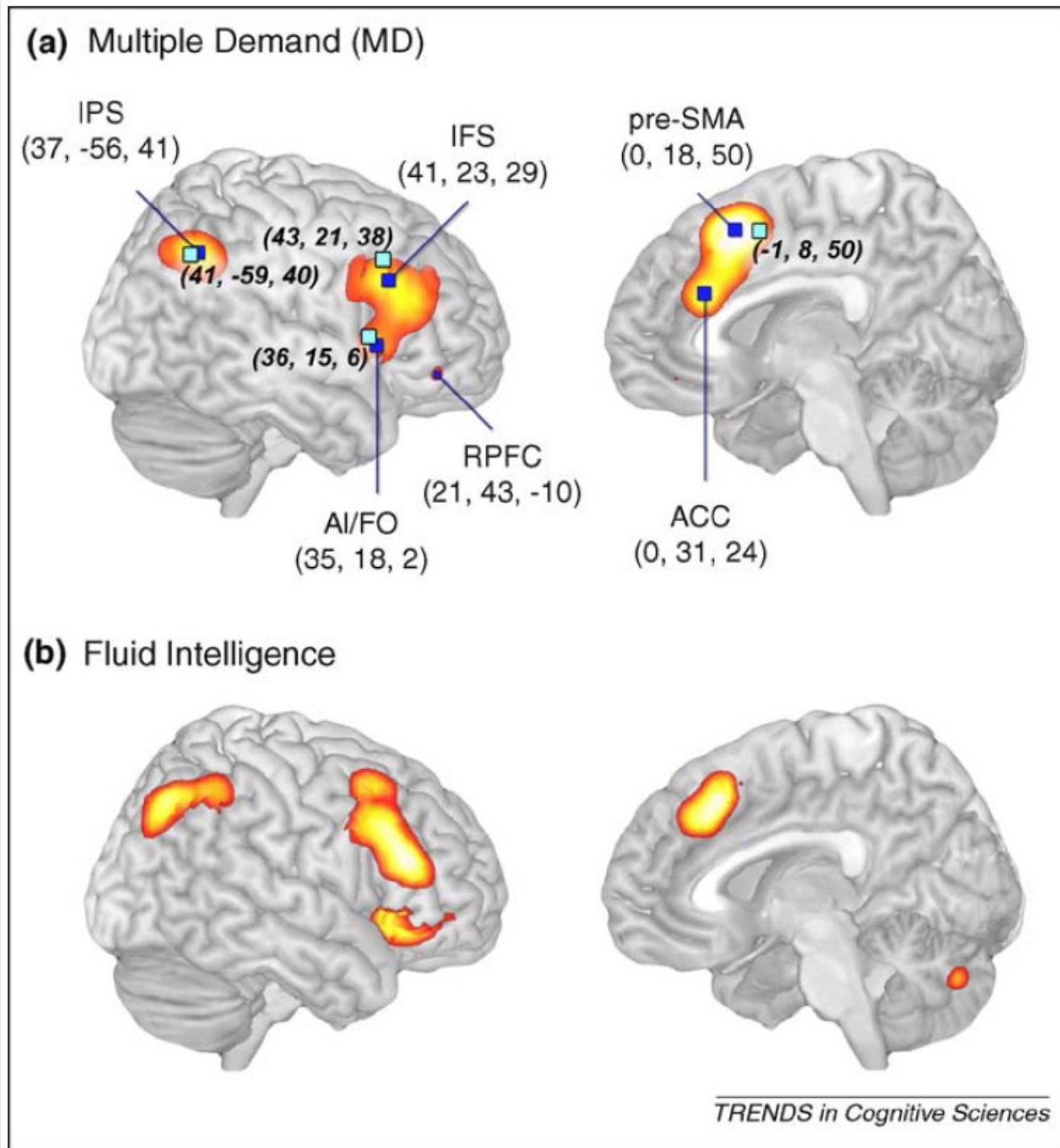


Multiple Errands Test

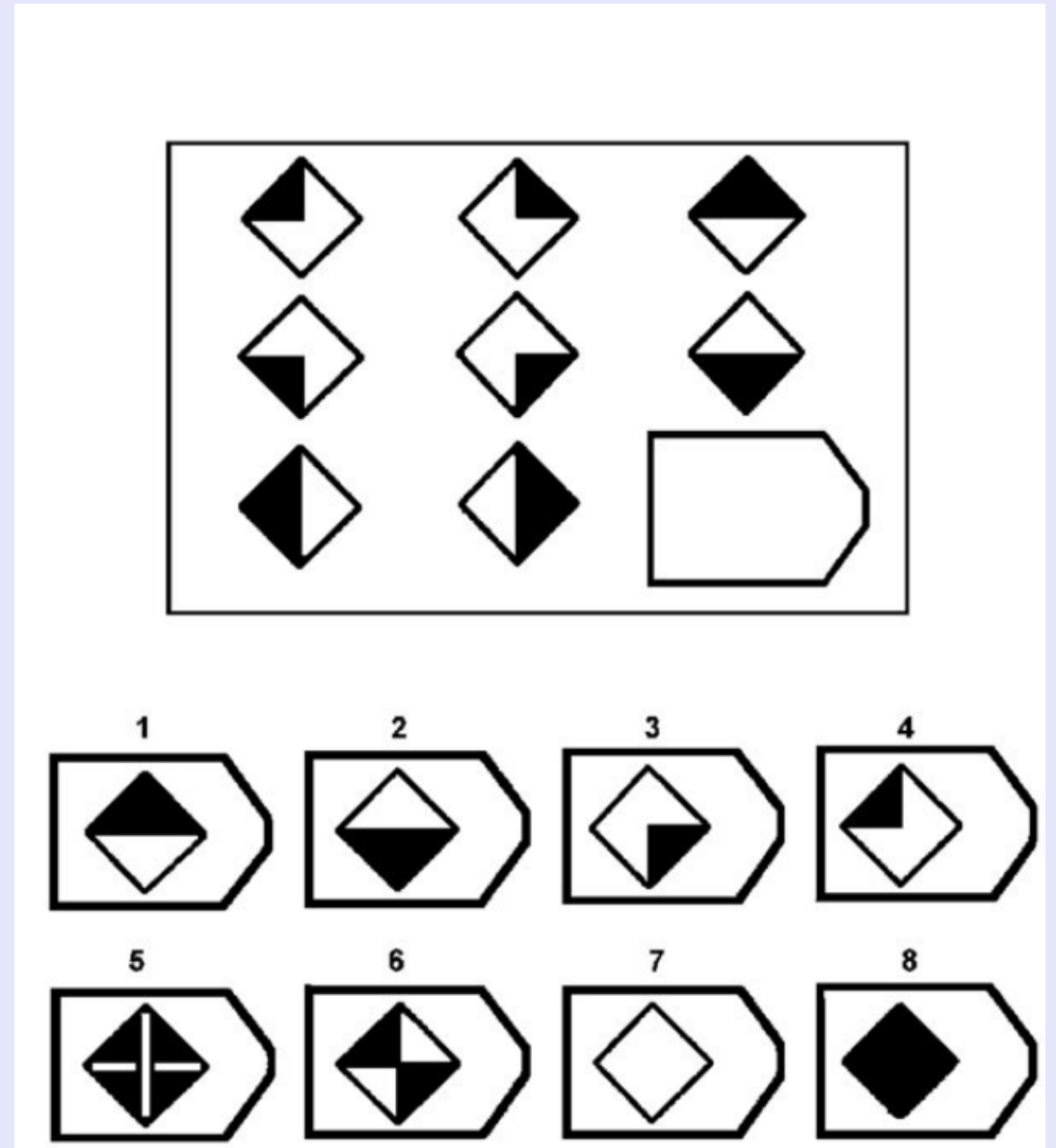
- Notably, all three patients had current IQ scores > 120 .
- Performed standard tests of executive function well, often better than control participants.



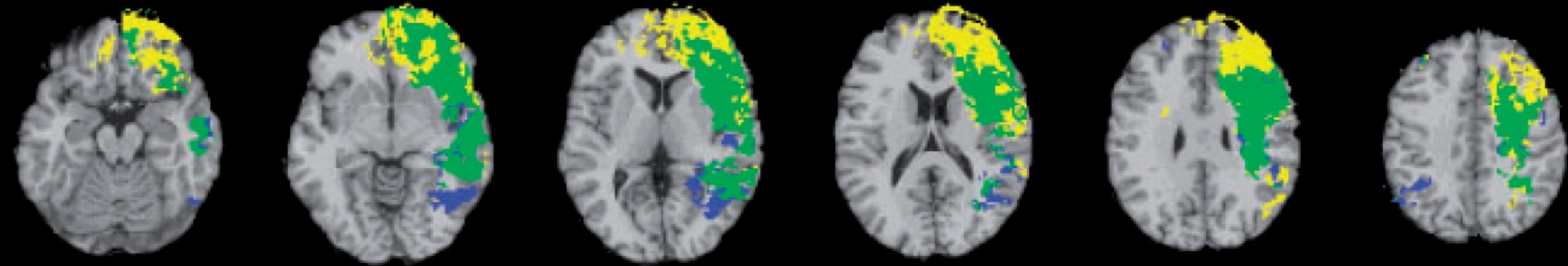
- The multiple demand system is active with any high task-load, independently of modality.
- It is also invoked by traditional fluid intelligence tests.
- This is proposed as the neurophysiological basis of both executive function and general intelligence.



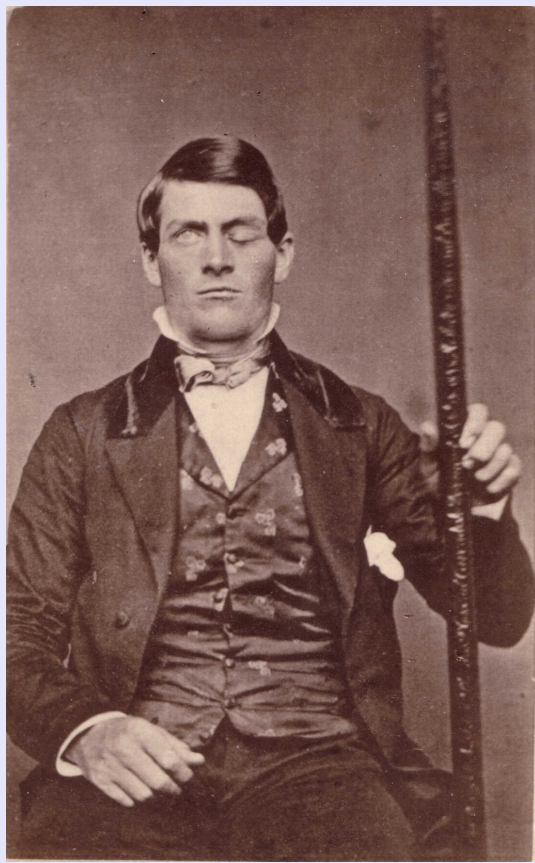
- General intelligence (g) influences performance on all cognitive tasks.
- A typical assessment of g is this, from the Raven's Progressive Matrices.
- g accounts for virtually all the variance in executive function ability.



Psychometric g and executive function



Areas of the brain, that when damaged, cause a drop in task performance. The **Green** shows overlap of areas associated with *both* drop in g and drop in executive function.



John M. Harlow M.D.
of Woburn

Recovery from the passage of an iron bar through the head

Read before the Massachusetts Medical Society
3 June 1868

Boston: David Clapp & Son
Medical and Surgical Office, 1869

The equilibrium or balance, so to speak, between his intellectual faculties and animal propensities, seems to have been destroyed. He is fitful, irreverent, indulging at times in the grossest profanity (which was not previously his custom), manifesting but little deference for his fellows, impatient of restraint or advice when it conflicts with his desires, at times pertinaciously obstinate, yet capricious and vacillating, devising many plans of future operation, which are no sooner arranged than they are abandoned in turn for others appearing more feasible.

Experience linked variation in Executive Functions

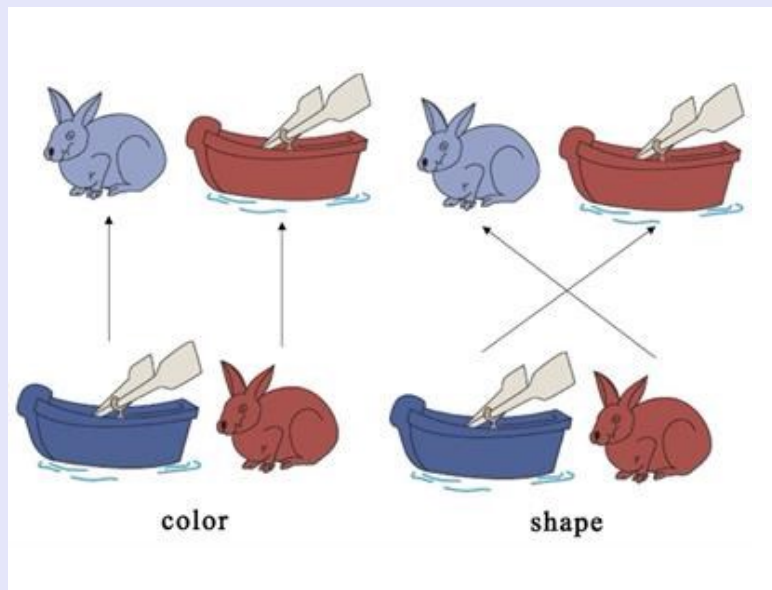
Homeless Bolivian children perform better than non-homeless children on this creativity test

Tell me alternative uses for this



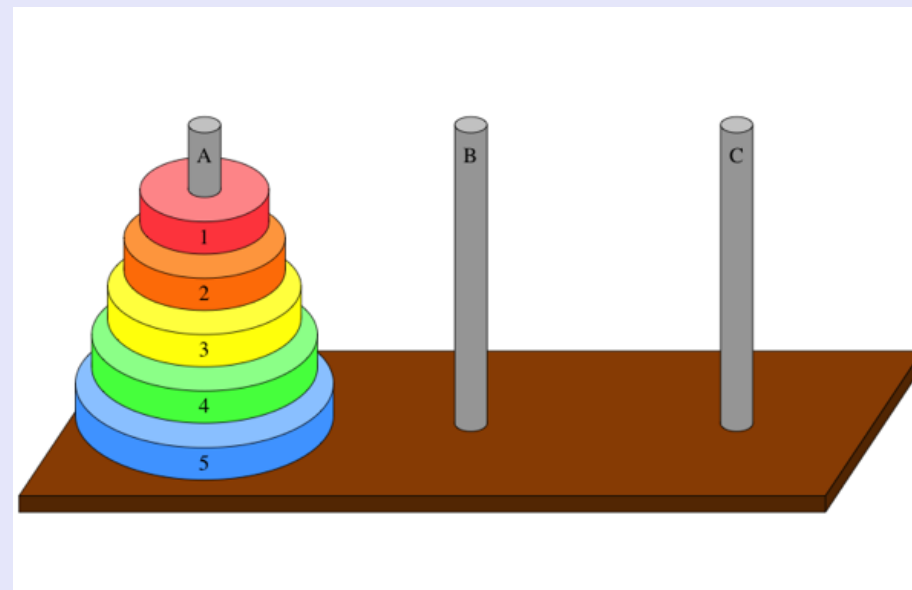
Dahlman, et al. (2013). Cognitive abilities of street children: Low-SES Bolivian boys with and without experience of living in the street. *Child Neuropsychology*, 19(5), 540-556.

Poor South African children perform better than middle-class Australian children on this switching test



Howard, et al. (2020). Challenging socioeconomic status: A cross-cultural comparison of early executive function. *Developmental Science*, 23(1), e12854.

Neglected children perform better than non-abused children on this planning test



Nolin, P., & Ethier, L. (2007). Using neuropsychological profiles to classify neglected children with or without physical abuse. *Child Abuse & Neglect*, 31(6), 631-643.

Children growing up in Asia, e.g., in Hong Kong, appear to develop executive control at earlier ages than children in Western countries, e.g., the UK (Ellefson, et al., 2017)



Ellefson, M. R., Ng, F. F. Y., Wang, Q., & Hughes, C. (2017). Efficiency of executive function: a two-generation cross-cultural comparison of samples from Hong Kong and the United Kingdom. *Psychological science*, 28(5), 555-566.



Adults raised in India (but living in the USA) show a different pattern of strengths and weaknesses in executive control compared to adults born and raised in the USA (Kelker et al., 2013).

Quito, Ecuador



Bangkok, Thailand



Chula
Chulalongkorn University



London, UK

Goldsmiths
UNIVERSITY OF LONDON





Questions:

1. Does executive function vary across the three different cultures?
2. If so, is it due to true executive control differences, or general intelligence differences?

PL = Planning

PR = Prioritization

ST = Selection

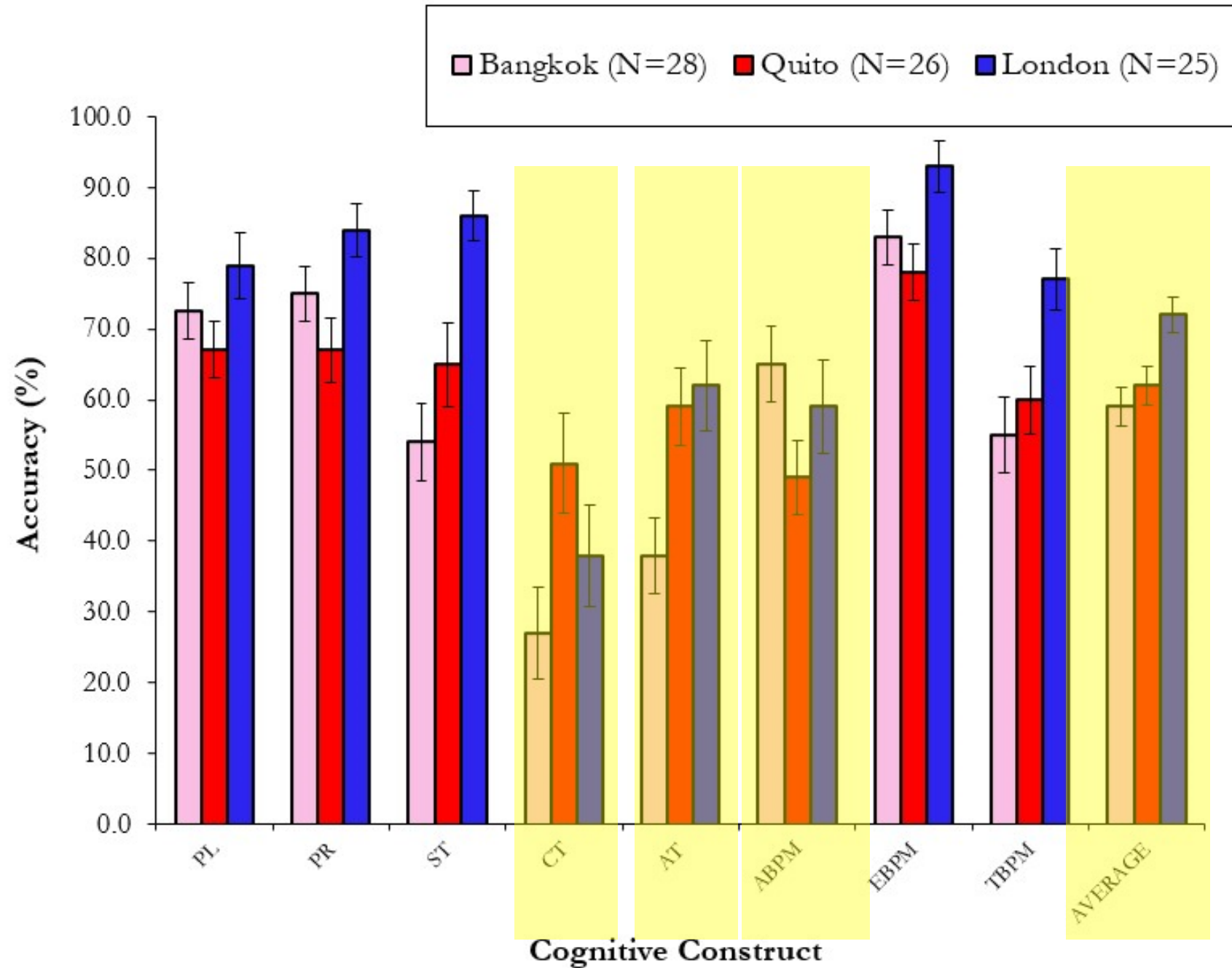
CT = Creative Thinking

AT = Adaptive Thinking

ABPM = Action-based
Prospective Memory

EBPM = Event-based
Prospective Memory

TBPM = Time-based
Prospective Memory



Is JEF performance linked to fluid intelligence?

Blue indicates JEF scores that showed large cross-cultural differences

PL = Planning

PR = Prioritization

ST = Selection

$r = .26$

CT = Creative Thinking

AT = Adaptive Thinking

ABPM = Action-based
Prospective Memory

$r = .31$

EBPM = Event-based
Prospective Memory

TBPM = Time-based
Prospective Memory

$r = .29$

Total score

$r = .19$

ANOVA of performance

Action-based Prospective Memory

Quito v Bangkok, $p = .03$

With fluid intelligence covaried, $p = .18$

Possibly that prospective memory difference is caused by general intelligence differences

Very preliminary interpretation

- There are some cross-cultural performance differences on JEF subscales
- In fact, they may “doubly dissociate”
- Some differences may be explainable by cross-cultural fluid intelligence differences.
- But some are likely not explainable in that way.





- Collect more data in Quito and Bangkok.
- Start data collection in London

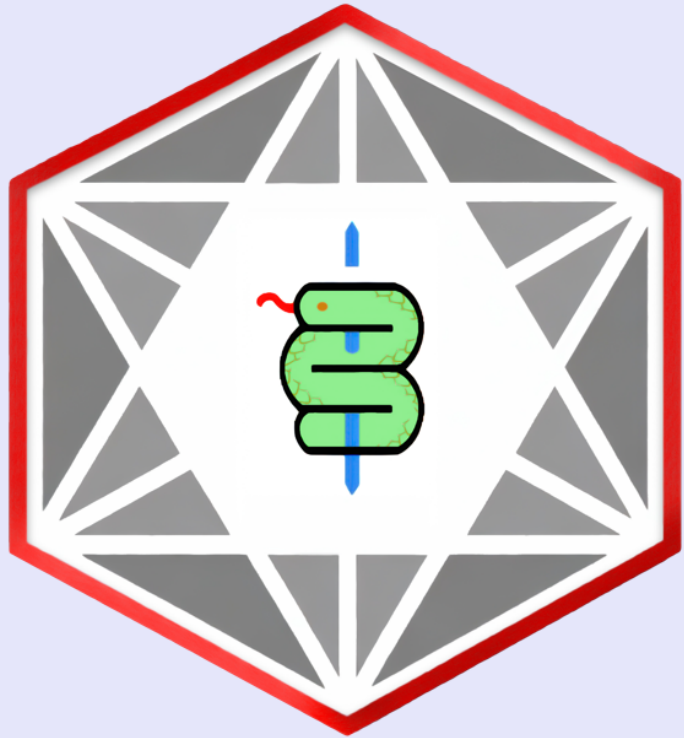


Ecuador team: Sol, Dani, & Nergiz

Thanks to:

**Thailand team: Phot, Jennifer,
Prang, Plearn, Ing Ing, & Non**





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