

Design of a Cognitive Control Mechanism for a Goal-based Executive Function of a Cognitive System

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Scope

- Background
- Representation of the Control Mechanism
- Illustrative Example
- Conclusions



Background

Executive functions and Cognitive Control

Executive function (EF)
resolving purposeful, goal-directed activities.

EF → Integrated supervisory or control system for information processing, formulating goals, planning, self-monitoring, and self-regulation.

EF → Cognitive processes used to develop a specific action.

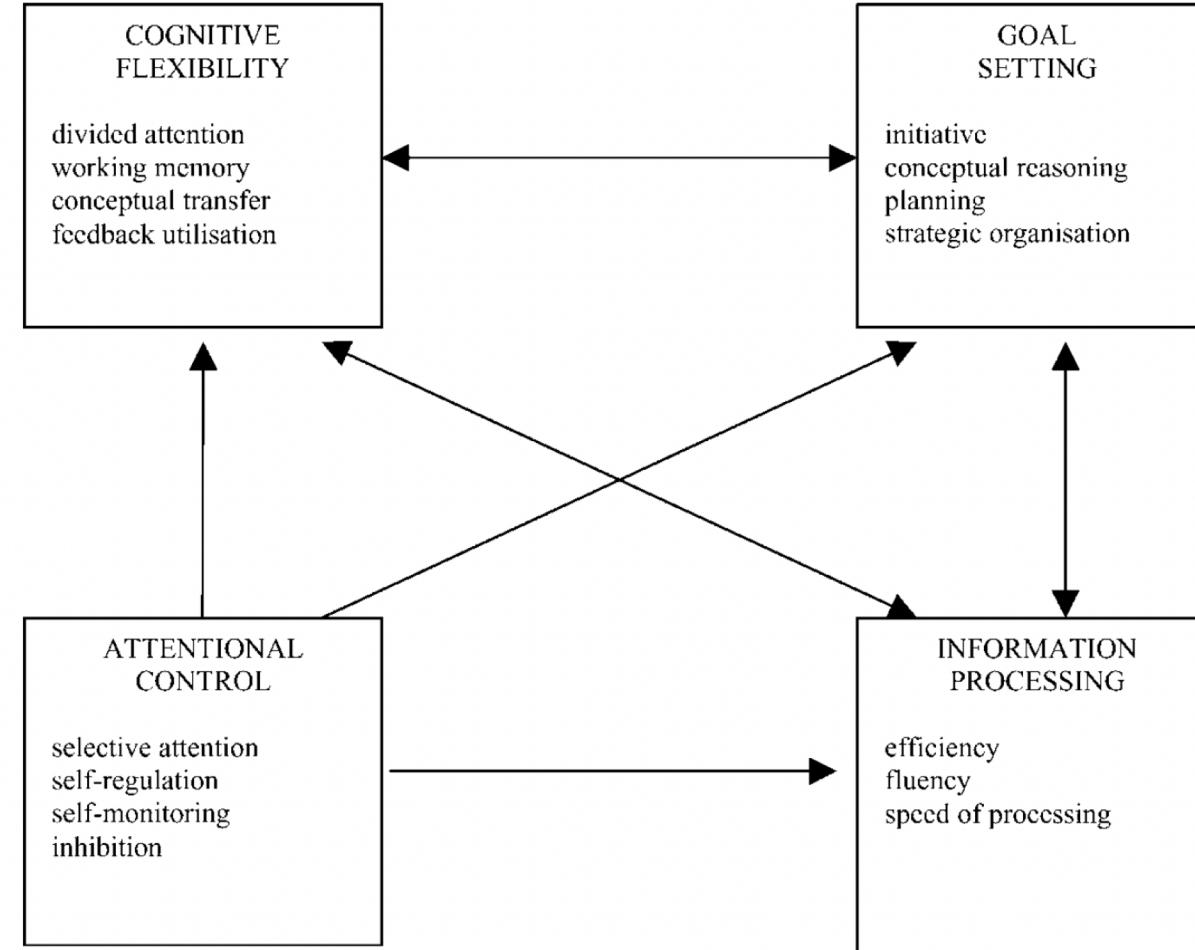
Functional element →
information processing to achieve the system's objectives
(Caro et al. 2014).

Theoretical model of cognitive control

- Information theory → $H(a) = -\log_2 p(a)$
- Processing of stimulus → mutual information $I(s, a)$ using → $I(s, a) = \log_2[p(s, a)/p(a)p(s)]$
- $Q(s) = H(a) - I(s, a) = -\log_2 p(s) \rightarrow Q(s) = \text{cognitive control}$

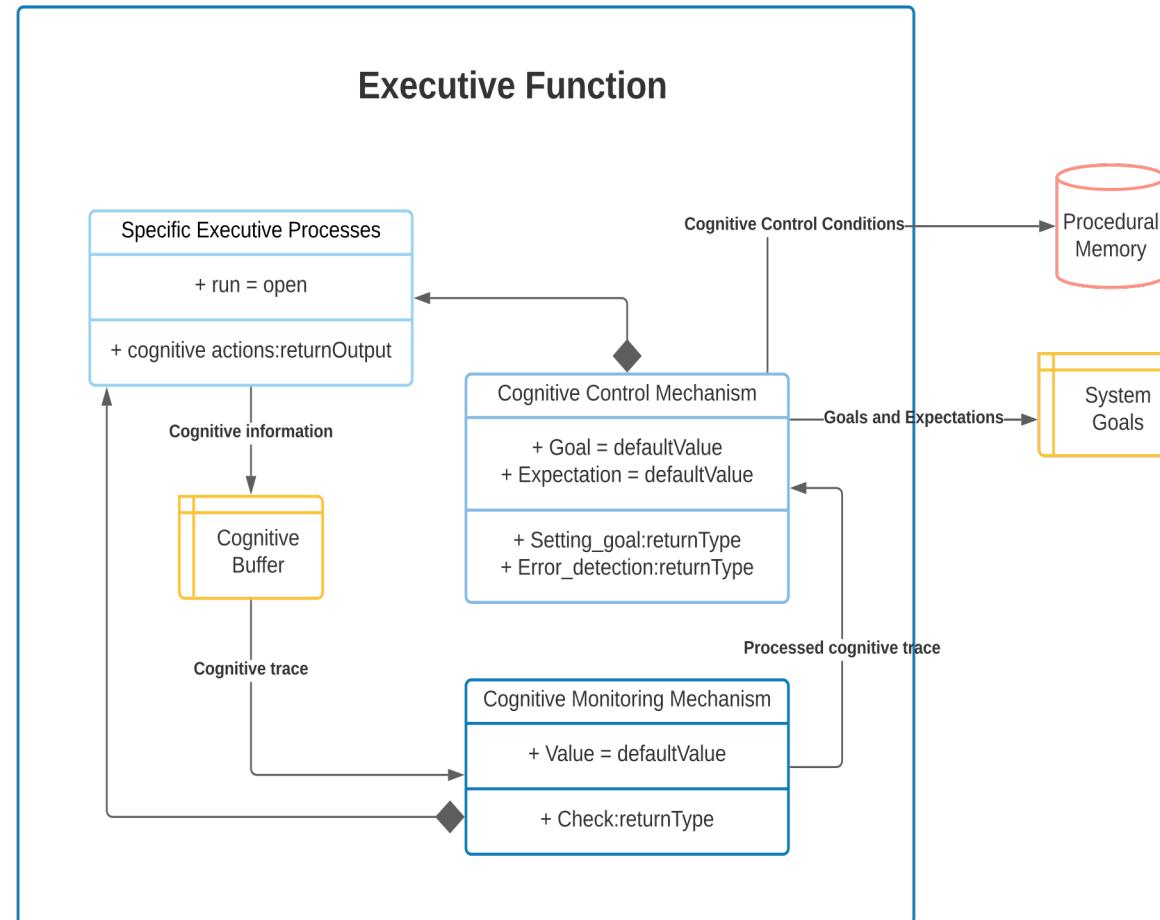
Koechlin, E., & Summerfield, C. (2007). An information theoretical approach to prefrontal executive function. *Trends in Cognitive Sciences*, 11(6), 229-235. <https://doi.org/10.1016/j.tics.2007.04.005>

Theoretical model of executive function



Representation of the Cognitive Control Mechanism

$$\varepsilon^c = \langle s, o, c, G, \chi \rangle$$



Illustrative Example

Functional structure of a goal-based executive function



Inicio Acerca de Área de Aprendizaje Perfil ▾

Protocolos de atención > Sífilis un problema de Salud Pública > Lección 4 > Definición

Unidad 4. Tratamiento de la sífilis gestacional y prevención de la sífilis congénita

Rendimiento del estudiante 25 %

77.6 % Historial de interacción 12 inicios de sesión 3 intentos Lección 4

Introducción

Definición

Contenido

Explicación

Ejemplo

Actividad

Evaluación



¿Como calificarías este recurso? 

La sífilis gestacional y congénita representa un gran desafío para la salud pública de todas las regiones del mundo; especialmente en la región de las Américas, no solo por las implicaciones asociadas a los costos de la atención en salud, sino también por las implicaciones que se derivan del proceso de rehabilitación de las secuelas que presenta esta infección en la población materna e infantil (1). A pesar de los esfuerzos gubernamentales, para tratar de controlar esta condición, siguen persistiendo un conjunto de elementos problemáticos que afectan de manera directa e indirecta el control y eliminación de la sífilis gestacional y congénita en contexto colombiano.

System's output after executing an executive function that selects an educational resource for a specific lesson of the system

The system considered the student's performance, interaction history, and score as cognitive control conditions for selecting the resource.



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Semestre: V

Perfil de Aprendizaje | Ajustes | Calificaciones

Lección	Intento	Recursos	Rendimiento	Dedición
1	4	Mapa conceptual Video Texto Video interactivo	100%	2hrs 36 min
2	2	Presentaciones Graficos Video interactivo Mapa mental	100%	2hrs 27 min
3	2	Fotografía Video interactivo Videoclase Línea de tiempo	100%	1hrs 50 min
4	3	Mapa conceptual Texto Video Video interactivo	25%	0hrs 37 min

Aceptar

- ✓ To control the cognitive actions for selecting resources.
- ✓ Four resources in that two attempts.
- ✓ Photo ("Fotografía" in Spanish), changed by an interactive video ("video interactivo", in Spanish) considering the control conditions.
- ✓ video of a class ("Video clase") replaced by a timeline ("linea de tiempo").
- ✓ the student obtained 100% in a time considerably less than the previous times.
- ✓ This situation could happen thanks to the changes done by the system considering the cognitive control cognitive stored in its procedural memory.

Conclusions

A First attempt of implementation of an approach for the use of cognitive control mechanisms based on biological-inspired theoretical assumptions. Mechanisms use a goal system and a procedural memory for developing the setting goal process.

An illustrative example is described presenting the output data of the system. However, it is necessary to continue developing cognitive systems that use multiple instances of cognitive functions in one or many reasoning cycles to solve real world problems.

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Thank you!