Executive Function

Computational Cognitive Neuroscience
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Who is in Charge of your Brain??
Prefrontal Cortex?
Integrates:
- Cognitive Control
- Planning
- Motivation
- Reward processing
- Decision making

Key Idea: Top-Down Biasing

- PFC active maintenance provides top-down biasing of posterior-cortical processing

The Homunculus Problem

It Takes a Network..

Sensory Input
Motor Output

Posterior Cortex: I/O Mapping
PFC: Context, Goals, etc
PVLV: DA (Critic)
BG: Gating (Actor)

PFC Does Active Maintenance
Active Maintenance Can Do it All

- Cognitive Control
  - Maintained activity drives top-down biasing
- Planning
  - Think about things that are not there (future)
- Motivation
  - Maintain goals
- Reward processing
  - Maintain possible outcomes
- Decision making
  - Maintain alternatives

The Need for Robust Maintenance

- “Every sound has to be an earthquake or tidal wave that topples governments and changes national boundaries and mutates whole species so they suddenly drift off the planet, across galaxies, only to return, years later, when nobody wants to know them cause their credit rating's bad or because they can't do the Mashed Potatoes.” - MFU by HC, 1998
- Subjective experience of PFC lesion: dreaming!

Stroop Task: Top Down Biasing

RED

GREEN

Stroop Task: Top Down Biasing

RED

GREEN
Asymmetric Conflict

In Stroop model, we just clamp PFC units on..

What makes them “clamped” in the real brain?

BG!

Motor Gating => Cognitive Gating

Toggles PFC bistable states

Resembles transistor logic gate!

PBWM System

Sensory Input

Motor Output

Posterior Cortex: I/O Mapping

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Robust Active Maintenance

In Stroop model, we just clamp PFC units on..

What makes them “clamped” in the real brain?

BG!

Dynamic, Adaptive Gating (BG)

Getting Loopy / Higher..
Biological Basis of PBWM

Executive Function

WHIP Model