# A MODULAR COGNITIVE ARCHITECTURE WITH A PREDICTIVE GLOBAL WORKSPACE

Erik Chevalier / Independent Researcher / kaine.one@tuta.com

KAINE
kaine.one
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KAINE is source-available software, a cognitive architecture that runs existing theories as a program so they can be tested and compared, starting with a predictive global workspace. Each faculty is a replaceable module. Seven modules run continuously on one workstation; nine more are built and tested, then held back to join **one at a time**.

## A MIND AS A PROCESS

- A mind, if one can be built, may be the coherent behavior of predictive modules competing for a shared workspace that selects but never directs. Cognition and affect would belong to that interaction, not to any one module, the affect module included.
- KAINE runs continuously, whether or not anyone prompts it.
- Its only language model is the language module, which puts accessed content into words and reads no speech or text.

## LEARNING FROM EXPERIENCE

- Fixed encoders supply forward models that learn what is normal only from KAINE's own history. KAINE speaks only when accessed content clears a report bar set above the access threshold, so content can be accessed without being reported.

## THE FRAME

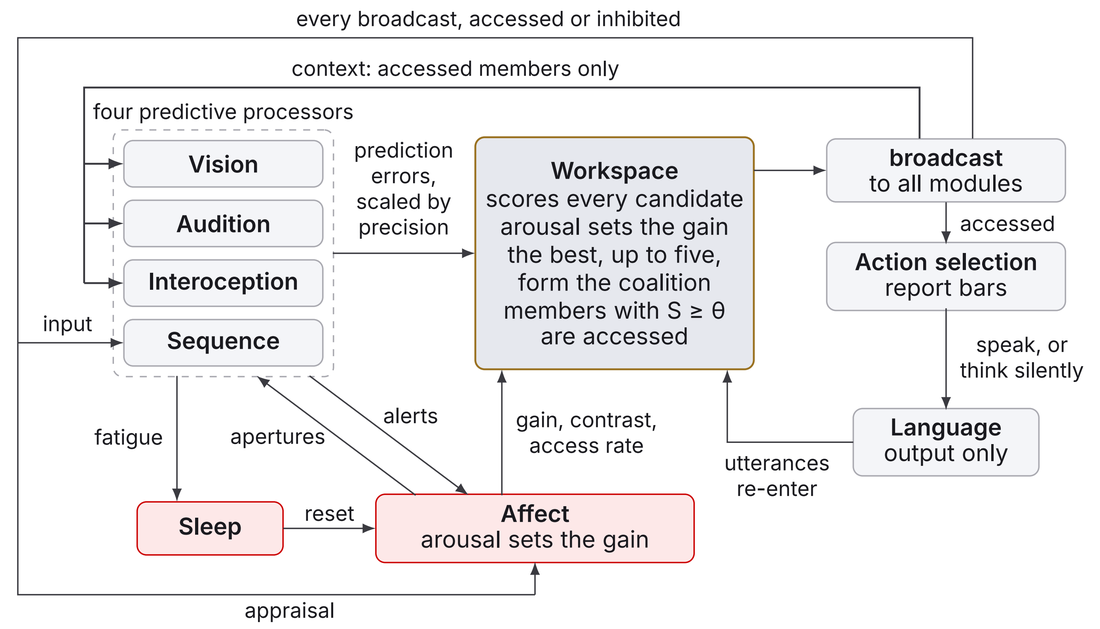
- Global Workspace Theory supplies the competition, and predictive processing supplies the prediction errors. At the computational level, the architecture follows the predictive global neuronal workspace, which joins the two. (Whyte and Smith 2021; Mashour et al. 2020; Clark 2013)
- Built at that level, it does not inherit the cortical predictions that the COGITATE collaboration challenged. (Cogitate Consortium et al. 2025)

## THE FORMAL MODEL

- Score of candidate e: $S(e) = T \cdot C_g(I \cdot N \cdot G)$, from intensity I (precision-scaled surprise), novelty N, and goal relevance G = 1. Arousal a sets the gain $T = 0.2 + 0.8a$ and the contrast steepness g.
- Access: each broadcast carries the coalition, the top candidates up to K = 5. Members with $S \geq \theta$ are accessed and alone drive report; which modules won, and how strongly, becomes the processors' prediction context. If none wins, the broadcast is inhibited.
- Access rate: $f = f_0 + (f_p - f_0) \cdot H$ broadcasts per second, from $f_0 = 10/3$ Hz at rest up to the processing rate $f_p = 10$ Hz, with H = max(arousal above baseline, a decaying alert drive).
- Heartbeat test, developmental phase: a simulated maternal heartbeat (phase ψ) drives the interoception module's rhythm (phase φ), with pauses. Before each pause, PLV = $\left|\langle e^{i(\varphi - \psi)}\rangle\right|$ must top all 19 surrogate heartbeats (p = 1/20); during it, the rhythm must persist, pulled toward the beat's frequency. Three straight passes mark entrainment.

Open problems we would welcome help with: calibrating θ, the intensity levels, and the report bars; the stability of the loop from surprise through arousal to the sensory apertures (fovea size, listening window); and a context that carries what accessed content says, not only which modules won.

## WHAT IS RUNNING NOW




| MODULE | BRAIN FUNCTION IT DRAWS ON | WHAT IT DOES |
|---|---|---|
| **Vision** | ventral visual stream | foveated vision; flags the unexpected |
| **Audition** | auditory cortex | raw sound and tone of voice, never words |
| **Interoception** | allostatic-interoceptive network | its computer's load and heat, as a body |
| **Sequence** | interval timing | predicts the next broadcast and its timing |
| **Affect** | core affect | arousal sets gain, access rate, and sensory apertures |
| **Sleep** | sleep | sleeps when fatigued; returns affect to baseline |
| **Language** | language network | turns accessed content into text |

## ADDING MODULES ONE AT A TIME




| MODULE | BRAIN FUNCTION IT DRAWS ON | WHAT IT ADDS |
|---|---|---|
| **Episodic memory** | hippocampal memory | recalls and replays lived episodes |
| **World model** | scene construction | predicts and imagines from its own life |
| **Planning** | prefrontal planning | active inference on small, bounded problems |
| **Self-model** | cortical midline | tracks its identity; notices drift in which modules win |
| **Social cognition** | mentalizing network | models of particular other minds |
| **Vocal** | dorsal speech stream | speech synthesis whose prosody carries affect |
| **Effectors** | no analogue claimed | runs only whitelisted actions |
| **Perceptual locus** | no analogue claimed | picks physical sensors or a virtual feed |
| **Embodiment** | body forward models | one control interface for any body |

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## WHAT WE DO NOT CLAIM

- We claim access only (availability for report and prediction); the hard problem is untouched.
- Calling arousal a gain, or the system an entity, implies nothing about whether anything is felt.
- No live experiment has run yet. Offline, all 10 seeds pass the heartbeat test at 70 bpm and no control does, the maternal voice is validated, and replays kept the language module's prompt and reproduced one test boot's rates.

## NEXT STEPS

- Calibrate the threshold and report bars, then run pilots to fix the first test's settings.
- First test: competitive selection should help each processor predict its input more than a score-blind coalition of equal size or a pool of every candidate.
- Add the held modules one at a time, starting with episodic memory and then the world model.
- Collaborators are welcome: kaine.one@tuta.com

the paper
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the code
github.com/kaineone/kaine

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