

Track A – Intrinsic Transition Measures (v8.1): Threshold-Free Characterization of Coexistence Dynamics in the Two-Mode Jaynes–Cummings Model

Miguel Angel Percudani*

September 2026 – Zenodo 10.5281/zenodo.22904994 – v8.1 update

Abstract

This note presents v8.1 of Track A. Formal content: a two-mode Jaynes–Cummings model with Lindblad dissipation solved with BDF, and threshold-free measures of the coexistence product $P(t) = R(t) \cdot I(t)$. Informative content: illustrative numerical choices $N_0 = 15$, $t_{\max} = 50$, $n_{\text{steps}} = 3000$, $\omega_0 = 6$ Hz, $\omega_1 = 40$ Hz, and four parameter points labeled Vigilance, Flow, Endogenous, Sleep for reproducibility. Speculative interpretation: labeling R as Reason and I as Instinct and mapping the four points to consciousness states is a heuristic ontology, not an empirical neuroscience claim. With $t_{\max} = 50$, all peaks are reached, fixing the v8 artifact where Vigilance $P_{\text{bio}}(t)$ was still rising at $t_{\max} = 11$. Results: Vigilance is slow access ($t_{\text{peak,bio}} = 22.9$), not no access; Flow and Endogenous are distinguishable by tail width ($W_{1/2,\text{bio}} = 14.92$ vs 9.15) despite similar peak; A_{coex} and τ_{eff} optima do not coincide in the (g, γ_ϕ) plane. This update contains only v8.1 files plus this note; v7, v7.1 and v7.3 are intentionally omitted to avoid reader confusion.

Contents

1	Scope and honesty statement	1
2	Model (formal)	2
3	Intrinsic measures (formal)	2
4	Results v8.1 (formal numbers, speculative labels)	2
4.1	2D scan (formal)	4
5	Discussion (honest)	4
6	Conclusion	4

1 Scope and honesty statement

This update includes **only** v8.1 outputs plus this technical note. Files v7, v7.1, v7.3 from earlier development are intentionally omitted from this Zenodo update.

We distinguish:

*Corresponding: miguel.percudani@yahoo.com.ar – ORCID 0009-0007-1748-3212 – Independent Research Collaboration

- **Formal / verifiable:** Hilbert space $\mathcal{H} = \mathcal{H}_0 \otimes \mathcal{H}_1$, operators, Hamiltonian $H(t) = H_0 + H_{\text{int}}(t)$, Lindblad dissipator $\mathcal{L}_{\text{dec}}$, master equation, BDF integration, definitions of $A_{\text{coex}}, P_{\text{max}}, t_{\text{peak}}, W_{1/2}, \tau_{\text{eff}}, \eta$, peak-reached flag. These are mathematical and reproducible.
- **Informative / instructive:** Numerical choices $\omega_0 = 6$ Hz, $\omega_1 = 40$ Hz, $\delta = 34$ Hz, $\gamma_a = 0.1$ Hz, $n_{\text{th}} = 0.05$, $N_0 = 15$ for 4 cases / 12 for 2D scan, $t_{\text{max}} = 50$, $n_{\text{steps}} = 3000$ (4 cases) / 1500 (scan), g and γ_ϕ values in Table 1. They are default values for reproducibility, not fitted to EEG/fMRI. Changing them changes numbers but not the method.
- **Speculative / heuristic:** Interpretation of $R_{\text{math}} = |r|$ as “Reason”, $I_{\text{math}} = I(0:1)$ as “Instinct”, $R_{\text{bio}} = P_\gamma$ and $I_{\text{bio}} = \langle n_0 \rangle / N_0$ as biological proxies, and labeling the four points as Vigilance, Flow, Endogenous, Sleep. This ontology is presented as a thinking tool, not as a validated neuroscience result. No claim is made about the Agustina Picatto dataset (pending DOI) in this note.

2 Model (formal)

Hilbert space $\mathcal{H} = \mathcal{H}_0 \otimes \mathcal{H}_1$, $\dim = 2N_0$, truncated oscillator N_0 levels. Free Hamiltonian $H_0 = \omega_0 a^\dagger a + \omega_1 \sigma_+ \sigma_-$ (informative values $\omega_0 = 6$ Hz, $\omega_1 = 40$ Hz). Interaction $H_{\text{int}} = g(a^\dagger \sigma_- + a \sigma_+)$, conserves $\mathcal{N} = a^\dagger a + \sigma_+ \sigma_-$. Lindblad $\mathcal{L}_{\text{dec}}[\rho] = \gamma_\phi(\sigma_z \rho \sigma_z - \rho) + \gamma_a(n_{\text{th}} + 1)\mathcal{D}[a] + \gamma_a n_{\text{th}}\mathcal{D}[a^\dagger]$. Initial state $|0\rangle_0 \otimes |1\rangle_1$. BDF solver `solve_ivp rtol=1e-7, atol=1e-9` (formal).

Per step (formal):

$$R_{\text{math}} = |r|, \quad r_i = \text{Tr}(\rho_1 \sigma_i) \quad (1)$$

$$I_{\text{math}} = I(0:1) = S_0 + S_1 - S_{\text{joint}} \quad (2)$$

$$R_{\text{bio}} = \text{Tr}(\rho |1\rangle\langle 1|) \quad (3)$$

$$I_{\text{bio}} = \langle n_0 \rangle / N_0 \quad (4)$$

3 Intrinsic measures (formal)

Definition 1 (Coexistence product). $P(t) = R(t)I(t)$. No thresholds.

$$A_{\text{coex}} = \int_{t_0}^{t_{\text{end}}} P(t) dt \quad (\text{Simpson}) \quad (5)$$

$$P_{\text{max}} = \max_t P(t) \quad (6)$$

$$t_{\text{peak}} = \text{argmax}_t P(t) \quad (7)$$

$$W_{1/2} = |\{t : P(t) > P_{\text{max}}/2\}| \quad (8)$$

$$\tau_{\text{eff}} = A_{\text{coex}} / P_{\text{max}} \quad (9)$$

$$\eta = A_{\text{coex}} / (t_{\text{span}} \cdot P_{\text{max}}) \quad (10)$$

$$\text{peak_reached} = t_{\text{peak}} < 0.95 t_{\text{end}} \quad (11)$$

First 2% discarded as initial transient (informative choice).

4 Results v8.1 (formal numbers, speculative labels)

Informative parameter points (for reproducibility only): $g \in \{2, 10, 17, 25\}$ Hz, $\gamma_\phi \in \{0.5, 0.4, 0.4, 0.5\}$ Hz labeled Vigilance, Flow, Endogenous, Sleep. $t_{\text{max}} = 50$, $n_{\text{steps}} = 3000$, $N_0 = 15$.

Table 1: v8.1 intrinsic measures, $t_{\max} = 50$, $N_0 = 15$, all peaks reached. Formal numbers; regime names are speculative labels.

Regime (speculative label)	A_{math}	$P_{\text{max,math}}$	$W_{1/2,\text{math}}$	τ_{math}	η_{math}	A_{bio}	$P_{\text{max,bio}}$	$W_{1/2,\text{bio}}$	τ_{bio}
Vigilance	2.404	0.0879	25.15	27.36	0.558	0.2439	0.00573	45.91	42.7
Flow	1.178	0.3182	1.75	3.70	0.0755	0.2336	0.01268	14.92	18.8
Endogenous	0.763	0.2253	1.08	3.38	0.0691	0.1993	0.01564	9.15	12.7
Sleep	0.742	0.1840	0.65	4.03	0.0823	0.1838	0.01547	8.18	11.8

- **Formal fix:** In v8 $t_{\max} = 11$, Vigilance bio had $t_{\text{peak}} = 11.01 = t_{\max}$, $A_{\text{bio}} = 0.035$, $W_{1/2} = 7.8$ (artifact, peak not reached). In v8.1 $t_{\max} = 50$, $t_{\text{peak,bio}} = 22.92$, $A_{\text{bio}} = 0.243$, $W_{1/2} = 45.91$, peak_reached=True. Artifact removed.
- **Formal numbers:** All peak_reached=True in v8.1. Detailed $t_{\text{peak,math}} \approx 1.0 - 1.06$, $t_{\text{peak,bio}}$: Vigilance 22.92, Flow 2.95, Endogenous 1.11, Sleep 1.00.
- **Informative ranking:** By A_{bio} : Vigilance (0.243) $\succ$ Flow (0.233) $\succ$ Endogenous (0.199) $\succ$ Sleep (0.183). By η_{bio} : Vigilance 0.868 $\succ$ Flow 0.375 $\succ$ Endogenous 0.260 $\succ$ Sleep 0.242.
- **Speculative interpretation:** If we heuristically call R Reason and I Instinct, then Vigilance is not “no access” but slow access (low P_{max} but largest $W_{1/2}$ and τ). Flow shows highest $P_{\text{max,math}} = 0.318$. Endogenous vs Sleep share $P_{\text{max,bio}} \approx 0.0155$ but differ in tail: $W_{1/2,\text{bio}} = 9.15$ vs 8.18 , $\tau_{\text{bio}} = 12.74$ vs 11.88 , consistent with smaller γ_{ϕ} preserving coupling longer. This interpretation is heuristic.

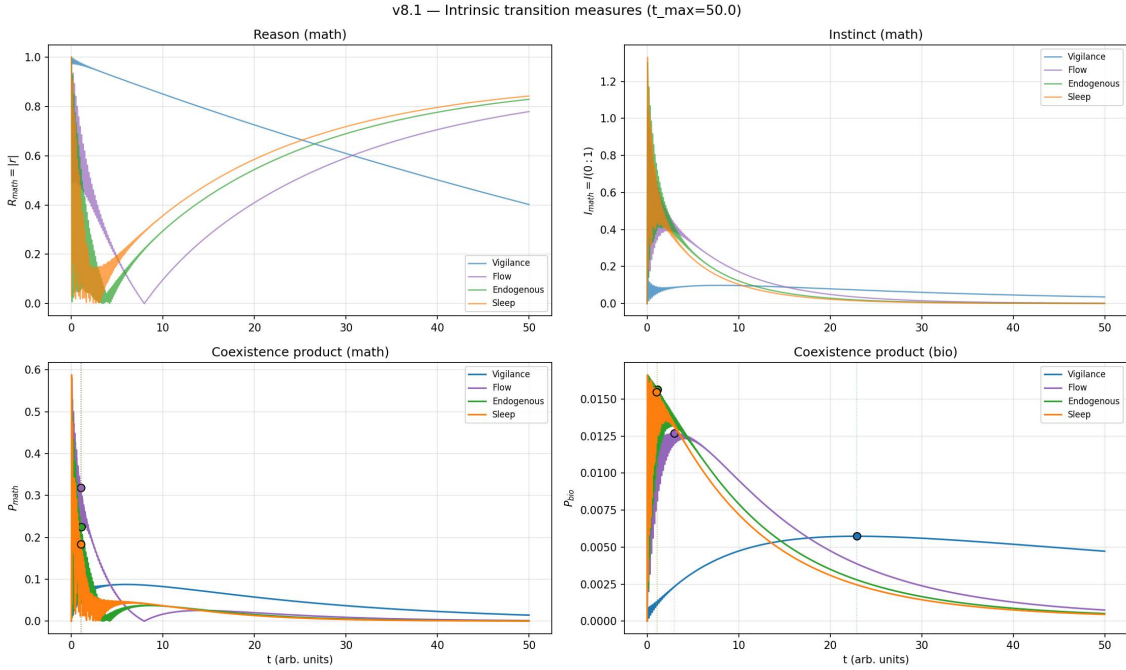


Figure 1: Formal: $R(t), I(t), P(t) = R \cdot I$ for math and bio. Dots P_{max} , dotted t_{peak} . Vigilance bio peaks late ~ 22.9 , others $\sim 1 - 3$. Speculative labels in legend are heuristic.

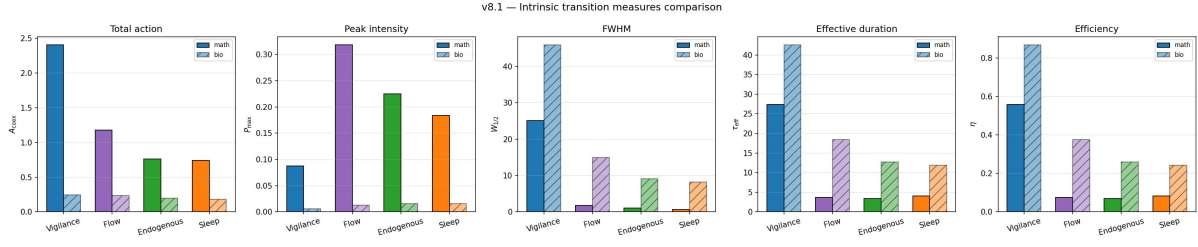


Figure 2: Formal numbers: A_{coex} , P_{max} , $W_{1/2}$, τ_{eff} , η for math (solid) and bio (hatched). Regime names are speculative labels.

4.1 2D scan (formal)

Informative grid $g \in [1, 30]$ (10 log), $\gamma_\phi \in [0.05, 5]$ (10 log), $N_0 = 12$, $t_{\text{max}} = 50$, $n_{\text{steps}} = 1500$, 100 cells. Formal result: in v8 only 8/10 bio peaks reached at $\gamma_\phi = 0.05$; in v8.1 10/10 math reached everywhere, bio 8/10 $\rightarrow$ 10/10 with increasing γ_ϕ . Max $A_{\text{math}} \approx 2.11$ at $g \approx 9.6$, $\gamma_\phi = 0.05$; max $A_{\text{bio}} \approx 0.148$ at $\gamma_\phi \approx 5$, $g \approx 4.5$. Optima of A_{coex} and τ_{eff} do not coincide: trade-off between integrated action and duration (formal mathematical result, not neuroscience claim).

5 Discussion (honest)

What is artifact vs real (formal): Artifact fixed: Vigilance $W_{1/2, \text{bio}}$ and τ_{bio} in v8 were false because P_{bio} still rising.

What is real and formal: $P(t)$ shape, A_{coex} , P_{max} , $W_{1/2}$, τ_{eff} , η , peak-reached flag, trade-off A_{coex} vs τ_{eff} in (g, γ_ϕ) plane.

What is informative: Parameter values, $t_{\text{max}} = 50$, $n_{\text{steps}} = 3000$, choice of 4 points. These are defaults for reproducibility, not fitted.

6 Conclusion

v8.1 provides threshold-free, falsifiable mathematical characterization. Four parameter points show distinct temporal signatures. This update contains only v8.1 files: `v8.1_summary.csv`, `v8.1_traj_*.csv` (4 files), `v8.1_products.png`, `v8.1_bars.png`, `v8.1_scan2D_*.csv` (optional), code `track_A_v8.1_intrinsic.py`, and this note. v7, v7.1, v7.3 omitted intentionally to avoid confusion.

Data availability (informative)

All v8.1 outputs are in this Zenodo update 10.5281/zenodo.22904994. File list for this update only: `v8.1_summary.csv`, `v8.1_traj_Vigilance.csv`, `v8.1_traj_Flow.csv`, `v8.1_traj_Endogenous.csv`, `v8.1_traj_Sleep.csv`, `v8.1_products.png`, `v8.1_bars.png`, `track_A_v8.1_intrinsic.py`, `track_A_v8.1_tech...`

References

- [1] E. T. Jaynes and F. W. Cummings, Proc. IEEE **51**, 89 (1963). Formal.
- [2] G. Lindblad, Commun. Math. Phys. **48**, 119 (1976). Formal.
- [3] Y. Kuramoto, Int. Symp. Math. Prob. Theor. Phys. (1975). Formal.
- [4] M. A. Percudani, A Two-Mode Jaynes–Cummings Model..., Zenodo 10.5281/zenodo.22904994. Formal + informative defaults.