

Supplementary Methods | Exact sources and observation rules

This supplement documents a post hoc, deterministic audit of the frozen 13 October experiment. It adds no independent source phrase, participant, neural recording or molecular measurement. The primary assay remains the 202 present-state dimensions; regional and neuromodulator links select dimensions from the full 889-dimensional pool. New examples were selected after inspecting the code and the response archive, rather than preregistered.

Ordered neuromodulator updates

Nuclei run in ascending processing depth, with stable registry order within a depth. The initial vector [DA, NE, OPI, 5HT] is [0, 0.5, 0, 0]. For driving dimension x and weight w , *produce* sets $c \leftarrow wx$; *amplify* sets $c \leftarrow c + wx(1-c)$; and *inhibit* sets $c \leftarrow c - wxc$. All channels are clipped to [0,1] after each nucleus. Produce therefore replaces an earlier direct write. The executor supplies acoustic, temporal and upstream C^3 outputs to mechanisms, without passing this channel state back into their computation.

The final direct source identities are $DA=0.65 \times ECT[f04:flexibility_index]$, $OPI=0.90 \times IOTMS[E0:mor_baseline_proxy]$ and $5HT=0.30 \times BCH[P0:consonance_signal]$. These are bounded source dimensions; no later link modifies these three terminal outputs in the frozen registry. NE retains nine amplify links and one inhibit link; the last is $TAR[T2:anxiety_reduction]$, weight 0.45. Table S3 lists all 52 valid links in execution order. Overwritten direct writes do not exclude indirect influence through the source mechanisms' upstream dependencies.

Ceiling and temporal contrasts

$IOTMS[E0:mor_baseline_proxy]$ is the clipped sum $0.55 \times pleasantness_mean_1s + 0.45 \times (1 - roughness_skew_1s)$. Its ceiling of 1 gives an effective OPI ceiling of 0.9. The formula uses acoustic summary inputs; its trait-labelled name is not evidence of a participant trait. The ceiling fraction counts frames exactly equal to $float32(0.9)$, pooled with equal weight across path anchors. MORMR RMS uses only its present-state dimensions and the path origin. For NE, the timing contrast $\delta(t) = NE(u=1,t) - NE(u=0,t)$ uses the same endpoint pair for both signed mean $mean[\delta]$ and framewise RMS $\sqrt{mean[\delta^2]}$. No temporal alignment or state carryover is introduced.

Regional sensitivity and contribution accounting

For region r , $RAM_r(t) = \max(0, \sum_l w_l Y_l(t))$. A weight-sum control divides each output by $W_r = \sum_l |w_l|$, without fitting weights or claiming physiological normalization. Correlations compare the 26 signed endpoint-change means across direct flute and piano paths. Regions share sources and are dependent; these correlations receive no inferential p-values. All four common-RMS endpoints had positive pre-ReLU sums (minimum 0.062835), so their signed changes decompose additively into per-mechanism weighted dimension changes. Tables S1–S2 and complete CSVs retain source counts, weights and signed contributions, including cancellation.

Reconstruction and reproducibility

NumPy float32 replay applied the pinned operators to stored C^3 tensors for all 1,146 recordings (484,758 frames). The three terminal identities agreed exactly with this replay. Channel means agreed with archived packed means within 2.9732×10^{-8} ; four-endpoint RAM means agreed within 9.4241×10^{-7} . These tolerances compare computational reconstructions; they are not measurement uncertainty. No engine formulas, renderings or stored C^3 outputs were changed. Full audit checks and rebuilding instructions accompany the package.

Supplementary Fig. S1 | Original regional and channel views

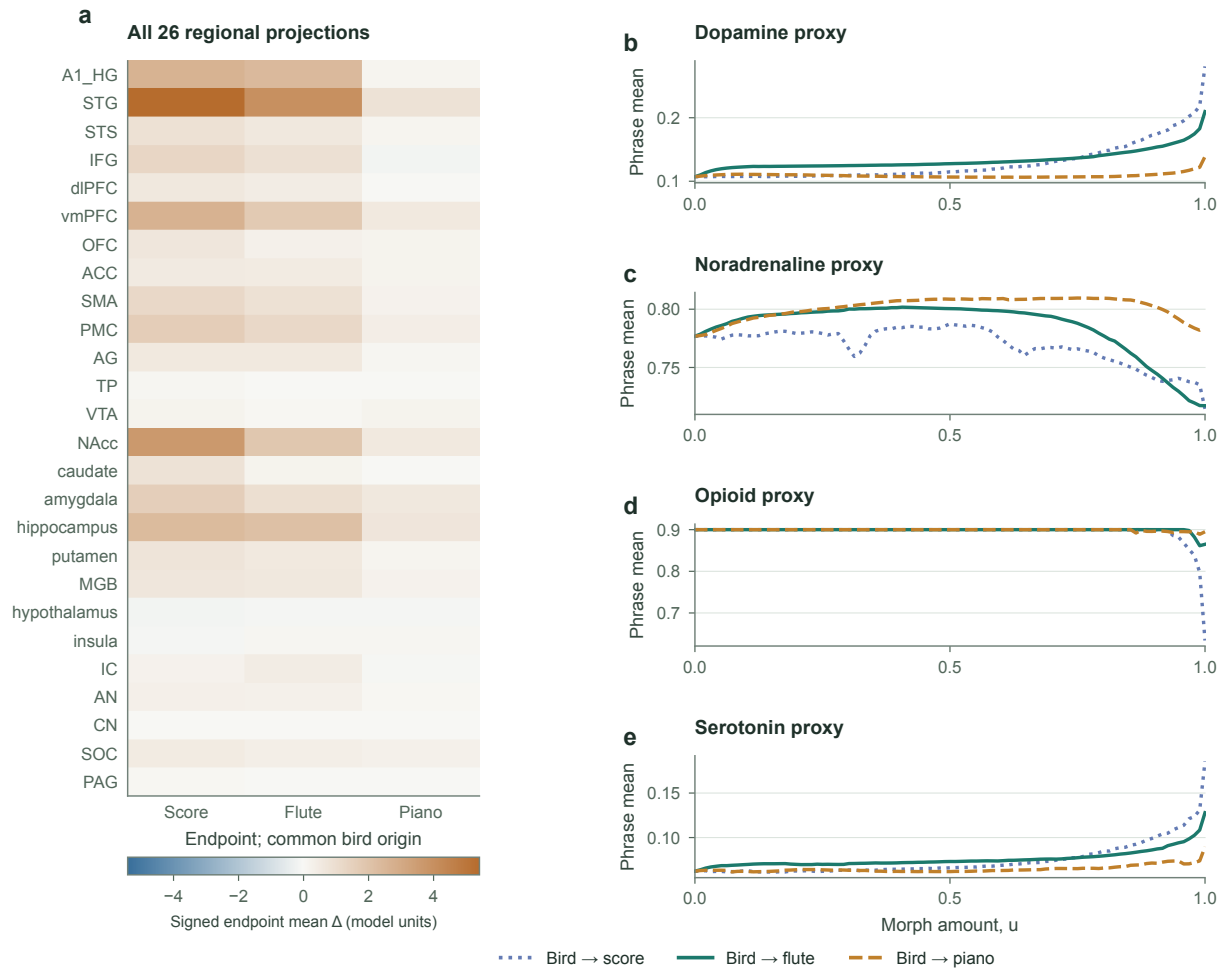


Fig. S1. The previous edition's Fig. 6 is retained without changing its plotted data. Left: all 26 signed regional endpoint changes from the common bird origin. Right: phrase means of the four neuromodulator-labelled channels over 97 anchors on bird $\rightarrow$ score, bird $\rightarrow$ flute and bird $\rightarrow$ piano paths, all at common whole-phrase RMS. These absolute channel means complement, rather than substitute for, source provenance and framewise contrasts in the revised main Fig. 6. Regional labels and channel names designate projections in the model.

Endpoint	DA mean	NE mean	OPI mean	5HT mean
Bird	0.107185	0.776831	0.900000	0.062243
Score	0.280851	0.714486	0.633937	0.185691
Flute	0.209672	0.717187	0.864804	0.127924
Piano	0.138955	0.783752	0.895003	0.089715

From the bird origin, score endpoint changes in STG and A1_HG were 5.411 and 2.640 model units; corresponding flute changes were 3.985 and 2.377. Raw regional magnitudes depend on source count and weights. The 131 weighted aggregates in the original archive are further views of the same model outputs, not independent tests.

Supplementary Fig. S2 | Shared regional patterns and connectivity

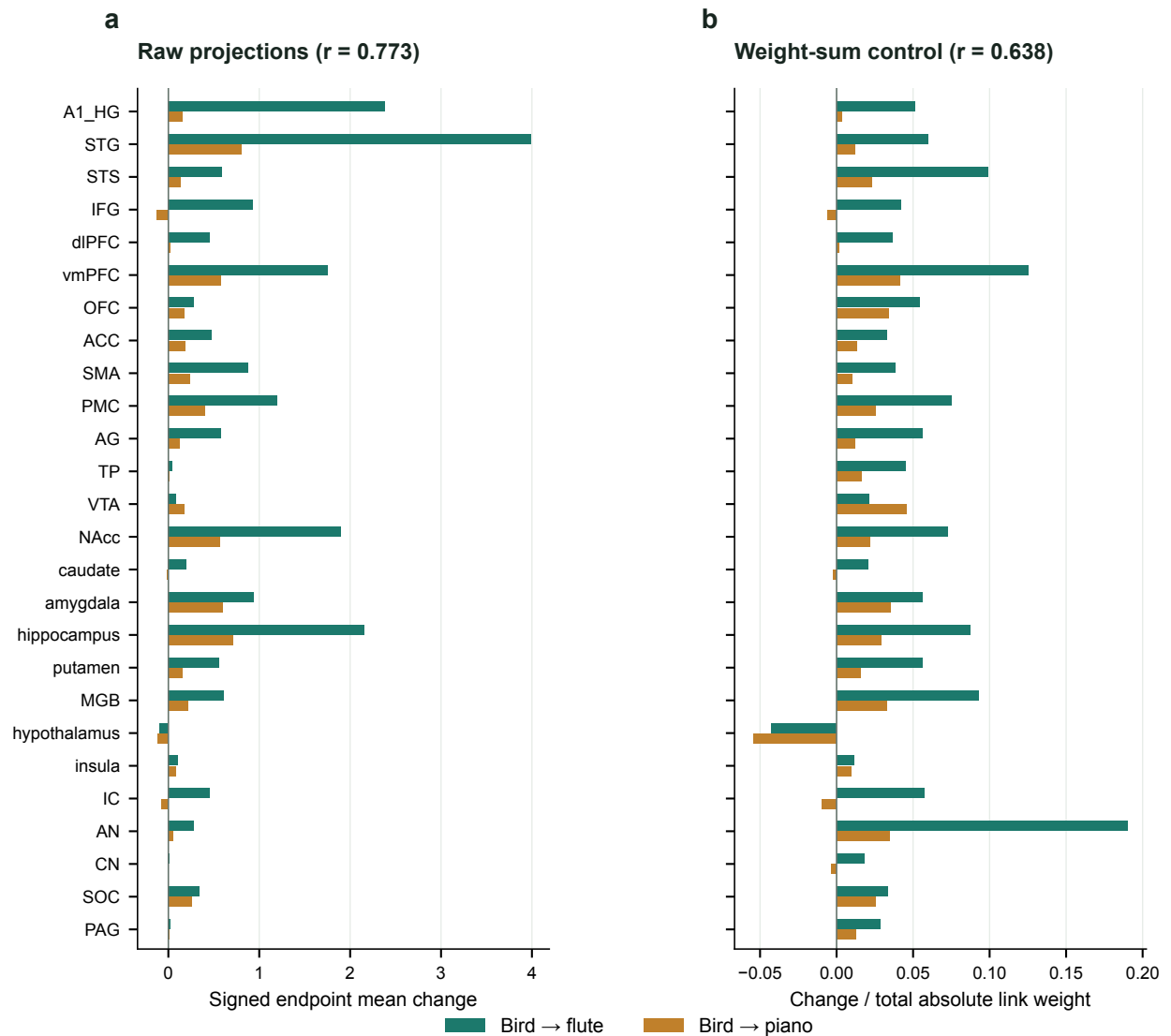


Fig. S2. All 26 signed direct endpoint-change means, with a common bird reference and common-RMS audio. **a**, Frozen RAM output. **b**, The same changes divided by the sum of absolute incoming link weights for each region. Flute and piano vectors correlate at $r=0.772922$ and $r=0.638289$, respectively. Signs agree in 22/26 regions; 25 flute and 21 piano changes are positive. Flute exceeds piano in signed change in 25 regions, with VTA the exception. Dividing by positive constants preserves within-region signs and order but changes cross-region scale and correlation. This is a connectivity sensitivity analysis, not physiological calibration or evidence of brain activation. All links and contribution signs are available in Tables S1–S2 and CSVs.

Supplementary Table S1 | Complete regional source inventory

Each row lists the number of dimension links, distinct source mechanisms and total absolute weight W . ΔF and ΔP are signed common-RMS endpoint mean changes from the bird origin. The last two columns divide these changes by W . Regional units are uncalibrated model units.

Region	Links	Mechs	W	ΔF	ΔP	$\Delta F/W$	$\Delta P/W$
A1_HG	63	44	46.65	+2.3774	+0.1595	+0.0510	+0.0034
STG	91	57	66.65	+3.9849	+0.8087	+0.0598	+0.0121
STS	9	6	6.00	+0.5923	+0.1383	+0.0987	+0.0231
IFG	31	24	22.30	+0.9293	-0.1332	+0.0417	-0.0060
dIPFC	17	14	12.45	+0.4558	+0.0180	+0.0366	+0.0014
vmPFC	19	16	13.95	+1.7502	+0.5742	+0.1255	+0.0412
OFC	7	7	5.10	+0.2771	+0.1723	+0.0543	+0.0338
ACC	20	20	14.55	+0.4738	+0.1885	+0.0326	+0.0130
SMA	30	24	22.90	+0.8788	+0.2342	+0.0384	+0.0102
PMC	21	14	16.00	+1.1979	+0.4048	+0.0749	+0.0253
AG	14	13	10.30	+0.5779	+0.1198	+0.0561	+0.0116
TP	1	1	0.90	+0.0404	+0.0149	+0.0449	+0.0165
VTA	5	5	3.85	+0.0816	+0.1749	+0.0212	+0.0454
NAcc	33	26	26.15	+1.9014	+0.5670	+0.0727	+0.0217
caudate	12	10	9.65	+0.1977	-0.0186	+0.0205	-0.0019
amygdala	22	18	16.80	+0.9373	+0.5955	+0.0558	+0.0354
hippocampus	33	27	24.70	+2.1556	+0.7111	+0.0873	+0.0288
putamen	13	12	9.90	+0.5532	+0.1575	+0.0559	+0.0159
MGB	10	8	6.55	+0.6086	+0.2137	+0.0929	+0.0326
hypothalamus	3	2	2.20	-0.0938	-0.1198	-0.0427	-0.0544
insula	12	10	9.00	+0.1036	+0.0860	+0.0115	+0.0096
IC	12	5	7.95	+0.4527	-0.0746	+0.0569	-0.0094
AN	2	1	1.45	+0.2757	+0.0505	+0.1902	+0.0348
CN	1	1	0.70	+0.0128	-0.0024	+0.0183	-0.0035
SOC	14	10	10.40	+0.3440	+0.2635	+0.0331	+0.0253
PAG	1	1	0.75	+0.0214	+0.0094	+0.0285	+0.0125

STG receives 91 dimension links from 57 mechanisms; A1_HG receives 63 from 44. CN, TP and PAG receive one link each. A high raw regional value therefore cannot establish greater biological recruitment. Counts describe the frozen registry. The normalization does not remove shared-input dependence or validate any region mapping. Full link-level weights and dimension names are in [data/region-links.csv](#).

Supplementary Table S2 | Signed contributors: flute

Three largest absolute contributions per region for the direct bird→flute endpoint contrast. Signs are retained: a large negative contributor can oppose positive contributors. Values are means of weighted per-frame C³ dimension changes, summed within each mechanism. Selection ranks absolute contributions separately within each region; it does not rank mechanisms globally.

Region	Largest contribution	Second	Third
A1_HG	DAP +0.2667	PCCR +0.2629	SSPS +0.2099
STG	TSCP +0.7563	MIAA +0.4104	ESME +0.3595
STS	CMAT +0.2312	ECT +0.1347	CHPI +0.1001
IFG	ECT +0.3279	CDMR +0.3202	SLEE +0.2463
dIPFC	MEAMR +0.2009	SLEE +0.1563	MSR +0.0620
vmPFC	CMAT +0.2188	DMMS +0.1960	DAP +0.1945
OFC	MORMR +0.1671	CLAM +0.0706	SRP +0.0524
ACC	CSG -0.1657	MEAMN +0.1456	VRIAP +0.1423
SMA	NSCP +0.1432	PEOM +0.1197	RIRI +0.1111
PMC	VRIAP +0.2474	SPH +0.2008	NSCP +0.1181
AG	EDNR +0.1594	TSCP +0.1447	HTP +0.1334
TP	MAD +0.0404	—	—
VTA	RPEM +0.0846	SRP +0.0640	MAD -0.0472
NAcc	DAED +0.4236	MORMR +0.2521	RPEM +0.1894
caudate	VMM +0.1436	SSRI -0.0671	DAED -0.0634
amygdala	DAP +0.2329	MEAMN +0.1606	DMMS +0.1423
hippocampus	DAP +0.2288	DMMS +0.1966	PSH +0.1594
putamen	WMED +0.1114	RIRI +0.1008	SPMC +0.0740
MGB	BCH +0.3400	PSH +0.1001	MORMR +0.0734
hypothalamus	AAC -0.0578	TAR -0.0360	—
insula	CSG -0.1462	VRIAP +0.1224	STC +0.1020
IC	BCH +0.3040	SDNPS +0.1471	SDED -0.1331
AN	BCH +0.2757	—	—
CN	BARM +0.0128	—	—
SOC	CTBB +0.3361	DGTP -0.0986	SPMC +0.0631
PAG	TAR +0.0214	—	—

These contributions sum to the endpoint change before float rounding because the four audited endpoint projections never enter the negative pre-ReLU range. A mechanism may contribute through several linked dimensions. Complete contributions, including those omitted from the top-three display, are in [data/region-contributions.csv](#); all weighted dimension links are in [data/region-links.csv](#). No causal neural attribution is implied.

Supplementary Table S2 | Signed contributors: piano

Three largest absolute contributions per region for the direct bird→piano endpoint contrast. Signs are retained: a large negative contributor can oppose positive contributors. Values are means of weighted per-frame C³ dimension changes, summed within each mechanism. Selection ranks absolute contributions separately within each region; it does not rank mechanisms globally.

Region	Largest contribution	Second	Third
A1_HG	SDL -0.1238	AMSS -0.1149	SSPS +0.1041
STG	SDL -0.3389	TSCP +0.2947	ESME +0.1344
STS	CMAT +0.1027	PSCL +0.0327	ECT +0.0273
IFG	PNH -0.1636	MEAMR -0.0792	ECT +0.0748
dIPFC	MEAMR -0.1305	SLEE +0.0438	WMED +0.0344
vmPFC	DAP +0.1269	CMAT +0.1198	VRIAP +0.0903
OFC	MORMR +0.0730	ICEM +0.0243	CLAM +0.0208
ACC	VRIAP +0.0903	VMM +0.0599	PNH -0.0563
SMA	MEAMR -0.0845	NSCP +0.0589	WMED +0.0415
PMC	VRIAP +0.0790	NSCP +0.0759	SPH +0.0516
AG	HTP +0.0329	EDNR +0.0324	SDL -0.0308
TP	MAD +0.0149	—	—
VTA	SSRI +0.0669	SRP +0.0424	RPEM +0.0392
NAcc	RPEM +0.1063	IUCP +0.0994	MORMR +0.0878
caudate	SSRI -0.1132	VMM +0.1015	DAED -0.0828
amygdala	PUPF +0.1181	MEAMN +0.0961	VMM +0.0792
hippocampus	VMM +0.1632	PMIM +0.1477	PUPF +0.1112
putamen	SPMC +0.0258	ASAP +0.0256	RIRI +0.0217
MGB	BCH +0.1162	MORMR +0.0562	PSH +0.0236
hypothalamus	TAR -0.1226	AAC +0.0029	—
insula	STC +0.0504	VRIAP +0.0483	CSG -0.0406
IC	SDED -0.0649	BCH -0.0562	PSH +0.0391
AN	BCH +0.0505	—	—
CN	BARM -0.0024	—	—
SOC	CTBB +0.2650	DGTP -0.0359	SPMC +0.0181
PAG	TAR +0.0094	—	—

These contributions sum to the endpoint change before float rounding because the four audited endpoint projections never enter the negative pre-ReLU range. A mechanism may contribute through several linked dimensions. Complete contributions, including those omitted from the top-three display, are in [data/region-contributions.csv](#); all weighted dimension links are in [data/region-links.csv](#). No causal neural attribution is implied.

Supplementary Table S3 | Ordered channel links (1/2)

All valid NeuroLinks, sorted by processing depth and stable registry order. Dimensions retain their frozen code names. A produce operation replaces the current direct channel value; amplify and inhibit depend on that value. The three terminal producers are marked with an asterisk. NE has no producer.

Order	Depth	Source / dimension	Channel	Effect	Weight
1	0	BCH* / P0:consonance_signal	5HT	produce	0.30
2	0	BCH / P0:consonance_signal	DA	produce	0.15
3	0	CSG / M2:aesthetic_appreciation	DA	produce	0.15
4	0	MIAA / E1:novelty_response	DA	produce	0.10
5	0	MPG / P0:onset_state	NE	amplify	0.15
6	0	ICEM / P0:surprise_signal	NE	amplify	0.75
7	0	ICEM / E1:arousal_response	NE	amplify	0.60
8	0	AAC / E0:emotional_arousal	NE	amplify	0.75
9	0	AAC / I0:chills_intensity	NE	amplify	0.50
10	0	DAED / f01:anticipatory_da	DA	produce	0.90
11	0	DAED / f02:consummatory_da	DA	produce	0.90
12	0	DAED / f03:wanting_index	DA	produce	0.85
13	0	DAED / f04:liking_index	OPI	produce	0.80
14	0	MORMR / f01:opioid_release	OPI	produce	0.95
15	0	MORMR / f02:chills_count	OPI	produce	0.85
16	0	RPEM / current_rpe	DA	produce	0.90
17	0	RPEM / rpe_magnitude	DA	produce	0.85
18	0	EDNR / f01:within_connectivity	DA	produce	0.70
19	0	EDNR / f04:expertise_signature	DA	produce	0.65
20	1	PSCL / P0:pitch_prominence_sig	NE	amplify	0.20
21	1	PUPF / G0:pleasure_P	DA	produce	0.75
22	1	MAD / D1:nacc_music_resp	DA	produce	0.80
23	1	IUCP / P0:current_preference_state	DA	produce	0.70
24	1	MCCN / F0:chills_onset_pred	DA	produce	0.80
25	1	MCCN / E3:chills_magnitude	OPI	produce	0.75
26	1	MCCN / E2:arousal_index	NE	amplify	0.55

The table enumerates 33 DA, 10 NE, 8 OPI and 1 5HT links. “Terminal” refers to direct updates in this execution order; it does not claim isolation from upstream C³ dependencies. Tables and code are frozen-version evidence, not an inference about neurotransmitter concentrations.

Supplementary Table S3 | Ordered channel links (2/2)

All valid NeuroLinks, sorted by processing depth and stable registry order. Dimensions retain their frozen code names. A produce operation replaces the current direct channel value; amplify and inhibit depend on that value. The three terminal producers are marked with an asterisk. NE has no producer.

Order	Depth	Source / dimension	Channel	Effect	Weight
27	1	MEAMR / E3:positive_affect	DA	produce	0.75
28	1	SSRI / P1:endorphin_proxy	OPI	produce	0.80
29	1	SSRI / f01:synchrony_reward	DA	produce	0.75
30	1	SSRI / f02:social_bonding_index	OPI	produce	0.70
31	1	HGSIC / M0:groove_index	DA	produce	0.55
32	1	ASAP / F0:beat_when_pred_0_5s	DA	produce	0.65
33	1	DDSMI / P0:partner_sync	OPI	produce	0.60
34	1	VRMSME / P0:motor_drive	DA	produce	0.70
35	1	SPMC / M0:circuit_flow	DA	produce	0.70
36	1	TSCP / f03:plasticity_magnitude	DA	produce	0.70
37	1	TSCP / F1:cortical_enhancement_pred	DA	produce	0.65
38	1	CDMR / P0:mismatch_signal	DA	produce	0.70
39	1	SLEE / f02:detection_accuracy	DA	produce	0.70
40	1	SLEE / F0:next_probability	DA	produce	0.65
41	2	PCCR / P0:chroma_identity_signal	NE	amplify	0.15
42	2	PWSM / P1:precision_estimate	DA	produce	0.45
43	2	PWSM / P0:weighted_error	NE	amplify	0.50
44	2	TAR / T3:depression_improv	DA	produce	0.75
45	2	TAR / T2:anxiety_reduction	NE	inhibit	0.45
46	2	LDAC / E1:pleasure_gating	DA	produce	0.70
47	2	IOTMS* / E0:mor_baseline_proxy	OPI	produce	0.90
48	2	IOTMS / E2:reward_propensity	DA	produce	0.75
49	2	SSPS / f04:peak_proximity	DA	produce	0.70
50	2	SSPS / optimal_zone_pred	DA	produce	0.65
51	2	ESME / M0:mmn_expertise_function	DA	produce	0.70
52	2	ECT* / f04:flexibility_index	DA	produce	0.65

The table enumerates 33 DA, 10 NE, 8 OPI and 1 5HT links. “Terminal” refers to direct updates in this execution order; it does not claim isolation from upstream C³ dependencies. Tables and code are frozen-version evidence, not an inference about neurotransmitter concentrations.

Supplementary Table S4 | Path summaries and integrity checks

Common-RMS paths. OPI ceiling fraction counts every frame and anchor. NE signed endpoint change is an endpoint mean difference; NE path RMS additionally spans all anchors and is a different estimand. The matched endpoint contrast below provides the direct temporal-averaging demonstration.

Path	Anchors	OPI ceiling fraction	NE endpoint mean Δ	NE path RMS
Bird $\rightarrow$ score	97	0.935902	-0.062344	0.064391
Score $\rightarrow$ flute	97	0.210670	+0.002701	0.058826
Score $\rightarrow$ piano	97	0.540908	+0.069266	0.075631
Pitch only	25	1.000000	-0.002502	0.016069
Timing only	25	1.000000	-0.000073	0.054246
Spectrum only	25	0.960000	-0.057793	0.047798
Bird $\rightarrow$ flute	97	0.978528	-0.059644	0.059656
Bird $\rightarrow$ piano	97	0.977261	+0.006922	0.060708

Same endpoint pair: NE(u=1) – NE(u=0)

Operator	Signed frame mean	Framewise RMS
Pitch	-0.00250191	0.01926322
Timing	-0.00007280	0.06331264

Computational integrity

Check	Result
Original waveform / engine hashes	1,146 / 855 checked; zero mismatches in original manuscript audit
Neuro replay	1,146 recordings $\times$ 423 frames = 484,758 frames
Terminal identity error vs float32 replay	0 for DA, OPI and 5HT
Maximum archived channel-mean error	2.9731868×10^{-8}
RAM endpoint-mean error; minimum pre-ReLU	9.4240157×10^{-7} ; 0.0628350
Original fresh full-engine reconstruction checks	Four exact endpoint checks; no new engine inference in this revision
Independent biological observations	None; one independent source phrase

The original assay, all primary response tables, and Figs. 1–5 are preserved. `data/readout-audit.json` records numerical checks and source hashes; `data/readout-traces.npz` stores exact plotted frame traces. The executable audit and figure scripts are included. Retained source snippets document the manager, executor and IOTMS extraction formula. The full engine and per-recording tensors remain in the separate experiment archive. `README.txt` states the rebuild commands and package boundary.