

Musical Intelligence: Scientific Supplement

This supplement accompanies the MI-AE-Architecture article. It documents six primary evidence packages and the additional protocols required to interpret every retained main-figure panel. Source tables and analysis records are indexed with the revision package.

Supplement S1. Computational trace: scope and results

This publication distinguishes an audit of a recorded execution from a public specification of the engine. The source recording, selected configuration and saved outputs identify the comparison. Equations, coefficients, temporal addresses, exact kernels and executable reconstruction records remain under controlled access. Independent reconstruction from the paper alone is consequently limited.

Recorded execution and selection

The Swan Lake input lasts 182.596984 s. The 30–50-s interval was selected before inspecting intervention effects. Acoustic inputs, temporal context, output identities and consumption records belong to the same saved execution. The calculation audit checks that the inspected output follows the recorded implementation; it does not establish a cognitive or physiological interpretation.

Controlled intervention

One temporal-context requirement is changed while the remaining inputs and calculations are fixed. The shared original temporal arrays remain exactly equal. The comparison uses 31,449 common valid frames after excluding frames that do not provide common support. Change counts use the recorded absolute tolerance of one ten-millionth plus a relative tolerance of one millionth. The published figure uses 100-ms display means, while native-frame values determine the checks.

Seventeen output dimensions change. ICEM, PWUP and CHPI are the three changed mechanisms among eight reachable mechanisms; all 805 dimensions outside the declared reachable graph remain exactly equal. Observer and identity-adaptor controls have maximum absolute difference zero. Within 30–50 s, maximum absolute and RMS changes in the selected ICEM output are 0.003632 and 0.000643. The full-record maximum is 0.011401. These are model-output differences, not effects measured in listeners.

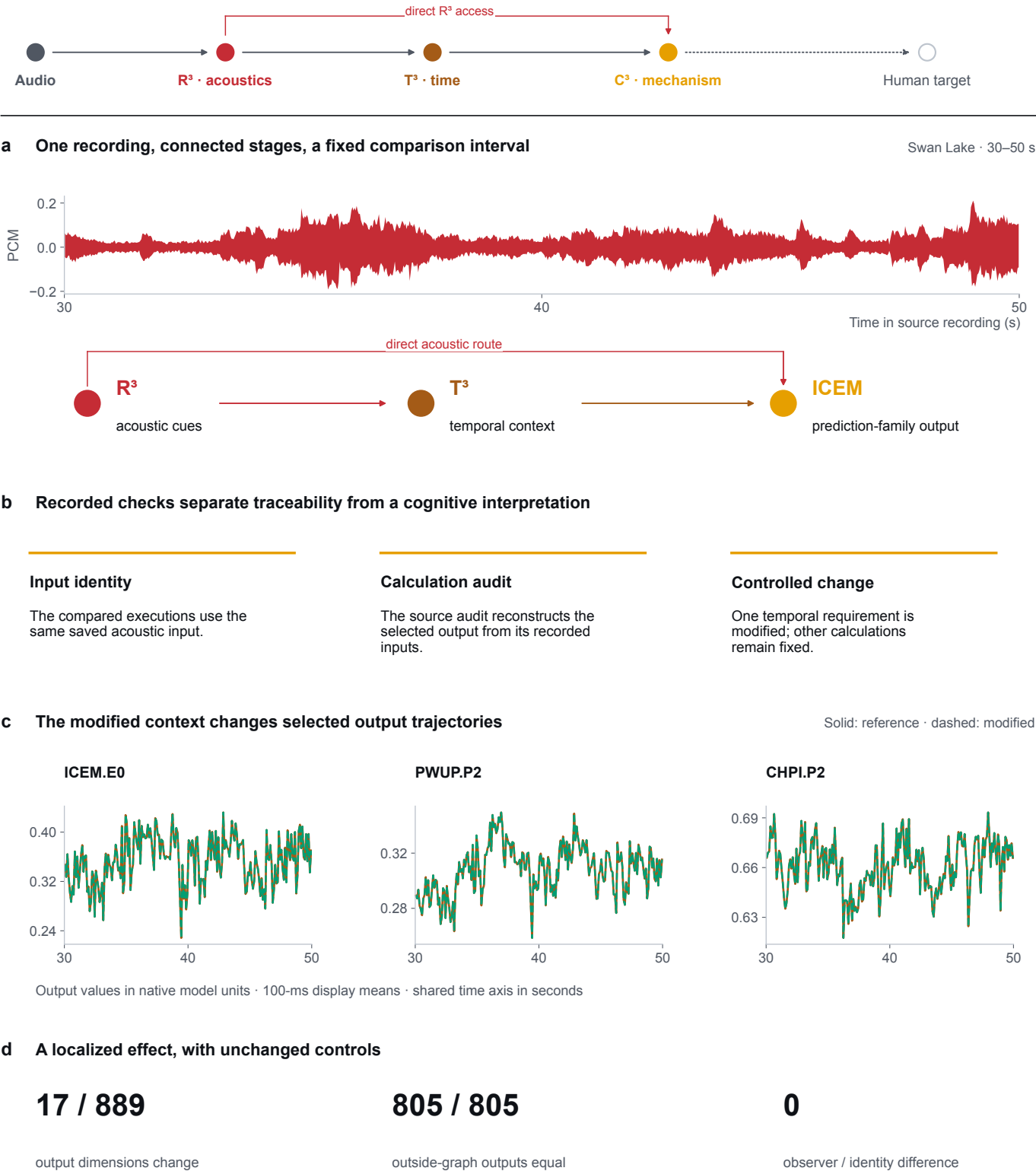
Interpretation and reproducibility boundary

Declared reachability does not establish that a receiving calculation consumes the changing dimension. The audit distinguishes these cases. Counts of mechanisms or outputs alone also cannot establish identity between different historical executions. The archived behavioural cache limitations remain attached to their corresponding protocols in S7.

AAC.F1 is separately evaluated as a dimensionless acoustic-context score against excerpt-level arousal. Its source audit checks agreement with saved records; it is not a heart-rate measurement or an additional human dataset. Physiology, personal memory and other proposed constructs require their own observations. Figure 9, S5 and Extended Evidence E3–E4 specify these distinctions. Detailed source inspection requires access to the retained implementation records under the stated research-access terms.

A mechanism traced through a controlled change

Recorded execution evidence, without publishing the implementation recipe



This is a computational intervention, not a participant experiment. Equations, coefficients and request definitions are withheld.

Figure S1. Publication-level trace and intervention summary, also shown as Extended Evidence E1. The source waveform and output trajectories are saved observations of the model. The architectural route is schematic. Audit outcomes characterize the recorded computational intervention, not a participant experiment. Implementation equations, parameters and temporal request definitions are not disclosed.

Supplement S2. Grouped tension prediction

Sample, grouping and observation model

The film comparison uses 110 entries and perceived tension ratings from the soundtrack material of [Eerola and Vuoskoski \(2011\)](#). Forty source-soundtrack groups keep repeated excerpts and segments together. Five fixed outer GroupKFold splits hold out 22 entries each. All representations use these same outer splits, recordings and targets. Outputs are summarized after the first 172 cached frames, with full-clip context retained. The saved C³ cache contains the channel means needed for the existing fifteen-output tension pool.

The pooled out-of-fold prediction vector supplies RMSE, Pearson r and R². RMSE is the primary error score. R² equals one minus the squared-error ratio relative to variation around the pooled observed target mean. The training-mean predictor is fitted separately within each outer training set. Table S2a reports all eight alternatives, and Table S2b retains the same five test-fold RMSEs. Their paired variation describes the observed split sensitivity; no significance or equivalence claim is inferred from five folds.

Representations and preprocessing

The 97-input representation contains one mean per R³ coordinate. The 970-input representation contains ten descriptors per coordinate: mean, standard deviation, 10th/50th/90th percentiles, mean absolute successive difference, normalized-time slope, and autocorrelations at 0.35, 1 and 4 s. These descriptors characterize the supplied acoustic series; they do not reproduce the complete canonical T³ collection. The 985-input representation appends the fifteen C³ means. The C³-only representation retains all fifteen means without choosing a new winning channel.

The fixed acoustic subset contains mean, standard deviation and mean absolute successive difference for roughness (R³ 0), pleasantness (4), loudness (10), tonalness (14) and spectral flux (21). These five coordinates were selected from the source audit before the compact fits. Their fifteen descriptors form a transparent comparator with the same number of regression inputs as C³. This dimensionality refers to the observation model's inputs; computing a C³ output can involve additional upstream quantities.

Representation	Inputs	RMSE	Pearson r	R ²
15 C ³ means	15	1.47194	0.67055	0.43148
15 fixed acoustic descriptors	15	1.48474	0.65325	0.42155
97 acoustic means	97	1.60410	0.58347	0.32480
970 acoustic/temporal descriptors	970	1.53508	0.61895	0.38165
970 descriptors + 15 C ³ means	985	1.53564	0.61868	0.38121
PCA15 of 97 acoustic means	15	1.65161	0.54102	0.28421
PCA15 of 970 descriptors	15	1.64603	0.55121	0.28904
Training-target mean	0	1.96593	-0.15862	-0.01415

Table S2a. Complete pooled held-out film-tension comparison.

Representation	Fold 1	Fold 2	Fold 3	Fold 4	Fold 5
15 C ³ means	1.37009	1.69754	1.87579	1.12379	1.13699
15 fixed acoustic descriptors	1.30096	1.80774	1.51696	1.24927	1.48323
97 acoustic means	1.33345	1.74878	1.93541	1.15757	1.71571
970 acoustic/temporal descriptors	1.20187	1.80417	1.86237	1.12779	1.53052
970 descriptors + 15 C ³ means	1.23221	1.80374	1.85695	1.12480	1.51843
PCA15 of 97 acoustic means	1.29656	1.81932	1.97706	1.19733	1.81816
PCA15 of 970 descriptors	1.30035	1.77968	1.95197	1.29779	1.78733
Training-target mean	1.89024	2.34042	2.13564	1.41956	1.92294

Table S2b. RMSE on the five fixed soundtrack-grouped folds; each test fold contains 22 entries.

Two PCA alternatives reduce the standardized 97- and 970-input representations to fifteen components. PCA is fitted within the relevant inner or outer training partition, without whitening. Components are not rescaled after transformation. The observation models use ridge regression with an intercept. Mean imputation and population-standard-deviation scaling are fitted only to the training partition. Four grouped inner folds choose alpha from 0.1, 1, 10, 100, 1,000 and 10,000 by mean inner-fold squared error. Transformations and model fitting are repeated within each split rather than computed on the pooled sample.

Comparison scope

The original matched comparison comprised 97 means, 970 descriptors and 970 descriptors plus C³. The fixed extension added C³ alone, the two PCA15 representations, the fixed acoustic subset and the training-mean reference. It retained the same outer folds and tuning grid. A separate NumPy implementation reproduced the original three baseline prediction vectors within 1.06×10^{-13} and selected the same penalties. The input columns, complete inner losses, fitted transformations, predictions and chosen penalties are retained in the compact-comparison package.

C³ alone gives pooled RMSE 1.47194; the fixed acoustic subset gives 1.48474. C³ has lower error in three of five folds against that subset and against the 970-descriptor representation. The pooled differences therefore coexist with heterogeneous paired-fold differences. Appending C³ to the 970 descriptors gives 1.53564 versus 1.53508 for those descriptors alone. Main Figure 6a includes these matched comparators alongside the useful C³-only result. Table S2a also retains the PCA and training-mean alternatives.

The comparison is exploratory. The corpus and tension pool had been inspected before the new fitting specification, and parts of the architecture have corpus-guided development histories. Training-only fitting addresses the current regression evaluation; it does not make earlier representation development independent of the film corpus. The present inference is that the specified output representation supports grouped prediction under this observation model. The complete saved comparison is retained without additional feature selection or a revised scoring rule.

Supplement S3. Arousal and valence correspondence

Observation targets and samples

The transfer comparison relates clip-mean model outputs to perceived arousal and valence ratings in MUSIFEAST-17 (van der Walle et al., 2025). The historical film column refers to the 360-entry energy/arousal and valence tables from the earlier soundtrack evaluation. Those film targets and the new perceived-emotion targets are not identical measurements. Table S3a preserves the eight selected channel identities and their signed Spearman associations across both datasets and the recorded MUSIFEAST subset.

The full MUSIFEAST analysis contains 356 thirty-second excerpts. Its recorded partition comprises seventeen consumed pilot, 274 development and 65 fixed test excerpts. Connected artist/composer, source and identical-audio identities are grouped during partition construction. The 65-excerpt subset is contained in the full sample; the two columns therefore describe overlapping observations. Scores use the channel mean after the first 172 cached frames and the human rating mean for the same excerpt. No multivariate regression, acoustic adjustment or fitted calibration enters these correlations.

Channel selection and chronology

Four arousal identities are AAC.F1, PUPF.U0, AAC.A1 and CSG.P0. Four valence identities are SRP.P1, CMAT.S0, SRP.P2 and VMM.V0. The mapping was revised after the initial pilot using prior film tables. There was no new winning-channel selection on the 65-excerpt test subset. Raw normative labels had already been accessed for curation and quality control. Different engine snapshots, populations and target definitions make this an exploratory cross-dataset comparison.

The earlier film analyses selected channels within specified target pools using whole-set absolute association. The 110-entry and 360-entry film

sets overlap, with the smaller set developed from the larger pilot. Their results document the channel-selection context, rather than providing two independent replications. The separate film residual procedure subtracted out-of-fold ridge predictions based on 97 R^3 clip means before examining mechanism associations; that procedure does not enter the direct transfer scores in Table S3a. Full film pools and their target identities remain in the source index.

Complete transfer family

All four transferred arousal readouts are positively associated with MUSIFEAST ratings. The full-sample correlations range from 0.531 to 0.691; in the 65-excerpt subset they range from 0.478 to 0.770. AAC.F1 and PUPF.U0 provide the leading full-sample arousal associations. The valence readouts are weaker, spanning -0.086 to 0.231 in the full sample and -0.049 to 0.211 in the subset. Table S3a keeps this complete family visible while the main article focuses on arousal correspondence.

Spearman ρ describes rank correspondence between one model mean and one human excerpt mean. These coefficients are neither percentages of correct predictions nor incremental variance beyond acoustic controls. Their observation unit is the excerpt, not a model frame or an individual rating trial. The channel keys identify the evaluated computations; the human targets specify the empirical interpretation. S1 summarizes the AAC.F1 audit and its interpretation boundary; the implementation expression is not published.

The source record includes the direct score table, historical film tables, partition definitions, transfer chronology and input hashes. The main four-channel table and Table S3a use the same primary mean window. No alternative trimming, target transformation or test-subset channel replacement is introduced for presentation. The displayed precision follows the retained score tables, with complete machine-readable values available through the source index.

Channel / target	Film, n = 360	MUSIFEAST, n = 356	Test subset, n = 65
AAC.F1 / arousal	+0.652	+0.691	+0.770
PUPF.U0 / arousal	+0.698	+0.676	+0.735
AAC.A1 / arousal	+0.646	+0.533	+0.530
CSG.P0 / arousal	+0.631	+0.531	+0.478
SRP.P1 / valence	+0.622	+0.231	+0.211
CMAT.S0 / valence	+0.653	+0.172	+0.155
SRP.P2 / valence	+0.623	+0.174	+0.160
VMM.V0 / valence	+0.643	-0.086	-0.049

Table S3a. Complete direct transfer family; the subset is nested within the total.

Supplement S4. Consonance comparisons

Acoustic routes and perceptual targets

The consonance comparisons evaluate explicit waveform-derived coordinates against interval or chord ratings. On the inspected route, detected spectral peaks contribute to pairwise beating and fusion calculations. Sensory pleasantness is the fixed combination a fixed model-specific combination of acoustic consonance cues. Inharmonicity equals one minus fusion on this route. Their signed correlations consequently describe related quantities within one computation. The mel-only fallback uses a different estimator; route identity is recorded with each evaluation.

The harmonic-dyad comparison uses thirteen semitone-bin rating means from [Marjeh et al. \(2024\)](#). The reported 0.8901 pleasantness coefficient, 0.8132 fusion coefficient and -0.8352 roughness coefficient use these interval means as observations. The pooled analysis uses 617 chord rows from [Eerola and Lahdelma \(2021\)](#), with pleasantness 0.5177, roughness -0.5825 and scaled Sethares dissonance -0.4337. These are different stimulus-level evaluations; individual ratings are not substituted for the aggregated observation counts.

Nine-reference panel

Main Figure 8G contains seven behavioural target rows and two analytical anchors. The behavioural rows concern harmonic dyads, flute/guitar/piano rating conditions, pure tones, Indian tension and the behavioural ratings from [Bidelman and Krishnan \(2009\)](#). The extended extractor synthesizes harmonic dyads with six partials of amplitude 1/h. Instrument names in the target columns therefore denote rating conditions; they do not indicate reconstruction of the original instrument recordings. The Indian tension target retains its recorded polarity correction ([Lahdelma et al., 2024](#)).

The speech-harmonics row ([Schwartz et al., 2003](#)) and analytical Sethares reference ([Sethares, 1993](#)) are plotted separately from the behavioural targets. Table S4a retains all 63 signed descriptor/reference correlations. Intervals or bins provide the n values. The Bidelman row uses six behavioural interval targets, not a neural frequency-following-response endpoint. The other harmonic, instrumental and pure-tone conditions use thirteen bins, and the Indian tension condition uses twelve.

The source records distinguish direction agreement, magnitude criteria and selected interval-subset ranking. The full signed associations are

Reference (n)	R	S	H	F	P	I	D
Harmonic dyads (13)	-0.8352	-0.8132	+0.3681	+0.8132	+0.8901	-0.8132	+0.1264
Flute ratings (13)	-0.7747	-0.7967	+0.2582	+0.5330	+0.7692	-0.5330	+0.4505
Guitar ratings (13)	-0.5330	-0.5495	+0.2253	+0.4396	+0.5989	-0.4396	+0.2967
Piano ratings (13)	-0.7363	-0.5824	+0.1484	+0.6154	+0.6923	-0.6154	+0.4725
Pure tones (13)	-0.7253	-0.3242	+0.1703	+0.4505	+0.3571	-0.4505	-0.5220
Indian tension* (12)	-0.5245	-0.3986	+0.3636	+0.8042	+0.5804	-0.8042	+0.4056
Bidelman ratings (6)	-0.8857	-0.9429	+0.0857	+1.0000	+1.0000	-1.0000	+0.0286
Speech anchor (13)	-0.8132	-0.7692	+0.2857	+0.9231	+0.8791	-0.9231	+0.2253
Sethares anchor* (13)	-0.8132	-0.7692	+0.2857	+0.9231	+0.8791	-0.9231	+0.2253

Table S4a. All 63 signed correlations. R: roughness; S: Sethares; H: Helmholtz-Kang; F: fusion; P: pleasantness; I: inharmonicity; D: harmonic deviation. Last two rows are analytical anchors; * marks target inversion.

Register	Synthesis	Fusion p	Roughness p
≈66 Hz	Decay	+0.3187	+0.2198
≈66 Hz	Sustained	+0.3901	+0.2198
≈66 Hz	Idealized	+0.3571	+0.2363
261 Hz	Decay	+0.5055	-0.6264
261 Hz	Sustained	+0.4341	-0.6264
261 Hz	Idealized	+0.3846	-0.6264
440 Hz	Decay	+0.5385	-0.7253
440 Hz	Sustained	+0.3901	-0.7253
440 Hz	Idealized	+0.4066	-0.7198
880 Hz	Decay	+0.8022	-0.6648
880 Hz	Sustained	+0.8297	-0.6758
880 Hz	Idealized	+0.8132	-0.6648

Table S4b. All twelve saved Carillon register/synthesis conditions.

presented here rather than combining those criteria into one accuracy percentage. The opposite signs for fusion and its algebraic complement are preserved. The source index retains the target conventions, extraction inputs and statistical tables for readers examining a particular rating condition.

Carillon register and synthesis conditions

The Carillon comparison follows published bell spectra and rating targets from [Harrison and MacConnachie \(2024\)](#). The saved sweep creates additive dyads at approximately 66, 261, 440 and 880 Hz, each under decaying, sustained and idealized spectral constructions. One extractor and its coefficients are retained across the twelve combinations. Inputs are synthesized rather than original bell recordings. The recorded MI sweep uses 1.5-second signals at 44.1 kHz and normalizes the component bells separately before combination.

Table S4b retains all twelve fusion and roughness associations. Fusion ranges from 0.3187 to 0.8297, with the largest value at 880 Hz sustained. Roughness is positive at the lowest register and negative at higher registers. These condition-specific results characterize the same computation under changes in spectral construction and register. The highest cell is not substituted for performance averaged across the design. Main Figure 8J presents the full fusion grid with its original scale.

Reproduction records

The source tables retain full-precision associations, their recorded probabilities, synthesis conditions and input hashes. The general R³ definitions specify waveform availability, sample rate, support and normalization. Clip-maximum normalization and batch-dependent groove normalization belong to the relevant feature definitions; they are not additional observations. The consonance comparisons reported here use their recorded waveform routes and target conventions. The source index separates these perceptual evaluations from earlier fitted baselines and other historical tasks.

Tables S4a–S4b and the main consonance figure are presentation views of existing numeric records. Together with the synthesis and route definitions, they identify the quantities that must be retained when reproducing the reported comparisons. The complete extended archive remains available for the additional analysis families, whose methods and conclusions are separate from the primary comparisons in this article.

Supplement S5. Mechanism provenance, evidence and revision

This record distinguishes the motivation for a proposal from evidence about its current implementation. A mechanism is an executable computational unit with a stable name, specified inputs and outputs. Its interpretation as a human process remains an outcome-specific hypothesis. Table S5a covers all 84 canonical names; the accompanying record preserves full source paths, 889 output identities, 484 registry citation entries, the 89 ledger definitions and their historical model links. The five repeated names are PNH, STAI, TPRD, IGFE and MAA. Same-name definitions are not assumed to compute the same function.

Literature synthesis and the origin of the repertoire

The original Cognitive Consonance Circuit programme organized literature extraction, feature queries, nine-domain aggregation, evidence classification, knowledge synthesis, representation refinement, cross-reference checks and theoretical synthesis. The retained extraction folders contain 448 JSON records and 1,116 claims. These include LLM-assisted extraction and subsequent enrichment; an extracted interpretation is not itself a new empirical observation. The original programme used exploratory meta-analytic summaries to organize candidate relationships before their later computational implementation.

The historical T01C documents contain 96 model headings, of which two are explicitly marked duplicates; the remaining 94 proposals have 27 mechanistic, 38 integrative and 29 speculative labels. A subsequent February catalogue contains 96 distinct names, including CHPI and SSRI. All 84 current canonical abbreviations occur in that catalogue, while 82 occur in the earlier T01C records; some full-name expansions differ across versions. The twelve catalogue names absent from the current canonical selection are AMSC, DSP, EDTA, MDNS, MPFS, MTNE, OMS, ONI, PTGMP, SDD, SDDP and TMRM. An individual scientific elimination decision was not recovered for each difference. The count 84 consequently identifies this implementation’s scope; it is not the outcome of an empirical optimization over the historical catalogue.

The extraction record is not a set of 448 independent studies. Simple normalization identifies 340 distinct DOI strings among 426 nonempty DOI fields, and 385 normalized title strings among all 448 records. Neither number is a final adjudicated study count. The historical Core-4 meta-analysis retains 149 effect/claim rows, including multiple rows from the same source and twelve rows with a default n=30. Its inspected code filters labelled Cohen’s d values at absolute magnitude below two, uses a common variance expression and does not model within-study effect dependence. The archived estimates therefore are not transferred to the current equations as validated coefficients or model-performance estimates. Protocol drafts and internal quality percentages likewise do not establish prospective registration or independently verified extraction accuracy. This study uses the traceable source lineage as hypothesis motivation; the original quantitative synthesis would require its own study-level re-adjudication for a renewed meta-analytic claim.

Evidence states and table interpretation

Every row has a located implementation and literature/design provenance. The revised compact anchors in Figure 9 and Table S5a identify one or two sources with an explicit role in Table S5b. The 4 October 2026 source-role review retains all 84 engine identifiers, computations and evaluation flags. It corrects source selection without claiming new implementation validation. Historical anchors, including the unresolved Sares (2023) entry removed from NEWMD, remain in the editorial record. Reviews and editorials are background, not independent experiments. The wider registry is an unchanged historical record, not an adjudicated evidence set. A retained label may extend beyond the cited observation, particularly at the brainstem, synaptic, cross-species, memory or transfer level; these gaps are stated individually in S5b. The selected examples below continue to distinguish source observation, computational translation and current evaluation.

The evaluation column uses nonexclusive links: **C**, a selected calculation or intervention inspected here or in the linked source audit; **P**, selected outputs included jointly in the fixed fifteen-output film-tension prediction comparison; **A**, selected outputs in the complete eight-channel film-to-MUSIFEAST association family; **H**, a specified historical comparison retained in S7 or the linked technical archive. **U** means no additional mechanism-specific outcome judgement is assigned by this compact crosswalk. **U** does not mean that the literature is empty, that the mechanism is false, or that every historical analysis involving it has been ruled out. **C** establishes arithmetic/access, **P** a joint representation test, and **A/H** a particular observation or dataset relationship; none establishes every output or the necessity of an entire mechanism.

For **P**, the fifteen-output representation gave $r=0.67055$ and $R^2=0.43148$ in the grouped film-tension comparison, while appending those outputs to the 970-descriptor baseline did not improve pooled error. For **A**, the full channel-specific arousal and valence associations are retained in Table S3a, including weaker or negative transfer. **H** preserves its original selection, timing and observation-model restrictions. A statistically weak comparison is not recoded as an unavailable test.

Table S5a. Complete canonical mechanism crosswalk

ID / function	Registry name	Reviewed anchors	Implemented operation	Evaluation links
BCH / F1	Brainstem Consonance Hierarchy	Bidelman 2009 ; Bidelman 2013	Combines consonance and pitch cues into brainstem-labelled consonance scores.	H
CSG / F1	Consonance-Salience Gradient	Bravo 2017 ; Sarasso 2019	Maps acoustic consonance and change cues to salience and affective-evaluation scores.	A
MIAA / F1	Musical Imagery Auditory Activation	Kraemer 2005 ; Halpern 2004	Uses the supplied audio to form imagery-labelled, retrieval and recognition proxies.	U
MPG / F1	Melodic Processing Gradient	Rupp 2022 ; Patterson 2002	Separates onset, sequence and contour cues into a melodic-processing gradient.	U
PNH / F1	Pythagorean Neural Hierarchy	Bidelman 2009 ; Tabas 2019	Maps interval-complexity cues to conflict and consonance-preference scores.	U
SDNPS / F1	Stimulus-Dependent Neural Pitch Salience	Cousineau 2015 ; Penagos 2004	Constructs pitch-salience and consonance proxies with an explicit stimulus-dependence interpretation.	U
SDED / F1	Sensory Dissonance Early Detection	Crespo-Bojorque 2018 ; Fishman 2001	Transforms roughness and harmonic cues into early-detection and mismatch-labelled scores.	U
TPIO / F1	Timbre Perception-Imagery Overlap	Halpern 2004 ; Zatorre 2005	Constructs shared perception/imagery-labelled timbre scores from the supplied audio.	U
TPRD / F1	Tonotopy-Pitch Representation Dissociation	Allen 2022 ; Norman-Haignere 2013	Separates frequency-pattern and pitch-labelled scores within the model.	U
HTP / F2	Hierarchical Temporal Prediction	Norman-Haignere 2022 ; Bonetti 2024	Combines acoustic cues at multiple horizons into hierarchical prediction scores.	H

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Table S5a (continued)

ID / function	Registry name	Reviewed anchors	Implemented operation	Evaluation links
SPH / F2	Spatiotemporal Prediction Hierarchy	Bonetti 2024; Fernandez-Rubio 2022	Constructs memory-match and deviation scores with oscillatory and hierarchical labels.	U
ICEM / F2	Information Content Emotion Model	Egermann 2013; Cheung 2019	Combines acoustic change and dispersion into unexpectedness and emotion-labelled proxies.	C, H
SNEM / F3	Sensory Novelty and Expectation Model	Nozaradan 2011; Nozaradan 2012	Transforms rhythmic and acoustic change cues into novelty and expectation scores.	U
IACM / F3	Inharmonicity-Attention Capture Model	Basinski 2025; Koelsch 1999	Maps inharmonicity and change cues to attention-capture and segregation proxies.	U
MEAMN / F4	Music-Evoked Autobiographical Memory Network	Janata 2009; Sakakibara 2025	Maps audio-derived familiarity and tonal cues to autobiographical-memory-labelled proxies.	U
MMP / F4	Musical Mnemonic Preservation	Jacobsen 2015; Fang 2017	Maps acoustic cues to preserved-memory, recognition and scaffolding-labelled proxies.	C, H
SRP / F5	Striatal Reward Prediction	Salimpoor 2011; Salimpoor 2013	Constructs wanting, liking, tension and reward-forecast proxies from audio-derived cues.	P, A
AAC / F5	Autonomic-Arousal Circuit	Egermann 2013; Salimpoor 2011	Maps acoustic intensity and change to autonomic-labelled arousal and chills proxies.	C, P, A
VMM / F5	Valence-Mode Mapping	Mitterschiffthaler 2007; Koelsch 2006	Combines mode-related and spectral cues into valence and happy/sad-labelled scores.	A
DAED / F6	Dopamine Anticipation-Experience Dissociation	Salimpoor 2011; Gold 2023	Separates anticipatory and consummatory reward proxies with caudate and accumbens labels.	H
MORMR / F6	mu-Opioid Receptor Music Reward	Putkinen 2025; Salimpoor 2011	Transforms acoustic and temporal cues into opioid-inspired reward proxies.	H
RPEM / F6	Reward Prediction Error in Music	Gold 2019a; Gold 2023	Combines surprise and liking proxies into signed reward-prediction-error scores.	P
PEOM / F7	Period Entrainment Optimization Model	Thaut 2015; Thaut 1998	Transforms rhythmic cues into entrainment and motor-timing-labelled scores.	U
MSR / F7	Musician Sensorimotor Reorganization	Bangert 2006; Lahav 2007	Constructs musician-labelled precision, inhibition and sensorimotor scores.	U
GSSM / F7	Gait-Synchronized Stimulation Model	Yamashita 2025	Constructs gait/stimulation-labelled synchronization scores from acoustic timing cues.	U
HMCE / F7	Hierarchical Musical Context Encoding	Mischler 2025; Norman-Haignere 2022	Combines local and extended temporal cues into hierarchical musical-context scores.	U
EDNR / F8	Expertise-Dependent Network Reorganization	Paraskevopoulos 2022; Leipold 2021	Maps acoustic cues to expertise, network-separation and efficiency-labelled proxies.	U
PSCL / F1	Pitch Salience in Cortical Lateralization	Penagos 2004; Allen 2022	Combines spectral cues and BCH outputs into pitch-prominence and cortical-response-labelled scores.	U
PWUP / F2	Precision-Weighted Uncertainty Processing	Mencke 2019; Cheung 2019	Uses HTP and ICEM outputs to weight tonal and rhythmic prediction-error proxies.	C
BARM / F3	Brainstem Auditory Response Modulation	Rathcke 2024; Grahn 2007	Combines rhythmic context and upstream scores into beat-alignment and regularization proxies.	U
STANM / F3	Spectrotemporal Attention Network Model	Haiduk 2024; Zatorre 2022	Partitions acoustic cues into temporal and spectral attention-allocation scores.	U
AACM / F3	Aesthetic-Attention Coupling Model	Sarasso 2019; Sarasso 2021	Combines acoustic and sustained-response cues into aesthetic-engagement scores.	U
AMSS / F3	Attention-Modulated Stream Segregation	Hausfeld 2021; Wikman 2025	Combines harmonic and temporal cues into auditory-stream segregation scores.	U
ETAM / F3	Entrainment, Tempo and Attention Modulation	Hausfeld 2021; Doelling 2015	Combines rhythmic timing cues into entrainment and attention-gain scores.	U
RASN / F4	Rhythmic Auditory Stimulation Neuroplasticity	Thaut 2015; Grahn 2007	Constructs rhythmic entrainment, motor-facilitation and plasticity-labelled proxies.	U
PMIM / F4	Predictive Memory Integration Model	Koelsch 2000; Koelsch 2009	Combines harmonic and temporal deviance cues into memory-updating proxies.	U
OII / F4	Oscillatory Intelligence Integration	Bruzzo 2022; Samiee 2022	Combines acoustic and upstream cues into integration, segregation and encoding scores.	U
HCMC / F4	Hippocampal-Cortical Memory Circuit	Squire 1995; McClelland 1995	Maps acoustic and memory cues to binding, segmentation and storage-labelled scores.	U
RIRI / F4	RAS-Intelligent Rehabilitation Integration	Thaut 2015; Harrison 2025	Combines rhythmic cues and available upstream averages into rehabilitation-labelled motor proxies.	U
MSPBA / F4	Musical Syntax Processing in Broca's Area	Maess 2001; Kim 2021	Transforms harmonic-pattern cues into syntax, violation and Broca-labelled scores.	U
PUPF / F5	Pleasure-Uncertainty Prediction Function	Cheung 2019; Egermann 2013	Combines uncertainty and surprise proxies into a pleasure response function.	P, A
CLAM / F5	Closed-Loop Affective Modulation	Ehrlich 2019; Daly 2016	Computes affect-tracking and control-labelled scores without an external closed-loop intervention.	U
MAD / F5	Musical Anhedonia Disconnection	Loui 2017; Martinez-Molina 2016	Constructs auditory/reward coupling and disconnection-labelled proxies from acoustic cues.	U
NEMAC / F5	Nostalgia-Evoked Memory-Affect Circuit	Sakakibara 2025; Barrett 2010	Combines memory and affect cues into nostalgia and memory-reward scores.	U
STAI / F5	Spectral-Temporal Aesthetic Integration	Kim 2019; Alluri 2012	Combines spectral and temporal integrity cues into aesthetic-response scores.	U

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Table S5a (continued)

ID / function	Registry name	Reviewed anchors	Implemented operation	Evaluation links
IUCP / F6	Inverted-U Complexity Preference	Gold 2019b ; Gold 2023	Applies complexity/preference functions to information-content and entropy proxies.	U
MCCN / F6	Musical Chills Cortical Network	Chabin 2020 ; Putkinen 2025	Combines arousal and reward cues into chills and cortical-network-labelled scores.	U
MEAMR / F6	Music-Evoked Autobiographical Memory Reward	Janata 2009 ; Salimpoor 2011	Combines familiarity and tonal cues into autobiographical-memory reward proxies.	U
SSRI / F6	Social Synchrony Reward Integration	Kokal 2011 ; Bigand 2025	Transforms rhythmic and reward cues into synchrony, bonding and group-flow-labelled proxies.	U
HGSIC / F7	Hierarchical Groove State Integration Circuit	Potes 2012 ; Grahn 2007	Combines beat, metre and motor-labelled cues into a groove-state score.	U
ASAP / F7	Action Simulation for Auditory Prediction	Ross 2022 ; Patel 2014	Constructs motor-simulation-labelled timing predictions from acoustic and upstream cues.	U
DDSMI / F7	Dyadic Dance Social Motor Integration	Bigand 2025 ; Kohler 2025	Combines acoustic and upstream timing cues into partner-coordination-labelled scores.	U
VRMSME / F7	VR Music Stimulation Motor Enhancement	Liang 2025	Constructs virtual-reality-labelled motor and connectivity proxies from acoustic and upstream cues.	U
SPMC / F7	SMA-Premotor-M1 Motor Circuit	Grahn 2007 ; Hoddinott 2024	Combines timing cues into sequence-planning, motor-preparation and execution-labelled scores.	U
TSCP / F8	Temporal Synaptic Consolidation Processor	Pantev 2001 ; Bellmann 2024	Constructs timbre-specific recognition and plasticity-labelled scores from spectral cues.	U
CDMR / F8	Context-Dependent Mismatch Response	Rupp 2022 ; Crespo-Bojorque 2018	Combines acoustic context and deviance cues into mismatch and expertise-labelled scores.	P
SLEE / F8	Synaptic Long-term Encoding Engine	Paraskevopoulos 2022 ; Porfyri 2025	Constructs regularity, detection and learning-labelled scores from acoustic and temporal cues.	U
PCCR / F1	Pitch Chroma Cortical Representation	Briley 2013 ; Allen 2022	Combines chroma and upstream pitch scores into pitch-class identity and octave-equivalence proxies.	U
WMED / F2	Working Memory-Entrainment Dissociation	Noboa 2025 ; Yuan 2025	Separates rhythm-entrainment and working-memory-labelled contributions to prediction scores.	U
DGTP / F3	Domain-General Temporal Processing	Rathcke 2024 ; Grahn 2007	Combines timing proxies into shared music/speech-labelled temporal scores.	U
SDL / F3	Salience-Dependent Lateralization	Haiduk 2024 ; Zatorre 2022	Transforms spectral and temporal salience cues into lateralization-labelled scores.	U
NEWMD / F3	Neural Entrainment-Working Memory Dissociation	Noboa 2025	Separates entrainment and working-memory-labelled rhythm scores.	U
PWSM / F3	Precision-Weighted Salience Model	Basinski 2025 ; Millidge 2022	Combines error and reliability cues into precision-weighted salience scores.	U
VRIP / F4	VR-Integrated Analgesia Paradigm	Deng 2025	Combines acoustic and upstream cues into engagement and analgesia-labelled proxies.	U
CMAPEC / F4	Cross-Modal Action-Perception Common Code	Lahav 2007 ; Bangert 2006	Combines acoustic and upstream representations into action/perception transfer scores.	U
DMMS / F4	Developmental Music Memory Scaffold	Partanen 2022 ; Qiu 2025	Constructs developmental binding and memory-scaffold proxies from acoustic and upstream cues.	U
CSSL / F4	Cross-Species Song Learning	Burchardt 2025	Combines rhythmic and melodic cues into copying and shared-learning-labelled scores.	U
CDEM / F4	Context-Dependent Emotional Memory	Sachs 2025	Combines acoustic affect and memory cues into context-dependent binding scores.	U
DAP / F5	Developmental Affective Plasticity	Scholkmann 2024 ; Trainor 2012	Maps acoustic and upstream cues to developmental-plasticity and affect-labelled proxies.	C
CMAT / F5	Cross-Modal Affective Transfer	Spence 2011	Combines acoustic affect cues into supramodal-labelled valence and arousal scores.	A
TAR / F5	Therapeutic Affective Resonance	Kheirkhah 2025 ; Ehrlich 2019	Combines acoustic and upstream affect cues into therapeutic-target-labelled proxies.	U
LDAC / F6	Liking-Dependent Auditory Cortex	Gold 2023 ; Cheung 2019	Combines liking and unexpectedness proxies into an auditory-cortex-labelled response.	U
IOTMS / F6	Individual Opioid Tone Music Sensitivity	Putkinen 2025 ; Salimpoor 2011	Maps reward cues to individual-sensitivity and opioid-tone-labelled proxies.	U
SSPS / F6	Saddle-Shaped Preference Surface	Cheung 2019 ; Gold 2019b	Combines information-content and entropy proxies on a preference surface.	U
NSCP / F7	Neural Synchrony Commercial Prediction	Leeuwis 2021	Transforms timing and upstream cues into synchrony and popularity-labelled proxies.	U
CTBB / F7	Cerebellar Theta-Burst Balance	Sansare 2025 ; Okada 2022	Constructs cerebellar-stimulation-labelled timing and balance proxies.	U
STC / F7	Singing Training Connectivity	Zamorano 2023 ; Kleber 2013	Combines acoustic and upstream cues into singing-related interoceptive and motor scores.	U
ESME / F8	Error-Signal Modulated Encoding	Koelsch 1999 ; Vuust 2012	Combines spectral, timing and available expertise cues into modality-specific mismatch proxies.	U
ECT / F8	Expertise Compartmentalization Trade-off	Paraskevopoulos 2022 ; Porfyri 2025	Combines acoustic and upstream expertise cues into efficiency and transfer-limit proxies.	U
UDP / F2	Uncertainty-Driven Pleasure	Mencke 2019 ; Gold 2019b	Combines uncertainty and prediction confirmation into a pleasure-labelled score.	U

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Table S5a (continued)

ID / function	Registry name	Reviewed anchors	Implemented operation	Evaluation links
CHPI / F2	Cross-Modal Harmonic Predictive Integration	Moller 2021 ; Cheung 2019	Combines acoustic and upstream prediction scores into harmonic-integration proxies.	C
IGFE / F2	Individual Gamma Frequency Enhancement	Yokota 2025 ; Bolland 2025	Constructs gamma-labelled matching and enhancement proxies from acoustic and upstream scores.	U
MAA / F2	Multifactorial Atonal Appreciation	Mencke 2019 ; Gold 2019b	Combines complexity, familiarity and contextual proxies into atonal-appreciation scores.	U
PSH / F2	Prediction Silencing Hypothesis	Millidge 2022 ; Auksz-tulewicz 2016	Combines hierarchical prediction scores into high-level suppression and low-level persistence proxies.	U

The P pool contains PUPF.E0/E1/U0/U1/U2/P0, SRP.C2/T0/T1/M0, AAC.F0/F1, CDMR.f01/P0 and RPEM.rpe_magnitude. The A family contains AAC.F1, PUPF.U0, AAC.A1 and CSG.P0 for arousal, and SRP.P1, CMAT.S0, SRP.P2 and VMM.V0 for valence. H links BCH to the harmonic/bonang comparison, HTP/ICEM to the recorded pleasure comparison, MMP to the selected chills comparison, and DAED/MORMR to the ChillsDB–DEAM output contrast. The latter compares model outputs across datasets; it does not measure opioid release. These links concern the named outputs and protocols. They are not an exhaustive index of all channels in historical searches or the later full-suite families in S6. C marks the ICEM intervention (with PWUP/CHPI propagation) and the AAC arithmetic example and the DAP/MMP examples retained in the source audit. Full citations, output names, declared falsification criteria and source paths are preserved for every mechanism in the companion record. The crosswalk indexes the source, implemented operation and recorded evaluation link for each mechanism. An equation-level attribution to a particular empirical finding is supplied only where it has been checked, as in the examples below. Elsewhere that translation remains to be adjudicated; the controlled-access mechanism records preserve the declared input roles, output identities and proposed falsification criteria. These criteria are design records requiring prospective specification, not evidence that a test was completed or that its threshold is justified.

From an empirical finding to an implemented proposal

BCH. [Bidelman and Krishnan \(2009\)](#) report neural and behavioural relations for consonance. The MI implementation combines explicit acoustic/temporal cues into consonance-related scores. Its mixture coefficients, four-stage organization and output names are additional modelling decisions; the occurrence of a neural effect in the source is not evidence that the current score measures a brainstem response. The consonance comparisons in this manuscript primarily concern specified acoustic descriptors and stimulus constructions, not a validation of every BCH output. Natural-timbre transfer and a matched mechanistic alternative remain separate tests.

ICEM. [Egermann et al. \(2013\)](#) studied expectation and psychophysiological emotion in a live-concert experiment. Their probabilistic information-content account uses the event probability conditional on context. The inspected MI extraction instead derives a score from acoustic context; it does not compute that event probability or return information in bits. The source audit and temporal intervention are summarized in Section 3 and S1. These characterize the recorded calculation and its propagation without publishing the implementation rule. Testing the proposed expectancy interpretation requires probability/violation measures and acoustic-change alternatives. The source history also records TenseMusic-guided changes, so the formula is not described as developmentally independent of that corpus.

IUCP. [Gold et al. \(2019b\)](#) examine predictability, uncertainty and musical pleasure using an information-theoretic expectation model. Their quadratic relationships motivate an intermediate-complexity proposal. MI uses a non-monotonic complexity-preference proposal; its response shape and combination rule are additional implementation assumptions that are not specified here. The source finding does not determine those choices. An appropriate test would compare the specified curve with alternative shapes and with the pleasantness input under the same human target and held-out protocol.

AAC and MMP. The AAC arithmetic restatement and its arousal association refer to a dimensionless acoustic-context score. The metadata entry assigning PET/raclopride dopamine findings to Salimpoor 2009 conflicts with the primary article ([Salimpoor et al., 2011](#)); the historical label is retained in the source audit with the discrepancy, not endorsed as a corrected reference. MMP’s inspected familiarity-labelled path uses audio-derived information and does not receive an individual’s listening history. Autonomic coupling and personal recognition therefore require their respective measured targets and listener variables. Neither the label nor an association with another target supplies that missing observation.

Other recorded translation issues remain traceable: the ICEM design note combines Cheung’s 39-person behavioural and 40-person imaging samples into an incorrect single fMRI $n=79$; the primary study separates them [Cheung et al. \(2019\)](#). The historical HTP card describes a cross-domain visual-motion analogy, which must not be presented as a directly measured music-specific time constant. These checks delimit source roles without changing the archived code or silently repairing prior numerical results.

Revision and prospective measurement

A proposed process remains useful only insofar as it produces distinguishable consequences. Sensory proposals require matched stimuli and perceptual targets; expectancy proposals require contextual probabilities or controlled violations; personal-memory proposals require exposure/history and recognition measures; autonomic proposals require synchronized physiological and subjective responses; motor proposals require tapping, phase correction or other appropriate movement outcomes. Regional and neuromodulator mappings require separately specified observation models and measurements. These are requirements for future tests, not completed experiments.

A revision record should identify the new evidence, affected mechanism/output, previous and revised computation, development data and version hash. The next version is frozen for evaluation, with matched alternatives, grouping and temporal access specified before outcome-based selection. Retaining, combining, narrowing, replacing, removing and extending proposals are all admissible outcomes. Parameter estimation and runtime state evolution remain distinguishable from changing the repertoire. Negative or inconclusive results remain attached to the tested version.

S5b. Source roles and limits of the retained mechanism names

This focused editorial audit compares all 84 full-name expansions with the compact source set and retained naming records. It is not a systematic review, a study-quality meta-analysis or an empirical evaluation of MI. DOI-matched primary abstracts were inspected where available, and accessible full texts were examined for selected ambiguous mappings. The source-access inventory records abstract-only, full-text and unresolved cases. One relevant source is preferable to an unrelated second citation. A source can directly motivate a topic without supporting every word of a label or the corresponding equation. References added in this revision supply retrospective scientific context; they are not claimed to have determined the original implementation.

All current names remain unchanged to preserve correspondence with the engine. Historical expansions help explain source selection, but neither an earlier name nor the presence of a citation establishes the current biological interpretation. The phrases in the right column are explicit limits on interpretation, not changes to the implementation. Future renaming or computational revision would require a versioned change to the engine and its paper together. No model was executed, refitted or empirically re-evaluated for this editorial update.

Gold (2019a) denotes the PNAS reward-prediction-error study; Gold (2019b) denotes the Journal of Neuroscience predictability/uncertainty study. Removed anchors and all old-to-new selections are retained in the accompanying editorial record. The C/P/A/H/U evaluation flags in Table S5a retain their original meaning and are independent of this source-role audit.

Table S5b. Source motivation and untested interpretation, by fixed identifier

Identifier	Published observation / source role	Limit on the retained label
BCH	Bidelman (2009) relates frequency-following responses to consonance; Bidelman (2013) reviews brainstem pitch processing. <i>Sources:</i> Bidelman 2009 ; Bidelman 2013 .	The computational score is not a brainstem recording; the review is not an independent replication.
CSG	Bravo studies interval appraisal; Sarasso relates aesthetic responses to attention. <i>Sources:</i> Bravo 2017 ; Sarasso 2019 .	The studies do not establish a universal monotonic salience gradient; intermediate dissonance can have low salience.
MIAA	Kraemer and Halpern link musical imagery to auditory cortical activity. <i>Sources:</i> Kraemer 2005 ; Halpern 2004 .	An audio-only output does not observe whether a listener is imagining music.
MPG	Patterson supplies empirical evidence for cortical progression in pitch/melody processing; Rupp is an editorial. <i>Sources:</i> Rupp 2022 ; Patterson 2002 .	The editorial supplies context, not an independent gradient experiment or validation of the implemented gradient.
PNH	Ratio-related consonance and early auditory processing motivate the label. <i>Sources:</i> Bidelman 2009 ; Tabas 2019 .	Pythagorean is an interpretive label, not an established distinct neural hierarchy.
SDNPS	Cousineau examines stimulus dependence of neural pitch salience; Penagos supplies cortical pitch-salience evidence. <i>Sources:</i> Cousineau 2015 ; Penagos 2004 .	The natural-sound limitation is part of the motivation; generalization across stimulus classes is not assured.
SDED	Early auditory responses differentiate consonance/dissonance under studied contexts. <i>Sources:</i> Crespo-Bojorque 2018 ; Fishman 2001 .	Timing and expertise effects do not establish a context-independent dissonance detector.
TPIO	Halpern investigates timbre perception/imagery overlap; Zatorre reviews musical imagery. <i>Sources:</i> Halpern 2004 ; Zatorre 2005 .	Overlap of activation does not show that an audio-derived score measures ongoing imagery.
TPRD	Allen directly compares pitch and tonotopic representations; Norman-Haignere characterizes pitch-sensitive cortex. <i>Sources:</i> Allen 2022 ; Norman-Haignere 2013 .	Representations partly overlap; dissociation does not mean wholly separate cortical systems.
PSCL	Penagos localizes pitch-salience responses; Allen compares pitch representations. <i>Sources:</i> Penagos 2004 ; Allen 2022 .	These anchors do not establish hemispheric lateralization. The historical label used Localization; the current engine label remains unchanged.
PCCR	Briley directly examines cortical pitch-chroma mapping; Allen supplies broader pitch-representation context. <i>Sources:</i> Briley 2013 ; Allen 2022 .	Pitch chroma and tonotopic frequency are distinct constructs; the sources do not validate this model score.
HTP	Temporal integration windows and predictive-memory hierarchy supply complementary motivations. <i>Sources:</i> Norman-Haignere 2022 ; Bonetti 2024 .	Combining them into this temporal-prediction model is a design choice; integration is not itself prediction.
SPH	The cited work concerns hierarchical spatiotemporal prediction and predictive processing. <i>Sources:</i> Bonetti 2024 ; Fernandez-Rubio 2022 .	The implemented temporal/topological organization is not derived in full from those studies.
ICEM	Egermann links expectation violations with psychophysiology; Cheung links uncertainty and surprise with pleasure. <i>Sources:</i> Egermann 2013 ; Cheung 2019 .	An unexpectedness-labelled acoustic score is not automatically a probabilistic information-content estimate.
PWUP	Mencke theorizes atonal appreciation and uncertainty; Cheung examines uncertainty, surprise and pleasure. <i>Sources:</i> Mencke 2019 ; Cheung 2019 .	These anchors do not directly test precision weighting. The precision variable, weighting rule and acoustic translation require explicit model definitions and tests.
WMED	Noboa examines different contributions of entrainment and working memory to synchronization; Yuan studies auditory-memory load. <i>Sources:</i> Noboa 2025 ; Yuan 2025 .	These findings are not a general double dissociation. WMED and NEWMD are overlapping proposals, not independent replications.
UDP	Uncertainty and atonal appreciation motivate a pleasure-related proposal. <i>Sources:</i> Mencke 2019 ; Gold 2019b .	The relation is not uniformly increasing; context and individual differences remain relevant.
CHPI	Audiovisual integration and harmonic expectation supply separate components. <i>Sources:</i> Moller 2021 ; Cheung 2019 .	Their combination is a proposed synthesis. Relations among audio features are not evidence of visual-auditory transfer.
IGFE	Individual-frequency auditory stimulation motivates the label; related oscillatory evidence supplies context. <i>Sources:</i> Yokota 2025 ; Bolland 2025 .	A personalized stimulation protocol does not establish that ordinary music or this score enhances gamma-mediated cognition.
MAA	Theoretical work on atonal appreciation addresses multiple listener/context factors; Gold supplies predictability background. <i>Sources:</i> Mencke 2019 ; Gold 2019b .	The named multifactorial model remains a theoretical synthesis, not a mechanism validated by both sources.
PSH	Predictive coding and response suppression motivate the hypothesis. <i>Sources:</i> Millidge 2022 ; Auksztulewicz 2016 .	Silencing refers to a proposed reduction of prediction-related responses, not all neural activity.
SNEM	Nozaradan's studies concern selective entrainment to beat and meter. <i>Sources:</i> Nozaradan 2011 ; Nozaradan 2012 .	They support the historical Selective Neural Entrainment Model, not a direct novelty test; the current expansion is retained as an identifier.

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Table S5b (continued)

Identifier	Published observation / source role	Limit on the retained label
IACM	Basinski directly examines inharmonicity and attention; Koelsch supplies tuning/mismatch context. <i>Sources:</i> Basinski 2025; Koelsch 1999.	Spectral inharmonicity and sequential uncertainty must not be treated as equivalent manipulations.
BARM	Rathcke concerns beat ability and speech timing; Grahn concerns beat-related motor-system activity. <i>Sources:</i> Rathcke 2024; Grahn 2007.	Neither study measures brainstem ABR/FFR modulation. The historical Beat Ability Regulatory Model explains the anchor lineage, not the current brainstem claim.
STANM	The sources examine spectrotemporal cues, selective attention and network organization. <i>Sources:</i> Haiduk 2024; Zatorre 2022.	Distributed associations do not establish this model as a distinct biological attention circuit.
AACM	Aesthetic appraisal and attention/motor inhibition motivate coupling. <i>Sources:</i> Sarasso 2019; Sarasso 2021.	Attention, inhibition and memory remain different outcomes; one does not validate every named output.
AMSS	Selective-attention studies concern auditory object and stream representations. <i>Sources:</i> Hausfeld 2021; Wikman 2025.	The relation is task-dependent and includes nonmusical objects; the model requires its own segregation task.
ETAM	Envelope tracking, musical timing and attention supply related motivations. <i>Sources:</i> Hausfeld 2021; Doelling 2015.	The current expanded label is broader than the historical envelope-tracking formulation; tempo modulation is not independently established for every output.
DGTP	Speech, rhythm and movement timing motivate shared temporal processing. <i>Sources:</i> Rathcke 2024; Grahn 2007.	Transfer between the studied domains does not establish unrestricted domain generality.
SDL	Spectrotemporal properties and attention relate to hemispheric asymmetry. <i>Sources:</i> Haiduk 2024; Zatorre 2022.	Salience is not interchangeable with either acoustic structure or attentional instructions.
NEWMD	Noboa examines entrainment and working-memory predictors of synchronization. <i>Sources:</i> Noboa 2025.	The unresolved Sares (2023) anchor is excluded. Different predictor associations are not a universal double dissociation or an independent replication of WMED.
PWSM	Basinski separates spectral from sequential uncertainty; predictive-processing accounts motivate precision weighting. <i>Sources:</i> Basinski 2025; Millidge 2022.	Its inharmonicity effect must not be cited as proof that every salience effect is precision-weighted prediction error.
MEAMN	The sources examine music-evoked autobiographical memory and associated networks. <i>Sources:</i> Janata 2009; Sakakibara 2025.	An acoustic recording does not supply an individual's history or demonstrate actual autobiographical recall.
MMP	Jacobsen examines preserved musical memory in Alzheimer's disease; Fang reviews music-based interventions. <i>Sources:</i> Jacobsen 2015; Fang 2017.	Preservation of one memory function does not imply intact general memory or a personal-familiarity measure from audio alone.
RASN	Rhythmic stimulation and auditory-motor rehabilitation motivate the proposal. <i>Sources:</i> Thaut 2015; Grahn 2007.	Clinical effects and entrainment do not uniquely identify the proposed neuroplasticity mechanism.
PMIM	Musical syntax, mismatch responses and stored regularities motivate prediction-memory integration. <i>Sources:</i> Koelsch 2000; Koelsch 2009.	The integration rule is a model synthesis; ERAN and MMN are not interchangeable observations.
OII	Oscillatory accounts of intelligence and auditory processing supply separate motivations. <i>Sources:</i> Bruzzone 2022; Samiee 2022.	Their integration is a proposed extension, not demonstrated transfer from a pitch score to intelligence.
HCMC	Complementary-learning-system and hippocampal-neocortical theories motivate the architecture. <i>Sources:</i> Squire 1995; McClelland 1995.	These are general memory accounts, not music-specific validation of a circuit or this implementation.
RIRI	Rhythmic auditory stimulation and rehabilitation provide the source topic. <i>Sources:</i> Thaut 2015; Harrison 2025.	Intelligent integration remains a proposed computational organization; a clinical benefit requires an appropriate intervention study.
MSPBA	Maess links music-syntactic processing with inferior frontal regions; Kim provides complementary syntactic-processing evidence. <i>Sources:</i> Maess 2001; Kim 2021.	Broca's area and its right homologue should not be reduced to a unique isolated music-syntax centre.
VRIAP	Deng directly compares active and passive VR modes, pain ratings and fNIRS measures in 15 healthy participants. <i>Sources:</i> Deng 2025.	This supports VR-analgesia motivation, not analgesia from an audio-only MI score. The intervention includes motor and visual differences.
CMAPEC	Auditory-motor action/perception studies motivate shared representations. <i>Sources:</i> Lahav 2007; Bangert 2006.	Coactivation supports a common-code hypothesis without establishing identical codes or the implemented integration.
DMMS	Developmental music exposure and auditory plasticity motivate a scaffold proposal. <i>Sources:</i> Partanen 2022; Qiu 2025.	Human and animal findings are distinct; a memory scaffold is an interpretation, not the directly measured endpoint.
CSSL	Burchardt studies tutor-song rhythm learning in zebra finches. <i>Sources:</i> Burchardt 2025.	The retained anchor is within one species. Cross-species learning/generalization remains unsupported by this compact source set.
CDEM	Sachs concerns context-dependent emotional transitions during music. <i>Sources:</i> Sachs 2025.	Context-sensitive emotion does not establish emotional-memory encoding or recall. Memory remains an untested part of the retained label.
SRP	Striatal music-reward responses and anticipation motivate a prediction-related proposal. <i>Sources:</i> Salimpoor 2011; Salimpoor 2013.	The model's prediction computation is an additional design choice, not a measured striatal signal.
AAC	Egermann measures psychophysiological expectation responses; Salimpoor relates pleasure, dopamine and autonomic arousal. <i>Sources:</i> Egermann 2013; Salimpoor 2011.	The implemented readout remains dimensionless and audio-derived; it is not a heart-rate, skin-conductance or dopamine measurement.
VMM	The sources investigate affective responses and musical valence. <i>Sources:</i> Mitterschiffthaler 2007; Koelsch 2006.	A unique mode-to-valence mapping is not isolated from other musical and listener factors by this source pair.
PUPF	Cheung examines uncertainty/surprise and pleasure; Egermann examines expectation-related psychophysiology. <i>Sources:</i> Cheung 2019; Egermann 2013.	Pleasure and arousal are separate targets; an arousal association does not validate a pleasure-prediction function.
CLAM	The sources concern closed-loop music/affect regulation protocols. <i>Sources:</i> Ehrlich 2019; Daly 2016.	An audio-only calculation is not an operating feedback intervention without sensed state and an adaptive control loop.
MAD	Musical anhedonia studies concern atypical auditory-reward connectivity. <i>Sources:</i> Loui 2017; Martinez-Molina 2016.	Disconnection does not imply complete absence of anatomical connections or a diagnosis obtainable from audio.
NEMAC	Music, nostalgia, autobiographical memory and affect motivate the proposal. <i>Sources:</i> Sakakibara 2025; Barrett 2010.	Circuit is an interpretive synthesis; listener history is required to study individual nostalgia.

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Table S5b (continued)

Identifier	Published observation / source role	Limit on the retained label
STAI	Spectral/temporal properties and aesthetic appraisal motivate integration; Alluri supplies acoustic-network context. <i>Sources:</i> Kim 2019 ; Alluri 2012 .	The sources do not fix the particular integration equation or establish every aesthetic output.
DAP	Development and musical experience motivate plasticity. <i>Sources:</i> Scholkmann 2024 ; Trainor 2012 .	Affective plasticity is more specific than the cited developmental auditory effects and needs affect-related developmental outcomes.
CMAT	Spence reviews crossmodal correspondences and supplies general conceptual background. <i>Sources:</i> Spence 2011 .	The retained source does not establish learned music-visual affect transfer. The unrelated infant-speech anchor is removed; transfer remains a hypothesis.
TAR	Music-related affect and intervention literature motivate an affect-regulation proposal. <i>Sources:</i> Kheirkhah 2025 ; Ehrlich 2019 .	Therapeutic resonance is not a uniquely demonstrated mechanism or evidence of treatment efficacy for this score.
DAED	Salimpoor distinguishes reward anticipation from peak pleasure; the second source provides complementary reward evidence. <i>Sources:</i> Salimpoor 2011 ; Gold 2023 .	Different phases are supported, but not every cited study measures dopamine, and MI does not measure neurotransmitter release.
MORMR	Putkinen directly studies music reward and mu-opioid receptors; Salimpoor concerns dopaminergic reward. <i>Sources:</i> Putkinen 2025 ; Salimpoor 2011 .	The second source is not an opioid replication; receptor availability/binding and release require distinct interpretations.
RPEM	Gold (2019a, PNAS) models musical reward prediction errors and learning; Gold (2023) reports RPE-like responses. <i>Sources:</i> Gold 2019a ; Gold 2023 .	This motivates the construct without establishing the same latent error or reinforcement-learning process in the MI equation.
IUCP	Gold (2019b, Journal of Neuroscience) studies predictability, uncertainty and liking. <i>Sources:</i> Gold 2019b ; Gold 2023 .	An inverted-U is not a universal preference law; the implemented response shape needs comparison with alternatives.
MCCN	Chabin supplies cortical EEG evidence related to chills; Putkinen supplies reward/opioid context. <i>Sources:</i> Chabin 2020 ; Putkinen 2025 .	Neither establishes that every model output measures chills or a uniquely specified cortical network.
MEAMR	Autobiographical-memory and music-reward studies supply complementary components. <i>Sources:</i> Janata 2009 ; Salimpoor 2011 .	Their coupling in a single proposed mechanism is a synthesis, not an independently tested integrated process.
SSRI	Kokal relates synchronized drumming to reward-localizer caudate activity, conditional on rhythm proficiency; Bigand concerns dyadic dance. <i>Sources:</i> Kokal 2011 ; Bigand 2025 .	The integration rule is proposed. Reward-related activity and interpersonal synchronization are distinct observations, not an audio-only social-reward measure.
LDAC	The sources relate liking to auditory cortical responses. <i>Sources:</i> Gold 2023 ; Cheung 2019 .	Dependent denotes an observed association/modulation, not proven causal necessity for the implemented readout.
IOTMS	Putkinen relates individual receptor measures to pleasure-dependent responses; other reward work supplies context. <i>Sources:</i> Putkinen 2025 ; Salimpoor 2011 .	A second reward citation is not an independent opioid-tone result; receptor availability is not momentary release.
SSPS	Uncertainty-by-surprise interactions motivate a two-dimensional preference proposal. <i>Sources:</i> Cheung 2019 ; Gold 2019b .	The exact saddle geometry is a modelling choice, not an invariant response surface derived from the sources.
PEOM	Period entrainment and phase-correction studies motivate timing adjustment. <i>Sources:</i> Thaut 2015 ; Thaut 1998 .	Optimization describes a computational proposal; the particular objective and coefficients are not automatically source-derived.
MSR	Bangert examines shared auditory-motor networks in musicians; Lahav studies action representations elicited by learned sounds. <i>Sources:</i> Bangert 2006 ; Lahav 2007 .	Task/training-specific effects motivate reorganization, without proving a universal sensorimotor transformation or this model's score.
GSSM	The main source studies gait-synchronized electrical brain stimulation after stroke. <i>Sources:</i> Yamashita 2025 .	That external stimulation protocol is not implemented merely by processing or listening to music; motor benefit is not inferred here.
HMCE	The source studies hierarchical neural encoding of musical context. <i>Sources:</i> Mischler 2025 ; Norman-Haignere 2022 .	Encoding-model performance does not establish the implementation as a distinct discovered biological circuit.
HGSIC	Potes relates high-gamma activity to sound intensity; Grahn concerns beat-related motor activity. <i>Sources:</i> Potes 2012 ; Grahn 2007 .	These anchors do not establish hierarchical groove-state integration. The historical High Gamma-Sound Intensity Coupling label explains the source lineage.
ASAP	Patel and Iversen explicitly propose Action Simulation for Auditory Prediction. <i>Sources:</i> Ross 2022 ; Patel 2014 .	MI is an implementation inspired by that published hypothesis; its outputs are not an independent validation of ASAP.
DDSMI	Dyadic dance and joint musical-action studies motivate social-motor coordination. <i>Sources:</i> Bigand 2025 ; Kohler 2025 .	Dance and piano tasks supply different evidence; the integrated model is not directly tested by both.
VRMSME	Liang studies VR music stimulation, motor observation and imagery with fNIRS. <i>Sources:</i> Liang 2025 .	Network activation/connectivity is not demonstrated motor-performance enhancement. The motion-sickness source is removed.
SPMC	Grahn and Hoddinott concern beat-related motor/association systems, including SMA and putamen. <i>Sources:</i> Grahn 2007 ; Hoddinott 2024 .	The specified serial SMA-premotor-M1 circuit and its directionality are not established by this pair.
NSCP	Leeuwis relates intersubject neural synchrony to subsequent streaming success. <i>Sources:</i> Leeuwis 2021 .	The removed pupil/groove study is not commercial-prediction evidence. Audio-derived synchrony-labelled values are not measured intersubject EEG synchrony.
CTBB	Sansare studies cerebellar theta-burst stimulation and balance; Okada provides different cerebellar timing context. <i>Sources:</i> Sansare 2025 ; Okada 2022 .	The monkey saccade study is not a balance/ITBS replication; an audio-derived score is not the external stimulation intervention.
STC	Zamorano relates singing training to connectivity; Kleber probes expertise and altered vocal feedback. <i>Sources:</i> Zamorano 2023 ; Kleber 2013 .	Training associations and experimental feedback perturbation are distinct designs, not interchangeable causal estimates.
EDNR	Paraskevopoulos and Leipold concern musician-related network differences. <i>Sources:</i> Paraskevopoulos 2022 ; Leipold 2021 .	Cross-sectional expertise differences do not by themselves establish training-induced causal reorganization.
TSCP	Pantev studies timbre-specific cortical responses; Bellmann synthesizes timbre neuroimaging. <i>Sources:</i> Pantev 2001 ; Bellmann 2024 .	Neither measures synaptic consolidation. The historical Timbre-Specific Cortical Plasticity label and current identifier differ in explanatory level.
CDMR	Crespo-Bojorquez examines context/expertise effects on mismatch responses; Rupp is an editorial. <i>Sources:</i> Rupp 2022 ; Crespo-Bojorquez 2018 .	The editorial is background, not a second mismatch experiment; MMN timing and presence depend on the studied context.

Continued on next page

Table S5b (continued)

Identifier	Published observation / source role	Limit on the retained label
SLEE	Paraskevopoulos examines statistical-learning expertise; Porfyri studies network changes after four weeks of training. <i>Sources:</i> Paraskevopoulos 2022 ; Porfyri 2025 .	MEG/EEG network findings do not measure synaptic long-term encoding. The historical Statistical Learning Expertise Enhancement interpretation is narrower.
ESME	Koelsch and Vuust show expertise-related mismatch responses to musical features. <i>Sources:</i> Koelsch 1999 ; Vuust 2012 .	They do not directly test error-gated encoding or learning. The historical Expertise-Specific MMN Enhancement label is narrower than the current expansion.
ECT	Paraskevopoulos reports greater within-network and reduced between-network communication; Porfyri studies training-related connectivity. <i>Sources:</i> Paraskevopoulos 2022 ; Porfyri 2025 .	Compartmentalization does not establish a necessary behavioural cost or general trade-off.

Supplement S6. Public-data coverage and access decisions

The study uses secondary human data; no new purpose-designed participant experiment was collected under the project's available research conditions. This section documents the practical boundary of the recorded public-data search rather than asserting that the field contains no further usable datasets. Availability was assessed for a particular output, observation and stimulus correspondence. Audio availability, target suitability and completed analysis are separate decisions.

The 30 September 2026 review inventoried 159 existing local dataset/cache directories and searched prior analysis and manuscript records before considering additional releases, prioritizing 2025–2026. This does not prove that a source had never been used anywhere in the project or that music recordings do not overlap across datasets. New release date, data-collection date and new-to-project status were distinguished. Prior-use search records, dataset registries, download logs, mapping decisions and the full-suite method are retained with the source package.

Reuse constraints are documented independently of MI. In [Eerola's \(2025\)](#) sample of music-psychology publications from 2017–2022, only two of ten accessible datasets appeared complete and clearly documented. This historical sample provides context, not a census of 2026 data availability. The [ManyMusic-Stim project](#) explicitly provides open audio, metadata and human ratings while addressing stimulus-selection and copyright constraints. The [FME-24 repository](#) instead states that original audio is omitted because of copyright. These cases illustrate why missing access and a deferred available resource must receive different entries. Existing consonance, chord-pleasure, film-emotion, TenseMusic, chills, PMemo and neural comparison records retain their individual stimulus and timing qualifications in S1–S4 and S7, with separate historical families in the technical archive. Table S6a concerns the additional recent-dataset review; it is not a replacement for that prior-use inventory. A missing original recording is also distinct from a historical experiment evaluated using an explicitly disclosed proxy synthesis.

Table S6a. Recorded access and eligibility decisions (30 September 2026)

Dataset / source	Recorded state	Access or mapping boundary	Consequence for the proposed test
MUSIFEAST-17	Processed; partial response mapping	356/356 released recordings; 32 response rows lack a released stimulus match.	Excerpt-level affect, enjoyment and familiarity targets; direct transfer and fitted comparisons remain distinct.
Lucerne Groove Library	Processed except one file	443/444 waveforms; one recorded HTTP 500 failure (SheW+4).	Pleasure, energy, movement, regularity and interest; source groups retained.
MEET	Partially released; processed	38/116 rated stimuli have released audio; accuracy inconsistencies and perceived/felt wording remain.	Continuous affect comparisons use the accessible subset; classification accuracy held back.
GlobalMood	Original experiment segments unresolved	1,180 local song identities; exact random 15-s stimuli/start times not recovered.	Ratings audited; full-track links do not identify the rated excerpt, so no MI comparison.
FME-24	Original audio unavailable	422 excerpts; repository omits recordings for copyright; 78 published features available.	Published-feature comparisons only; no MI inference from unavailable recordings.
ManyMusic-Stim	Available; deferred	30.4-GB archive not acquired in this run.	Identify rated subset and exact timing before processing; not a missing-audio case.
AIME	Source card checked; deferred	15,600 pairwise comparisons; no completed MI comparison.	Separate music preference from text–audio alignment and group by generator/prompt.
SongEval	Source card checked; deferred	Whole-song judgements; no completed MI comparison.	Short excerpt is not the same target; memorability rating is not delayed recall.
Affective surprise–memory	Separate event-alignment task; deferred	2026 release not acquired in this run.	Align object events and music for recognition/source-memory hypotheses.
Sonic Seasoning	Outside primary target scope	377-record mixed collection; historical and generated stimuli must be separated.	Music–taste associations require a distinct test; not treated as affect/groove replication.
PGGT	Exact audio access not verified	2025 release of a 2024 survey.	Pop-music groove candidate; resolve stimulus correspondence before MI comparison.

Mapping, target and licence qualifications

MUSIFEAST's raw response table contains an additional stimulus identifier, 60s_LOW_08, with 32 rows that do not map to the 356 released audio/metadata records; those rows were retained outside the MI mapping. The Lucerne access failure concerns one identified waveform, not the other 443 successfully processed files. MEET contains ratings for 116 stimuli but publishes 38 corresponding audio files. Among the 7,600 response-code/accuracy pairs examined for those files, 441 disagree; the accuracy target was held back. The repository and workbook also differ between perceived and felt emotion wording. A nominal emotion code was not averaged into a continuous affect score.

GlobalMood's downloaded tables contain 1,180 song identities, 988,925 raw ratings and 117,996 mean-rating rows. The exact random fifteen-second experiment excerpts or their starting times were not available in the inspected releases; a full-track YouTube identifier was not substituted for the rated segment. The local 1,180 count differs from a web summary of 1,182. Four expected mean-label cells are absent, and the number of participant identifiers also differs from the reported rating-phase sample. These unresolved source issues remain in the integrity report. FME-24 supplies 1,784 annotation rows, 91 columns and 78 published features for 422 excerpts, but not the original audio. Its feature-only comparisons are therefore not MI evaluations.

Source licences and redistribution permissions are retained separately from technical accessibility. MUSIFEAST's data licence does not make all commercial audio unconditionally CC0. An explicit redistribution licence was not recovered for Lucerne in the local review; MEET reports CC BY 4.0. The manuscript does not supply new permissions or redistribute these recordings. The broader neural eligibility inventory contains 32 records across modalities; it is not a set of 32 suitable independent fMRI/PET datasets.

Completed processing and outcome-specific comparisons

The separate recent-dataset pipeline records processing of 837 available audio files: 356 MUSIFEAST, 443 Lucerne and 38 MEET. Each saved record contains the available 1,791-channel collection, including 889 outputs from 84 unique mechanisms. Output production is not equivalent to matched human validation of every channel. This run includes native belief observations and model-derived RAM/neuro outputs, but not Bayesian posterior loops or the context-dependent reward formula.

Table S6b reproduces the fixed-family comparisons from the saved full-suite report. MUSIFEAST uses the 65-excerpt held-out partition; Lucerne and MEET use pilot-excluded nested grouped cross-validation. The saved protocol was fixed after the initial pilots and before these comparisons; it is

a local scope lock, not a prospective registration. Imputation, scaling, categorical encoding and ridge selection use training data only, with four inner group folds and alpha in {0.1, 1, 10, 100, 1000}. MUSIFEAST holds artist/source/audio-related groups together. Lucerne and MEET hold source works together and exclude pilot-related works, but may share artists across folds. Listeners are not separately held out. The intervals use 2,000 source-group bootstrap draws of fixed predictions; they neither refit the model nor quantify new-participant generalization. These fitted comparisons are distinct from the direct-channel associations in Table S3a. Lucerne’s movement/regularity/interest families are exploratory selections over 132 F7 channels. The MEET R³-97 baseline is unstable at n=30; a positive delta from a strongly negative baseline does not imply good absolute prediction. The alternative prespecified four-acoustic-feature MEET comparison gives arousal R² 0.318 to 0.523 and valence -0.298 to -0.122, illustrating control sensitivity. FME’s raw published-feature comparison was disrupted by two feature values of magnitude 10⁹ in one annotation. A separately labelled post-result robustness check used training-fold-only 1st–99th percentile feature limits, leaving observations and targets unchanged. That feature-only check is not evidence for MI. These outcomes demonstrate why unavailable observations, limited datasets and tested weak increments must remain separate categories.

Table S6b. Saved full-suite primary-window comparisons

Dataset / target / family	n	Baseline R^2	+MI R^2	ΔR^2 [95% interval]
MUSIFEAST-17 / valence / paper_valence_leaders	65	0.301	0.341	+0.040 [-0.045, +0.109]
MUSIFEAST-17 / arousal / paper_arousal_leaders	65	0.586	0.569	-0.016 [-0.087, +0.036]
MUSIFEAST-17 / enjoyment / archive_liking_top3	65	0.700	0.703	+0.003 [-0.028, +0.024]
MUSIFEAST-17 / enjoyment / paper_native_pleasure	65	0.700	0.698	-0.002 [-0.011, +0.009]
Lucerne / PLE / paper_native_pleasure	426	0.237	0.254	+0.017 [-0.008, +0.049]
Lucerne / PLE / archive_liking_top3	426	0.237	0.230	-0.007 [-0.019, +0.003]
Lucerne / ENE / paper_arousal_leaders	426	0.612	0.611	-0.001 [-0.006, +0.005]
Lucerne / MOV / exploratory_F7_MOV	426	0.486	0.493	+0.007 [-0.021, +0.035]
Lucerne / REG / exploratory_F7_REG	426	0.372	0.361	-0.010 [-0.027, +0.007]
Lucerne / INT / exploratory_F7_INT	426	0.295	0.296	+0.001 [-0.023, +0.025]
MEET / valence / paper_valence_leaders	30	-0.475	-0.432	+0.043 [-0.012, +0.109]
MEET / arousal / paper_arousal_leaders	30	-7.839	-7.791	+0.048 [+0.012, +0.118]

Baseline follows the saved source comparison: MUSIFEAST combines four acoustic features, MIR33, genre and two familiarity ratings; Lucerne combines the four acoustic features, published numeric rhythm descriptors, style and familiarity; MEET combines the four acoustic features and 97 R³ means. The four acoustic features are RMS, spectral centroid, zero-crossing rate and onset-envelope variability. Human familiarity is an explicit covariate, so these are not uniformly audio-only baselines. PLE, ENE, MOV, REG and INT denote pleasure, energy, movement, regularity and interest. Deltas and intervals are copied at the report’s precision; differences of displayed rounded scores need not equal the displayed delta. The source records all sensitivity windows and alternative controls. No fitting or significance testing was performed for this table.

Source record and access date

The linked mechanism–evidence package retains machine-readable rows for every mechanism, historical catalogues, the 448-record extraction index, source hashes and document checks. The dataset record retains DATASET_RESEARCH, FULL_DATASET_RESULTS, FULL_SUITE_METHOD and the full integrity audit, all dated 30 September 2026. Access states are dated observations; they are not promises that a repository will remain unchanged. Detailed calculation paths and unresolved source questions remain inspectable without converting editorial or schema checks into scientific validation.

Detailed evaluation tables and source roles are retained in this supplement. Implementation-level audit records are available through the controlled-access route stated in the article.

Supplement S7. Protocols for additional retained figure panels

Main Figures 6g,h and 7a–e retain the full plotted families. This section preserves their human targets, channel selection, weaker outcomes and analysis limits. These records are separate from the compact fitted tension comparison in S2 and direct arousal transfer in S3.

Continuous tension and reported chills

The archived analysis tests changing tension within a piece, rather than a correlation across whole-piece means. Across 38 TenseMusic pieces with 30 raters and 50-Hz continuous ratings (Barchet et al., 2024), AAC.F1:hr_pred_2s (autonomic-forecast-labelled output) had an archived Fisher-z mean Spearman correlation of +0.421 with consensus tension in the lag-selected within-piece analysis. All 15 channels in the specified tension pool met its Bonferroni criterion, with positive forecast associations and negative associations for selected prediction-error and mismatch readouts (Figure 7c,d). The forecast was positive in 34 of 38 pieces. The +0.421 and 34/38 values describe that historical procedure; the later timing audit does not establish them as a final, clock-verified positive-tracking estimate (S7).

Lags span ± 5 s in 0.5-s steps. The largest absolute correlation selects the lag, while the reported coefficient retains its sign; selection repeats in 200 circular-shift nulls. These are within-piece associations, not held-out forecasts. Fisher-combined significance need not imply consistent direction: SRP harmonic tension averages +0.018, with 19/38 positive pieces, despite corrected $p = 3.04 \times 10^{-26}$. The separate ridge leave-one-piece-out median (+0.101) and human inter-rater agreement (+0.386) use different comparisons.

AAC reconstruction passed tolerance on all 38 cached inputs. Float64 M14 arithmetic changed its aggregate correlation by -3.96×10^{-8} , retaining 34 positive pieces; null probabilities were not rerun (this section). In clean-seven ChillsDB (Schoeller et al., 2023), MMP.P2 (familiarity-labelled output) was elevated within ± 5 -s event windows: mean rank-biserial $r = +0.2307$, Bonferroni $p = 0.0072$, positive in all seven stimuli. This detailed table supersedes the earlier summary manifest. Nine-stimulus and alternative-denoising effects were +0.1599 and +0.2287, with corrected $p = 0.4526$ and 0.4775. The latter also changes the 8-s exclusion, event/frame masks, effect aggregation and null p calculation; it is not a denoising-only comparison (this section). AAC.IO:chills_intensity gives +0.0378, corrected $p = 1$. These results support neither a measured familiarity mechanism nor autonomic physiology: neither was independently observed.

The physical audio/annotation clock relation and behavioural response lag are separate. The audit identified a Schoenberg annotation cross-mapping, invalid initial samples and normalized-time stretching in the historical evaluation. A source-verified clock origin and a specified directional or fixed-lag rule are required before accepting a replacement positive-tracking coefficient. The retained numerical-stability check above addresses arithmetic, not these alignment questions.

Emotion ratings across excerpts and over time

We contrasted emotion judgements about whole excerpts with ratings that vary during listening. In the 110-entry film-soundtrack set of Eerola and Vuoskoski (2011), all eight specified emotion pools contained Bonferroni-significant associations. For selected leading channels, original and acoustic-residual correlations were +0.741 $\rightarrow$ +0.430 for sadness, +0.722 $\rightarrow$ +0.447 for tenderness, and $-0.683 \rightarrow -0.504$ for tension (Figure 6g). Targets are perceived musical emotion, not felt emotion or GEMS scales; model labels do not measure physiology.

Ratings were predicted from 97 clip-averaged R^3 features with five-fold ridge regression; each out-of-fold prediction was subtracted before correlating residuals with mechanism outputs. Clip averaging removes temporal information, and whole-set channel selection limits generalisation. Seven of eight selected leading readouts retained residual $|\rho| \geq 0.10$. This effect-size criterion differs from corrected significance: the selected anger and happiness readouts did not pass residual Bonferroni correction. Every full pool contained at least one residual $|\rho| \geq 0.10$ in the detailed tables. In the 360-excerpt pilot set, three leading channels were identical across sets; the other five leading associations used different members of

the specified pools (Figure 6h). The 110-entry Set 2 was developed from the 360-entry Set 1 pilot, so this is overlapping cross-set correspondence rather than independent held-out replication.

The archived dynamic-emotion test was less consistent. Its 2-Hz ratings define within-excerpt trajectories rather than one value per excerpt. In the 200-selected-excerpt PMemo pilot (Zhang et al., 2018), leading channels had 192 usable excerpts. No arousal channel among 19 met Bonferroni correction, compared with three of 15 valence channels (Figure 7a,b). Leading mean correlations were +0.1619 for the arousal-labelled output and +0.1197 for wanting. The separate human reliability analysis used 740 excerpts and cannot turn these results into matched ceiling estimates.

Positive excerpt-level associations and weak dynamic effects answer different questions. The observation units and timing requirements remain distinct. PMemo timing and finite-sample limitations are recorded alongside the preserved historical results in S7.

Why the chills protocols are not interchangeable

TC005 uses all reported events and frames, ± 5 -s windows, 500 uniformly placed event-time nulls over the complete record, seed 2026051205, and a Fisher-z mean effect. Its empirical p is $(1 + \text{count}(\text{null} \geq \text{observed})) / (1 + \text{number of valid nulls})$. TC006 excludes events at or before 8 s and masks the first 8 s of frames, constrains null centres to keep windows within the remaining interval, uses seed 2026051206, and reports an arithmetic mean effect. Its p is a raw tail fraction without the +1 correction; the tail changes for negative observed effects. The shared Fisher helper discards $p = 0$ values. Thus the number of pieces entering the combined statistic can differ even when the mean effect is similar. Both apply channel-family Bonferroni correction, but they are not otherwise the same test.

The aggregate tables do not identify each discarded p or isolate the contribution of each procedural difference. A matched sensitivity rerun is required to attribute the change quantitatively. The alternative result is retained as a protocol-dependent observation, not a denoising-only robustness test.

AAC F1: targeted numerical sensitivity

The preserved audit fixed all 38 pieces, the AAC.F1 output and the original signed effect summary before inspecting the numerical alternative. Conditional reconstruction from the retained inputs agreed with the cached outputs within the recorded tolerance. The targeted precision change left the signed Fisher-z mean association effectively unchanged: 0.4206821003 for the reference and 0.4206820608 for the alternative, with 34 positive pieces in each. This does not settle other numerical regimes or AAC's physiological interpretation. Circular-shift null probabilities were not recomputed; archived corrected probabilities are not assigned to the alternative. Implementation-level numerical definitions and reconstruction records remain under controlled access.

Execution identity and retained gaps

For the central Swan Lake example, the audio checksum matches the recorded input, all 852 Python files in the preserved snapshot match the original selection lock, and all 84 selected implementation paths and their ordered inventory agree with recorded execution. Saved R^3/T^3 arrays, reference/intervention outputs, successful-read traces, calculation audits, display arrays and figure scripts form a separately hashed chain. The prior executor replay exactly reproduced the saved $C^3/\text{RAM}/\text{proxy}$ outputs from saved R^3/T^3 inputs. It was not a repeat of audio extraction. Missing-lookup behaviour is recoverable from locked code and recorded availability, but there is no complete dynamic log of every fallback branch. The controlled R^3/T^3 figures have a second chain of 86 verified preserved input/source records, synthesis definition, intermediate arrays and display queries.

The historical TenseMusic cache is less fully identified. All 38 clip checkpoints and the build pin cite d74d3ee760c5..., whereas the dataset manifest gives e537f90e6d14.... The currently available source tree has aggregate 482ade45c50f... under the recorded hashing algorithm. This is a disagreement among identity records, not interchangeable names for one verified execution. The retained builder instantiates 89 mechanisms before name-keyed overwrites produce 84 arrays; the current 84-name inventory cannot substitute for its caller. Successful AAC numerical reconstruction does not determine all historical duplicates, execution paths

or fallback use. The film cache also stores 84 mechanism arrays and 889 columns; these cardinalities alone identify neither implementation selection nor execution order.

The current canonical inventory records duplicate STAI selection differences, same-depth HCMC/MSPBA inputs unavailable to OII, and belief precision requests absent from the canonical mechanism-only demand collection. Those facts cannot fill absent run-level logs. Selected implementation paths, actual execution order and fallback consumption remain explicitly unresolved for archived families where they were not recorded. Future runs need to store these fields with the outputs.

Timing audit and the status of the archived tension coefficient

The archived AAC.F1 coefficient +0.421, its 34/38 positive-piece count and the 15-channel significance summary are retained with the historical tables and figures. They used normalized-time interpolation and lag selection by maximum absolute Spearman correlation. The later source audit verified all 38 audio identities against original OSF SHA-256 meta-data, identified the Schoenberg/Schoenberg_2 annotation cross-mapping and found invalid initial consensus samples. Dropping an invalid sample must use the same time mask for both aligned series; it must not independently reset either clock. These findings limit the interpretation of the retained coefficient and count.

The original Barchet analysis joins feature and rating time columns and applies a 4.5-s reporting-delay shift. This analysis convention does not establish the physical audio-to-rating clock offset. The inspected public

source files did not supply a sound-start event or the experiment clock-reset relation. A duration excess or first valid mouse sample alone cannot identify audio onset. No replacement primary coefficient is accepted until that relation and the directional or fixed-lag rule are specified. Selecting the largest signed correlation would require repeating that same selection in every null draw; probabilities from the historical absolute-maximum test cannot be reused. Post-result corrective choices remain exploratory.

A negative selected correlation can identify an inverse association, but is not evidence for a pre-specified positive-tracking claim. The historical combined absolute-association test and a directional tracking test therefore have different null hypotheses. The small point-estimate change from a finite-value mask also does not imply that missing-value handling is neutral for the null probabilities.

Dynamic emotion and resolution limits

The PMemo values in the Figure 7a,b remain those of the archived 200-selected-excerpt pilot, with 192 usable excerpts per leading channel. The subsequent audit found that target timestamps and the 15-s annotation exclusion must be represented explicitly; short-record eligibility, constant channels and undefined observed or surrogate correlations also require explicit handling. Corrective calculations are separately recorded rather than substituted for the deposited numbers. Weak or null dynamic arousal results cannot be explained away by its 2-Hz grid, and positive valence effects do not establish 172-Hz human validation. Establishing a resolution effect would require the same stimuli, target, filtering, time support, lag rule and dependence-aware evaluation across controlled resolutions.

Table S7a. All historical within-piece tension channels (Figure 7c,d).

Channel	Pieces	Fisher-z mean ρ	Positive pieces	Bonf. p
AAC.F1:hr_pred_2s	38	+0.42068	34	1.42e-37
AAC.F0:scr_pred_1s	38	+0.38834	34	1.83e-37
SRP.T0:tension	38	+0.31927	32	1.51e-31
SRP.T1:prediction_match	38	-0.18903	9	8.01e-31
CDMR.P0:mismatch_signal	38	-0.16817	8	4.04e-28
SRP.C2:prediction_error	38	-0.13595	11	1.6e-28
PUPF.U0:entropy_H	38	+0.10351	29	5.86e-31
RPEM.rpe_magnitude	38	-0.09866	7	1.03e-32
CDMR.f01:mismatch_amplitude	38	-0.05143	17	2.73e-26
PUPF.U2:HS_interaction	38	+0.03912	23	1.33e-23
PUPF.E0:prediction_err	38	-0.02958	17	5.82e-27
PUPF.U1:surprise_S	38	+0.02266	29	1.14e-26
PUPF.P0:surprise_pleasure	38	-0.02175	16	6.86e-25
SRP.M0:harmonic_tension	38	+0.01803	19	3.04e-26
PUPF.E1:uncertainty	38	-0.01611	19	5.96e-22

Table S7b. All chills channels under three overlapping protocols (Figure 7e).

Channel	Clean 7 effect	Bonf. p	Full 9 effect	Bonf. p	Alternative 7 effect	Bonf. p
AAC.P0:current_intensity	+0.03005	0.926	+0.01677	0.044	+0.02403	0.13
AAC.I0:chills_intensity	+0.03783	1	+0.01370	0.142	+0.02833	0.419
AAC.I1:ans_composite	+0.08154	0.0454	+0.05585	0.0471	+0.06831	1
AAC.F0:scr_pred_1s	+0.10086	0.0204	+0.06441	0.168	+0.07289	1
AAC.F1:hr_pred_2s	+0.13269	0.0319	+0.08697	1	+0.10262	0.308
AAC.E0:emotional_arousal	+0.16972	0.0141	+0.11255	0.472	+0.14685	0.0533
AAC.E1:ans_response	-0.01559	1	-0.02140	0.102	-0.01339	0.654
AAC.P1:driving_signal	-0.00263	1	-0.00865	0.789	-0.00789	0.706
AAC.P2:perceptual_arousal	+0.11439	0.0557	+0.07355	0.0235	+0.09031	1
DAED.f01:anticipatory_da	-0.02741	1	-0.03245	0.148	-0.02632	0.222
DAED.f02:consummatory_da	-0.11818	1	-0.14530	0.0536	-0.12420	0.234
DAED.f03:wanting_index	-0.11135	1	-0.11664	0.0177	-0.09599	0.162
DAED.f04:liking_index	-0.11569	1	-0.14176	0.0637	-0.12085	0.162
SSRI.P1:endorphin_proxy	-0.02899	1	-0.04219	0.243	-0.02998	0.316
MMP.P2:familiarity	+0.23070	0.00716	+0.15990	0.453	+0.22870	0.477
SRP.M0:harmonic_tension	-0.00226	1	-0.01028	0.87	-0.01102	0.4

Table S7b (continued)

Channel	Clean 7 effect	Bonf. p	Full 9 effect	Bonf. p	Alternative 7 effect	Bonf. p
SRP.M2:peak_detection	-0.03909	1	-0.04616	0.145	-0.02524	0.107
SRP.P2:pleasure	-0.08482	1	-0.10917	0.0992	-0.08255	0.217
BCH.P0:consonance_signal	-0.03674	1	-0.05556	0.158	-0.03408	0.264
PUPF.P0:surprise_pleasure	-0.00412	1	-0.00299	1	+0.00493	1
UDP.M1:pleasure_index	-0.08371	1	-0.10802	0.225	-0.07378	0.392
MORMR.f02:chills_count	+0.00079	1	+0.01674	1	+0.01036	1

The clean-seven column uses the TC005 Fisher-z mean; the alternative seven-stimulus protocol changes denoising, exclusion, masks, aggregation and null handling as described above. The columns are not independent replications and are not a denoising-only sensitivity test. The complete event and per-piece records remain in Source Data S4.2.

Table S7c. Complete dynamic-emotion families (Figure 7a,b).

Target	Channel	Clips	Fisher-z mean ρ	Positive clips	Bonf. p
Arousal	AAC.E0:emotional_arousal	192	+0.16192	118	1
Arousal	AAC.A1:hr	192	+0.13218	123	1
Arousal	AAC.E1:ans_response	192	-0.08508	80	1
Arousal	AAC.A0:scr	192	-0.07061	88	1
Arousal	CSG.E1:sensory_evidence	192	-0.06809	84	1
Arousal	PUPF.E1:uncertainty	192	-0.06319	83	1
Arousal	AAC.P2:perceptual_arousal	192	+0.06265	110	1
Arousal	AAC.P1:driving_signal	192	-0.05878	86	1
Arousal	AAC.P0:current_intensity	192	-0.04893	92	1
Arousal	PUPF.U0:entropy_H	192	+0.04522	105	1
Arousal	PUPF.E0:prediction_err	192	+0.04205	107	1
Arousal	AAC.F1:hr_pred_2s	192	+0.03769	106	1
Arousal	AAC.F0:scr_pred_1s	192	+0.03646	104	1
Arousal	MCCN.E2:arousal_index	192	+0.03274	106	1
Arousal	AAC.A2:respr	192	+0.03015	102	1
Arousal	CSG.P0:salience_network	192	+0.03014	104	1
Arousal	TAR.T0:arousal_mod_tgt	192	-0.02961	88	1
Arousal	PUPF.U1:surprise_S	192	-0.01499	93	1
Arousal	CSG.E0:salience_activation	192	-0.00232	99	1
Valence	SRP.P0:wanting	192	+0.11967	121	0.00379
Valence	VMM.R0:happy_pathway	192	+0.08945	104	0.0183
Valence	SRP.P2:pleasure	192	+0.07485	110	1
Valence	CMAT.S0:supramodal_valence	192	+0.06430	108	0.515
Valence	CLAM.P1:valence_tracking	192	+0.03674	101	1
Valence	VMM.V0:valence	192	+0.03025	99	0.803
Valence	VMM.V1:mode_signal	192	+0.02672	96	0.0237
Valence	SRP.P1:liking	192	+0.02257	97	1
Valence	CSG.P1:affective_evaluation	192	-0.02179	38	1
Valence	PUPF.G0:pleasure_P	192	-0.01778	89	1
Valence	CSG.M1:rt_valence_judgment	192	+0.01656	91	1
Valence	VMM.R1:sad_pathway	192	-0.01654	92	1
Valence	CSG.E2:consonance_valence	192	+0.00986	45	1
Valence	CSG.F0:valence_pred	192	+0.00766	76	1
Valence	UDP.M1:pleasure_index	192	+0.00711	97	1

All eight original film-emotion pools, their residual comparisons and the 360-entry pilot tables are retained in the emotion source records. Main Figure 6g selects the largest absolute original association within each

110-entry pool; Figure 6h permits a different leading channel in the overlapping pilot, identifying changed selections by marker shape. Complete tables, rather than only these maxima, define the comparison family. The R2 source index identifies all files and the figure-panel mapping.

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