# New Paper Explores Periodism in Caldwell's Dynamic Ringframe Theory of Consciousness

*Periodic events—whether externally or internally generated—may engage rotational dynamics in brain modeling space, both experienced and measured.*

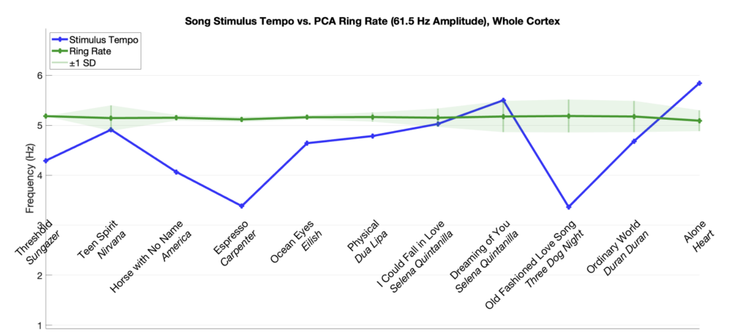


Figure 23: **Description:** PCA ring rate remained at ∼5.15 Hz, invariant to the changing tempo of the eleven stimulus songs. Average ring rate of 5.153 Hz; average standard deviation of +/- 0.167 Hz. **Electrodes:** 16 total (whole cortex): Fp1, Fp2, C3, C4, Pz, Fz, O1, O2, F7, F8, F3, F4, T3, Cz, P3, P4. **Matlab code for this figure:** `https://github.com/caldwbr/tempoLockPCA/blob/main/tempoVsRingRate.m`.

Whole-Cortex Dynamic AM-PCA of 61.5 Hz: Steady 5.15 Hz Ring Rate Despite 3–6 Hz Tempos

AUBURN, AL, UNITED STATES, July 13, 2025 /EINPresswire.com/ -- A newly released paper by researcher Brad Caldwell (BSCE, Auburn University) investigates the role of periodicity in shaping rotational cortical dynamics, offering new support for the broader framework of his Dynamic Ringframe Theory of Consciousness. The analysis focuses on principal component analysis (PCA) of cortical EEG data during musical listening, evaluating whether macroscale brain rhythms track external tempo and/or lock to transient events.

> “Periodic rhythms—whether seen, heard, or generated—may engage rotational dynamics in how the brain models experience.”
>
> *Brad Caldwell*

The primary image shows whole-cortex PCA ring rate staying 5.15 Hz, invariant to drifting song tempos (this is in contrast to microscale PCA of motor areas that show tempo-locking). The table (image 2) explores observed vs. measured rotational dynamics as they relate to various periodic stimuli. Image 3 shows how the raw 60 Hz power envelopes of EEG signals already show 5.16 Hz periodism, aloof to the song's 4.78 Hz tempo.

The work builds on a growing body of evidence that recurring rhythms—whether externally or internally generated—may engage rotational dynamics in brain modeling space, both phenomenally and in measured activity.

Caldwell’s latest findings are derived from a dynamic PCA approach applied to amplitude or power envelopes across multiple frequency bands. While the PCA trajectory (ring) rate was found to hold steady at 5.15 Hz invariant to the songs' varying tempos, the data did reveal apparent transient locking to salient musical events such as beat drops and vocal onsets. This suggests that dynamic PCA, though perhaps not the right lens to be looking through, might be showing some real clues of perceptual encoding telegraphing through. This assumes the novel idea that consciousness is largely the interpretation of a filtered events or transients stream.

This interpretation aligns with one of the central claims of the Dynamic Ringframe Theory: that conscious perception unfolds through a sequence of discrete, geometry-like frames (“ringframes”) formed by transient neural responses, with revolution or radar-like sweep often being a key facet. These ringframes, often sweeping a torus or sphere, are proposed to act as structural anchors for how the brain builds and updates its world-model, and may under certain PCA lens settings appear clearly as period-locked rotation.

While Caldwell’s analysis focused on macroscale cortical dynamics derived from EEG, it complements prior work showing strong evidence of periodicity-linked rotation at the neural population level. In a PLOS Biology study involving monkeys trained to tap in rhythm, researchers found that frequency-modulated spike train patterns in medial premotor cortex formed clean circular trajectories when plotted via PCA. These neural “rings” expanded or contracted based on tapping tempo but maintained a consistent internal rotation—completing one full revolution per tap interval. This result suggests that low-dimensional rotational structure may serve as an internal timekeeping scaffold in the motor system.

**Periodism—Observed vs. Measured Across Conditions**

| Period Type | **Observed** (Phenomenal) | **Measured** (Micro-/Macro-) |
|---|---|---|
| **1. Motor** *(Hand-Pedal, Walking)* | Sense of Repetition; Bank/Radar Revolution | Motor FM-PCA Period-Locked Rings *(Microscale)* |
| **2. Metronome/Song Tempo** *(Internal or External)* | Sense of Rhythm; Rings Printed or Perturbed to Salient Transients | Medial Premotor FM-PCA Period-Locked Rings *(Microscale)* / Whole Cortex AM- or PM-PCA Period-Aloof Rings with Possible Transient-Locking (Fixed 5.15 Hz) *(Macroscale)* |
| **3. Photic Drive** | Occasional Revolution in Visual Field (Up to ≥13 Hz); Possibly Period-Locked | No PCA Rings (Unclear; may exist in microscale studies but not yet shown at macro level) |
| **4. Sedation** | Revolution/Rotation Noted; Typically 0.5–12 Hz | Potential Periodic Stimulus Involving HCN1 Channels of Layer 5 in Retrosplenial Cortex / Default Mode Network |

Phenomenal vs. Measured Rotation in Response to Periodic Stimuli

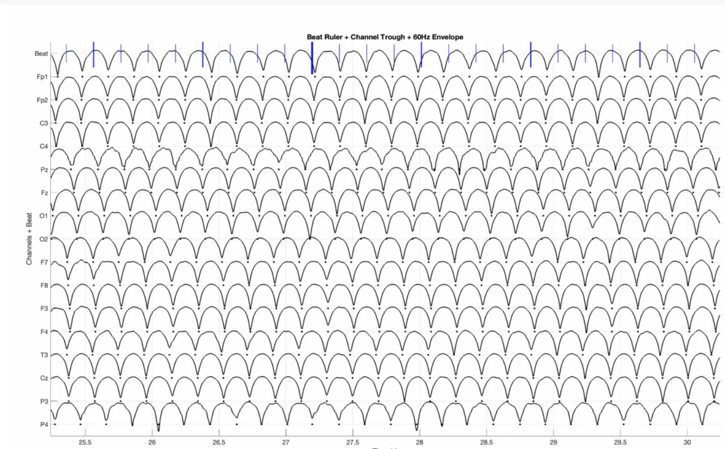


Figure 3: **Stimulus:** *Physical* by Dua Lipa (500 ms depicted here). **Signal:** Log of the 60 Hz power envelope. **Electrodes:** 16 total (whole cortex): Fp1, Fp2, C3, C4, Pz, Fz, O1, O2, F7, F8, F3, F4, T3, Cz, P3, P4. **Results:** `https://www.youtube.com/watch?v=z1ByAxASAAk`. **Beat Ruler and Video Code:** `https://github.com/caldwbr/tempoLockPCA/blob/main/arches.m`.

Log of 60 Hz Power Shows 5.16 Hz Periodism, Aloof to 4.78 Hz Song Tempo

A similar pattern has been observed in the Mark Churchland work on motor cortex, where low-dimensional neural trajectories during cyclic movements form null-output elliptical loops in PCA space, using PCs 1–3 (a sort of phase-address system, to which are attached specific muscle outputs using PCs 4–6+). As movement speed changes, the ring moves normally to itself and grows/shrinks, but the loop's shape remains fairly stable—slightly different trajectories are traversed to allow the slowing or speeding of the task.

Caldwell's paper adds to this picture by examining the macro-level end of the spectrum, where data reflects a noisy summation of millions of action potentials, artifacts, and potential washout of any neural-level orthogonalization. Instead of discrete spike sequences, the EEG-based PCA captures coordinated amplitude modulations in broad cortical networks. Despite the messiness no doubt present in whole-cortex EEG, 5.15 Hz ring attractors of specific shape (using amplitude or power of 52.5–62.5 Hz gamma band of EEG) arose for most songs following the intro, and dissipated after the end of the song (song tempos varied from 3 to 6 Hz).

Caldwell emphasizes the need to distinguish between phenomenal revolutions (those experienced subjectively, such as a sense of revolution in the visual field while wearing strobing glasses, or the repetitive cycle of walking) and measured revolutions (those detected in data, such as PCA ring trajectories). While microscale studies often show clear alignment between the two—particularly in tasks involving motor timing—macroscale measurements have not yet been seen to show period-locking. Caldwell notes that different PCA approaches (e.g. static, dynamic, jPCA, dPCA), signal types (FM of spikes vs. amplitude or power of EEG frequency bands), and parameter choices (window length, taper width, interpolation method) can all influence what kind of rings emerge, if present.

Photic drive (strobing white light—sometimes referred to as Ganzflicker when alternating red light and blackness) is a reliable method for inducing eyes-closed hallucinatory visual field patterns from periodic stimuli, often in the 8–13 Hz range. Reported phenomena include zigzagging chevrons laid down in a rotational or revolving fashion (resembling the black-and-white floor of the Black Lodge in Twin Peaks, or the zigzag on Charlie Brown's shirt), as well as square tunnels, plus and X shapes, and checkerboard grids. The perceived revolution rate in the visual field often locks to the stimulus interval (e.g., 100 ms per flash for 10 Hz).

As of now, no published studies are known to have investigated FM-PCA at the microscale in occipital cortex under photic drive, though it remains a potentially rich domain for future work. No macroscale AM-PCA rings were observed in a whole-cortex EEG study using 9.8 Hz photic stimulation via Kasina glasses, though transient entrainment was evident in the raw EEG waveforms.

Together, the convergence of findings—from tempo-period-locking FM-PCA rings in premotor cortex to task-period-locking ones in motor control, to fixed-rate AM-PCA rings arising sometimes during song listening—suggest that periodism may often invoke revolution or rotation in experience and in neural data. Although microscale FM-PCA appears most promising, macroscale AM- or PM-PCA reveals occasional rotational dynamics that appear so shape-consistent as to warrant further study.

Brad Caldwell
Caldwell Contracting LLC
+1 334-332-7799
Caldwbr@gmail.com
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X

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