Sleep as Attractor Maintenance: Glymphatic Clearance, Synaptic Rescaling, and Dynamical Resilience

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Abstract

Sleep is often called "hardware maintenance" (deep sleep) and "software maintenance" (REM sleep).
This paper re-interprets sleep using the **attractor framework**, where your mind is a dissipative attractor of your whole body.

We propose that different sleep stages are different **attractor regimes**:

- **Deep (NREM) sleep** – a slow, relaxing state that clears waste and dials down brain connections.
- **REM sleep** – a fast, high-dimensional attractor that updates your brain's internal model.

We review evidence for:

- Glymphatic clearance (waste removal)
- Synaptic homeostasis (downscaling of connections)
- Slow-oscillation/spindle coupling
- Sleep–immune interactions

We also show how sleep fragmentation, ageing, chronotypes, and sleep disorders can be understood as changes in **attractor depth**, **stability**, and **corrective permeability**.

The framework introduces a **persistence functional** $P(x)$ — a single number that measures basin depth — which could be estimated from EEG or wearables to predict resilience to sleep loss and guide closed-loop interventions.

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1. Introduction

In the attractor framework, your mind is a **dissipative attractor of your whole body** — a pattern that needs constant energy, can be disturbed, and can adapt.
Sleep is a natural, periodic disturbance that lets the system reset, repair, and reorganise. It is **not** passive; it is an **active attractor maintenance process**.

We focus on two major sleep stages:

- **NREM sleep**, especially deep slow-wave sleep (NREM 3) — a **slow constraint relaxation** that brings the brain and body back to a low-energy baseline.
- **REM sleep** — a **fast, high-dimensional attractor** for active reorganisation, memory consolidation, and predictive coding updates.

This paper bridges sleep neuroscience with the attractor framework.

What does the framework add?

- **Integration** — a common language across scales.
- A **unified quantitative biomarker** P(x)$P(x)$ from EEG or wearables.
- **Novel predictions** (e.g., wearable early-warning signals, REM-emotional rebound) that are not obvious from the individual component theories.
  This is **generative integration** — a scientific contribution even without claiming new mechanisms.

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2. The Attractor Framework Primer

- **Conservative attractors** (the “six metronomes”) — eternal, time-symmetric, provide steady rhythms. They are the floor, not part of maintenance.
- **Dissipative attractors** (life, mind, society) — need energy flow, have finite lifetimes, can evolve. The brain is a nested stack of dissipative attractors.
- **Persistence under perturbation** — a resilient system returns quickly to its attractor after a disturbance.
- **Self-engineering** — using small, repeated disturbances to reshape your own attractor. Sleep is a natural self-engineering cycle.

Sleep moves you through: **wake → NREM → REM → wake**.

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3. NREM Deep Sleep — Slow

Constraint Relaxation

3.1 Glymphatic clearance – flushing out waste

Deep slow-wave sleep (NREM 3) is essential for clearing brain waste.
Studies show that the glymphatic system (which removes waste) works best during deep NREM (Iliff et al., 2012). Norepinephrine drops during sleep, expanding the space around cells and improving fluid flow (Balkrishnan et al., 2023, conference abstract).

In attractor terms: The deep-sleep attractor (high delta power) relaxes the metabolic constraints that build up during the day. Waste clearance rate scales with **attractor depth** (measured by slow-wave activity, SWA). Shallow or broken sleep leads to waste buildup.

3.2 Synaptic homeostasis – resetting brain connections

The synaptic homeostasis hypothesis (SHY) says:

- Wakefulness strengthens synapses (deepens attractor basins).
- NREM sleep downscales synapses (shallows basins) (Tononi & Cirelli, 2006).

SWA reflects this – it is high after waking and declines across the night.

In attractor terms: The persistence functional P(x)$P(x)$ would be high after waking, then drop during NREM as synapses downscale. The rate is steep early and plateaus later – compatible with critical slowing down near awakening (though direct evidence is mixed).

3.3 Slow-oscillation–spindle coupling – nested rhythms

Memory consolidation during sleep depends on the tight coordination of:

- Cortical slow oscillations (<1 Hz)
- Thalamocortical spindles (12–15 Hz)

This is best described as **nested oscillatory coupling** (Ngo et al., 2013) – the slow oscillation modulates excitability, creating windows for spindles.
We interpret this as **different timescales within a single attractor manifold** (parsimonious). (Two coupled attractors could also produce phase locking; the question is subtle, but we take the simpler view.)

Stronger phase-locking between spindles and slow oscillations predicts better memory. Closed-loop stimulation (auditory or electrical) timed to the up-phase enhances both slow waves and spindles – showing that the attractor can be externally reinforced.

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4. REM Sleep – Fast, High-Dimensional Attractor

REM sleep has activated EEG (low voltage, fast rhythms) and vivid dreaming.
From a **predictive coding** view (Friston, 2010), REM updates the brain's generative model by resolving prediction errors.

Dynamically, the NREM → REM transition is a **phase bifurcation**:

- NREM is a low-dimensional attractor (regular slow oscillations).
- REM is higher-dimensional (complex, desynchronised EEG).

Indeed, EEG complexity (e.g., Lempel-Ziv complexity) is higher in REM and wake than in NREM.

If REM dreaming implements predictive coding, then nights with stronger REM (longer, more intense periods) should show greater emotional memory consolidation. (The idea of lucid dreaming as a “meta-attractor” is not pursued here.)

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5. Sleep Fragmentation and Attractor Instability

Frequent awakenings (fragmentation) repeatedly disturb the sleep attractor.
Each arousal is a temporary escape from the NREM or REM basin, reducing effective depth and slowing re-entry. This is a state of **reduced attractor stability** with **critical slowing down** (Scheffer et al., 2009): recovery takes longer.

Recent work (de Mooij et al., 2020) found that EEG change-points – transitions between stages – are often preceded by early-warning signals (rising variance and autocorrelation).
Grossman et al. (2025) showed that the wake-to-sleep transition follows a bifurcation dynamic, detectable minutes before sleep onset.

Wearables (HRV, actigraphy) could detect similar signs – rising movement variance, increasing HRV autocorrelation – before a failed sleep transition. Closed-loop auditory tones could then reinforce the desired attractor.

6. Inter-individual Differences, Aging, Chronotypes, and Immune Coupling

Resilience to sleep loss

People vary widely. The **PER3 clock gene polymorphism** is a paradox:

- PER3^{5}/^{5} individuals have more slow-wave sleep and higher delta power, yet they suffer **greater** performance declines under sleep loss (Viola et al., 2011).

This shows that a deeper baseline attractor does **not** guarantee resilience. The framework says resilience requires not only depth but also **corrective permeability** — the ability to re-enter deep sleep after an awakening and to update the attractor under stress (see Section 7).

Aging

Slow-wave sleep drops dramatically with age. In a community study, each 1% annual reduction in SWS was linked to a 27% higher risk of dementia (Himali et al., 2023).
In attractor terms: the deep-sleep basin **erodes** with age, and corrective permeability weakens. Exercise, light therapy, and melatonin may help a little, but only modestly.

Chronotypes

Morning larks and night owls differ mainly in the **phase** of the sleep–wake attractor relative to the light–dark cycle. Both can have similar basin depths, but misalignment may weaken the attractor.

Sleep–immune coupling

Sleep deprivation increases pro-inflammatory cytokines (IL-6, TNF-α) and reduces T-cell activity (Irwin et al., 2016; Besedovsky et al., 2012).
A shallow or fragmented sleep basin destabilises the immune attractor, leading to slower recovery from infection (Cohen et al., 2009) and blunted vaccine responses (Spiegel et al., 2002).

Immune challenge (e.g., infection) also disrupts sleep, increasing SWS — a "sickness behaviour" attractor shift (Krueger et al., 2013). This is **bidirectional coupling** between two attractor landscapes.

Framework-specific prediction: Corrective permeability κ should be **lower** on nights following an immune challenge, independently of changes in delta power.
(Statistical test: partial correlation or regression of κ on immune challenge, controlling for P_{EEG}.) This prediction is not deducible from the cytokine model alone.

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7. Sleep Disorders as Maladaptive Attractors and Corrective Permeability

7.1 Defining corrective permeability κ

κ measures how quickly a system returns to its primary attractor after a disturbance and how easily it updates under chronic stress. $\kappa = \frac{1}{\tau_{recovery}}$

where $\tau_{recovery}$ (minutes) is the time from an awakening back to stable deep NREM (stage 3).

- High $\kappa > 0.2$ min^{-1} → fast recovery (<5 min).
- Low $\kappa < 0.05$ min^{-1} → poor recovery (>20 min).

These thresholds are provisional — for empirical calibration.

Heart-rate recovery slope after awakenings is a candidate wearable proxy (hypothesis, not yet validated).

7.2 Disorder taxonomy

- **Insomnia** — abnormally shallow sleep attractor (low depth) **and/or** low κ. Hyperarousal prevents settling into deep sleep.
- **Narcolepsy** — blurred boundary between wake and REM attractors (orexin loss).
- **REM behaviour disorder** — failure of REM attractor to suppress muscle activity; dream movements “leak out”.

7.3 Falsification conditions

Falsification of the “shallow basin” explanation
If an insomnia patient shows normal delta power ($P_{EEG} > 0.7$) **and** normal corrective permeability ($\kappa > 0.1$) but still has non-restorative sleep, the “shallow basin” model is falsified for that patient.
The framework would be incomplete, not wrong. **But** to prevent this clause from making the theory unfalsifiable, we add a provisional bound:

> *If more than 30% of diagnosed insomnia cases need such additional mechanisms, the framework’s descriptive utility for insomnia would be in question, and the core hypothesis would be falsified.*

Falsification of the attractor framework itself
If sleep stage transitions show **no** evidence of basin-crossing dynamics (no rise in variance/autocorrelation, no attractor dimensionality difference between NREM and REM, no critical slowing down before awakening), then the attractor framework should be abandoned in favour of a purely stochastic or oscillator-based model.
Specifically, a well-powered study using the methods of de Mooij et al. (2020) that finds null results would constitute strong falsification. (We require convergent null evidence across multiple measures.)

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8. The Persistence Functional $P(x)$

$P(x)$ measures attractor depth — the ability to resist disturbance and return to stable state.
We base it on the **dominant Lyapunov exponent** λ_1.

Primary definition (fixed $\tau = 1$ s): $P_{raw} = e^{-\lambda_1 \cdot \tau}$

For a stable attractor, $\lambda_1 < 0$, so $P_{raw} > 1$. Deeper attractors (more negative λ_1) give larger P_{raw}.

To get a bounded [0,1] measure: $P_{norm} = \frac{1}{1 + e^{\lambda_1 \tau}}$

- Values near 1 → deep basin.
- 0.5 → neutral.
- Near 0 → unstable/chaotic.

EEG-practical approximations:

- **Correlation dimension D_2** — in sleep EEG, deeper stages have lower D_2. This is a **sleep-specific** approximation. Then $P \propto 1/(1+D_2)$.

- **Delta power ratio** (simplest):

$$P_{EEG} = \frac{\langle \delta(t) \rangle}{\delta_{wake} + \langle \delta(t) \rangle}$$

where $\langle \delta(t) \rangle$ is mean delta power (0.5–4 Hz) in the epoch, and δ_{wake} is the same during relaxed wakefulness. Deep sleep → value close to 1; shallow sleep → near 0.

We recommend P_{EEG} for practical sleep research. All three definitions should correlate under the framework's assumptions, but empirical validation is needed.

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9. Testable Predictions

Prediction	Type	Proposed Test Protocol	Source / Support
Glymphatic clearance correlates with SWA	Retrodiction	—	Iliff et al., 2012
EEG complexity decreases across NREM	Retrodiction	—	Tononi & Cirelli, 2006
SO–spindle coupling predicts memory	Retrodiction	—	Ngo et al., 2013
Sleep fragmentation preceded by rising variance/autocorrelation	Novel	Re-analyse existing sleep EEG datasets	de Mooij et al., 2020; Grossman et al., 2025

Prediction	Type	Proposed Test Protocol	Source / Support
Wearable early-warning signals (HRV lag-1 autocorrelation) predict night-to-night sleep quality	**Novel**	Pilot N=1 wearable study (30+ nights); confirm with larger cohort	Proposed here
REM rebound scales with emotional load during wake	Plausible	Daily stress diary (1–10) + actigraphy/PSG for REM%	Proposed here
Immune challenge reduces next-night κ independently of delta power	**Novel (framework-specific)**	Controlled immune challenge (e.g., vaccine) with wearable/PSG κ; partial correlation controlling for P_{EEG}	Proposed here

Falsification of core framework: If no evidence of basin-crossing dynamics (rising variance/autocorrelation, difference in attractor dimensionality) is found in a well-powered EEG study using de Mooij et al.'s methods, the attractor framework for sleep should be abandoned.

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10. Conclusion

Sleep is not passive — it is a dynamic, bifurcated process of **attractor maintenance**.

- **Deep NREM sleep** — slow constraint relaxation, clearing waste and downscaling synapses.
- **REM sleep** — fast, high-dimensional attractor, updating the brain's generative model.

Fragmentation, aging, and sleep disorders can be understood as changes in attractor depth, stability, and corrective permeability.

The persistence functional $P(x)$ gives a quantitative language for sleep engineering.

The dance of sleep is the dance of maintenance — and we can learn to engineer it.

References

- Balkrishnan, S., et al. (2023). Glymphatic function maintains sleep-sensitive cognitive performance and predicts overnight changes in plasma amyloid β in humans. *Alzheimer's & Dementia*, 19(S2), e083169. [Conference abstract.]
- Besedovsky, L., Lange, T., & Born, J. (2012). Sleep and immune function. *Pflügers Archiv – European Journal of Physiology*, 463(1), 121–137.
- Cohen, S., et al. (2009). Sleep habits and susceptibility to the common cold. *Archives of Internal Medicine*, 169(1), 62–67. (Note: journal renamed to *JAMA Internal Medicine* in 2013.)
- de Mooij, S. M., et al. (2020). Dynamics of sleep: Exploring critical transitions and early warning signals. *Computer Methods and Programs in Biomedicine*, 193, 105448.
- Friston, K. (2010). The free-energy principle: a unified brain theory? *Nature Reviews Neuroscience*, 11(2), 127–138.
- Grossman, N., et al. (2025). Falling asleep follows a predictable bifurcation dynamic. *Nature Neuroscience*, 28, 2515–2525.

- Himali, J. J., et al. (2023). Association of slow-wave sleep with incident dementia: The Framingham Heart Study. *JAMA Neurology*, 80(6), 589–598.
- Iliff, J. J., et al. (2012). A paravascular pathway facilitates CSF flow through the brain parenchyma and the clearance of interstitial solutes. *Science Translational Medicine*, 4(147), 147ra111.
- Irwin, M. R., et al. (2016). Sleep deprivation and activation of the inflammatory response. *Biological Psychiatry*, 80(3), 229–235.
- Krueger, J. M., et al. (2013). The role of cytokines in sleep regulation. *Current Pharmaceutical Design*, 19(27), 4908–4915.
- Ngo, H. V., Martinetz, T., Born, J., & Mölle, M. (2013). Auditory closed-loop stimulation of the sleep slow oscillation enhances memory. *Neuron*, 78(3), 545–553.
- Scheffer, M., et al. (2009). Early-warning signals for critical transitions. *Nature*, 461(7260), 53–59.
- Spiegel, K., Sheridan, J. F., & Van Cauter, E. (2002). Effect of sleep deprivation on response to immunization. *JAMA*, 288(12), 1471–1472.
- Tononi, G., & Cirelli, C. (2006). Sleep function and synaptic homeostasis. *Sleep Medicine Reviews*, 10(1), 49–62.
- Viola, A. U., et al. (2011). Interindividual differences in circadian rhythmicity and sleep homeostasis in older people: effect of a PER3 polymorphism. *Neurobiology of Aging*, 32(7), 1270–1279.

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Whirling as Attractor Engineering: Chirality, Shared Resonance, and a Minimal-Dose Protocol for Whole-Body Resilience

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Date: May 2026 (Revised June 2026)

 Note (June 2026): This paper’s description of conservative attractors has been updated to reflect the refined framework in *Metronome, Memory, and the Threefold Anchor: A Relational Account of Time* [F] (2026). The health and self-engineering content is unchanged.

Abstract

Whirling – the spinning practice of Mevlevi dervishes – is often seen as a mystical ritual. This paper reinterprets it through the attractor framework, where the mind is a dissipative attractor of the whole body.

Whirling is a controlled, repeated perturbation. It trains your balance, nervous system, and heart to settle into a stable, coherent pattern – a form of attractor engineering.

We discuss two additional ideas:

- **Chirality alignment** – spinning counter-clockwise may symbolically align with the universe's handedness (e.g., left-handed neutrinos), but this is speculative and not needed for health benefits.
- **Shared resonance** – group whirling synchronises heartbeats, creating a collective attractor.

We review scientific evidence showing that whirling improves heart rate variability (HRV), sleep quality, anxiety, brain plasticity, and physical fitness. A minimal effective dose is 5–15 minutes per day, 3–4 times per week. A graduated protocol is provided.

The health benefits are real. The chirality interpretation is optional.

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1. Introduction

In the attractor framework, your mind is a dissipative attractor of your whole body – a pattern that needs energy flow to stay stable, can be disturbed, and can adapt. Self-engineering means using small, repeated disturbances to reshape your own attractor towards greater resilience.

Whirling is a sustained, counter-clockwise spin performed by Mevlevi dervishes for centuries. It is spiritual, but modern science has found clear physical and mental benefits.

This paper argues that whirling is a powerful attractor engineering practice: a rhythmic whole-body disturbance that forces your system to become more stable and coherent. We also explore two extra ideas:

- **Chirality** (spinning with the universe's "handedness" – speculative)

- **Shared resonance** (heartbeat synchronisation in groups – well supported).

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2. The Attractor Framework Primer (Very Brief)

- **Conservative attractors** are eternal, time-symmetric, and require no energy input. They form the *eternal skeleton*. The three most fundamental conservative attractors – the *metronomes* – are the **electron**, **neutrino mass eigenstates** (collectively), and **proton**. (The photon is a signal carrier, not a metronome; see *Metronome, Memory, and the Threefold Anchor* for details.)
- **Dissipative attractors** (life, mind, society) need energy flow, have finite lifetimes, and can change. Your body is a stack of dissipative attractors.
- **Persistence under disturbance** is the basic mark of reality. A resilient system returns to its attractor after a knock.
- **Self-engineering** uses small, repeated nudges to reshape your own attractor basin.
- **Whirling** is a strong, repeated disturbance. Your body must adapt. That adaptation is the engineering.

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3. Chirality Alignment – A Speculative Interpretation

3.1 What do we know about universal handedness?

- **Weak interactions:** Neutrinos produced in weak decays are always left-handed (Wu experiment, 1956). This is a fact. But electrons and protons do not have a universal spin direction.

- **Astronomical rotations:** From the north pole, Earth, the solar system, and the Milky Way rotate counter-clockwise. From the south pole, they appear clockwise. That's just a viewpoint – there is no privileged direction in space.
- **Cosmic Microwave Background:** Some studies suggested a preferred axis ("axis of evil"), but these results are contested and likely statistical artifacts. No clear evidence.

3.2 The speculative claim

The dervish's counter-clockwise spin can be seen as a heuristic alignment with these physical handednesses (neutrino helicity, frame-dependent rotation). In our attractor framework, we propose that spinning with the majority direction (as seen from the northern hemisphere) may resonate symbolically and phenomenologically with the invariant rhythms of the conservative substrate – the three metronomes.

Crucially, there is no known physical mechanism linking a rotating body (~1–2 rpm) to particle spin or photon polarisation. The scale difference is huge. So this alignment is presented as a speculative metaphysical claim within our framework, not as proven physics. It's a way to frame the practice, not a testable hypothesis. The health benefits of whirling do not depend on this speculation.

3.3 Clockwise vs. counter-clockwise

No study has compared clockwise and counter-clockwise whirling for health effects. The idea that clockwise spinning "needs more energy" or "opposes the Tao" is unsupported – we label it as speculation. You can try both directions, but the traditional counter-clockwise spin is recommended for alignment with our framework’s interpretive preferences.

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4. Shared Resonance: Heartbeat Synchronisation

A published study measured heart rates during a group Sufi whirling ritual. It found that participants’ heartbeats became synchronised – the biological data matched the spiritual goal of unity.

In attractor terms: the shared rhythm creates a common basin of attraction across people. Each body locks onto the same external rhythm (the group spin), and through mutual coupling, their cardiac oscillators fall into step.

This is like metronomes placed on a movable platform – they eventually synchronise (a classic demonstration from Huygens, 1665). Here, the “platform” is the shared sound and feel of the group whirling. The result is a collective attractor – a stable shared state where heart rates align, possibly amplifying resilience.

Note: The term “collective attractor” simply means a stable pattern in a coupled system. The 2019 study showed cardiac synchronisation, but the idea that whirling together increases resilience beyond what you can do alone is still a plausible hypothesis that needs testing.

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5. Evidence for Health Benefits

5.1 Heart Rate Variability (Autonomic Resilience)

A 2012 study on “Whirling-Kung” (5–15 minutes, three times per week) found the practice prevented a decline in key HRV measures (SDNN, total power) seen in a control group. Higher HRV means a wider attractor basin, faster recovery, and greater resilience.

5.2 Sleep Quality and Stress Markers

A 2022 study on whirling dervishes found significantly better sleep quality and much lower anxiety ($p < 0.001$) compared to non-whirling controls. The dervishes also had lower levels of VEGF, BDNF, and GDNF — markers often elevated by chronic stress.

Note on BDNF: Lower BDNF is usually linked to depression, not less stress. The authors of the study interpreted this as a possible protective effect, but the relationship is complex. We simply report the finding without endorsing a specific interpretation.

5.3 Neuroplasticity — Reshaping the Brain’s Attractor Landscape

An MRI study found that long-term dervishes have cortical thinning in the default mode network (DMN) and motion-perception areas (right DLPFC, lingual gyrus, visual area V5). This thinning is experience-dependent neuroplasticity: the brain prunes inefficient connections to become more specialised.

5.4 Physical Fitness and VO_2max

A 12-week whirling training programme improved body composition, leg strength, flexibility, grip strength, and both anaerobic and aerobic power (VO_2max). Whirling is effective whole-body cardiovascular exercise.

5.5 Mental Health — Less Anxiety, Better Self-Regulation

Multiple studies confirm lower anxiety. Participants report better mind-body focus, self-regulation, positive feelings, and a “quietness in the centre of the vortex” — the subjective experience of a stable core attractor.

Finding the original studies: The papers cited here (2012 HRV, 2022 sleep/anxiety, MRI, 12-week fitness, and the 2019 heartbeat study) can be found by searching terms like “whirling dervish heart rate variability,” “whirling kung HRV,” “Dursun whirling MRI,” “Karakaya whirling sleep,” or “Genc whirling VO2max.”

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6. The Minimal Effective Dose

Based on the 2012 study and traditional practice:

- 5–15 minutes per session
- 3–4 times per week
- Counter-clockwise rotation (traditional; clockwise not harmful but lacks evidence)
- Gradual progression

Phase	Duration	Frequency	Goal
Adaptation (weeks 1–2)	5 min	3–4x/week	Get used to the spin
Consolidation (weeks 3–4)	10–15 min	3–4x/week	Find the rhythm, notice calm
Expansion (week 5+)	20–30 min	3–4x/week	Explore deeper states

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7. Practical Instructions

- **Space:** A large, empty room. Bare feet.

- **Posture:** Start with arms crossed on your chest. Begin turning counter-clockwise. After a few revolutions, open your arms: right hand up (palm to sky), left hand down (palm to earth).
- **Gaze:** Soft, unfocused – don't fixate on a single point.
- **Safety:** Stop if you feel severe nausea. Use a wall for support if needed.
- **Afterward:** Rest lying down for 5–10 minutes to let your balance system settle.

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8. Conclusion

Whirling produces real, measurable benefits: better HRV, sleep, anxiety, brain plasticity, and fitness. A minimal dose of 5–15 minutes a day, three to four times a week, is enough.

The shared resonance (heartbeat synchronisation in groups) is empirically supported.
The chirality alignment (spinning counter-clockwise to align with the universe) is a speculative interpretation – not required for the health benefits.

The dervish's spin is a dance of persistence under perturbation – a transient dancer humming along with the eternal skeleton. The dance has a new step.

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Attractor Dynamics in Belief Formation, Correction, and Mental Health: A Research Programme

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Abstract

This paper applies the attractor framework (persistence under disturbance) to **belief systems** and **mental health**.

We introduce three measurable concepts:

- **Attractor depth** – how rigid or unstable a belief is.
- **Error half-life** – how long it takes for a false belief to fade after correction.
- **Coupling strength to error signals** – how open a belief is to reality checks.

We contrast two disorders:

- **OCD** (obsessive-compulsive disorder) may involve *overly deep* (rigid) attractors.
- **Schizophrenia** may involve *too shallow* (unstable)

attractors — with appropriate caution.

We propose experiments to measure error half-life, detect early warning signs of belief shifts (while managing false alarms), and find the optimal pace for correction (“critical damping”).

We also outline:

- **N=1 attractor engineering** (self-experimentation)
- **Wearable early-warning systems** for relapse prevention (discussing lag time and false positives)
- **Cross-coupling** as a measure of resilience (distinguishing healthy from brittle coupling)

This paper is a **research roadmap**, not a finished theory.

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1. Introduction

In the attractor framework, your mind is a **dissipative attractor of your whole body** — a pattern that needs energy, can be disturbed, and can adapt (Galida, 2026, *Persistence Under Perturbation*).
Beliefs are smaller attractors inside that landscape. Their stability determines how easily you update when faced with contradictory evidence.

This paper turns attractor concepts into testable ideas about how beliefs form, stick, and change — and how to help them change. It is a roadmap, not the final word.

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2. Attractor Depth and Mental Disorders

Neurocomputational models suggest a contrast between OCD and schizophrenia, but we must be careful.

Disorder	Attractor Property	Behavioural Sign	Example Task
OCD	Too deep (rigid)	Stuck, hard to switch	Reversal learning (changing rules)
Schizophrenia	Too shallow (unstable)	Jumpy, over-sensitive to noise	Delayed match-to-sample with distractions

Evidence:

- Unmedicated OCD patients make many perseverative errors on reversal-learning tasks; this correlates with symptom severity (Remijnse et al., 2006).
- Reduced NMDA/GABA function in schizophrenia makes attractor networks unstable, leading to cognitive slips and delusions (Rolls, 2021).

Caveats:

- Mental disorders are complex, with multiple attractors. We are talking about symptom clusters, not whole-disorder diagnoses.
- Disorders like anxiety, depression, and personality disorders lie in the middle – their attractors are **domain-specific** (e.g., depression has deep negative-belief basins but shallow positive ones).

Prediction: Attractor depth could be measured from behaviour (switching rates, reaction time variability) by fitting a two-state hidden Markov model to reversal-learning data – a hypothesis for future work.

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3. Error Half-Life: A New Measure of Belief Rigidity

Error half-life $T_{1/2}$ is the time it takes for a false belief's confidence to drop by half after you present corrective evidence.

How to measure it

1. Give people a false belief (e.g., a made-up fact).
2. Give them correct information (text, video) every day for a while.
3. Ask them to rate their belief confidence (0–100) at intervals.
4. Assume a simple **exponential decay** model $C(t)=C_0 e^{-t/\tau}$ as a starting point (real decay could be sigmoidal or power-law).
5. Then $T_{1/2}=\tau \ln 2$.

What we expect in different conditions

- **Delusional disorders** → very long half-life (deep attractor).
- **Depression** → long half-life for negative self-beliefs, but normal for positive ones (asymmetric updating).
- **Anxiety** → short half-life, but possible overshoot (shallow basin → oscillation).

Therapeutic application

The goal is to **shorten error half-life**. Methods like **spaced repetition** and **active recall** (quizzing) could help — they strengthen corrective memory traces, similar to memory reconsolidation.

Relationship to attractor depth

Attractor depth is a **static** measure (inertia). Error half-life is a **dynamic** measure (recovery speed). They are related but not the same: depth gives initial resistance, half-life gives the time course. We need both.

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4. Critical Slowing Down Before Belief Shifts

Before a sudden change of belief (e.g., leaving a cult, political conversion, therapy breakthrough), you may see **early warning signals** — rising variance, higher autocorrelation, slower recovery from small disturbances. This is called **critical slowing down** (Scheffer et al., 2009).

How to detect it

- Collect daily belief ratings, mood scores, or social media sentiment.
- Compute rolling variance and autocorrelation with a moving window.
- If they exceed a baseline threshold, a shift may be coming.

False positive problem

Rising variance can be caused by other things (seasonal mood, life events). To reduce false alarms:

- Use control periods (compare with a stable trait belief).
- Combine multiple signals (HRV, sleep, activity) with self-report.
- Use a conservative threshold (e.g., 3 standard deviations above baseline).

This is a research tool, not a clinical diagnostic yet.

Prediction: You can detect these signals in diaries before a person deconverts, changes politics, or relapses into depression. A well-timed prompt might help, but false positives must be managed.

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5. Optimal Correction Dosing (Critical Damping)

From control theory, there is an **optimal pace** for delivering corrections: not too slow (oscillates), not too fast (overshoot/backfire). This is called **critical damping**.

N=1 protocol

- Vary the gap between corrections (massed vs. spaced).
- Track belief confidence over time.
- Measure how quickly and smoothly it changes.

Hypothesis: Spaced correction (e.g., daily micro-doses) works better than one big confrontation — a well-known finding in memory research (Ebbinghaus, spaced repetition). The twist is applying it to **beliefs**, which are more emotional and identity-linked. The mechanism may be similar, but emotional valence may change the optimal schedule.

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6. Fantasy vs. Shared Reality Attractors — Operational Metrics

Metric	Low Corrective Permeability (Fantasy)	High Corrective Permeability (Shared Reality)
Coupling to error signals	Low (few fact-checks, no update)	High (active correction)
Basin depth	Deep (needs large evidence)	Shallow (small anomalies work)
Error-correction latency	Long (days/weeks)	Short (hours/days)
Information diversity tolerated	Low (echo chamber)	High (multiple sources)

Double-bind computational model

In conspiracy cultures, contradictory evidence gets reinterpreted as confirmation (“cover-up”). We can model this as an **asymmetric Bayesian update**: $P(\text{belief} \mid \text{contrary evidence}) \geq P(\text{belief} \mid \text{supporting evidence})$

Example: Start with belief probability 0.9. A contrary piece of evidence that would normally lower it to 0.3 is instead interpreted as evidence of suppression, so the new probability stays at 0.85. The belief drifts only slowly.

Breaking the loop: Indirect interventions work better than direct refutation:

- Point out internal inconsistencies.
- Seed doubt through trusted messengers.
- Use graduated reality-testing.

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7. Wearable Early Warning of Attractor Shifts

Protocol: Use consumer wearables (HRV, skin conductance, actigraphy, sleep) plus daily self-reports (mood, belief rigidity). Compute rolling variance and autocorrelation in real time.

Evidence: Drops in nocturnal HRV preceded a depressive relapse in a case study (Tonge et al., 2024).
Prediction: Rising variance/autocorrelation in HRV, plus mood volatility, can predict an imminent crisis.

Latency and false alarms

- Useful lead time is **days**, not hours. HRV changes can appear 1–2 weeks before relapse.
- False positives are a concern. Use a **two-stage alert**: first detect statistical anomaly, then confirm with a brief self-report (EMA).
- Specificity needs to be established in longitudinal N=1 studies.

Intervention: When thresholds are crossed, trigger a micro-intervention (mindfulness, therapist call) — a closed-loop prevention system.

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8. N=1 Attractor Engineering — Minimal Perturbation Protocol

Goal: Find the smallest intervention that shifts a maladaptive attractor (phobia, obsessive thought) without causing oscillation or backfire.

Procedure:

1. Define the target (e.g., fear rating 0–10).
2. Start with very low-intensity perturbations (e.g., brief exposure, mild counter-evidence).
3. Measure change after each step.
4. When a threshold shift is detected (say, 30% reduction — a provisional starting point; adjust based on baseline variability), record the dose.
5. Back off slightly and check stability.

Principle: Never collapse an attractor faster than reality can correct. Use fine steps (5–10% increments) and frequent monitoring. This is **precision self-regulation**. Generalisability from N=1 to populations is an open question (see Section 12).

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9. Cross-Coupling as a Resilience

Metric

Hypothesis: High cross-domain coupling (e.g., HRV ↔ mood ↔ sleep) indicates **adaptive resilience** — the system is coordinated and self-correcting. Low coupling or unidirectional cascades indicate **brittle coupling** (a disturbance in one area spreads uncontrollably).

Measurement: Collect simultaneous time series (HRV, sleep, activity, mood). Compute cross-correlation or Granger causality.

- **Adaptive** = bidirectional, with negative feedback (e.g., poor sleep → lower HRV → mood drop → social support → sleep improves).
- **Brittle** = unidirectional, amplifying (e.g., sleep loss → stress → more sleep loss).

Prediction: Good recovery from stress shows strong bidirectional influences. Low coupling or unidirectional cascades will precede breakdowns.

Intervention: Improve adaptive coupling with synchrony exercises (e.g., daily breathing with light exposure, yoga, social rhythm therapy). Testable in an N=1 self-tracking experiment.

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10. Philosophical Extensions (Brief)

- **Are attractors real?** Yes, as structural patterns (process metaphysics). They have causal power — like the path of a river.

- **Free will as attractor autonomy** – acting according to your own attractor is compatibilist freedom. Our framework adds that freedom is about basin width and flexibility, not a binary.
- **Cosmic attractor** – speculative. The universe might have a global attractor (e.g., heat death), but it’s untestable now.
- **Darwinian problem of evil** – animal suffering is a strong challenge to theism; the “deep harmonies” hypothesis is hard to falsify.

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11. Open Questions and Next Steps

- Can error half-life be measured reliably from smartphone-based belief tracking? What decay model fits best?
- What is the dose-response curve for corrective interventions? Linear, exponential, or threshold? How does it vary with attractor depth?
- Can wearables detect early warning signs before a psychiatric relapse? What are the false-positive rates and lead times?
- Does adaptive cross-coupling improve after synchrony-based therapies?
- How are error half-life and attractor depth related? Same thing at different timescales, or different constructs?
- How can N=1 findings be aggregated into population-level knowledge? One approach: meta-analysis of single-subject time series using hierarchical Bayesian models.

12. Conclusion

This research programme puts attractor dynamics to work on beliefs and mental health.

We have proposed **testable metrics** (attractor depth, error half-life, coupling strength) and **experimental protocols** for N=1 self-engineering and early warning.

The framework provides a naturalistic language for understanding why some beliefs resist correction and how to intervene optimally.

We acknowledge our limitations — the exponential decay assumption, false positives in early warning, and the generalisability of N=1 results — and treat them as open questions for future work.

This extends the attractor trilogy into **actionable health and epistemology**.

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