A Preliminary Mapping Between Ring Attractor Dynamics and the Attractor Framework

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Abstract

The attractor framework proposes that persistence under perturbation is the fundamental mark of reality, and that corrective permeability (κ)—the rate at which a system dissipates perturbation and returns to its basin—is a key diagnostic variable distinguishing reality-aligned from fantasy attractors. A recent computational neuroscience study by Chen et al. (2024) developed a ring attractor network with synaptic dynamics that exhibits structural parallels with these concepts. This paper offers a preliminary, post-hoc mapping between the ring attractor model and the attractor framework. The network's synaptic recovery speed (α) is proposed as a candidate analogue for corrective permeability (κ). The network's transition from weighted cue integration to winner-take-all dynamics maps onto the framework's distinction between reality-aligned and sealed attractor behavior. The network's multimodal integration and bistable perception also bear structural resemblance to constraint field navigation and attractor switching, though bistable perception as attractor switching is an existing interpretation in computational neuroscience. The mapping is offered as a set of testable correspondences for future formal investigation, not as

independent validation of the framework. The attractor framework remains a self-published construct awaiting independent peer review.

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1. Introduction: A Post-Hoc Mapping

The attractor framework (Galida, 2026a) is a unified naturalistic ontology grounded in the principle that persistence under perturbation is the mark of reality. Its central diagnostic concepts are corrective permeability (κ), defined in Table 1, and the distinction between reality-aligned and fantasy attractors. The framework was developed independently through philosophical inquiry, systems theory, and N=1 self-engineering experiments. It is self-published and has not yet undergone independent peer review.

A recent computational neuroscience study by Chen et al. (2024) developed a ring attractor network with synaptic dynamics that exhibits behaviors structurally similar to those described by the framework. The present paper does not claim that Chen et al. independently validated the framework; they had no knowledge of it, and their model was built within an established tradition of ring attractor research (Amari, 1977; Zhang, 1996; Skaggs et al., 1995). Rather, this paper offers a post-hoc mapping between the two, identifying structural parallels and proposing testable correspondences for future investigation. The value of such a mapping lies in the potential for the framework's qualitative claims to be anchored in a mathematically specified, biologically validated model, and for the ring attractor's quantitative relationships to be extended, hypothetically, into the domains the framework addresses.

Table 1: Key Framework Terms and Operational Definitions

Term	Definition
Dissipative attractor	A system that exports entropy while converging toward a stable basin
Basin	The minimum-energy configuration toward which the system evolves (in physical systems; the analogue in cognitive and social systems is structural, not energetic)
Corrective permeability (κ)	The rate at which a system dissipates perturbation and returns to its basin. Defined here as $\kappa = 1/\tau_{recovery}$, where $\tau_{recovery}$ is the time to return to baseline after a specified perturbation. This definition currently requires a specified perturbation magnitude and an independently established baseline for each domain of application. The measurement of κ in cognitive and social systems is an unresolved methodological challenge.
Reality-aligned attractor	A system with high κ that integrates perturbations and updates its basin
Fantasy attractor	A system with low κ that seals against perturbations, often via reframing or winner-take-all dynamics

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2. The Ring Attractor Model

Chen et al. (2024) developed a ring attractor network with asymmetrical neural connections and adaptive synaptic processing. Excitatory neurons are recurrently connected in a functional ring, connected to a uniform inhibitory neuron. The key innovation is the incorporation of synaptic dynamics: available presynaptic resources are depleted at a rate governed by β and recover at a speed governed by α.

The model's behavior is governed by recovery speed α. When α is fast (low recovery time), the network sustains a stable activity bump indefinitely, even without inputs—a self-maintaining basin. When α is slow, the bump decays. The duration of sustainable activity exhibits a negative nonlinear relationship with α (Chen et al., 2024, Fig. 3D).

The network receives exogenous external cues (modeled as Gaussian functions representing sensory inputs) and endogenous shifting signals (self-motion). Its behavior—integration, competition, tracking, switching—depends on cue conflict and certainty.

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3. Structural Parallels

3.1 Synaptic Recovery α as a Candidate Analogue for Corrective Permeability κ

The ring attractor's persistence depends on α. Fast recovery yields a stable, persistent bump; slow recovery leads to decay. The framework's corrective permeability κ describes how quickly a system recovers from perturbation and returns to its basin. The parallel is structural: both α and κ govern the resilience of a stable state.

We propose a testable correspondence: $\kappa \sim f(\alpha)$, where the functional form f is unknown and may not be linear. A specific candidate form is $\kappa = 1/\tau_{decay}(\alpha)$, where τ_{decay} is the bump duration as a function of α. This mapping is hypothetical. It has not been formally derived, and the functional relationship between synaptic recovery and cognitive-level corrective permeability is unknown. It is offered as a bridge for future formal work, not as an established result.

3.2 Weighted Integration vs. Winner-Take-All → Reality-Aligned vs. Sealed Attractor

When cue conflicts are small, the ring attractor integrates them via weighted averaging. When conflicts exceed a critical threshold (≈1.4 radians for $\sigma_1=0.8$, $\sigma_2=1$), it switches to winner-take-all mode. This transition is quantified.

The framework describes a similar dynamic: high-κ systems integrate perturbations (reality-aligned); low-κ systems seal against them (fantasy attractor). The ring attractor's conflict threshold provides a candidate mathematically specified analogue for the framework's qualitative tipping point. Whether the same quantitative relationship holds in cognitive or social attractors is an open hypothesis.

3.3 Multimodal Integration → Constraint Field Navigation

The ring attractor integrates cues from multiple modalities, weighting by certainty and resolving conflicts dynamically. This is structurally analogous to the framework's concept of a dissipative attractor navigating a constraint field. The grouping approach for more than two cues—small conflicts integrated first, then competition among groups—suggests hierarchical constraint navigation, a dynamic the framework predicts but has not operationalized in formal terms. Of the four parallels identified in this section, this is the most loosely specified and the most in need of formal development before quantitative correspondences can be established.

3.4 Bistable Perception → Attractor Switching (with Prior Art)

Under ambiguous cues and slow recovery, the ring attractor exhibits spontaneous alternation between two perceptual interpretations. The framework describes this as attractor switching. However, the interpretation of bistable perception as attractor dynamics is not novel to the framework; it is a standard account in computational neuroscience (Deco & Rolls, 2006; Moreno-Bote et al., 2007). The framework's contribution is the extension of this switching concept to cognitive and social systems, an extension that remains a research hypothesis rather than an established result.

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4. Hypothetical Implications (Research Hypotheses)

The structural parallels documented above suggest several testable hypotheses. These are not supported by Chen et al. (2024) and require independent investigation. They are listed in descending order of current testability.

1. **The conflict threshold hypothesis.** The framework's transition from belief integration to belief sealing may exhibit a quantifiable conflict threshold, analogous to the ring attractor's 1.4 radian transition point. This could be tested in belief-updating paradigms where the degree of conflict between existing beliefs and new evidence is systematically varied, and the point of transition from integration to rejection is measured. Of the three hypotheses presented here, this is the most amenable to current experimental methods.
2. **The κ-α correspondence hypothesis.** If κ and α share a functional relationship, then interventions that modulate synaptic recovery (neuromodulators, pharmacological agents) should analogously modulate corrective permeability in cognitive systems. This hypothesis requires operationalizing κ in cognitive domains, a measurement challenge acknowledged in Table 1.
3. **The hierarchical navigation hypothesis.** Complex belief systems facing multiple simultaneous perturbations may exhibit hierarchical resolution strategies similar to the ring attractor's grouping approach for multiple

cues. This hypothesis is the most speculative of the three and requires further specification of the domain of application (e.g., small-group decision-making, multi-source evidence integration in individual cognition) before it can be tested.

These hypotheses are speculative. They are offered as potential bridges between the framework and empirical research programs, not as established implications.

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5. Limitations

This mapping is post-hoc. The ring attractor model was not designed to test the attractor framework, and the correspondences identified here were constructed after the fact. The framework itself remains a self-published construct that has not undergone independent peer review. The operational definitions of κ, while stated here, have not been validated against empirical data in cognitive or social domains. The measurement of κ in these domains requires specifying perturbation magnitudes and establishing independent baselines, challenges that are currently unresolved. The value of this paper lies not in demonstrating validation, but in proposing concrete, testable correspondences that could, if investigated, either strengthen or falsify the framework's claims.

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6. Conclusion

The ring attractor model of Chen et al. (2024) provides a mathematically specified, biologically validated system that bears structural parallels with the attractor framework.

Synaptic recovery speed α is proposed as a candidate analogue for corrective permeability κ. The transition from integration to winner-take-all maps onto the framework's reality-aligned/fantasy distinction. Multimodal integration and bistable perception correspond, respectively, to constraint field navigation and attractor switching, with the latter being a standard interpretation in existing neuroscience.

These correspondences are not independent validation. They are post-hoc structural analogies. Their value lies in the testable hypotheses they generate, not in the confirmation they appear to provide. The framework remains a research program in its early stages, and this mapping is a contribution to its ongoing development.

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*"The framework's consistency with established nonlinear dynamics has been explored elsewhere. For a tracing of its structural correspondences with the foundational work of Ruelle, Takens, and Prigogine, see Galida (2026b)."*https://people.math.harvard.edu/~knill/teaching/mathe320_2014/blog/RuelleIntelligencer.pdf

"see also" https://jamestobinphd.com/the-psychology-of-attractor-states/