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LETTER to the EDITOR

SONAPPS: A Spatiotemporal Coherence-based Framework for Adaptive Self-regulatory Rehabilitation - A Hypothesis-generating Conceptual Letter

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Dear Editor,

The phenotypic heterogeneity observed within diagnostic categories, such as progressive multiple sclerosis (MS) and autism spectrum disorder, wherein patients with the same diagnosis exhibit qualitatively distinct functional profiles and respond differently to identical interventions, challenges rehabilitation frameworks that target domain-specific deficits in isolation (1,2). We propose that this heterogeneity reflects disruptions in spatiotemporal coherence among regulatory contexts rather than isolated structural failures, and that this distinction has direct implications for rehabilitation design.

Self-organizing Neuro-adaptive Personalized Physiological System (SONAPPS) is proposed as a hypothesis-generating framework grounded in a spatiotemporal coherence model of pathology. This model conceptualizes dysfunction as a disruption in the coherent coupling among regulatory contexts—that is, within and across physical-structured functional and psychological-behavioral-cognitive domains—operating across multiple temporal and spatial scales (3,4). This perspective distinguishes SONAPPS from allostasis, which focuses on restoring homeostatic set points, and from conventional cybernetic control models, which rely on externally imposed regulatory correction. Rather than applying external regulatory templates, SONAPPS aims to restore endogenous inter-context coherence—the ability of each regulatory context to accurately represent and coordinate its relationship with all others (Figure 1).

A central feature of the model is a structured noise taxonomy that distinguishes five configurations of spatiotemporal incoherence: isolated intra-context noise, coherent intra-context pathology with inter-context incoherence, propagated noise, compensatory noise, and cross-domain decoupling (3,5). Each configuration is proposed to generate a distinct clinical phenotype and a corresponding prediction regarding intervention sequencing and response trajectories, thereby providing a basis for empirically testable and refutable hypotheses. The temporal dissociation pattern previously reported in MS case observations (6-9) is particularly consistent with cross-domain decoupling, illustrating how the model may generate testable clinical predictions.

We acknowledge concerns regarding the methodological structure of the framework. Operationally, SONAPPS is characterized by three core features: a passive resting state maintained by the patient throughout all sessions (i.e., without

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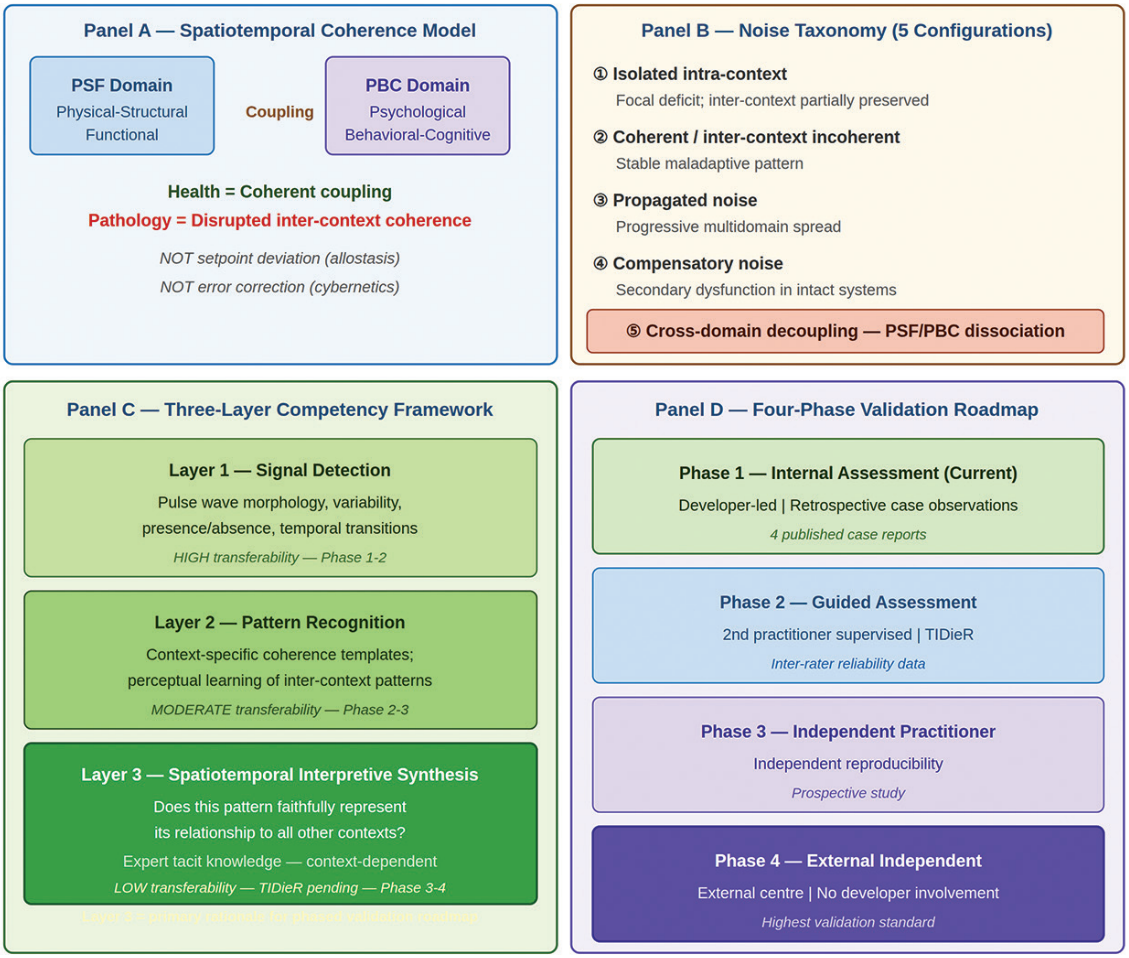

Figure 1. SONAPPS: spatiotemporal coherence-based rehabilitation framework
SONAPPS: Self-organizing Neuro-adaptive Personalized Physiological Systems

volitional movement or exercise), non-contact delivery at a distance of 1-1.5 m, and coherence-targeted modulation using practitioner pulse self-monitoring in conjunction with individualized patient-specific contextual reference materials. The proposed pulse-based assessment mechanism remains hypothetical and currently lacks direct empirical validation; its inclusion reflects the practitioner's clinical observational framework rather than an established physiological measure. Assessment is organized into three hierarchical practitioner competency levels—signal detection, pattern recognition, and spatiotemporal interpretive synthesis—with each level exhibiting distinct transferability characteristics and validation requirements. A TIDieR-compliant protocol description is currently in preparation and will be finalized following completion of Phase 2 of a four-phase validation roadmap (6).

The preliminary case observations (9,10) are anecdotal, uncontrolled, single-case descriptions and should not be interpreted as proof-of-concept findings or evidence of efficacy. They are cited solely as descriptive clinical observations intended to motivate further empirical investigation. The underlying mechanisms remain uncertain. Contemporary literature on predictive processing and active inference (3), multiscale physiological complexity (4), interpersonal physiological synchrony (7), and network neuroscience (5) provides a theoretical basis for the proposed mechanisms; however, these connections remain speculative and require direct empirical validation. Accordingly, the SONAPPS framework is presented not as a validated intervention but as a structured, falsifiable, and empirically testable conceptual architecture that warrants controlled prospective investigation.

In conclusion, SONAPPS proposes the restoration of spatiotemporal coherence as a distinct target for rehabilitation. The framework is differentiated from existing models, grounded in contemporary systems neuroscience, structured around a falsifiable noise taxonomy, and operationally defined through three competency levels supported by a phased validation roadmap. We invite empirical scrutiny and collaboration to evaluate its theoretical and clinical utility.

Footnotes

Authorship Contributions

Surgical and Medical Practices: H.N., Concept: H.N., Design: H.N., S.N., A.R., Data Collection or Processing: H.N., S.N., A.R., Analysis or Interpretation: H.N., Literature Search: H.N., S.N., A.R., Writing: H.N., S.N., A.R.

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