

Commentary

Who Monitors Organismal Coherence During Aging?

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In our previous conceptual paper ^[1], Holmes' carriage was proposed as a metaphor for two fundamentally different models of aging: fragmented aging, characterized by progressive failure of individual biological subsystems requiring continuous repair, and coherent aging, characterized by long-term preservation of organism-level functional integration until a relatively rapid terminal decline. This framework naturally raises another question. If systemic coherence is preserved throughout most of life, what biological mechanism continuously monitors its integrity and initiates corrective responses before functional fragmentation becomes clinically apparent? A recently proposed model suggests that aging may represent progressive biological decoherence caused by increasing deviation from systemic redox equilibrium (α -bio) ^[2]. However, every stable biological control system requires not only an organizational principle but also a mechanism capable of sensing deviations from that principle. Recent studies on interoception describe a distributed physiological system responsible for monitoring the body's internal state while simultaneously questioning whether interoception represents a single unified function or multiple independent sensory modalities ^{[3][4]}. We propose the testable hypothesis that these apparently independent interoceptive modalities collectively function as a distributed biological monitoring system for organism-level coherence.

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In our previous conceptual paper ^[1], Holmes' carriage was introduced as a metaphor illustrating two fundamentally different ways biological systems may age. One model describes fragmented aging, in which individual biological subsystems progressively fail and require continuous technological repair. The second describes coherent aging, in which the organism preserves functional integration for decades before entering a relatively brief terminal decline. This immediately raises another question: if systemic

coherence can indeed be preserved throughout much of life, what biological mechanism continuously monitors the integrity of the organism and initiates corrective responses before functional fragmentation becomes clinically apparent?

A recently proposed conceptual model suggests that aging may reflect progressive deviation from systemic redox equilibrium (α -bio), leading to increasing biological decoherence over time [2]. Within this framework, morbidity emerges not simply from isolated molecular damage but from the gradual loss of coordinated functional organization throughout the organism. Yet every stable biological control system requires not only a regulated variable but also a mechanism capable of continuously sensing deviations from that variable. If systemic coherence represents such an organizational principle, the identity of its biological monitoring system remains largely unexplored.

Recent advances in interoception research may provide an unexpected conceptual bridge. Interoception is generally understood as the perception and processing of signals originating from within the body and has been associated with physiological regulation and maintenance of internal stability [3]. Remarkably, a recent conceptual analysis argues that interoception is not a single physiological function but rather a collection of relatively independent modalities—including cardioception, respiroception, gastroception and thermoception—each characterized by distinct physiological pathways [4].

At first glance, this conclusion appears to weaken the concept of organism-level regulation. We propose the opposite interpretation. Modern aircraft contain hundreds of independent sensors measuring different physical variables, yet collectively they monitor the integrity of a single aircraft. Likewise, cardioception, respiroception, gastroception, thermoception and other interoceptive modalities may not primarily represent independent physiological functions. Instead, they may constitute a distributed biological monitoring system through which the organism continuously evaluates its own functional organization.

Within this framework, systemic coherence becomes the regulated organizational variable, whereas interoception becomes the physiological interface through which deviations from coherence are detected before irreversible functional fragmentation occurs. If progressive deviation from redox equilibrium represents an underlying physical process driving biological decoherence [2], the various interoceptive modalities may provide complementary physiological windows through which this loss of coordination becomes detectable at the organism level. None of these modalities would directly measure coherence itself; rather, each would monitor one of its physiological consequences.

Importantly, this hypothesis is experimentally testable. Individuals exhibiting prolonged preservation of functional lifespan should demonstrate greater integration among multiple interoceptive modalities than individuals experiencing fragmented aging. Conversely, progressive loss of functional capacity should be accompanied by increasing dissociation among these physiological monitoring systems. Furthermore, interventions capable of preserving systemic coherence should improve the integration of interoceptive signals and delay the onset of functional fragmentation.

This hypothesis does not attempt to redefine interoception. Rather, it proposes a different level of biological interpretation. Recent literature suggests that interoception is a distributed physiological network rather than a single sensory modality^[4]. We suggest that the common biological purpose of this distributed network may be the continuous preservation of organism-level coherence.

The Holmes' carriage metaphor originally emphasized that future longevity medicine should perhaps focus not only on repairing damaged biological parts but also on preserving the integrity of the organism as a coordinated whole^[1]. The present hypothesis extends that concept one step further. If systemic coherence indeed represents a fundamental determinant of healthy aging, nature may already possess a biological system dedicated to monitoring its preservation. Interoception may represent that system. Future research should therefore investigate whether systemic coherence and interoceptive integration represent complementary manifestations of the same underlying biological principle governing long-term functional lifespan.

References

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