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Editorial

What aging research loses between data and meaning: Representational flattening

For decades, aging research has accumulated data faster than it has accumulated understanding. We measure more, store more, and publish more—yet the biological systems we study remain stubbornly resistant to the interventions we design. The March 2026 Vision editorial argued that aging is best understood as a trajectory, and performance, not pathology, as the scientific object worth measuring[1]. This corollary takes up a quieter but equally consequential problem: the way aging research routinely compresses complex, dynamic biological systems into simpler representational forms—and what that compression costs.

We call this problem *representational flattening*. It is not a failure of effort or rigor. It is a structural habit, reinforced by analytical convenience and publication norms, in which living systems are reduced to forms that are easy to analyze but increasingly distant from the biology they are meant to describe. The result is a literature that often optimizes for tractability over fidelity—and mistakes the two for the same thing.

This editorial defines representational flattening, illustrates it with concrete examples across study types, examines its appearance in scholarly writing itself, and outlines four provisional editorial directions the *Journal of Aging Research & Lifestyle* (JarLIFE) is considering for 2027 author guidance. It closes by describing how JarLIFE intends to consult its community throughout the remainder of 2026 before committing to any change.

Data abundance is not meaning preservation

The most important distinction in this discussion is between the volume of data a study generates and the meaning that data preserves about the underlying biological object. These are not the same thing and conflating them is the root of the problem.

A biological system—a neuron regulating intracellular calcium, a set of physiological systems sustaining homeostasis, a brain aging across decades—exists at multiple scales, operates across multiple modalities, and changes over time under conditions of uncertainty, causality, and adaptation. Every act of measurement and modeling makes choices about which of these properties to preserve and which to discard. Flattening occurs when the discarded properties are biologically essential, yet the resulting representation is treated as if it were complete.

Consider the work on physical frailty as an emergent state of a dysregulated complex dynamical system. Frailty arises not from the failure of any single system but from the nonlinear interaction of metabolic, musculoskeletal, and stress-response systems, made visible only when the organism is challenged. A study that records dozens of biomarkers at rest may generate a large dataset while still flattening the biology—because the meaningful signal lives in the dynamic, between-system interactions that a static, resting snapshot cannot capture. More data, in this case, does not mean more fidelity.

Six dimensions of fidelity are repeatedly at risk when we flatten:

- **Scale**: collapsing molecular, cellular, physiological, and organismal levels into a single tier of description.
- **Modality**: reducing multimodal signals (behavioral, functional, biochemical) to one convenient proxy.
- **Time**: replacing trajectories with cross-sectional snapshots.
- **Uncertainty**: reporting point estimates as if measurement and biological variability were noise to be discarded.
- **Causality**: substituting association for mechanism without acknowledging the substitution.
- **Adaptation**: ignoring that systems compensate, reorganize, and sometimes recover, treating change as decline alone.

When a representation sacrifices one or more of these without justification, the science is quietly degraded—not at the time of publication, but at the moment of inference.

Three examples of flattening in practice

1. How does a DHA trial flatten a dynamic system?

Consider a randomized controlled trial of DHA or omega-3 supplementation in cognitively unimpaired older adults[2]. The design is methodologically clean: randomize, dose, and compare a cognitive endpoint between groups at a fixed follow-up. Yet the biology being tested is a continuous, time-dependent modulation of neuronal and metabolic function. By compressing that process into a between-group mean difference at a single endpoint, the trial flattens *time* and *adaptation*. Early drift, compensatory fluctuation, and individual differences in response trajectory—the very signals that would tell us whether and for whom the intervention matters—are absorbed into residual error. A null result, under these conditions, may reflect the representation as much as the intervention.

2. What does pharmacoepidemiology lose about causality?

Pharmacoepidemiology studies of antihypertensive medication and dementia risk, including findings from the Cache County Study, illustrate flattening along the dimensions of *causality* and *time*[3]. Population-based studies of this kind are indispensable, and the Cache County work was notably careful about case ascertainment and the heterogeneity of susceptibility[3]. The flattening risk lies in how such associations are interpreted downstream: a hazard ratio linking drug exposure to incident dementia is a powerful summary, but it represents a complex, dynamic vascular-neuronal process as a single directional estimate. When interpretive strength outruns

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design strength—when association is read as mechanism—the representation has been flattened beyond what the data support.

3. Can AI and disease models avoid flattening?

AI and computational disease-modeling efforts confront flattening most directly, because representation *is* their explicit object. Systems-based frameworks such as the Calcium Systems Theory (CAST), knowledge-integration platforms like GUIDE, and collaborative AI initiatives such as CLARA were each conceived precisely to resist reductionism—to model the nonlinear, multiscale dynamics that simpler approaches discard[4]. CAST reframes Alzheimer's pathogenesis as accumulating system failures rather than a single etiologic trigger. CLARA applies machine learning to the complex relationships between biology, disease, and environment that conventional models omit. The cautionary point is that even multiscale models flatten whenever their data representations or coupling assumptions quietly drop *scale, uncertainty*, or *adaptation* while presenting outputs as comprehensive. The ambition to model complexity does not exempt a model from flattening; it raises the stakes of getting the representation right.

Flattening in scholarly writing

Representational flattening is not confined to data and models. It appears in how we write. Narrative reviews can flatten a contested, multidimensional literature into a tidy consensus, smoothing over the boundary conditions and failed generalizations that carry the most scientific information. Umbrella reviews can compound the problem, aggregating syntheses of syntheses until the original biological objects are several abstraction layers removed from the claims made about them. Pilot studies—valuable precisely because they probe uncertain terrain—are sometimes written to project more certainty than their design can bear, flattening *uncertainty* in pursuit of a publishable narrative.

None of these article types is inherently flawed. The problem is a writing convention that rewards apparent coherence over faithful representation of what remains unknown, unstable, or contested.

Editorial consequences for JarLIFE

If aging is a trajectory and performance is the scientific object, then representation is where that science is either preserved or lost. A journal committed to performance-based aging science cannot treat representation as a downstream formatting concern. It must treat it as a core question of scientific quality—on par with design and analysis.

This commitment carries obligations. It means asking authors to be explicit about the biological object they are studying, the representation they have chosen, and what that representation preserves and discards. It means evaluating whether a paper's interpretive claims are calibrated to the fidelity of its design. And it means being willing to publish work that preserves complexity even when complexity is harder to summarize.

Four provisional editorial directions for 2027

JarLIFE is considering four directions for 2027 author guidance. These are provisional, offered for principled disagreement rather than adoption by decree.

1. **A structured subsection on biological object, representation, and model.** Authors would briefly describe the architecture of the biological object under study, how it is represented in their data, and the analytical model applied to it. The aim is to make flattening visible and deliberate rather than implicit.
2. **Support for article types that develop good questions from partial data.** Strong scientific questions often precede complete datasets. JarLIFE is weighing formats that allow well-posed questions to be developed with preliminary or partial data, without forcing premature closure or overstated certainty.
3. **Evaluation of review articles by inferential reorganization, not citation breadth.** A review's value would be judged by its capacity to reorganize the inferential landscape—to clarify what is known, contested, and unresolved—rather than by the sheer number of references it assembles.
4. **Updated reviewer guidance on object definition and interpretive calibration.** Reviewers would be asked two questions explicitly: Is the biological object of inference clearly defined? And does the interpretive strength of the conclusions match the design strength of the study?

Consultation through the remainder of 2026

These directions will not be adopted without consultation. JarLIFE intends to use the remainder of 2026 to test them against the judgment of its community. Plans include a virtual editorial board meeting in September 2026, a series of podcasts, focus groups with researchers across disciplines, and invited commentaries that argue both for and against these proposals. A journal that asks authors to risk being wrong in public must be willing to do the same.

Frequently asked questions

What is representational flattening?

Representational flattening is the reduction of a complex, dynamic biological system into a simpler form that is easier to analyze or publish but that discards biologically essential properties—such as scale, time, or uncertainty—while being treated as if it were complete.

Is always flattening a mistake?

No. All representation involves simplification, and simplification is necessary. Flattening becomes a problem only when biologically essential dimensions are discarded without justification and the resulting representation is treated as a faithful account of the system.

How is this different from the March 2026 Vision editorial?

The Vision editorial argued that aging should be studied as a trajectory and performance treated as the scientific object[1]. This corollary addresses the mechanism by which that aim can fail in practice—through representations that quietly discard the dynamics performance-based science depends on.

Do these editorial directions apply to my submission now?

Not yet. The four directions are provisional and under consultation throughout 2026. They are intended to inform 2027 author guidance only after community input through the September board meeting, podcasts, focus groups, and invited commentaries.

What can authors do today?

Authors can state clearly what biological object they are studying, describe what their chosen representation preserves and discards, and ensure that interpretive claims are calibrated to the strength of the study design.

Where science is preserved or lost

Aging is a trajectory. Performance is the scientific object. Representation is where the science is either preserved or lost. The abundance of data in contemporary aging research is not, by itself, evidence of

progress; what matters is whether our representations remain faithful to the systems they describe. JarLIFE's task—shared with its authors, reviewers, and board—is to keep fidelity and tractability from being mistaken for one another, and to make the choices behind every representation explicit enough to argue about. That is the work the remainder of 2026 is meant to begin.

Declaration of competing interest

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