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Not All Sitting Is Equal in Later Life: A Perspective on Cognitively Active Sedentary Behavior

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Abstract

Sedentary behavior is conventionally defined as waking time spent sitting, reclining, or lying at very low energy expenditure (≤1.5 METs), a definition that supports surveillance and guideline translation. For cognitive and mental-health outcomes in later life, however, total sedentary minutes may be too coarse: seated episodes differ in cognitive demand, social context, autonomy over pacing, and stopping cues. This perspective advances a falsifiable thesis: distinguishing cognitively active from cognitively passive sedentary domains should yield more coherent and interpretable associations with cognition and mental health than total sedentary time alone. Existing evidence suggests that passive, media-dominant patterns and cognitively engaging seated practices relate differently to cognitive decline, dementia risk, and depression-related outcomes, although confounding and reverse causality remain central concerns. We propose a minimal measurement agenda: domain reporting, key modifiers, reliability flags for mixed episodes, episode-linked ecological momentary assessment, and time-reallocation contrasts. If domain resolution does not improve stability, coherence, or substitution-based interpretability, the thesis should be rejected or revised.

Keywords: sedentary behavior; older adults; cognitive aging; domain disaggregation; mental health; time-use reallocation

1. The Category Error Risk: Why Total Sedentary Time Can Mis-Specify Brain-Related Outcomes in Later Life

Sedentary behavior research earned its authority through definitional discipline. The field converged on a posture–energy expenditure construct precise enough for surveillance, comparability, and guideline translation: waking behavior performed in a sitting, reclining, or lying posture at very low energy expenditure (≤1.5 metabolic equivalents [METs]) [1]. That precision enabled population-scale quantification and supported public health guidance recommending moving more while reducing sedentary time [2,3].

Yet, this success creates an inferential vulnerability when outcomes are brain-related. An exposure optimized for posture–energy accounting can be treated as a psychologically unitary "dose," collapsing heterogeneity relevant to cognition, mood, and participation [4,5]. This paper does not redefine sedentary behavior; it argues that total sedentary time may mis-specify brain-related exposures when episodes differ in cognitive demand, social

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embedding, autonomy over interruption, and within-episode mixing. These sources of instability are testable with minimally more resolved designs.

In later life, this is not a minor nuance but a structural feature of the day. Older adults often spend a substantial share of waking time sedentary, making sitting less a removable excess than a dominant substrate of daily living [6]. The WHO message to "move more and sit less" remains the necessary public health anchor, while acknowledging that evidence is insufficient to specify a universal sedentary threshold and that feasibility is unequally distributed [3]. This perspective tightens, rather than dilutes, that guidance: for cognitive and psychosocial endpoints, the question is not only how much sitting occurs but also what is enacted while sitting—constraint, symptom management, externally paced low-agency routine, or posture-bound participation that sustains autonomy, identity, and connection [7,8].

Two empirical strands make the reframing methodologically urgent. The first is the comparatively robust cardiometabolic evidence. Total sedentary time is strongly associated with mortality and cardiometabolic risk at the population level, particularly when physical activity is low, even as attenuation at higher activity volumes shows that "sedentary dose" is not a simple toxin [9,10]. The second is the less coherent evidence for brain-related outcomes. Treating sedentary time as a single exposure yields findings that are often modest, heterogeneous, and sometimes contradictory, with persistent concerns about residual confounding and reverse causality [11]. This contrast matters because cardiometabolic endpoints are closer to posture–energy accounting, whereas cognitive and psychosocial endpoints are more plausibly content- and context-sensitive.

The methodological implication follows from this contrast: sedentary-domain inference for brain endpoints requires explicit reallocation logic. Evidence for moderate-to-vigorous physical activity and brain-health outcomes is comparatively robust, whereas evidence for light-intensity activity is still emerging [12,13]. Future work should test whether sedentary-domain contrasts depend on the intensity distribution elsewhere in the day and should frame estimates as reallocations across sedentary domains and intensity bands, rather than as content-free "more versus less sitting" contrasts. This is consistent with evidence that replacing leisure sedentary time with physical activity is associated with lower dementia risk [14].

Recent brain-health syntheses already treat the sedentary type as an inference-relevant moderator, with cognitively passive domains showing more consistent adverse signals than cognitively active domains [4,5]. This paper builds on that work by asking what follows methodologically: how sedentary content should be defined, coded, tested, and integrated into an explicit exposure ontology when cognitive and mental-health outcomes are the target. The implication is not that posture is irrelevant, nor that cognitively active sitting should be presumed beneficial. It is that posture-defined minutes are often a coarse proxy for mechanism-bearing features of everyday life-engagement mode, autonomy over pace and interruption, social ecology, and the opportunity structure that determines what seated time displaces [4,15]. Bidirectionality remains central: emerging cognitive vulnerability can shift time use toward highly scaffolded, low-demand routines, while sustained dominance of low-agency passive routines could narrow everyday cognitive practice, social–cognitive exposure, and recovery patterns. Without domain resolution, these dynamics are easy to misread as noise—or to misattribute to posture itself [4].

This perspective therefore advances a falsifiable thesis: in later life, the cognitive and psychosocial meaning of sedentary behavior depends on its content and context, and failure to disaggregate cognitively passive from cognitively active sedentary modes will continue to blur mechanisms and distort targets. Within-bout mixing adds a further measurement complication. Compound episodes—those involving co-occurring or rapidly

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switching active/passive engagement within the same sedentary bout—are treated here as measurement-reliability flags rather than substantive domains. A television program running in the background while an older adult reads, completes paperwork, or participates in conversation should not automatically be coded as purely passive sitting. When episode-linked sampling detects secondary activities or within-bout switching, the episode should be flagged as compound and examined in sensitivity analyses. The purpose is to prevent dominant-label coding from concealing structured misclassification, not to create a third category of sedentary behavior [16–18].

The next section clarifies this exposure ontology before turning to domain-sensitive evidence and measurement implications.

2. Clarifying the Construct: Defining Sedentary Behavior and Cognitive Engagement

A perspective article can carry a thesis; it cannot afford terminological drift. This article therefore retains the Sedentary Behavior Research Network (SBRN) consensus definition: sedentary behavior is waking behavior characterized by energy expenditure ≤1.5 METs while in a sitting, reclining, or lying posture [1]. WHO guidance treats sedentary time as a distinct target alongside physical activity, recommending that adults and older adults move more and reduce sedentary time while acknowledging that evidence remains insufficient to specify a universal sedentary threshold and that feasibility differs across people and contexts [2,3].

Two boundary conditions follow. First, sedentary behavior is not synonymous with physical inactivity. In later life, similar sedentary accumulation may reflect pain pacing, disability, fear of falling, transport barriers, caregiving routines, or purposeful seated participation—all of which change the meaning and feasibility of "sit less" without changing posture-defined minutes [7,19]. The posture–energy expenditure definition is valuable precisely because it specifies observable features while remaining agnostic about motive, constraint, or lived meaning [1,2].

Second, "activity" is not only energetic. In the classic public health taxonomy, physical activity is bodily movement produced by skeletal muscles resulting in energy expenditure; exercise is a planned subset; and physical fitness refers to attributes related to the ability to perform activity [20]. That taxonomy remains indispensable, but activity can also be cognitive, social, and cultural in ways not captured by energy expenditure alone [21]. For cognitive aging, the same posture-defined exposure can host radically different engagement modes—passive reception versus active meaning-making, isolation versus reciprocal exchange, low-agency continuation versus self-paced control. When outcomes are cognitive and psychosocial, the question is not whether a seated minute is "inactive" but what engagement it contains and whether that engagement is self-regulated or environmentally driven by external pacing and weak stopping cues [4,21].

The conceptual move is therefore limited but consequential. Sedentary behavior remains defined by posture and very low energy expenditure; cognitive engagement is treated as a co-occurring content layer, not as a redefinition of the construct [1]. "Domain" names the episode's dominant engagement mode, while "modifiers" describe mechanism-relevant features—cognitive demand, autonomy over pacing and interruption, social embedding, and stopping cues—without redefining the domain. Where measurement permits, engagement mode and autonomy should remain separable so that "active" does not quite mean "high-agency," and "passive" does not quite mean "low-agency."

To make this ontology explicit, Table 1 separates the primary exposure domain from mechanism-relevant modifiers, reliability tags, and replacement context. This distinction is intended to prevent "active" from being read as automatically high-agency, "passive" as automatically low-agency, or "compound" as a third substantive domain.

Table 1. Minimal ontology for domain-resolved sedentary behavior in cognitive aging.

Layer	Definition	Examples	Analytic Role
Domain	Dominant engagement mode of the sedentary episode	Cognitively active; cognitively passive	Primary exposure contrast
Modifiers	Mechanism-relevant descriptors that can vary within either domain	Cognitive demand; autonomy over pacing and interruption; social embedding; stopping cues	Potential moderators, mediators, or stratification variables
Reliability tag	Indicator that dominant-label coding may be unstable	Compound episode: co-occurring or rapidly switching active/passive engagement within the same sedentary bout	Sensitivity analysis; misclassification assessment
Replacement context	Behavior displaced or substituted within the finite 24-h day	Passive sedentary time replaced by cognitively active sitting, social interaction, light activity, or sleep	Explicit reallocation contrast

Cognitively active sedentary behavior serves here as an umbrella construct for related notions in adjacent literatures, including Hallgren and colleagues' distinction between "mentally active" and passive sedentary behavior [22,23]. It denotes posture- and low-energy-defined episodes involving sustained cognitive engagement and/or social–cognitive exchange, often under self-paced control—reading with comprehension, writing, structured learning, creative production, strategy-based games, craftwork requiring planning, and purposeful conversation. Cognitively passive sedentary behavior denotes low-demand receptive consumption, limited elaboration, and weak stopping cues, often sustained by externally paced or continuously available streams, such as prolonged television viewing or feed-like consumption that is easy to continue and difficult to "finish" [22–24]. The novelty is not the active/passive distinction itself but its integration into an exposure ontology for cognitive aging: domains are separated from modifiers, compound episodes are treated as reliability flags rather than a third domain, and associations are interpreted through explicit time-reallocation contrasts.

These labels are analytic rather than moral. "Cognitively active" does not mean beneficial, and "cognitively passive" does not mean harmful. The same seated engagement can be capacity-preserving or capacity-depleting depending on stress, resources, baseline status, and the broader opportunity structure of the day [5]. The purpose of domain disaggregation is interpretability rather than optimism: it makes confounding, selection, prodromal change, and genuine heterogeneity more visible instead of averaging them into a single posture-defined total [4,11,15]. Consistent with Table 1, compound episodes function only as reliability flags when co-occurring or rapidly switching active/passive engagement makes dominant-label coding uncertain and should be examined through sensitivity analyses when measurement permits [16,18,25].

For cognitive aging, the key time-use issue is not compositionality in general but within-sedentary substitution as a feasibility-driven counterfactual. Daily behavior is finite: time spent in one domain necessarily displaces time in others, including other sedentary domains, physical activity, and sleep. Contemporary sedentary behavior syntheses and time-use epidemiology model such interdependence through isotemporal substitution and compositional data analysis [15,19,26–28], a logic consistent with broader calls to treat time in human movement research as a calibrated resource rather than a neutral container [29]. In later life, where pain, disability, fear of falling, caregiving routines, environmental barriers, and unequal access to safe activity spaces may make global "sit less" prescriptions less feasible, the most actionable reallocation may occur within sedentary time itself—shifting minutes away from low-demand, externally paced, weak-boundary modes toward more cognitively and socially engaging seated practices [4,6,7]. Analytically, the relevant counterfactual is therefore the expected change in cognitive or psychosocial outcomes when a fixed duration is reallocated from one sedentary domain to another while the rest of the 24 h composition is held constant [26–31].

The definitional spine remains SBRN [1] and WHO [3]. This article adds only a minimal exposure layer for brain-related outcomes: principled disaggregation of sedentary time into cognitively active and cognitively passive domains, with compound episodes treated as reliability flags where measurable. The remainder of the article uses this ontology to interpret domain-sensitive evidence and motivate a low-burden measurement agenda, including episode-linked sampling, Ecological Momentary Assessment (EMA), and Just-In-Time Adaptive Intervention (JITAI) design principles [32,33].

3. The Evidence for Disaggregation: What Total Sedentary Minutes Conceal

Empirical findings on sedentary behavior and cognitive aging suggest that total sedentary time is an unstable exposure for brain-related outcomes. Systematic reviews document substantial heterogeneity in sedentary assessment, cognitive operationalization, and follow-up windows, and meta-analytic syntheses in middle-aged and older cohorts report small, heterogeneous associations between total sedentary time and cognition, with estimates sensitive to measurement mode and analytic specification [11,34,35]. This evidence does not prove that sedentary content is causal, but it shows that posture-only totals often provide limited interpretive leverage. Few studies have isolated how specific sedentary behavior characteristics—type, timing, bout patterning, and frequency—relate to cognitive performance, and fewer still have modeled these features jointly with the intensity distribution of physical activity across the same 24 h day [35,36]. The empirical question is whether domain-resolved models improve stability and substitution-based interpretability relative to total sedentary minutes.

Recent syntheses of lifespan brain health sharpen this point by treating the sedentary type as a plausible moderator, with cognitively passive domains showing more consistent adverse associations than cognitively active domains [4,5,37]. The claim here is not that sedentary behavior matters only after disaggregation but that the estimand "total sedentary time/cognition" becomes unstable when it averages across episodes differing in processing demand, autonomy over pacing and interruption, and social embedding. Consider two older adults who each accumulate 90 min of seated time in the evening. One watches continuous television with minimal interruption, low elaborative demand, and no social exchange; the other reads an expository article, annotates it, discusses it by phone, and stops when the task is complete. Under a posture-defined metric, both episodes contribute the same 90 sedentary minutes. As cognitive exposures, however, they are not equivalent. The second recruits attentional control, working-memory support, inference generation, language comprehension, and social–cognitive exchange—processes central to expository comprehension and discourse engagement [38,39]. The first may be more externally paced, less bounded, and more susceptible to attentional capture, although this remains an episode-level hypothesis rather than an assumed harm. When such episodes are averaged into the same total, near-null associations or contradictions may reflect exposure averaging and misclassification rather than evidence that sedentary content is irrelevant [40].

Patterns in very late life reinforce the same concern. In device-based data from adults aged ≥80 years, latent profiles distinguish sedentary accumulation architectures—how sedentary time is distributed into bouts and breaks—alongside differences in geriatric-relevant health indicators [41]. Similar sedentary totals can therefore arise from different daily structures, including different distributions of cognitive demand, social contact, and agency. If the internal composition of "sedentary time" differs systematically across people, totals become a mechanistically opaque proxy by construction [4,19].

Domain-sensitive longitudinal evidence makes this problem difficult to ignore. Table 2 summarizes illustrative cohort, longitudinal, and meta-analytic evidence by sample, exposure operationalization, outcome, and direction of association.

Table 2. Illustrative domain-sensitive evidence linking sedentary behavior to cognitive and brain-health outcomes.

Study/Source	Sample/Context	Exposure Operationalization	Outcome	Direction/Interpretive Point
Fancourt and Steptoe, ELSA [42]	Older adults followed over six years	Television viewing and other sedentary pursuits	Verbal memory and semantic fluency	Higher television viewing predicted faster verbal-memory decline, while semantic fluency showed no parallel decline, suggesting that sedentary domains are not interchangeable.
Raichlen et al. and Zhuang et al., UK Biobank [43,44]	Large prospective cohorts, including family-history stratification	Leisure-time television viewing and computer use	Incident dementia	Television viewing and computer use showed distinct associations with dementia risk, supporting domain-sensitive interpretation and caution against treating "screen time" as a uniform exposure.
Raichlen et al. [45]	Older adults with accelerometer-assessed sedentary time	Device-assessed total sedentary time	Incident dementia	Risk was concentrated at very high sedentary volumes; objective totals remain informative but content-blind.
Nemoto et al. and Zhu et al. [46,47]	Longitudinal and prospective cohort evidence	Mentally active/passive sedentary behavior; physical and mental activity profiles	Dementia incidence/risk	Mentally active, passive, physical, and mental activity profiles differed in relevance, supporting interpretation through combined activity patterns rather than isolated sedentary totals.
Chang et al., Quialheiro et al., and Benge and Scullin [48–50]	Longitudinal cohort and meta-analytic evidence	Reading, internet, and technology use	Cognitive decline, cognitive impairment, and cognitive aging	Cognitively engaging seated practices showed generally favorable but context-dependent associations, indicating that sedentary content should be specified by purpose, demand, and baseline resources.

This evidence does not establish that cognitively active sitting is protective or that passive sitting is harmful in any simple causal sense. Its value is more precise: domain resolution makes rival explanations—including confounding, selection, baseline resources, physical activity context, education, and prodromal change—more visible than total sedentary minutes alone [5,24,37,51]. "Screen time" is not a mechanism but a container whose contents must be specified before mechanistic inference is coherent. The point is therefore not to rank activities as intrinsically beneficial or harmful but to state an exposure principle: when cognitively active and cognitively passive engagement states—including compound episodes flagged for mixed content—are collapsed into the same posture-defined bucket, inconsistent associations become an expected consequence of exposure averaging rather than a definitive verdict on sedentary behavior's relevance to the aging mind [4].

Mental health evidence reinforces the same asymmetry. Longitudinal work shows that passive and mentally active sedentary behaviors display distinct prospective relationships with depression-related outcomes [22,23]. Meta-analytic evidence aligns with this dissociation, with mentally passive sedentary behaviors showing clearer links to depression risk [52]. Recent work tests plausible mediation pathways for passive sedentary time, including inflammation-related mediators, rather than treating "sitting" as a psychologically uniform exposure [53]. The falsifiable claim is not that passive sitting causes depression, but that passive-dominant time should behave differently from mentally active time once the counterfactual replacement is made explicit.

Treating content as exposure also clarifies a second implication: time use is compositional. Minutes spent in one domain displace minutes in others, and reallocation frameworks such as isotemporal substitution and compositional data analysis address this finitude directly [19,26,28]. For cognitive aging, the most relevant substitution may occur within sedentary time itself, because the meaningful contrast is often not simply sitting versus moving but passive-dominant sitting versus cognitively or socially engaging sitting, alongside downstream effects on social contact, fatigue, and sleep regularity [27,28,31]. If the internal mix of sedentary domains carries inference-relevant heterogeneity, then domain-resolved compositional contrasts are part of what makes "sedentary time" interpretable for brain-related outcomes [4].

Overall, this section supports one bounded claim. It is not that any one sedentary activity protects, nor that passive media harms in a simple causal sense. It is that for cognitive and psychosocial outcomes, posture-only totals are often an under-resolved exposure. Disaggregating sedentary time by domain should therefore yield more interpretable estimates—including nulls—because key threats to inference, from confounding and selection to prodromal change, become explicit targets of design and analysis [4,5,11]. The next section shifts from why totals are unstable to how domains plausibly differ, specifying proximal pathways in a way that can be measured, challenged, and falsified rather than merely asserted.

4. Proximal Pathways: How Sedentary Content Influences Cognitive and Psychosocial Health

A content-as-exposure stance requires mechanistic plausibility. The proposed distinctions—cognitively active and cognitively passive sedentary domains, with compound episodes treated as reliability flags—map onto pathways already legible within cognitive aging, affective science, and time-use epidemiology [4,5,11]. For brain-related outcomes, engagement mode—its demand profile, autonomy over pacing and interruption, and social ecology—sits closer to plausible proximal pathways than posture-defined minutes alone. The pathways below therefore link domain descriptors to measurable episode-level processes and testable predictions under explicit time-reallocation contrasts.

One pathway is cognitive practice density: repeated recruitment of age-vulnerable processes, including attentional control, working-memory updating, controlled retrieval, and executive monitoring [54–56]. This is a measurement hypothesis, not a settled causal mechanism. The claim is not that cognitively active sitting directly produces neuroprotection, but that cognitively demanding seated episodes embed different operations than low-demand receptive episodes. Broader evidence on cognitively stimulating leisure activities supports this possibility, with systematic and meta-analytic work linking cognitive leisure activities to lower future risk of cognitive impairment or dementia, although these associations remain vulnerable to confounding, selection, and reverse causality [57]. More recent evidence cautions against assuming durable or uniform effects, with stimulating leisure-time activities associated with reduced dementia risk in short-term but not long-term follow-up [58]. Against the background of age-related structural brain change [59], the small video-game training trial cited here [60] should be read only as plausibility evidence. Domain-resolved sedentary behavior should therefore be tested as a difference in embedded cognitive demand, not assumed to be beneficial because it is "active."

A second pathway is social–cognitive scaffolding: late-life cognition is partly distributed across routines, relationships, and interactional structures that supply cues, feedback, and correction [61,62]. Reciprocal interaction recruits language production and comprehension, discourse tracking, perspective-taking, and executive monitoring [63,64]. Contemporary evidence linking social relationships, social participation, and loneliness-related vulnerability to cognitive trajectories in older adults supports this pathway [65–67]. The implication is not that socially embedded sitting is inherently protective but that cognitively active sedentary time should not be treated as homogeneous unless social embedding is measured. A solitary crossword, a structured learning task, a phone conversation, and a group discussion may all be seated and cognitively engaging, yet differ in linguistic demand, reciprocity, perceived agency, and emotional aftereffects. Social embedding is therefore both a mechanism-relevant feature and a potential selection pathway, because access to people, spaces, and roles is unequally distributed in later life.

A third pathway concerns autonomy, attention capture, and stopping cues. Qualitative work in older adults suggests that sitting time is often organized around symptom pacing, fatigue management, relaxation, background company, and practical constraints [7,68]. Some passive domains are therefore not simply "chosen"; they are low-friction, continuously available, and easy to sustain when alternatives are constrained. Television viewing may provide structure, company, and rest, even when people report ambivalence about prolonged viewing [68]. It may also be patterned by social context: older adults living alone have reported greater loneliness during intervals involving television viewing, suggesting that passive media use can be embedded in affective and relational circumstances [69]. Many passive media environments minimize stopping cues: the next program, clip, or feed item appears without requiring a renewed decision. Evidence on autoplay and video-streaming interfaces shows that design can prolong engagement by weakening natural points of closure [70,71]. However, much of this evidence comes from general or younger populations; its transferability to older adults should be treated as a hypothesis, not an established mechanism. Future studies should investigate whether weak stopping cues predict passive-bout duration in older adults after accounting for mood, loneliness, functional limitations, and media habits.

Neuroscience can add plausibility, but only with restraint. Rest is not neural silence; internally oriented cognition recruits networks implicated in self-generated thought, autobiographical remembering, and future simulation [72,73]. Some seated episodes may involve remembering, meaning-making, incubation, wakeful rest, or attentional recovery, experiences consistent with evidence from life-review interventions, incubation, and wakeful rest [74–76]. The point is not to prescribe seated stillness as beneficial, but to avoid treating all non-task sitting as cognitively empty. These findings do not justify inferring psychosocial value from posture-defined sedentary time; rather, they show why measurement should distinguish restful pause from passive capture.

Operationally, a restful pause can be defined as a bounded, chosen, and potentially restorative sedentary episode, typically returning the person to the day with greater calm, clarity, or readiness. Passive capture, by contrast, refers to a low-agency, externally paced, weakly bounded episode that is difficult to stop and more likely to be followed by fatigue, irritability, rumination, or a sense of lost time. Brief episode-linked items could therefore assess whether the episode was chosen or automatic, bounded or difficult to stop, restorative or draining, solitary by preference or constraint, and followed by clarity, fatigue, calm, irritability, or rumination. This distinction should be treated as an empirical coding problem rather than a moral ranking of activities: the same seated practice may function as a restorative pause in one context and passive capture in another, depending on agency, affective aftereffects, social context, and stopping cues.

Finally, these pathways are inseparable from the finite ecology of the day. Passive sedentary time reallocates the day's composition and changes the counterfactual: more passive minutes instead of what—light activity, cognitively active sedentary time, social contact, or sleep? Isotemporal substitution and compositional time-use models make this replacement explicit [19,26–28,77]. Under later-life feasibility constraints, the most plausible substitutions may occur within sedentary time itself—shifting minutes from prolonged passive exposure toward seated practices with greater cognitive demand, social embedding, and autonomy—without implying that posture change is always realistic. Mechanistic plausibility therefore depends on counterfactual clarity: the relevant pathway cannot be interpreted without specifying what behavior is displaced or replaced.

This section supports a restrained claim: sedentary domains may differ for cognitive and psychosocial outcomes because they differ in cognitive demand, autonomy over pacing and interruption, and social ecology. Posture remains necessary for surveillance and comparability, but it is not sufficient as an explanatory variable when minutes are treated as psychologically exchangeable. The contribution is to specify tractable episode-level descriptors that reduce mis-specification and make alternative explanations empirically separable. The next step is translation: measuring sedentary content with minimal but rigorous resolution so the field can test whether not all sitting is the same.

5. A New Agenda: From "Sit Less" to "Sit Differently" in Research and Practice

For research and practice, the implication is not to abandon "sit less" guidance but to make it more precise for brain-related outcomes. Current guidelines recommend reducing sedentary time while increasing physical activity, but they do not specify which sedentary domains matter most for cognition or mental health in later life [2,3]. The translational target is therefore to reduce prolonged passive dominance where feasible—especially externally paced and weakly bounded routines—while protecting seated practices that sustain cognition, autonomy, identity, and connection [5,11]. This shifts the intervention question from "How do we reduce sitting?" to "Which sedentary episodes should be interrupted, replaced, or redesigned, and with what?"

For brain-related outcomes, the most tractable target may be substitution within sedentary time, not merely the substitution of sedentary time with movement. Because daily time use is finite, behavior change is reallocation: X minutes of one domain replace X minutes of another while the rest of the 24 h composition is held constant [19,26–28]. This is especially relevant in later life, where pain, fatigue, functional limitations, fear-related restrictions, environmental barriers, impairment, literacy, culture, resources, and digital access shape feasible replacements [78,79]. Studies should therefore report both the reduced domain and the observed replacement domain rather than assuming replacement by movement. Experimental crossover work suggests that the sedentary behavior–brain relation is modifiable by how sitting is patterned and interrupted; in older adults, morning exercise and/or structured breaks during prolonged sitting have mitigated sitting-associated decrements in cerebral blood flow and influenced cognitive outcomes [80,81].

This substitution logic sharpens how "break up sitting" recommendations should be interpreted for brain-related outcomes. Brief interruptions of prolonged sitting have a credible cardiometabolic rationale [19,82], but for cognitive and psychosocial endpoints, the more defensible target may be prolonged passive capture—episodes combining passive content, weak stopping cues, low perceived agency, and extended duration. A posture-based prompt treats all uninterrupted sitting as equivalent; a content-sensitive prompt asks what the person is doing. If an older adult is reading, writing, completing paperwork, or speaking with another person, the prompt might be delayed, softened, or framed as optional. If the bout is television-dominant or feed-dominant, prolonged, low-interaction, and difficult to stop, the prompt could target passive capture directly: "Would this be a good moment to pause, stretch, call someone, or switch to another activity?" The outcome would not be posture change alone but reduced passive accumulation, greater perceived agency, or reallocation toward social, cognitive, or light-activity alternatives. Where cognitive endpoints show mixed responsiveness to sedentary behavior-focused interventions, longer-horizon trials appear more consistent for cardiometabolic intermediates plausibly relevant to cognitive aging [83].

The central scientific agenda is measurement. Wearables can estimate posture-defined sedentary time and bout structure; they cannot infer whether an episode contained television viewing, reading, conversation, or mixed engagement. Studies should therefore report a small, interpretable set of sedentary domains—for example, television-dominant passive sitting, cognitively demanding seated activity, and socially engaged seated time—and, where feasible, apply reliability flags to concurrent or rapidly switching episodes [5,24,37]. Because misclassification is likely to be structured, coding rules should be preregistered and stress-tested in sensitivity analyses; papers should report at least the domain set, concurrency rule, and decision thresholds. Studies should also predefine outcomes beyond cognition alone, including cardiometabolic mediators, brain structure or function indices, and socioemotional markers [83,84].

Because domain measures introduce reporting error, socioeconomic patterning, differential digital access, and monitoring reactivity, linkage designs and sensitivity analyses should be built into the agenda. Device-detected sedentary episodes can be paired with low-burden EMA items asking what the episode contained and what followed in mood, clarity, fatigue, or perceived agency [33]. JITAI principles formalize when to prompt, when to refrain, and how to manage burden [32], and sensor-triggered EMA in older adults supports treating "when to ask" as a design variable [85]. Recent mobile health evidence further supports the feasibility of digital approaches to reducing sitting time in older adults, while underscoring the need to monitor acceptability and burden [86]. Qualitative work can strengthen construct validity before those constructs are scaled quantitatively [7]. Digital methods should extend ecological coverage, but passive sensing should be opt-in, privacy-preserving, and justified by incremental validity over self-report or EMA [87–89].

A minimal older-adult protocol could combine device-detected sedentary bouts with a few episode-linked prompts per day, oversampling longer bouts across morning, afternoon, and evening. Each prompt should take under one minute and assess only what is needed for domain coding: primary and secondary activity, social context, perceived cognitive demand, autonomy over stopping, affective state, and immediate aftereffect. Feasibility should be treated as empirical through accessible formats, training trials, caregiversupported setup where appropriate, prompt-free periods, non-response logging, and rules for reducing or suspending prompts when adherence drops, burden increases, or distress is reported.

A content-first agenda also requires analytical discipline. Domain associations do not automatically imply causal effects; they may reflect baseline vulnerability, prodromal changes, or socioeconomic patterning. The gain is not causal certainty but conceptual validity: better-specified exposures yield more interpretable estimates and cleaner falsification. Because time use is finite, any association is implicitly a comparison to some replacement; reallocation approaches can extend beyond posture categories to substitutions within sedentary domains, plausibly the most relevant contrasts when mobility constraints make large increases in physical activity unrealistic [19,26–28,77]. Greater exposure resolution may initially increase variance and widen confidence intervals; the criterion is interpretability and cross-context stability, not effect inflation.

A perspective earns its value by specifying what would count against its thesis. The framework would be weakened or require revision if (1) domain-resolved models showed no gain over total sedentary minutes [4,5,11]; (2) cognitively passive and cognitively active sedentary time showed no distinguishable patterns after adjustment for confounding, baseline status, total sedentary time, and physical activity context [4,22–24]; (3) explicit reallocation contrasts added no interpretive value beyond conventional adjustment approaches [19,26–28]; (4) compound episodes were uncommon or analytically irrelevant, such that accounting for co-occurring or rapidly switching engagement did not change estimates, improve stability, or reduce misclassification concerns [16–18,25]; or (5) content-sensitive interventions showed no added value over posture-only approaches in adherence, perceived agency, passive-bout reduction, or brain-related outcomes. Under these conditions, sedentary content would no longer qualify as a necessary exposure layer for brain-related outcomes.

In later life, sedentary time is not a homogeneous residue of inactivity. It may reflect constraint, recovery, habit, symptom management, social participation, or cognitively meaningful engagement. Cognitive-aging research therefore does not need a new definition of sedentary behavior but a better-specified exposure. Minimally disaggregated sedentary content, interpreted through explicit substitution contrasts and measured with low-burden episode-level designs, can help distinguish prolonged passive dominance from seated practices through which many older adults preserve autonomy, identity, language, memory, and connection. If this agenda succeeds, sedentary time will become more interpretable for brain-related outcomes; if it fails, the field will know that the instability of total sedentary time was not primarily a measurement-resolution problem.

6. Testing the Thesis: Conclusions and Limitations

This perspective argues that, for cognitive and psychosocial outcomes in later life, total sedentary time is often an under-resolved exposure. Sedentary behavior should remain defined by posture and low energy expenditure, but brain-related inference requires additional information about what seated time contains (cognitive demand, social embedding, autonomy over pacing and interruption, stopping cues, and the behavior being displaced). Distinguishing cognitively active from cognitively passive sedentary domains, while treating compound episodes as reliability flags, offers a more interpretable and falsifiable way to study sedentary behavior in cognitive aging.

Several limitations should temper this argument. This is a perspective article rather than a systematic review or meta-analysis, and the proposed ontology should be treated as a framework for future testing, not as settled evidence of causal effects. Existing studies remain vulnerable to residual confounding, reverse causality, socioeconomic patterning, and baseline differences in cognitive, functional, and social resources. Measurement also remains challenging. Self-report may misclassify mixed episodes, device-based measures cannot infer content, and EMA or sensor-triggered designs may increase burden or exclude people with limited digital access. Finally, the distinction between restful pause and passive capture is proposed as an empirical coding problem, not a validated classification system. The framework should therefore be revised or rejected if domain-resolved measures do not improve interpretability, stability, or substitution-based inference beyond total sedentary time.

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