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Designing Digital Interventions for Midlife Dementia Risk Reduction: A Realist Framework Incorporating Futures Theory and Interpretative Engagement

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Abstract

Public health messages about modifiable dementia risk factors often assume that information alone will change behaviour. Recent evidence suggests otherwise: public knowledge of these factors is limited, and gains in knowledge do not reliably become lasting lifestyle change [1]. This article examines the contribution of Dr Peter Carey, whose 2026 programme of scholarship applies realist evaluation to digital dementia education and brings into health the futures thinking developed in his education research [2-4]. Instead of creating new Context-Mechanism-Outcome (CMO) reasoning, it builds upon current CMO reasoning. Carey specifies the mechanism in digital education as the user's interpretative engagement, supported by entertainment and Futures Theory, and proposes behavioral readiness as the intended intermediate outcome [5,6]. Three illustrative scenarios covering diet, physical activity and sleep show how the framework could guide app design, and a three-stage realist evaluation is outlined. The framework is conceptual and still emerging. Its constructs are consistent with independent literature, but its effects on behaviour have yet to be tested, and empirical evaluation is planned in a proposed doctoral study of midlife adults. Privacy, psychological safety and equity are discussed as design safeguards.

Keywords: Futures Theory, Context–Mechanism–Outcome, Interpretative Engagement, Realist Evaluation, Dementia Risk Reduction, Midlife

1. Introduction

Dementia is a major and fast-growing global health challenge. The 2024 Lancet Commission estimates that about 45% of cases worldwide could be prevented or delayed by addressing 14 modifiable risk factors across the life course [7]. Yet public recognition of many of these factors is low. A 2026 systematic review and meta-analysis of 155 studies, covering 164,644 participants in 41 countries, found that recognition of established modifiable risk factors was below 50% for all but physical activity, social isolation and traumatic brain injury [1]. Its authors add that knowledge tends to raise the intention to adopt healthier behaviours, but actual lifestyle change often fails to follow.

For many years public health campaigns have worked on an information-transfer assumption: if people are told which risk factors exist, they will adjust their daily habits. Carey (2026b)

challenges this assumption and reconceptualises dementia education as behavioural and contextual change, not information delivery [8]. The question has become pressing as health services lean more heavily on websites, smartphone applications and digital tracking tools. The evidence on digital education is encouraging but mixed. In a randomised trial of 510 adults, an e-learning programme improved knowledge of dementia risk and self-reported physical activity, most clearly among participants with lower educational attainment [9]. Large open courses can reach many people, but the research participants in the Preventing Dementia Massive Open Online Course were mostly women who were highly educated and lived in high-income countries [10].

Across 2026, Carey published a connected programme of scholarship that asks a different question. Instead of asking only whether digital education raises knowledge, it asks how, for whom

and under what conditions digital education leads to behavioural change [5]. The programme is intended to lead into a proposed doctoral study that will evaluate digital dementia risk-reduction education among unimpaired midlife adults aged 40–65 years. Figure 1 summarizes the five contributions examined in this article, and Table 1 lists the outputs on which they draw.

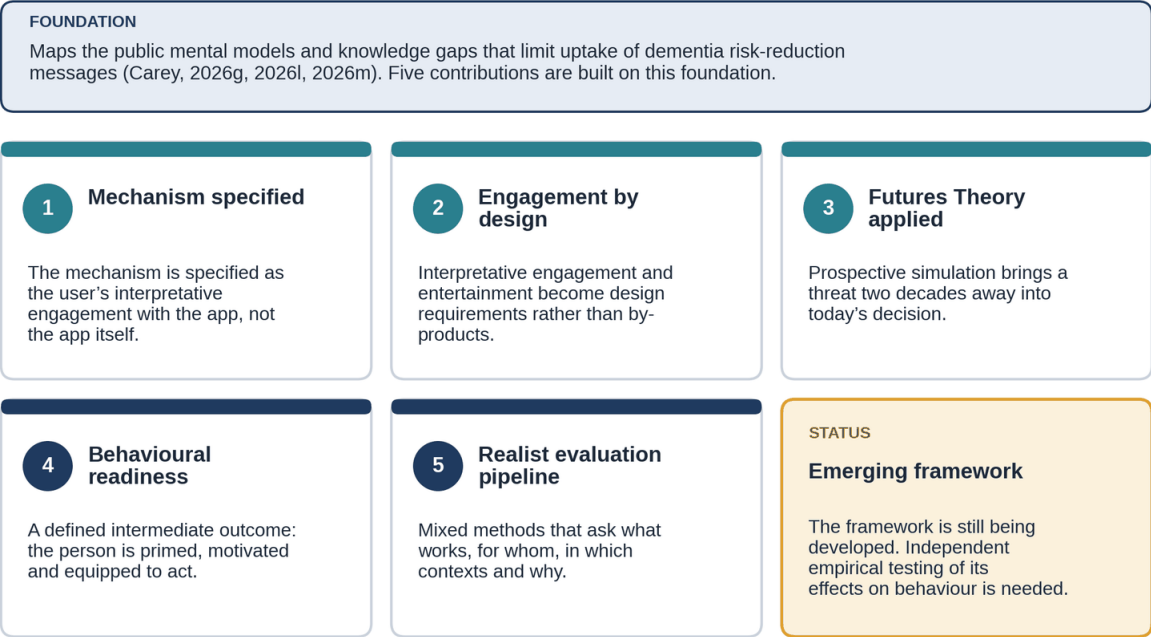


Figure 1: Five Contributions of Carey’s Realist Framework for Digital Dementia Risk Reduction Education

Note. Contributions are as described in this article [5,6,11-13]. They build on established realist evaluation and CMO reasoning and do not replace them. The status statement is this article's assessment of the evidence base, not a claim made by Carey.

1.1. Defining the “App” in Digital Public Health

In this article, **app** is short for *application software*. Digital behaviour change interventions have been defined as products or services that use computer technology to promote behaviour change, and they can be delivered through websites, smartphone applications or wearable devices [14]. Contemporary health apps typically combine an interactive interface, data capture (from wearables, for example) and feedback that adapts to the user. In that sense they can act as an ambient environmental intervention, delivering timely cues and adjusting how information is presented to the literacy level of the person using them.

In Carey’s realist framing, an app is best understood as a set of resources, not a mechanism [5]. The software does not alter biology or behavior. It offers information, prompts and simulations that may or may not change how a person reasons about their health. The wider realist literature draws the same line between the resources an intervention provides and the change in participants’ reasoning that those resources may trigger [15].

1.2. Carey’s Programme of Scholarship

Table 1 groups Carey’s outputs into five strands: a futures thinking foundation drawn from his education research, the definition of the problem, concepts of literacy and education, realist theory and an evaluation framework, and empirical work. The grouping is this article’s. Within the dementia outputs, the order runs from diagnosis to concepts, then to theory and evaluation.

Strand	Output	Focus
Futures thinking foundation (education)	Carey (2022) <i>The value of futures thinking and scenario analysis</i>	Futures thinking and scenario analysis as tools for education system change in an age of disruptive technologies.
	Carey (2025) <i>Future schooling and futures thinking</i> (discussion and conclusion)	How futures thinking is construed and evidenced in Australian education, and how educators view emerging forms of learning.
	Carey (2026n) <i>Future schooling and futures thinking</i> (doctoral thesis)	Teachers' and school leaders' perspectives on emerging forms of learning and skills education.
Problem and evidence gap	Carey (2026l) <i>Mind the knowledge gap</i>	Maps deficits in global dementia education and care infrastructure.
	Carey (2026g) <i>Public understanding of dementia and modifiable risk factors</i>	Conceptual review of public understanding of dementia and its modifiable risk factors, including persistent misconceptions and a gap between evidence and public interpretation.
	Carey (2026m) <i>From knowing to recognising</i>	Asks when dementia prevention evidence becomes personally relevant in midlife.
Concepts of literacy and education	Carey (2026c) <i>Dementia prevention literacy</i>	Develops the Dementia Prevention Literacy Translation Framework, which treats prevention literacy as a multi-level translation process rather than a linear route from information to behaviour.
	Carey (2026b) <i>Reconceptualising dementia education</i>	Recasts dementia education as a dynamic, non-linear process, drawing on health literacy, COM-B, implementation science and interpretative engagement theory.
	Carey (2026d) <i>From prevention literacy to realist-informed digital education</i>	Links the prevention literacy framework to a realist-informed digital education framework through explicit CMO reasoning.
	Carey (2026k) <i>The midlife dementia risk-management paradox</i>	Proposes Midlife Preventive Capacity: a provisional capacity to coordinate and sustain several prevention activities in midlife.
Realist theory and evaluation framework	Carey (2026a) <i>Beyond information delivery</i>	Describes digital dementia education as a multi-component system (resources, engagement, interpretation, readiness, context and outcomes) and introduces CMO reasoning to explain variation in outcomes.

Table 1: Carey's Programme of Scholarship on Futures Thinking and Digital Dementia Education

Note. Focus statements summaries each output as described in the author's programme documentation and, for Carey (2025) and Carey (2026a), the published abstracts. Several outputs also exist as preprints or repository deposits; see References. Posters and infographics are not listed [2,5].

Two points follow from Table 1. First, the outputs are closely linked. Futures thinking in education comes first, and the dementia work then moves from problem to concept, theory and evaluation, with the CMO extension at the center of the theory strand [5,6]. Second, the programme does not claim to originate realist evaluation or CMO reasoning, which are established traditions. Its contribution lies in applying, integrating and specifying them

for digital dementia risk-reduction education, and in planning their empirical investigation. The work is also recent and largely single-authored, so independent scrutiny is only beginning. For that reason this article cites Carey for what he argues and relies on independent sources for empirical claims.

1.3. Dissemination, Open Access and Priority

Alongside submission to journals, elements of the programme have been made openly available on a preprint platform (Preprints.org) and an open research repository (Fig share). Each deposit receives a permanent DOI, which creates a public, time-stamped record of when specific concepts, frameworks and theoretical contributions were first set out. That record matters here for two

reasons. The original contribution of the programme lies largely in framework development and theoretical synthesis, so the date on which an idea was first articulated is part of the evidence for it. In addition, the planned doctoral study is intended to be part-time, which means the path from first articulation to a completed thesis and peer-reviewed empirical papers is necessarily long. An independently verifiable record of authorship and dating helps protect the originality of the work while that longer process runs.

Preprints and repository deposits complement peer review and do not replace it. Both platforms carry out editorial and ethical screening, but neither provides independent peer review. Work deposited in this way is best read as a time-stamped conceptual and theoretical contribution, and the empirical findings from the planned doctoral study will be submitted to peer-reviewed journals as the study progresses. Preprints.org outputs are indexed by discovery services including Google Scholar and the Clarivate Web of Science Preprint Citation Index, so they can be found and cited before, or independently of, the longer timelines of formal peer review. Open-access publication was chosen so that researchers, clinicians and public health practitioners can read the

work without subscription barriers. The programme also includes three evidence-informed posters and infographics that translate the scholarship for midlife adults, their families and the professionals who support them, and outputs have been shared through LinkedIn, X and Facebook. Social media engagement is no substitute for citation metrics, but it gives an early sign that the work is reaching its intended audiences.

2. Literature Review: The Translation Gap and Public Mental Models

Biomedical evidence and public interpretation do not line up neatly. Figure 2 compares how often the public recognizes six modifiable risk factors with the share of dementia cases each is estimated to account for. Recognition is highest for physical activity, social isolation and traumatic brain injury, and lowest for less education, air pollution and obesity [1]. Recognition and population impact are only loosely aligned: physical activity is well recognized but accounts for a modest share of cases, whereas less education and social isolation account for more [7]. Generic awareness messaging is a blunt instrument.

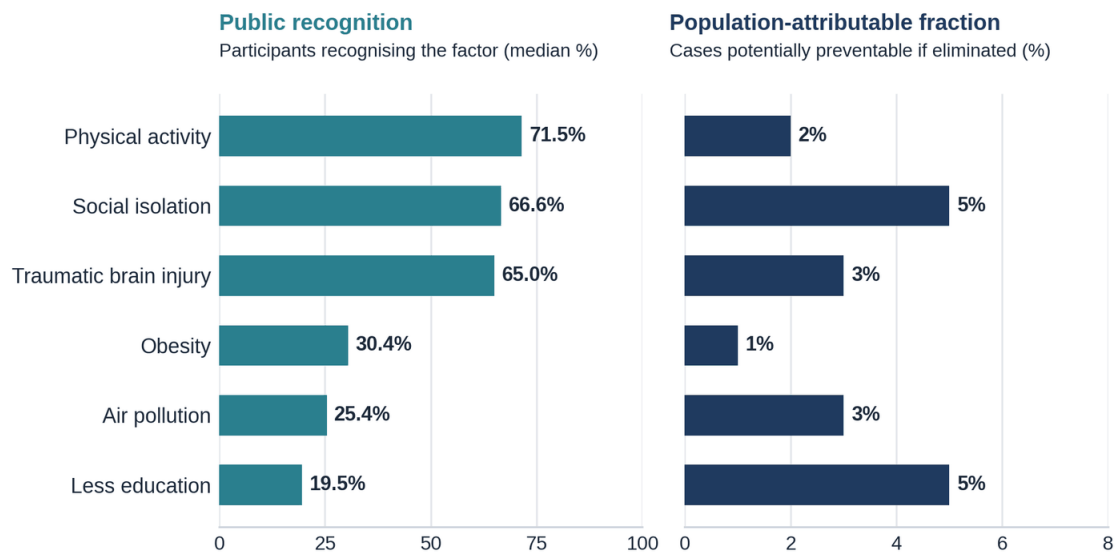


Figure 2: Public Recognition of Six Modifiable Dementia Risk Factors Compared With Their Population-Attributable Fractions

Note. Recognition values are median percentages across studies, and heterogeneity between studies was large [1]. Population-attributable fractions are from Livingston et al. (2024) [7]. They are population-level estimates of potential prevention, not individual risk, and should not be summed across factors without accounting for overlap. Only factors with values in both sources are shown.

Mental models matter as well as knowledge. Qualitative studies in the Sambou et al. (2026) review found that some participants regarded cognitive impairment as inevitable or a matter of bad luck, which leaves little room for prevention [1]. Earlier work synthesized population surveys on what the public understands

about dementia prevention, and a meta-analysis found low public knowledge of the cardiovascular risk factors for dementia [16,17]. Carey (2026g) reviews these lay frameworks and argues that they tend to favor psychological or social explanations over systemic biological ones, so cardiovascular and metabolic health are seldom connected to later cognition [11]. Carey (2026m) adds that the difficulty is recognizing when the evidence applies to oneself, as well as knowing it [13].

Carey (2026c) responds with the Dementia Prevention Literacy Translation Framework [18]. It links epidemiological evidence, public mental models, health literacy, behavioral appraisal and

preventive action, and it gives interpretive mental models and structural conditions a central role instead of assuming a straight line from information to behavior.

Researchers have also drawn on the COM-B model, which holds that behavior change needs *Capability*, *Opportunity* and *Motivation* to line up [19]. Carey (2026a) argues that digital education tools often overemphasize *Capability* (supplying information) while neglecting *Motivation* and the shifting user *Context* [5]. Independent work on digital behavior change points the same way. Engagement is both an experience and a behavior, and it is shaped by the intervention, the context of use and the behavior being targeted [14]. Rather than treating technology as a simple binary intervention that either works or fails, a realist evaluation framework shifts the core inquiry to examine what

aspects of a digital tool work, "for whom, in what circumstances, and why" [20,21]. Realist evaluation has already been used in dementia health literacy work. Grace and Horstmansh of (2019) applied it to a regional project in New South Wales and identified context–mechanism–outcome configurations around co-designing and distributing a support kit for people with dementia and their careers [22]. That project concerned a different population and purpose from digital risk reduction education for midlife adults, and its authors noted that further evaluation was needed to confirm effects on service users' behavior. Carey's framework applies the same style of reasoning to that newer setting.

Table 2 places three independent digital programmes alongside the realist questions that Carey's framework would add.

Programme	Design and reported findings	Realist question added by the CMO lens
Preventing Dementia MOOC (Farrow et al., 2022)	Free online course, seven iterations from 2016 to 2020; over 100,000 participants, 55,739 in the research sample. Participants had a mean age of 49, and 86% were women, 77% had post-secondary education and 93% lived in high-income countries.	Which contexts (C) are missing from the audience, and what engaged the people who did take part?
DementiaRisk.ca randomised trial (Levinson et al., 2026)	510 adults randomised to a 35-minute multimedia lesson with micro-learning emails or a comparison lesson. Knowledge and self-reported physical activity improved, particularly among participants with lower educational attainment.	Why did benefit concentrate among lower-education participants? Which mechanisms (M) operated, and in which contexts?
"Keep your brain healthy" e-learning (Van Asbroeck et al., 2025)	Dutch pre-post study of 477 adults across seven weekly themes. 71.1% completed the post-course survey and 50.5% the three-month follow-up.	Who dropped out, and at which points? Interaction telemetry (Stage 2, Figure 5) would help locate where engagement failed.

Table 2: Independent Digital Dementia Risk-Reduction Programmes and the Realist Questions They Leave Open

Note. Findings are as reported in the cited studies. The third column is this article's analysis and is not drawn from those studies.

2.1. The Theoretical Framework: The Extended CMO Model

At the center of Carey's contribution is the Context–Mechanism–Outcome configuration of Pawson and Tilley (1997), which he specializes for digital dementia education [5,6,20]. In realist evaluation the mechanism is not the intervention itself. It is the way an intervention's resources change participants' reasoning, and it operates by degree, not as an on/off switch [15]. Carey applies this to digital design by

separating context, intervention characteristics, resources and user engagement. He proposes interpretative engagement, grounded in constructivist and sensemaking perspectives, as a potential mechanism linking exposure to content with behavioural intention and action [5,6]. He also proposes behavioural readiness as an intermediate outcome that can be examined before long-term habits appear [6].

Figure 3 shows the streams of thought on which this extended framework draws and what it adds to them.

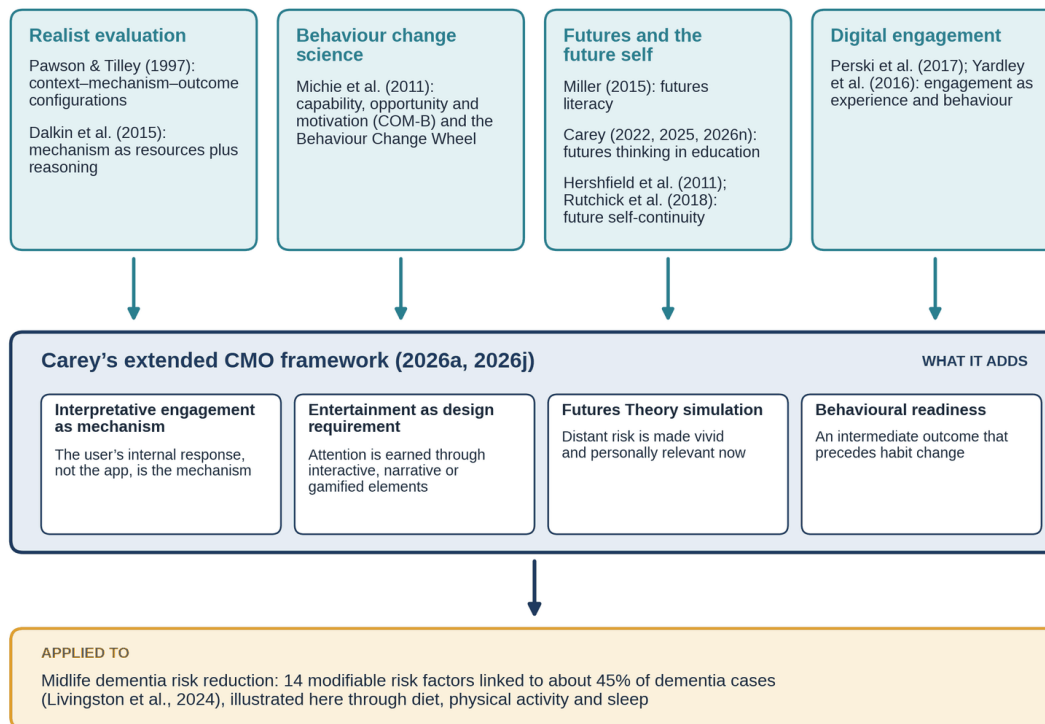


Figure 3: Intellectual Foundations of the Extended CMO Framework

Note. Arrows show conceptual lineage assembled for this article. They do not imply that Carey cites each source. The 45% figure is the potential reduction in future dementia if all 14 risk factors were eliminated [7].

Figure 4 contrasts the information-transfer model with the extended CMO model. In the extended model the intervention is described through three linked elements, and design and evaluation both have to address each of them.

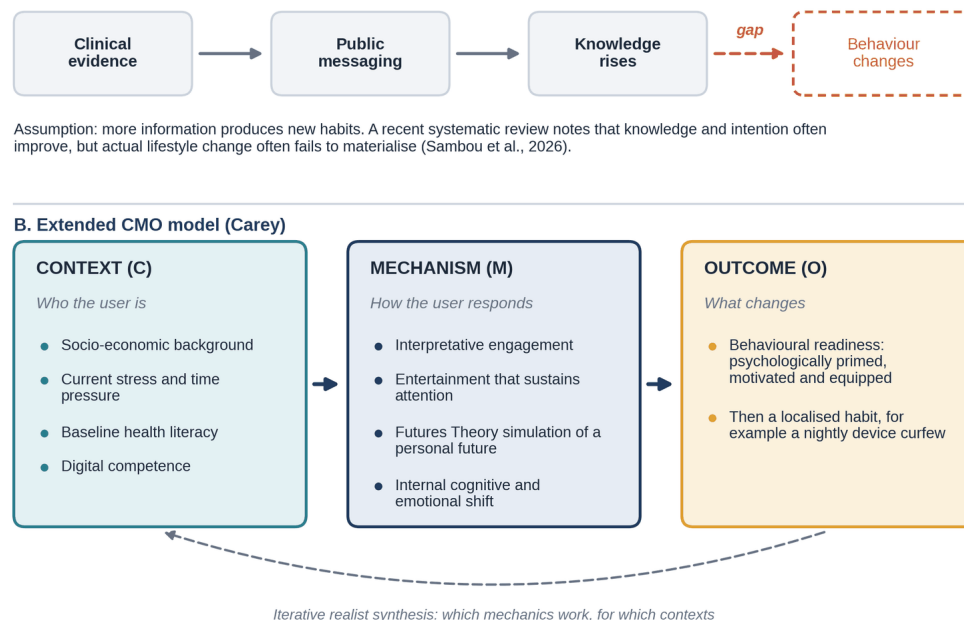


Figure 4: The Information-Transfer Model Compared With the Extended CMO Model

Note. Panel A is a simplified representation of the assumed pathway. Panel B follows the extended CMO description in Carey (2026a, 2026j) [5,6]. The dashed arrow indicates iterative realist synthesis.

The three elements are as follows:

- Context (C): the pre-existing realities of the user's life, including socio-economic background, current stress, baseline health literacy and digital competence. An app cannot treat a time-poor corporate executive and a digitally isolated retiree as the same user.
- Mechanism (M): the process of interpretative engagement and entertainment. The app has to capture and sustain attention through interactive, gamified or narrative elements. Futures thinking enters through prospective simulation, which brings a risk decades away into the present so that it carries emotional and logical weight now.
- Outcome (O): behavioural readiness, the intermediate state in which a person is psychologically primed, motivated and equipped to move from thinking about health to carrying out a localized habit [5,6].

2.2. Futures Thinking and Futures Theory

The Futures Theory component asks how a distant, abstract threat can become personally meaningful now. This article uses “Futures Theory” for the futures-oriented element of the framework. In this article, the term “Futures Theory” is used as a shorthand label for the futures-oriented theoretical element incorporated into the framework. Carey's earlier work uses the term “futures thinking”; the present paper extends this futures-oriented approach conceptually into digital dementia risk-reduction education. Carey's own term is futures thinking, an educational concept concerned with preparing people to make informed decisions that shape long-term outcomes [2-4]. His earlier doctoral research in education examined how futures thinking is construed and evidenced in Australian education, through leadership views, school policies, decision-making and practices [2,4].

Carey's proposal for health rests on a simple observation. The benefits of adopting risk reduction behaviors in midlife may not appear for many years, so people have to weigh long-term consequences against present habits. A future-oriented perspective could make risk information more personally relevant, strengthen engagement with preventive behavior and help sustain motivation while the payoff is delayed. It would also complement the realist perspective, because people interpret present information in light of the health outcomes they anticipate. On this view, lasting

behavior change depends not only on what people know but on how they envision, value and act on their future health. This is a proposition to be tested, not a finding. The education studies concern educators' perspectives and school practice, not health outcomes.

Independent work elsewhere shows why a future orientation may matter. Futures literacy is the capacity to understand how people use imagined futures to make sense of the present [23]. Interacting with age-progressed renderings of the self-increased people's tendency to choose later rewards over immediate ones, and stronger future self-continuity has been associated with better health and more exercise. Whether the same holds for dementia risk, where the threat is stigmatized and feared, remains untested [24,25].

2.3. Midlife Preventive Capacity: A Complementary Lens

Carey (2026k) later proposed the concept of Midlife Preventive Capacity (MPC) to address another part of the translation problem: the ability to coordinate and sustain several prevention activities within the circumstances of midlife. MPC is described as a provisional, context-dependent capacity to recognize, integrate, priorities, implement, adapt and sustain such activities, supported by relational and structural resources. It draws on existing work on prevention burden, workload, capacity, self-management and health literacy [26].

MPC is not presented as an established mechanism or a demonstrated outcome. It generates propositions for testing, for example that the cumulative workload of many prevention recommendations interacts with a person's resources to shape whether preventive behaviour lasts. Within the extended CMO model it works as a complementary lens on the step from behavioural readiness to sustained action, not as a new primary construct.

2.4. How the Proposed Constructs Relate to Existing Ones

Two of the framework's central constructs overlap with established ones, and it is better to say so openly. The framework does not propose replacing intention, stages of change or existing engagement measures. It proposes that, for digital dementia risk-reduction education in midlife, two more specific constructs may explain variation in outcomes that the older constructs leave unexplained, and it treats that proposition as open until it has been tested. Table 3 sets each proposed construct beside its closest existing counterpart, states where the proposed difference lies and suggests how that difference could be tested.

Proposed construct	Closest existing construct	Proposed difference	How it could be tested
Behavioural readiness (intermediate outcome; Carey, 2026j)	Deliberate motivational intent in the theory of planned behaviour (Ajzen, 1991); evolutionary milestone progression seen in the transtheoretical model (Prochaska & DiClemente, 1983).	While intention captures a person's inner drive to act and stages map sequential positioning across a timeline of change, readiness represents a distinct fusion of motivation alongside feeling psychologically primed and practically equipped to execute an action within unique personal environments. Furthermore, readiness is conceptualized as an immediate product of context-specific interpretive engagement.	Design and empirically validate a metric dedicated to readiness, applying it to evaluate whether this state offers unique predictive utility for future actions beyond standard intentionality scores and traditional stage-of-change classifications.
Interpretative engagement (potential mechanism; Carey, 2026a, 2026j)	Engagement as extent of use and as a subjective experience of attention, interest and affect (Perski et al., 2017)	Interpretative engagement is proposed to describe one process within the experiential side of engagement: how users construct personal meaning from information and judge its relevance to their own lives.	Combine interaction telemetry with interviews or in-app prompts, and test whether meaning-making predicts readiness beyond time spent or interest.

Table 3: Behavioral Readiness and Interpretative Engagement Compared With the Closest Existing Constructs

Note. The comparisons are this article's analysis. The proposed differences are conceptual, and whether either construct adds explanatory value beyond the existing ones is an empirical question that the planned doctoral study can address.

3. Operationalizing the Model: Three Illustrative Scenarios

The three scenarios below are illustrative composites constructed for this article. They show how CMO reasoning could guide design. They are not participants from Carey's studies, and they are not empirical findings. The domains were chosen because they are common midlife behaviours. Physical inactivity, obesity and diabetes are among the Lancet Commission's 14 factors [7]. Sleep disturbance and unhealthy diet are further candidate factors that are under study but are not among the 14 [1].

3. 1. Dietary Intervention: Managing Processed Foods and Sugar

The first scenario applies the model to a time-poor worker who relies on sugar to get through long days.

- **Context (C):** David, a 48-year-old corporate worker in a high-stress job with severe time constraints. He uses high-sugar snacks to cope with late shifts and finds text heavy nutrition apps unengaging.
- **Mechanism (M):** Instead of logging calories, David opens an app with a gamified "Vascular Futures Simulator". After he enters his usual daily sugar intake, the app projects an interactive timeline of possible vascular health trajectories over 20 years. Higher average blood glucose has been associated with higher dementia risk even in people without diabetes, which gives the simulation an evidence base [31]. The projection should be presented as a range of possible futures that David can influence, not as a prediction.

- **Outcome (O):** David sees cognitive decline as a plausible future that his own habits can shift. He reaches behavioural readiness and replaces sugary energy drinks with lower-sugar options such as unsweetened tea or a small handful of nuts.

3.2. Physical Activity: Combating Sedentary Lifestyles

The second scenario concerns a woman with low digital literacy who has repeatedly dropped out of fitness apps.

- **Context (C):** Elena, a 52-year-old woman with a sedentary lifestyle, low digital literacy and a history of disliking gym culture. Complex dashboards frustrate her, and she has abandoned earlier tracking apps.
- **Mechanism (M):** The app removes complex metrics and uses a simple, voice-guided narrative. Applying Futures Theory, it asks Elena to choose a personal milestone she wants to attend in 15 years, such as walking her daughter down the aisle, and converts her daily steps into visible progress toward it. An illustrative visual of brain health responds to her activity; it should be labelled as an illustration, not a measurement. Observational data suggest lower dementia incidence even at modest step counts, with about 3,800 steps per day associated with 25% lower incidence and further benefit up to about 9,800 steps. Linking movement to a valued future self also fits evidence on future self-continuity and exercise [25,26].
- **Outcome (O):** Because the interface avoids her technical anxiety and ties movement to a meaningful future event, Elena reaches behavioral readiness and establishes a sustainable, non-intimidating 20-minute daily walk.

3.3. Sleep Hygiene: Reversing Chronic Sleep Restriction

The third scenario looks at late-night phone use and short sleep, and at how far the evidence can support a memorable metaphor.

- **Context (C):** Marcus, a 45-year-old professional who stays up late scrolling on his phone, a pattern often called “revenge bedtime procrastination”. The underlying behaviour, failing to go to bed at the intended time when nothing external prevents it, has been linked to insufficient sleep and to weaker self-regulation [27]. Marcus believes that lost sleep only causes next-day tiredness.
 - **Mechanism (M):** During a late-night window that Marcus has chosen, the app offers an interactive sequence called “The Nightly Brain Wash”, which turns his wearable sleep data into a visual “cleaning score”. The safest evidence base is epidemiological: in a cohort of 7,959 adults followed for 25 years, sleeping six hours or less at ages 50 and 60 was associated with higher dementia risk than sleeping seven hours [28]. The metaphor of the brain being washed during sleep draws on the glymphatic hypothesis, but a later mouse study found that brain clearance was reduced, not increased, during sleep [29,30]. The metaphor should therefore be presented as a hypothesis, and the message should rest on the association with dementia risk.
 - **Outcome (O):** Marcus starts to see sleep as active maintenance, not wasted time. The shift leads to a firm behavioral boundary: turning off his device at 10:00 pm each night.
- Table 4 summarizes the three configurations.

Risk domain	Context (C)	Digital mechanism (M): engagement, entertainment and Futures Theory	Behavioural outcome (O): behavioural readiness
Diet and glucose	High-stress, time-poor professional who uses sugar to cope.	Interactive vascular timeline simulator that maps current sugar intake to possible health trajectories at age 68.	Substitution of high-sugar coping habits with lower-sugar alternatives.
Physical activity	Sedentary lifestyle, low digital literacy, easily alienated by complex data.	Simplified voice-driven narrative that links daily steps to a chosen future family milestone.	Internalised value of activity and an accessible 20-minute daily walking habit.
Sleep	Late-night phone user unaware of the link between short sleep and dementia risk.	Visual sleep score that frames sleep as brain maintenance, presented as a hypothesis alongside epidemiological evidence.	Boundary setting, including a device curfew at 10:00 pm.

Table 4: Illustrative Context–Mechanism–Outcome Configurations for Three Midlife Risk Domains

Note. Configurations are illustrative constructions from the framework, not empirical findings. Supporting evidence: diet and glucose; physical activity; sleep [25,26,28,31].

4. Methodology: Realist Evaluation Design for Apps

Figure 5 outlines a three-stage design for testing whether a public health application triggers the mechanisms described above. It elaborates the mixed-methods realist approach that Carey proposes for digital dementia education, and it is offered as an illustration, not as the protocol of any particular study [5]. The design fits current guidance on complex interventions, which asks researchers to look beyond whether an intervention works and to

consider how it works in context [32]. A scoping review of digital health promotion and prevention in settings similarly called for more research on how digital technologies can be implemented successfully [33]. Realist evaluation compares CMO configurations within a programme or across sites, rather than comparing only outcomes between intervention and control arms [34]. That does not make randomised trials redundant. The DementiaRisk.ca trial, for example, combined a randomised design with qualitative analysis in a sequential explanatory mixed-methods approach, and a realist evaluation can build on that kind of pairing to explain why an effect appeared, for whom and in which contexts [9]. Studies of this kind should be reported to the RAMESES II standards [34].

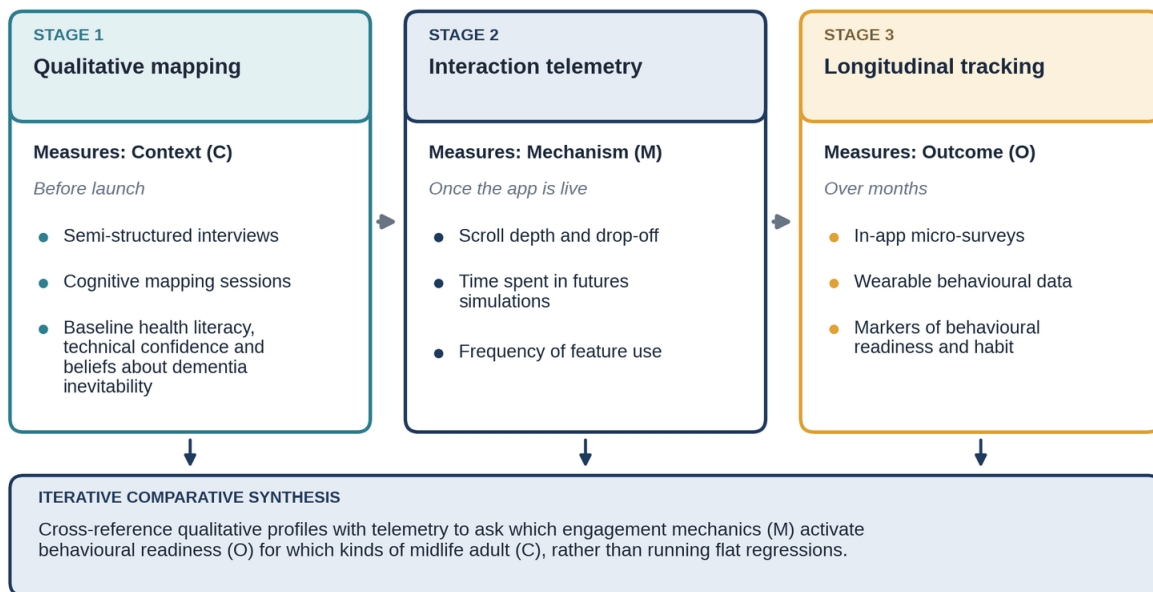


Figure 5: Three-Stage Realist Evaluation Pipeline for a Digital Dementia Risk-Reduction App

Note. The stage design is this article’s illustration of a mixed-methods realist evaluation [5]; it is not the protocol of the proposed doctoral study. Telemetry indicators describe behaviour, whereas engagement also has an experiential component [14].

Stage 1: Qualitative Mapping of Public Mental Models

Before software is deployed, researchers run semi-structured interviews and cognitive mapping sessions with the target group. This stage sets the Context (C) baseline, including existing health literacy, technical confidence and beliefs about the inevitability of dementia.

Stage 2: Quantitative Telemetry and Interaction Analytics

Once the app is live, the system records passive interaction metrics such as scroll depth, drop-off rates, time spent in futures simulations and frequency of feature use. These metrics show whether the Mechanism (M) was present, that is, whether the app held attention or was closed out of boredom. Because engagement is experiential as well as behavioral, telemetry should be paired with brief in-app questions or interviews before anyone concludes that users were “engaged and entertained” [14].

Stage 3: Longitudinal Behavior Tracking and Realist Synthesis

The final stage measures the Outcome (O). In-app micro-surveys and wearable data track whether users reach behavioral readiness and whether habits persist. Rather than relying on flat statistical regressions alone, researchers cross-reference qualitative user profiles with interaction telemetry to ask which engagement mechanics (M) activated behavioral readiness (O) for which kinds of midlife adult (C). Carey (2026e) reports a preliminary empirical operationalization of the framework, a mixed-methods study of engagement, interpretation and behavioral readiness in midlife adults [35]. The proposed doctoral study is intended to extend it

through a more systematic realist evaluation.

5. Discussion: Privacy, Surveillance and Ethical Data Architecture

The framework depends on personal data. To build accurate futures simulations or track behavioural readiness, an application has to ingest sensitive information, including sleep patterns, movement, diet and health literacy. This creates an ethical paradox: the app needs continuous data to optimize its psychological mechanisms, yet the same data exposes users to risk. The concern is not hypothetical. A traffic analysis of 24 top-rated medicines-related Android apps found that 19 (79%) shared user data, and that 55 entities received or processed it [36].

If dementia risk profiles built from vascular health or chronic sleep loss were commercialized or intercepted, insurers or employers could plausibly use them to adjust premiums or decisions. Any implementation of the framework should adopt a privacy-by-design architecture. In practice that means processing biometric data on the device instead of on cloud servers wherever possible, strong end-to-end encryption, and transparent, granular consent that separates educational functions from commercial data systems. Tools built to protect cognitive health must not compromise users’ data sovereignty.

Psychological safety is a second issue. Fear of developing dementia is widespread, and the Sambou et al. (2026) review notes that such fear can be turned into greater knowledge and more positive attitudes towards prevention, although it is also distressing [1]. Futures simulations should therefore be probabilistic, should always offer a concrete action, and should let users opt out. Equity is a third issue. Elena’s scenario shows the value of designing for low digital literacy, and Table 2 shows that reach and benefit differ

by education. Individual-level tools also need to sit alongside population-level measures that reduce exposure to risk factors [1]. A scoping review of 200 publications on digital health promotion and prevention in settings found that the majority of the publications were focused on individual behavior and not structural change, and it is unclear how digital technologies can foster structural or organizational change [33].

6. Limitations and Directions for Future Research

The framework is a starting point for testing, not a finished model. The limits below cover how mature the supporting literature is, what the scenarios can and cannot show, whether futures thinking carries over from education to health, and which constructs still need to be validated.

- **Emerging Theoretical Scope:** As a recent, primarily single-authored framework, the model currently invites independent replication and broader critical appraisal as the supporting literature matures [5,6].
- **Publication Status:** Several outputs are also available as preprints or open repository deposits, which give a time-stamped public record but are not independent peer review. The programme's empirical claims will therefore rest on peer-reviewed reports of the planned doctoral study.
- **Proof-of-Concept Methodology:** The scenarios presented are intended as heuristics, to demonstrate the internal logic of the model, not as an empirical validation of its effectiveness.
- **Translational Scope:** While established research links future self-continuity to outcomes such as savings and exercise, and Carey's work addresses educational contexts, applying these concepts to dementia risk represents a novel extension. The psychological and clinical impacts of vivid dementia simulations thus warrant careful empirical evaluation.
- **Single-Behaviour Scenarios:** Each scenario addresses one behaviour, whereas midlife adults are asked to coordinate several prevention activities at once. Midlife Preventive Capacity points to this problem, but it remains a provisional concept that generates propositions, not an established mechanism [26].
- **Mechanistic and Observational Constraints:** Associations involving sleep, glucose and glymphatic clearance rely on observational data, and the underlying physiological mechanisms remain an area of active scholarly discussion.
- **Methodological Development:** Constructs such as behavioural readiness require formal psychometric validation to establish whether they reliably predict long-term behaviour change and whether they add explanatory value beyond established constructs (Table 3).

These limitations can be addressed in a number of ways in future work. The proposed doctoral study will use a mixed-methods realist evaluation with unimpaired adults aged 40–65 to explain what works, for whom, in what contexts, how and why. Trials could compare futures-based simulations with standard education alongside a realist process evaluation. Co-design with people who have low digital literacy or lower education would test whether the approach works beyond the groups that digital courses already reach. Independent teams should also test the framework's core

propositions.

7. Conclusion

Dr Peter Carey's work shifts attention from what dementia risk information is delivered to how people engage with and interpret it through digital media. It does not claim to originate realist evaluation or CMO reasoning. Its contribution is to specialize those established traditions for digital dementia risk-reduction education: naming interpretative engagement as a potential mechanism, drawing on futures thinking to make distant risk personally meaningful, and treating behavioral readiness as an intermediate outcome that can be evaluated. The framework remains conceptual, and its value will depend on independent testing, beginning with the planned doctoral study of midlife adults. If that testing supports it, the framework could help bring prevention evidence into the everyday decisions of midlife adults.

Declarations

Generative AI Use

The author used AI-based language tools (OpenAI ChatGPT) to assist with editing, formatting and reference organization during preparation of this manuscript. Generative AI (Claude, Anthropic) was used to assist with literature searching and reference verification, revision and editing of the manuscript text, and design and refinement of the figures. The author reviewed all AI-assisted content and is responsible for the content, arguments, citations, figures and conclusions.

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Ethics Approval: Not applicable. This is a conceptual paper and did not involve human participants, animal subjects, or the collection of new empirical data.

Data Availability: No new datasets were generated or analyzed for this conceptual article. The values plotted in Figure 2 are taken from the published sources cited in the figure note [1,7].

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