

## Research Paper

# Humans peak in midlife: A combined cognitive and personality trait perspective

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## ARTICLE INFO

## Keywords:

Cognitive aging  
Personality development  
Lifespan development  
Achievement

## ABSTRACT

Fluid intelligence, which peaks near age 20 and declines materially across adulthood, is often regarded as the most critical cognitive ability for predicting important life outcomes. Yet, human achievement in domains such as career success tends to peak much later, typically between the ages of 55 and 60. This discrepancy may reflect the fact that, while fluid intelligence may decline with age, other dimensions improve (e.g., crystallized intelligence, emotional intelligence). To examine this possibility, we analyzed age-related trends across nine constructs associated with life success: cognitive abilities, personality traits, emotional intelligence, financial literacy, moral reasoning, resistance to sunk cost bias, cognitive flexibility, cognitive empathy, and need for cognition. We extracted age-related findings from published studies for each dimension and standardized all scores to T-scores for comparability. We then constructed a Cognitive-Personality Functioning Index (CPF) and compared two weighting approaches: a Conventional model, emphasizing intelligence and core personality traits, and a Comprehensive model, integrating a broader array of dimensions. Both models revealed a peak in overall functioning during late midlife (ages 55 to 60) but diverged at the younger and older ends of adulthood: under Conventional weighting, older adults scored well below young adults, whereas under Comprehensive weighting, the two groups were roughly equivalent. These findings suggest that functional capacity, defined in terms of key differential psychological traits, may peak in late midlife, closely aligning with the typical peak in career achievement. Also, individuals best suited for high-stakes decision-making roles are unlikely to be younger than 40 or older than 65.

## 1. Introduction

Based on several physical criteria, including physical strength (Lindle et al., 1997), cardiovascular endurance (Pandey et al., 2020), bone density (Hereford et al., 2024), and brain volume (Hedman et al., 2012), humans tend to reach their physical peak between the mid-20s and early 30s. Correspondingly, elite athletic performance is typically achieved between the ages of 20 and 35 (Allen & Hopkins, 2015; Tanaka & Toussaint, 2023).

While physical ability is important, it is not the sole determinant of success in many critical activities. In traditional societies, for instance, hunting success tends to peak between the ages of 35 and 50 (Gurven et al., 2006). Similarly, in modern societies, individuals often reach the apex of their careers, measured by indicators such as hourly earnings and occupational prestige, between approximately 50 and 55 years of age (Bihagen et al., 2024; Luong & Hébert, 2009; Turner et al., 2020;

Withisuphakorn & Jiraporn, 2017). Political leaders of major countries also tend to be elected in their mid-50s to early 60s (Olenski et al., 2015).

Like physical strength, several core cognitive abilities, including reasoning, memory span, and processing speed, tend to peak relatively early in adulthood, typically between 18 and 22 years of age (Salthouse, 2019). Correspondingly, mathematical innovations, highly dependent on abstract reasoning, are most likely to occur in a scientist's late 20s to early 30s (Simonton, 2003). However, not all cognitive domains follow this pattern. Crystallized intelligence, for example, is known to increase steadily across much of the adult lifespan, often into late adulthood (Salthouse, 2019). Similarly, several literacies, conceptualized as domain-specific competencies that are essential for effective participation in modern society (Weinert et al., 2019), also tend to improve into late adulthood (e.g., financial literacy; Okamoto & Komamura, 2021).

Beyond crystallized intelligence and financial literacy, several other

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cognitive dimensions important for decision-making and life success, such as emotional intelligence, moral reasoning, and resistance to the sunk cost fallacy, also do not appear to peak in early adulthood (Bruine de Bruin et al., 2007; Dawson, 2002; Kafetsios, 2004). These compensatory developments may help offset the declines observed in fluid cognitive abilities, facilitating effective decision-making and achievements well into later adulthood (Li et al., 2013; Staudinger et al., 1989). Such compensatory growth may help explain why peaks in career earnings, occupational prestige, and leadership attainments often occur relatively late in adulthood. Correspondingly, in traditional societies, the accumulation of knowledge, as well as the continued development of personality traits such as conscientiousness (Apicella, 2014; Seifert et al., 2024), likely underpins the later-life peaks observed in activities such as hunting success.

Consequently, the present investigation sought to provide a review of both widely recognized and some lesser-known individual difference dimensions, spanning cognitive abilities and personality traits, and to chart their age-related trajectories using a common metric to enable direct comparisons. Additionally, weighted composites of these dimensions were developed and plotted across the adult lifespan to estimate the age at which humans reach their peak in overall cognitive-personality functioning. It was hypothesized that although fluid intelligence peaks relatively early, the integration of other relevant dimensions would reveal a composite peak occurring later in adulthood.

Next, we outline the conceptual framework that guided the selection of candidate dimensions for inclusion in the weighted composite index. This is followed by detailed sections defining each individual difference dimension retained for analysis, reviewing their relevance to important life outcomes, and summarizing evidence on their age-related trajectories across adulthood. Finally, we conclude with a dedicated section that describes several theoretically relevant but ultimately excluded dimensions, along with the rationale for their omission.

### 1.1. Framework for dimension consideration and selection

To guide the selection of dimensions in our weighted composite—the Cognitive–Personality Functioning Index (CPFI)—we adopted a broad differential psychology framework. We emphasized traits with empirically established links to real-world functioning, evidence of age-related variation across adulthood, and availability of psychometrically validated measures. Conceptually, we organized these traits into two overarching categories: cognitive traits and personality traits (Johnson, 1997). This distinction parallels Cronbach's (1960) differentiation between maximal performance (i.e., ability) and typical performance (i.e., personality), both of which are known to predict real-world outcomes such as job performance (Sackett et al., 1988).

Cognitive traits, or cognitive abilities, refer to individual differences in information-processing capacity, typically assessed through performance-based tasks (Johnson, 1997). This category encompasses both conventional abilities—such as reasoning, memory span, processing speed, and executive functioning (e.g., cognitive flexibility)—as well as less traditional but conceptually aligned emotional-social cognitive traits, including emotional intelligence, moral reasoning, and cognitive empathy. It also includes relatively applied forms of judgment, such as resistance to the sunk cost fallacy and financial literacy, which reflect the real-world deployment of cognitive resources in decision-making contexts.

Personality traits refer to enduring patterns of thought, emotion, and behavior, typically assessed through self-report measures (Johnson, 1997). For the purposes of our framework, we considered a broad range of personality domains, including the Big Five model of trait dimensions (Goldberg, 1990), as well as traits proposed in extended models of personality, including honesty/humility (Ashton et al., 2014), narcissism (Miller et al., 2021), and need for cognition (Cacioppo et al., 1996), for example. All candidate personality traits were evaluated for their theoretical relevance to adaptive functioning, empirical links to

important life outcomes, and coverage of trait variability across the adult lifespan. As with cognitive traits, personality traits were selected to reflect both conceptual breadth and practical utility within the context of our composite index.

### 1.2. Cognitive intelligence

Human intelligence may be defined as an individual's "maximal capacity to achieve a novel goal successfully using perceptual-cognitive processes" (Gignac & Szodorai, 2024, p. 2). One of the most widely accepted models of intelligence, the Cattell–Horn–Carroll (CHC) framework, posits a hierarchical structure with a general intelligence factor (Stratum III) at the top, supported by more than 14 broad cognitive abilities at Stratum II (Schneider & McGrew, 2018). Among the most prominent of these broad abilities are reasoning, verbal comprehension, visual processing, memory span, and processing speed. We consider dimensions such as reasoning, visual intelligence, memory span, and processing speed as fluid abilities, i.e., capacities involved in novel problem solving, adaptive thinking, and real-time cognitive processing, as distinct from crystallized abilities, i.e., knowledge-based capacities acquired primarily through the investment of fluid abilities and environmental opportunity (Horn & Cattell, 1967; Schneider & McGrew, 2018).

Extensive research has established cognitive intelligence as a critical predictor of important life outcomes, including academic achievement (Lozano-Blasco et al., 2022), job performance (Bobko et al., 2025), income (Zagorsky, 2007), occupational status (Wolfram, 2023), and mortality (Wrulich et al., 2015). Intelligence predicts job performance more strongly in complex, dynamic roles where problems are novel, evolving, and require high-level reasoning and decision-making (Schmidt & Oh, 2023). Moreover, contrary to threshold hypotheses, large-scale studies tend to indicate that incremental gains in intelligence continue to predict better outcomes even at the highest levels of intellectual ability (Brown et al., 2021). Correspondingly, Simonton (2006) found that U.S. presidents with higher estimated intelligence were consistently judged as more effective leaders, highlighting the practical value of cognitive traits in leadership at the highest levels. Thus, cognitive intelligence represents a foundational asset for human functioning, particularly in high-stakes roles that demand adaptive reasoning, strategic foresight, and complex decision-making under uncertainty.

At the group-factor level, fluid intelligence is often considered the core component of intellectual functioning and a primary driver of predictive validity evidence (Chuderski, 2019; Geake & Hansen, 2005; Kent, 2017). However, crystallized intelligence is known to capture unique intellectual variance, independently predicting knowledge-based performance and real-world expertise beyond what fluid intelligence and environmental inputs alone can explain (Ackerman, 1996; Beier & Ackerman, 2005; Hambrick & Engle, 2002).

Age-related changes in intelligence across adulthood are well-documented. Research consistently shows that fluid abilities, such as reasoning, memory span, and processing speed, peak in early adulthood and then decline progressively from approximately age 25–30 into late adulthood (Horn et al., 1981; Ryan et al., 2024; Yang et al., 2024). Between ages 20 and 70, performance on fluid intelligence tasks declines by approximately three-quarters to one full standard deviation (Salthouse, 2019). In contrast, crystallized abilities, including vocabulary and general knowledge, tend to improve throughout much of adulthood, typically peaking in the 60s, with only slight declines observed in advanced old age (Horn & Hofer, 1992; Ryan et al., 2024; Shafto et al., 2017). Between ages 20 and 70, vocabulary increases by approximately one full standard deviation (Salthouse, 2019). These findings highlight distinct trajectories of conventional cognitive abilities across the lifespan, with some declining and others improving, potentially offsetting one another to some extent. Staudinger et al. (1989) conceptualized this divergence as a distinction between the mechanics

and pragmatics of intelligence, where mechanics (e.g., processing speed, working memory) decline with age, while pragmatics (e.g., accumulated knowledge, life insight) may continue to grow, thus reflecting both the limits and the potential of adult intellectual adult development (see also Li et al., 2013).

### 1.3. Personality

In contrast to maximal performance that characterises cognitive intelligence, personality represents typical performance patterns that reflect consistent individual differences in behavior, thoughts, and feelings across situations and over time (Ackerman & Heggestad, 1997; Cronbach, 1960). Stated alternatively, while cognitive intelligence measures what a person can do at their best, personality captures how people typically think and behave, influencing how they approach everyday challenges, sustain social relationships, experience emotions, and commit to long-term goals, for example.

A substantial body of research supports the existence of five to six major personality dimensions: extraversion, emotional stability (the inverse of neuroticism), conscientiousness, openness to experience, agreeableness, and, in some models, honesty–humility (Matz et al., 2016). Personality is typically assessed through self-report measures, in which individuals indicate the extent to which they agree with descriptive adjectives or statements reflecting common patterns of thought, feeling, and behavior (Olinio & Klein, 2015). A tremendous amount of research supports the perspective that personality can be measured in a reliable and valid manner (Ashton, 2022; West & Finch, 1997). With respect to important life outcomes, conscientiousness and emotional stability may be regarded as the most important personality predictors (Barrick & Mount, 2000; Roberts et al., 2007).

Researchers have conceptualized conscientiousness as containing multiple inter-related facets (DeYoung et al., 2007; Roberts et al., 2014). These subdimensions cluster around two primary themes: professional dedication (encompassing traits like industriousness, perseverance toward goals, organizational abilities, and disciplined work habits) and interpersonal reliability (including qualities such as responsibility, prudence, and consistency). Together, these elements create a personality profile characterized by an appreciation for order, goal attainment, and reliability across both work environments and personal relationships.

Conscientiousness is a robust predictor of job performance (Iliescu et al., 2023; Wilmot & Ones, 2019), with stronger effects observed in complex roles (Le et al., 2011). Consistently rated highly by human resource professionals (Jones et al., 2011; Lange & Houran, 2009), conscientiousness is often regarded as the most valuable psychological attribute for workplace success after intelligence (Barrick & Mount, 2000; Dumfart & Neubauer, 2016). In business executives, conscientiousness is positively associated with effective management of critical organizational vulnerabilities, suggesting that more conscientious leaders tend to oversee stronger systems for organizational resilience (Gabriel & Jaja, 2014). Finally, over a 65-year study, conscientious individuals achieved higher career success and lower mortality risk (Kern et al., 2009). Conscientious individuals also report greater life satisfaction (Smith et al., 2013).

Following conscientiousness, emotional stability is widely regarded as the second most important personality trait in personnel selection (Barrick & Mount, 2000). Individuals high in emotional stability tend to exhibit equanimity, lower stress reactivity, self-assurance, and calm dispositions—traits that promote psychological resilience and reduced distress across a range of contexts (Howland et al., 2017; Instinske & Kandler, 2024; Roberts & Yoon, 2022). These characteristics indicate emotional stability's broader relevance to effective functioning in professional and high-stakes environments. Meta-analytic evidence shows that emotional stability correlates positively with both job satisfaction and job performance, highlighting its importance across roles and industries (Judge & Bono, 2001). Furthermore, higher emotional stability

is associated with improved job performance, particularly in dynamic or unpredictable work environments (Tewfik et al., 2024), and may help delay emotional coping responses that would otherwise disrupt decision-making under pressure (Svensson et al., 1993). Thus, emotional stability is likely to be especially critical for success in high-profile or executive roles, where calm judgment, stress resilience, and psychological composure are essential under pressure.

Beyond conscientiousness and emotional stability, the remaining major dimensions of personality have yielded mixed results with respect to valued life outcomes, particularly career success (e.g., Judge et al., 1999; Salgado, 1997). Perhaps openness to experience may be regarded as a generally valuable trait, as it is linked to intellectual curiosity, creativity, and receptiveness to novel ideas, qualities that can facilitate innovation and adaptability in complex or rapidly changing work environments (Fayn et al., 2019; Mussel et al., 2011). However, elevated levels of openness can also lead to excessive distractibility and an overinvolvement in unconventional ideas (Brandt et al., 2015; Seddigh et al., 2016). Agreeableness and extraversion, similarly, show inconsistent associations with job performance, tending to matter more in social or team-oriented roles (Barrick & Mount, 1991). Arguably, in most high-powered roles, moderate levels of agreeableness and extraversion are optimal, with deviations from the mean, either too low or too high, tending to slightly undermine performance.

The developmental trajectory of personality across the lifespan is well-documented, with conscientiousness showing a marked increase from adolescence through middle adulthood (Jackson et al., 2009; Roberts et al., 2006). In later life, however, this trend appears to reverse, with conscientiousness exhibiting a gradual decline into old age (Judge et al., 2021; Seifert et al., 2024). Emotional stability also increases across the adult lifespan (Wortman et al., 2012), but it is often observed to plateau in older age (Roberts et al., 2006; Seifert et al., 2024). Openness to experience tends to increase moderately from adolescence through early adulthood (Roberts et al., 2006), but evidence suggests it begins to decline in midlife, with some studies indicating this downturn may start as early as the mid-40s (Schwaba et al., 2018; Seifert et al., 2024). Extraversion is generally observed to decline across adulthood. Though some research suggests that the rate of change may be inconsistent across age (Viken et al., 1994), other research with more comprehensive measures has reported a more consistent, linear downward trend (Seifert et al., 2024; Wortman et al., 2012). Agreeableness is typically reported to increase from adolescence through middle adulthood (Roberts et al., 2006), followed by a plateau or modest decline in later life (Seifert et al., 2024; Wortman et al., 2012).

### 1.4. Emotional intelligence

When conceptualized as an ability rather than a mixed-trait construct assessed through self-report measures (see Goldenberg et al., 2006), emotional intelligence can be defined as the capacity to deliberately navigate, shape, and select environments by applying emotionally relevant cognitive processes (Gignac, 2010). Emotional intelligence typically encompasses the ability to identify emotions, comprehend their significance, and regulate emotional responses in oneself and in social interactions (Mayer et al., 2008; Palmer et al., 2008). The Mayer-Salovey-Caruso Emotional Intelligence Test (MSCEIT; Mayer et al., 2002) is the most widely used ability-based measure of emotional intelligence, providing four branch scores and a total score. The Geneva Emotional Competence Test (GEC; Schlegel & Mortillaro, 2019) offers a similar approach, with a stronger emphasis on workplace-relevant scenarios.

Although ability-based measures of emotional intelligence correlate positively with cognitive ability, and to a lesser extent, share variance with personality, they also capture meaningful unique variance (Riyaz et al., 2023; van Rooy et al., 2005). Additionally, ability-based EI measures have been shown to predict a wide range of important life outcomes.

Meta-analytic evidence shows that ability-based EI predicts job performance above and beyond cognitive intelligence and the Big Five personality traits, demonstrating robust incremental validity across diverse work settings (O'Boyle Jr et al., 2011). Additionally, empirical evidence suggests that specific components of EI, i.e., emotion perception, understanding, and regulation, operate in a cascading sequence to influence job outcomes, and can even compensate for lower cognitive ability (Nguyen et al., 2019). Furthermore, ability-based EI has been shown to be especially predictive of performance in roles requiring high emotional labor, such as leadership and team-based work, reinforcing its relevance in emotionally dynamic environments (Farh et al., 2012).

In a longitudinal study, Rode et al. (2017) found that ability-based emotional intelligence measured via the MSCEIT predicted higher salary 10–12 years later, even after accounting for cognitive ability, GPA, personality, and gender. At higher organizational levels (e.g., senior executive), individuals with high EI were earning approximately \$30,000 to \$40,000 more per year than their low-EI counterparts (see also Sanchez-Gomez et al., 2021). EI predicts both career adaptability (Di Fabio & Saklofske, 2018) and leader adaptability in dynamic work environments, particularly when paired with strong inductive reasoning (Boyar et al., 2023), suggesting that emotionally intelligent individuals are better equipped to navigate complex transitions and challenges. Finally, a latent profile analysis revealed that individuals with consistently high scores across emotional intelligence dimensions reported significantly better outcomes across multiple life domains, including lower stress and burnout, greater life satisfaction and gratitude, improved work-home balance, and more future-oriented decision-making (Haag et al., 2025).

Based on a non-representative sample of high school and university students, Extremera et al. (2006) found a positive correlation ( $r = 0.20$ ) between age and overall emotional intelligence as measured by the MSCEIT. While some studies report age-related declines in facial emotion identification—particularly among older adults—evidence also suggests that this ability may peak in midlife, with individuals in their 40s to 60s often showing equal or greater accuracy than younger adults, especially when identifying subtle or dynamic emotional expressions (Doerwald et al., 2016). Expanding on this work, Cabello et al. (2016) examined nonlinear age trends and found that ability-based emotional intelligence increases from adolescence into middle adulthood, followed by a decline in older age.

### 1.5. Financial literacy

Several domain-specific literacies have been proposed, including digital and health literacy (Weinert et al., 2019). Among these, financial literacy has received considerable attention; it refers to an individual's understanding of core personal finance concepts that are broadly applicable and practically valuable across society (Callis et al., 2023). This includes knowledge related to managing day-to-day finances such as budgeting, saving, and borrowing, as well as more advanced topics like investing and risk protection. Unlike broader constructs such as financial capability, which encompasses money values and typical financial behavioral tendencies, financial literacy is concerned specifically with the cognitive grasp of key financial principles (Remund, 2010; Xiao et al., 2022).

Objective measures of individual differences in financial literacy typically involve standardized assessments that test knowledge of core financial concepts using true/false, multiple-choice, or problem-solving items grounded in real-world scenarios (e.g., Buying a single company's stock usually provides a safer return than a stock mutual fund. True or false?). While some studies rely on as few as three items, more reliable and valid assessments generally include 13 to 15 questions (Gignac & Ooi, 2022). Individuals who have greater financial literacy select better banking products (Deuflhard et al., 2019), invest more successfully (Clark et al., 2017; Hilgert et al., 2003), understand and accept financial risk more appropriately (Kanagasabai & Aggarwal, 2020), prepare for

retirement more effectively (Alessie et al., 2011), and have a better quality of life (Çopur, 2017). While substantially positively associated with general intelligence, primarily through crystallized and quantitative intelligence, financial literacy is not redundant with conventional cognitive abilities (Callis et al., 2023), nor is it simply the product of formal education in finance or economics (Lin & Bates, 2022).

Financial literacy tends to rise steadily throughout adulthood, peaking around age 65, before gradually declining in later years (Lusardi & Mitchell, 2014). Henager and Cude (2016) found that while only 37 % of individuals aged 18–24 correctly answered a question assessing understanding of inflation and real purchasing power, 81 % of those aged 65 and older responded correctly. Based on a large sample of 15,228 individuals, Okamoto and Komamura (2021) found that the number of correct responses on an objective financial literacy test increased by approximately 40 % between ages 20 and 65. In a manner similar to conventional crystallized abilities, financial literacy likely improves due to the accumulation of knowledge and experience gained through repeated exposure to real-world financial decisions over time (Agarwal et al., 2009).

### 1.6. Moral reasoning

Moral reasoning ability refers to an individual's capacity to evaluate ethical situations and justify decisions using principled thinking about fairness, harm, justice, and rights (Kohlberg, 1969; Rest, Narvaez, Bebeau, & Thoma, 1999). It involves cognitive processing of complex social and moral information and is considered a developmental construct that reflects increasing moral sophistication (Derryberry & Thoma, 2000; Turiel, 1983). Several measures of moral reasoning have been published, including the Moral Judgment Interview (Colby & Kohlberg, 1987), the Defining Issues Test (Rest, 1979), and the Socio-moral Reflection Measure–Short Form (Gibbs et al., 1992) each designed to assess reasoning about ethical dilemmas based on developmental or schema-based frameworks.

Moral reasoning ability has been found to correlate positively with general intelligence ( $r \approx 0.30$ ) but not with personality (Proroković et al., 2017). Furthermore, moral reasoning ability predicts important life outcomes across domains such as leadership, career development, and personal well-being. For example, individuals who reason at a postconventional level tend to exhibit more effective leadership behaviors, including transformational traits like inspirational motivation and individualized consideration, suggesting that moral reasoning is a meaningful predictor of leadership success (Olsen et al., 2006). Similarly, research on career decision-making has found that individuals who employed virtue-ethical reasoning strategies during formative career choices reported higher levels of both subjective and objective flourishing in adulthood, including well-being and financial security (McLoughlin et al., 2023). Finally, group-based studies further reveal that individuals who apply principled moral reasoning can positively influence the collective moral judgment of their peers, especially when occupying leadership roles, indicating both personal and interpersonal benefits of advanced moral reasoning skills (Dukerich et al., 1990).

A review of the literature suggests that moral reasoning ability generally increases with age, as individuals develop greater cognitive complexity and social understanding. Across diverse cultural contexts, Sorokowski et al. (2024) found that adults aged 60 were consistently perceived as more moral than those aged 20 or 40. This perception may stem from the belief that older adults possess greater moral reasoning ability, informed by life experience and a developmental shift toward more principled and abstract prosocial values (Sorokowski et al., 2024). Correspondingly, older adults tend to recall morally charged story events well and, relative to younger adults, are more likely to draw moral inferences during comprehension (Narvaez et al., 2011). Some research suggests that the trajectory may reverse in later adulthood due to age-related declines in cognitive functions (Lockwood et al., 2025). However, Dawson (2002) reported a nonlinear developmental pattern in

which moral reasoning showed substantial gains from childhood to early adulthood and continued to increase, albeit more gradually, into late adulthood.

### 1.7. Sunk cost fallacy resistance

The construct of decision-making ability refers to an individual's capacity to make rational, informed, and adaptive choices by effectively evaluating options, anticipating consequences, and resisting cognitive biases (Phillips, 1997). Conceptually similar to conventional cognitive abilities, decision-making ability refers to a domain in which there are normatively correct and incorrect solutions, allowing for objective evaluation of decision quality (Bruine de Bruin et al., 2007). One of the key subdimensions of decision-making is relevant to the sunk cost fallacy or bias, which refers to the tendency to continue an endeavor based on prior investments of time, money, or effort, even when those investments are no longer recoverable and a change in course would yield better outcomes (Arkes & Blumer, 1985). Research shows it is often more adaptive to prioritize future gains over unrecoverable past costs (Jarmolowicz et al., 2016; Kahneman, 2011; Perignat & Fleming, 2022).

Resistance to the sunk cost bias can be measured as an individual difference using hypothetical decision-making scenarios involving irrecoverable investments of time, effort, or money, with responses evaluated based on the extent to which individuals prioritize future outcomes over past costs (Bruine de Bruin et al., 2007; Ronayne et al., 2021). Although resistance to sunk cost bias is positively correlated with fluid intelligence ( $r = 0.20$  to  $0.40$ ; Bruine de Bruin et al., 2007; Ronayne et al., 2021), the moderate strength of this association suggests that other factors also play a substantial role in mitigating the bias.

Theoretically, the ability to resist the sunk cost bias is thought to be supported, in part, by accumulated knowledge and life experience (Rover et al., 2009). Empirically, this is reflected in consistent findings that resistance to the sunk cost fallacy increases with age. For instance, Strough et al. (2008) found that older adults (aged 58–91) were approximately twice as likely as younger adults (aged 18–27) to base their decisions on future utility rather than prior investment, indicating a greater ability to disregard sunk costs. Similarly, Taylor et al. (2023) reported a significant positive correlation ( $r = 0.12$ ) between age and sunk cost resistance in a community sample of 308 adults aged 20 to 90.

### 1.8. Cognitive flexibility

Theoretically, executive functions closely resemble conventional cognitive abilities, as both involve the capacity to solve novel problems through perceptual-cognitive processes (Gignac & Szodorai, 2024). Although the empirical distinction between executive functions and general cognitive abilities remains debated (e.g., Demetriou et al., 2024), core dimensions of executive functioning, such as inhibitory control, updating, and cognitive flexibility, are often considered partially distinct in that they specifically govern the regulation and coordination of thought and behavior (Dias et al., 2024). Cognitive flexibility, exemplified by the ability to shift between mental sets, is widely recognized as essential for adaptive performance in complex, dynamic environments, including high-level professional roles (Chan et al., 2021; Ramchandran et al., 2016).

A widely used measure of cognitive flexibility is the Wisconsin Card Sorting Task (WCST), which assesses individuals' ability to infer, maintain, and shift between sorting rules in response to changing feedback, thereby evaluating adaptive strategy use in dynamic conditions (Berg, 1948; Miles et al., 2021). Performance on the WCST correlates positively with other complex decision-making tasks, such as the Iowa Gambling Task (Dong et al., 2016) and the Columbia Card Task (Buelow, 2015), suggesting shared demands on flexible cognitive control. Supporting its real-world relevance, Szumowska and Kossowska (2016) found that individuals with greater shifting ability outperformed others in dual-task settings, underscoring cognitive flexibility's role in

managing competing demands. Moreover, longitudinal evidence indicates that stronger set-shifting ability predicts lower risk of burnout over time, highlighting its function as a protective resource in adapting to evolving workplace challenges (Lemonaki et al., 2021).

Cognitive flexibility, particularly set-shifting ability, is well established to decline with age. In a meta-analysis, Rhodes (2004) reported that adults aged 75 and older committed approximately 2.3 times more perseverative errors on the WCST than younger adults aged 20–35. Complementing this, Shan et al. (2008) examined WCST performance across 10 age groups (from 20 to 29 to 85–89) using both Taiwanese and U.S. normative data. Their results mirrored Rhodes's findings, though they more clearly revealed a nonlinear pattern, with more pronounced difficulties emerging in later adulthood (age 65 and above).

### 1.9. Cognitive empathy

Cognitive empathy represents the ability to understand another person's perspective or mental state (Davis, 1983; Hoffman, 1975). Higher levels of cognitive empathy are considered beneficial, as a greater capacity to decode others' thoughts and perspectives accurately would be expected to enhance communication, cooperation, and social judgment in virtually every context (Stevens & Taber, 2021). A commonly used task to measure individual differences in cognitive empathy is the Reading the Mind in the Eyes Test (Baron-Cohen et al., 2001), which involves identifying complex mental states by selecting the appropriate emotion word that best describes the expression shown in photographs of only the eye region of human faces.

Measures of cognitive empathy, as well as the closely related construct Theory of Mind (ToM; Bzdok et al., 2015), have been shown to discriminate effectively between individuals with social cognitive deficits (e.g., schizophrenia, ALS) and healthy controls, suggesting that cognitive empathy taps into core social reasoning abilities (Aiello et al., 2022; Deng et al., 2024). Additionally, in a study involving individuals with schizophrenia, cognitive empathy was positively correlated with better work performance (Lysaker et al., 2015). Performance on the RMET has also been positively correlated with group effectiveness, indicating that individuals who score highly may enhance team dynamics and contribute more effectively to collaborative problem-solving (Woolley et al., 2010). Taken together, these findings suggest that the ability to accurately discern others' mental states may be beneficial in work settings, particularly in high-powered roles that demand interpersonal acuity, strategic coordination, and the capacity to anticipate or navigate others' perspectives.

Several empirical investigations have reported a negative association between adult age and cognitive empathy. For example, Charlton et al. (2009) found a moderate negative correlation ( $r \approx -0.30$ ) between ToM ability and age in a sample of healthy adults aged 50 to 90 years. In another study, Schroeter et al. (2022) found that RMET scores decreased in a relatively linear fashion across ages 19 to 79 years, amounting to a modest annual change (roughly equivalent to a quarter of an IQ point), but a meaningful cumulative decline of approximately one standard deviation. Finally, in a large cross-cultural study, Greenberg et al. (2023) found that performance on the RMET increased through adolescence and peaked around age 20, followed by a gradual decline until approximately age 55, after which the rate of decline accelerated through to age 70, the upper limit of the age range analyzed.

### 1.10. Need for cognition

Need for Cognition (NFC) refers to a motivational trait that indicates how much individuals are inclined to engage in complex cognitive activities, such as analytical reasoning, critical thinking, and abstract problem-solving (Cacioppo & Petty, 1982). Although NFC is moderately correlated with cognitive intelligence (Gignac & Stevens, 2024; von Stumm & Ackerman, 2013), it reflects a dispositional tendency toward typical cognitive engagement rather than maximal cognitive

performance, and thus represents a distinct construct. People high in NFC can be expected to appreciate spending significant amounts of energy generating solutions to problems, engaging deeply with complex ideas, and persisting through intellectual challenges for the intrinsic satisfaction of thoughtful exploration. Such characteristics have been found to facilitate better problem-solving, higher academic and professional achievement, and greater resilience when facing complex or ambiguous situations (Kearney et al., 2009; Liu & Nesbit, 2024; Sheshtowsky et al., 1998; Strobel et al., 2017).

Longitudinal and cross-sectional studies indicate that NFC tends to decline gradually with age. Soubelet and Salthouse (2017), analyzing data from over 5000 adults aged 18 to 99, reported a downward trajectory from early adulthood onward, with scores peaking around the early 20s and declining into later life. In z-score terms, the difference amounted to approximately half a standard deviation. Longitudinal evidence from Bruinisma and Crutzen (2018) further supports the stability of this downward trend, showing a modest but consistent decline in NFC over time, with some degree of accelerated decline in older age compared to middle age. Age-related reductions in NFC may partly reflect declines in cognitive capacity, but also shifting motivational and attitudinal priorities, including reduced enjoyment of effortful cognitive engagement. Such declines may serve as a counterindicator of peak performance in cognitively demanding careers, where sustained mental effort and motivation are important (Aliqaj & Carvajal, 2024; Fleischhauer et al., 2019).

### 1.11. Dimensions considered but excluded

Several dimensions were considered for inclusion in the cognitive-personality composite but were ultimately excluded, typically due to one or more of the following: insufficient evidence of unique variance beyond already-included constructs, limited empirical support for predicting important life outcomes, or unclear patterns of systematic age-related change.

For example, cognitive reflection, the ability to override initial impulses in favour of more deliberative thinking (Frederick, 2005), has been shown to largely overlap with general intelligence (Bates, 2025; Otero et al., 2022). Similarly, of the three core executive functions, only cognitive flexibility (shifting) was retained. Updating was excluded due to its conceptual and empirical redundancy with complex memory span (Schmiedek et al., 2009), and inhibition was omitted owing to persistent concerns about its discriminant validity as a distinct psychometric construct (Gignac & Kretzschmar, 2017).

Additionally, intellectual curiosity traits beyond need for cognition were evaluated for potential inclusion. However, existing evidence suggests that epistemic curiosity functions as a higher-order construct substantially defined by need for cognition (Mussel, 2013; Powell et al., 2016). Moreover, when correcting for measurement error, intellectual engagement has been shown to be largely redundant with need for cognition (Mussel, 2010). Given this conceptual and empirical overlap, need for cognition was retained as the most psychometrically distinct and theoretically representative index of dispositional cognitive motivation.

Decision-making batteries typically assess a range of competencies beyond resistance to the sunk cost effect, such as resistance to framing, but these tend to show minimal age-related variation across adulthood (Bruine de Bruin et al., 2007). Tolerance to ambiguity, defined as the capacity to remain comfortable and effective in uncertain or contradictory situations (Budner, 1962), was also excluded, given its inconsistent age-related trends (e.g., Munteanu, 2008; O'Connor et al., 2018, 2022). Likewise, temporal discounting, the tendency to prefer immediate over delayed rewards, shows no reliable association with age (Seaman et al., 2022).

Finally, affective empathy, which represents the tendency to share or respond emotionally to another person's feelings (Hall & Schwartz, 2019), was excluded for several reasons. First, unlike cognitive

empathy, high levels of affective empathy are not consistently advantageous. For example, in high-stakes or leadership contexts, high levels of emotional attunement may hinder performance by increasing psychological burden (König et al., 2020). Elevated levels of affective empathy can also lead to emotional overinvolvement, difficulty maintaining professional boundaries, and impaired capacity to make tough but necessary decisions (Huang et al., 2025). Conversely, low levels of affective empathy may enable difficult decision-making by reducing emotional interference (Takamatsu, 2018), but they may also lead to interpersonal coldness, insensitivity to social norms, and reduced trust or respect from others (Leiberg & Anders, 2006; Sanz et al., 2016). Thus, the level of affective empathy that might be considered optimal likely varies by context, and no clear consensus exists regarding its ideal expression across diverse roles and situations. Finally, affective empathy does not appear to follow a clear developmental trajectory across adulthood (Beadle & de la Vega, 2019; Kelly et al., 2022). Consequently, affective empathy was not considered further in this investigation.

### 1.12. Summary and purpose

Although human achievement, measured through earnings, occupational prestige, and leadership attainment, tends to peak in the late 50s (Bihagen et al., 2024; Luong & Hébert, 2009; Olenski et al., 2015), core cognitive capacities such as fluid intelligence reach their apex by the mid-20s and decline thereafter (Ryan et al., 2024; Salthouse, 2019). This divergence implies that other psychological attributes, both cognitive (e.g., crystallized intelligence, financial literacy) and non-cognitive (e.g., conscientiousness, emotional stability), must increase across adulthood in ways that offset early declines in fluid abilities, as well as other dimensions (e.g., emotional intelligence, cognitive empathy). Such compensatory growth aligns with Baltes' Selection, Optimization, and Compensation (SOC) model (Baltes & Freund, 2003; Staudinger et al., 1989), which explicitly posits that gains in certain psychological capacities, which may include crystallized intelligence, can help offset losses in others, including fluid intelligence.

Consequently, the present study seeks to estimate the age at which humans attain their peak level of functional capacity, from a differential psychology perspective, by aggregating and weighting multiple dimensions shown to vary with age and linked to adaptive functioning, decision-making quality, and broader life success. While our framework incorporates both cognitive and non-cognitive traits, the majority of included dimensions are firmly rooted intelligence research, including conventional cognitive abilities (*Gf*, *Gc*, *Gsm*, and *Gs*), cognitive flexibility, emotional intelligence, moral reasoning, financial literacy, and cognitive empathy. Thus, the CPF remains fundamentally aligned with the study of individual differences in intelligence, broadly conceived. Identifying this composite peak may help clarify why real-world achievement and leadership often culminate in midlife, and inform age-related expectations in domains such as hiring and policymaking. Additionally, as a foundation for this analysis, we present novel age-related trajectories for cognitive abilities and personality traits, derived through a series of statistical analyses of existing data, using a common metric (T-scores), aligned age ranges, and comparable smoothing methods to facilitate direct comparison across domains.

## 2. Method

### 2.1. Data and measures

To model age-related trends across key psychological dimensions, data were extracted from large-scale published studies that reported age-specific values for each trait or ability, with the goal of estimating values across the adult lifespan from approximately age 18 to 85. Datasets were selected based on their capacity to reveal age-related trends (including nonlinear patterns), sample size, sample representativeness (e.g., not university students), and coverage of the adult

lifespan. We also prioritized studies that employed well-established or widely used psychometric measures within their respective domains. For each dimension, raw or standardized scores were digitized using WebPlotDigitizer (<https://automeris.io>) when not directly available in tabular form. To ensure comparability across variables, all scores were transformed into T-scores ( $M = 50$ ,  $SD = 10$ ). Smoothing using locally weighted regression (LOESS; Cleveland & Devlin, 1988) was typically applied to reduce irregularities in the observed data, preserving the overall trend while minimizing random fluctuations to yield a more theoretically plausible trajectory across age. When age-specific values were unavailable at the lower or upper bounds, Generalized Additive Models (GAMs; Wood, 2017) were used to extrapolate values slightly beyond the observed age range. In all cases, the data were analyzed within R (all data and code are available on the OSF: [https://osf.io/swz7f/?view\\_only=243dd6c69be54b1a9c48990b22eda374](https://osf.io/swz7f/?view_only=243dd6c69be54b1a9c48990b22eda374)). The following sections describe the data sources and modeling procedures used for each dimension individually (see Table S1 in supplementary document for a summary).

### 2.1.1. Cognitive intelligence

Intelligence data were obtained from Salthouse (2019), which reported age-related cognitive trajectories using three research designs: cross-sectional, longitudinal, and quasi-longitudinal. Due to substantial practice effects observed in the longitudinal results (see Salthouse, 2019), and the greater detail available in the cross-sectional data, the latter were used for the present analysis.

The cross-sectional sample comprised 5098 community-dwelling adults ranging in age from 19 to 88 years. Cognitive ability was assessed across four domains, reasoning ability, crystallized ability, memory span, and processing speed, using composite scores derived from three tests for each domain (Salthouse, 2019). To extract age-specific values, z-scores were digitized from Fig. 1 of Salthouse (2019) using WebPlotDigitizer. LOESS smoothing (span = 0.50) was applied to reduce noise and preserve the overall age-related trend for each dimension. The resulting smoothed z-scores were then converted to T-scores. To estimate scores for age 18, which fell just outside the observed age range, GAMs were fitted to the LOESS-smoothed data and used to extrapolate plausible values for each cognitive ability dimension.

### 2.1.2. Personality

Core personality data were drawn from Seifert et al. (2024), who analyzed 12 waves of longitudinal data from the LISS panel in the Netherlands ( $N = 10,163$ ; 55 % female), spanning up to 14 years. Participants ranged in age from 16 to 89 across waves, with a mean age of 47.44 years ( $SD = 18.10$ ), offering broad coverage of the adult lifespan.

The 50-item version of the IPIP based on Goldberg's (1992) Big Five markers was administered, with each trait represented by a 6-item subset to reduce multidimensionality (Seifert et al., 2024). Seifert et al. (2024) used fixed effects modeling to isolate within-person changes over time, reducing confounds from between-person differences. T-score values were extracted directly from Fig. 3 of Seifert et al. (2024) using WebPlotDigitizer, and no further transformation was required. Because the x-axis in Seifert et al. began at age 20 but the fitted trajectory extended back to age 16, we used a series of GAMs to interpolate T-scores at age 18 for all five personality dimensions.

### 2.1.3. Emotional intelligence

Emotional intelligence data were derived from the Geneva Emotional Competence test (GEC; Schlegel & Mortillaro, 2019), a performance-based measure that evaluates four core abilities: emotion recognition, understanding, regulation, and management. Compared to the MSCEIT (Mayer et al., 2002), the GEC offers improved internal consistency, avoids consensus scoring, and demonstrates stronger construct validity in predicting academic, social, and occupational outcomes (Simonet et al., 2021).

To model the relationship between age and EI, we used open-access

data from Gignac and Schlegel (2025), comprising adult participants aged 20 to 72 ( $N = 456$ ). A LOESS regression was applied across this observed range, and the resulting predicted values were used directly. For extrapolation beyond the available data, specifically at age 18 and from ages 73 to 85, predicted values were generated using a combination of quadratic polynomial regression model and a GAM. The polynomial model, derived from the Gignac and Schlegel (2025) supplementary files, included an intercept of  $-1.5292650$ , a linear age coefficient of  $0.0698676$ , and a quadratic age coefficient of  $-0.0007145$ . Predicted values from the polynomial and GAM models were averaged at each extrapolated age point to produce a single, smoothed trajectory, allowing for a defensible extension of the trend beyond the observed data range.

### 2.1.4. Financial literacy

The association between age and objective financial literacy was modeled using results reported in Okamoto and Komamura (2021), based on the 2016 Financial Literacy Survey of 15,228 Japanese adults aged 18 to 79. Financial literacy was assessed with a 25-item objective test covering key domains such as interest, inflation, investment risk, insurance, and regulation, with total correct responses serving as the composite score.

Financial literacy scores by age (20–78) were extracted from Fig. 1 using WebPlotDigitizer, with male and female means averaged to yield a composite trajectory. As data for age 18 were not available, a GAM was fitted to the extracted values, and the score at age 18 was estimated via spline-based extrapolation. To extend the trajectory beyond age 78, we applied a 0.65-point annual decline rate based on longitudinal results reported in Boyle et al. (2025), estimating scores through age 85. Using the overall mean (13.87) and standard deviation (6.6) from Okamoto and Komamura (2021), raw scores were then converted to T-scores.

### 2.1.5. Moral reasoning

Moral reasoning was assessed using stage scores derived from Kohlberg's Moral Judgment Interview (MJI), a semi-structured interview that evaluates individuals' justifications in response to structured moral dilemmas (Colby & Kohlberg, 1987). Stage assignments, comprising full and half stages, are based on reasoning across six issue domains (life, law, conscience, punishment, contract, and authority) and are designed to reflect the hierarchical progression of moral development within Kohlberg's framework (Colby & Kohlberg, 1987).

To improve measurement precision and developmental resolution, Dawson (2002) applied Rasch modeling to a large dataset ( $N = 996$ ; ages 5–86) of MJI responses, yielding a fine-grained, interval-scaled metric of moral ability expressed on a logit scale. Unlike brief self-report tools that assess content agreement (e.g., the Defining Issues Test-2; Rest, Narvaez, Thoma, & Bebeau, 1999), Dawson's implementation captures the structural complexity of moral reasoning and identifies nuanced developmental transitions across the lifespan.

To model the age–moral reasoning trajectory in adulthood, we extracted via the WebPlotDigitizer app the data points for individuals aged 18 to 86 from Dawson's (2002) scatterplot (Fig. 2), which displays separate developmental curves for males and females. Despite some visual overlap in the plot, the correlation between log-transformed age and moral ability in our extracted data ( $r = 0.74$ ) closely matched Dawson's reported value ( $r = 0.75$ ), supporting the validity of the reconstruction. Because the Rasch-derived scores in the figure were already standardized (z-scores), it was straightforward to convert them to T-scores. A LOESS function (span = 1.0) was then applied to yield a theoretically plausible developmental curve.

### 2.1.6. Sunk cost fallacy resistance

Karns (2012) examined age-related differences in susceptibility to the sunk-cost fallacy using a behavioral measure based on 10 decision-making vignettes. The sample included 130 adults across three age groups (18–33, 35–59, and 60–88), including both naïve and financially

trained participants (e.g., MBAs, CPAs). The primary outcome was the frequency of sunk-cost-consistent choices, scored dichotomously across scenarios.

To reproduce Karns's (2012) findings, we simulated data for the three age groups using the reported sample sizes, means, and standard deviations for age and sunk-cost responses. Scores were reverse-coded to reflect resistance to the fallacy, hereafter referred to as the SCF-R (Sunk Cost Fallacy–Resistance) score, with higher values indicating more rational decision-making. The simulation preserved the nonlinear trend: substantial improvement from young to middle adulthood, followed by a modest gain in older age. Despite its modest sample size, the age–SCF-R correlation from Karns (2012) ( $r = 0.37$ ) closely aligned with the true-score estimate from Bruine de Bruin et al. (2007) ( $r = 0.38$ ), based on a larger, more diverse sample. However, only the Karns (2012) data offered the granularity needed to examine nonlinear age trends, making it the more suitable basis for this analysis. The data were then converted to T-scores. Finally, the SCF-R data were smoothed using LOESS (span = 0.70) to estimate a continuous age-related trajectory of resistance to sunk cost bias across the adult lifespan, reducing random fluctuation while preserving the underlying nonlinear pattern.

### 2.1.7. Cognitive flexibility

Cognitive flexibility was represented by two indices from the Wisconsin Card Sorting Test (WCST): Percent Perseverative Errors (PPE) and Categories Completed (CC), as reported in Fig. 1 of Shan et al. (2008). This figure presents normative data across ages 20 to 89 for both a Taiwanese sample ( $N = 475$ ) and the original U.S. standardization sample from Heaton et al. (1993;  $N = 897$ ).

Because the x-axis in Fig. 1 of Shan et al. (2008) displays unevenly spaced age groupings (e.g., 20–29, 30–39, ... 80–84, 85–89), accurate extraction of WCST values using WebPlotDigitizer was not feasible. Consequently, instead, the CC and PPE charts reported in Shan et al.'s (2008) Fig. 1 were imported into PowerPoint, and evenly spaced horizontal gridlines were overlaid to aid in visually estimating the y-axis values for each age group. Separate values were recorded for the U.S. and Taiwanese samples and then averaged ( $N$ -weighted) across corresponding age groups. The resulting values were smoothed with LOESS regression (span = 0.90).

To estimate scores for ages not covered by the original data (i.e., 18), quadratic regression models were fitted to the LOESS-smoothed data for PPE and CC separately. These models captured the overall curvilinear trends and were used to extrapolate values down to age 18. The final dataset comprised predicted PPE and CC scores for ages 18 to 87.

Because the original metrics were not standardized, scores were converted to T-scores ( $M = 50$ ,  $SD = 10$ ). For PPE, the LOESS-predicted values yielded a mean of 17.01 across ages 18 to 87, with a pooled standard deviation of 11.32 calculated using  $N$ -weighted age-group  $SD$ s from Shan et al. (2008). For CC, the corresponding mean and  $SD$  were 4.23 and 2.04, respectively. As higher PPE scores indicate worse performance, PPE values were reversed prior to standardization so that higher T-scores consistently reflected better cognitive flexibility. Finally, T-scores from PPE and CC were averaged to produce a single composite score for each age.

### 2.1.8. Cognitive empathy

Though not without its critics and limitations (e.g., Oakley et al., 2016), scores from the Reading the Mind in the Eyes Test (RMET; Baron-Cohen et al., 2001) were used as indicators of cognitive empathy. The RMET is claimed to measure an individual's ability to infer others' mental states from subtle facial cues, particularly the eye region, and has been described as a measure of theory of mind and/or cognitive empathy (Deng et al., 2024; Jankowiak-Siuda et al., 2016).

Cognitive empathy data were sourced from Table S4 of Greenberg et al. (2023), which reported RMET sum score means, standard deviations, and sample sizes separately for males ( $n = 138,179$ ) and females ( $n = 145,035$ ) across each year of age from 16 to 70. Using these

values,  $N$ -weighted means and standard deviations were computed for each age. Next, to convert RMET sum scores to T-scores, raw values were first standardized using  $z$ -scores. This required an overall mean and standard deviation, which were calculated by combining the descriptive statistics reported for males ( $n = 142,694$ ;  $M = 26.94$ ,  $SD = 4.05$ ) and females ( $n = 148,923$ ;  $M = 27.62$ ,  $SD = 3.92$ ). The resulting  $N$ -weighted mean was 27.29, with a pooled standard deviation of 4.00. These values were used to compute age-specific T-scores ( $M = 50$ ,  $SD = 10$ ). To account for random noise and to model the nonlinear age trajectory of RMET performance, a GAM with penalized spline smoothing was fitted to the T-score data. This model was then used to extrapolate and estimate RMET values for ages 71 through 85.

### 2.1.9. Need for cognition

Data were sourced from Soubelet and Salthouse (2017), based on a sample of 5004 adults aged 18 to 99 years ( $M = 50.9$ ,  $SD = 18.2$ ; 64.9 % female), who completed the 18-item short form of the Need for Cognition Scale (Cacioppo et al., 1996), a validated measure of individuals' propensity to engage in and enjoy effortful cognitive activity. Soubelet and Salthouse (2017) reported total sum scores converted to  $z$ -scores.

The  $z$ -values were extracted from Fig. 1 of Soubelet and Salthouse (2017) using WebPlotDigitizer. Owing to modest subgroup sizes, the resulting age trajectory exhibited minor irregularities, including an anomalous spike in NFC at age 50, an isolated increase not observed in adjacent age groups. Specifically, scores rose between ages 40 and 50, then declined again at age 60, disrupting the otherwise gradual downward trend. Given longitudinal evidence supporting a smoother decline in NFC with age (e.g., Bruinsma & Crutzen, 2018), we applied an adjustment to the NFC value at age 50 (i.e., between ages 40 and 70) to reduce this local distortion while preserving the broader developmental trajectory. The adjusted  $z$ -scores were then converted to T-scores.

## 2.2. Data analysis and weighting models

To generate an overall Cognitive–Personality Functioning Index (CPFI), we first computed two weighted composites for two domains: a Weighted Cognitive Ability Composite (WCAC) based on four cognitive intelligence subdimensions, and a Weighted Personality Composite (WPC) based on the five core traits of the Big Five. For the WCAC, the cognitive intelligence subdimensions were weighted as follows: reasoning ability (0.425), crystallized ability (0.425), memory span (0.10), and processing speed (0.05).

Ideally, the specification of weights for the major conventional cognitive ability dimensions would be guided by evidence from a meta-analytic structural equation model that quantifies their unique predictive contributions to key life outcomes. However, to our knowledge, no such comprehensive analysis currently exists. In lieu of this, we drew on the extensive literature documenting the broad predictive power of intelligence across domains (Gottfredson, 2002), noting that different outcomes would be expected to be differentially associated with fluid versus crystallized abilities. That is, fluid abilities would be expected to associate more strongly with life outcomes that involve novel problem solving and decision-making under uncertainty, whereas crystallized abilities would be expected to be more relevant for outcomes that draw on accumulated knowledge, verbal comprehension, and domain-specific expertise. When the effects of reasoning and crystallized intelligence are statistically controlled, memory span and processing speed would generally be anticipated to emerge as relatively weaker unique predictors of consequential life outcomes. Accordingly, our weighting scheme, reflecting Horn's (Horn, 1989; Horn & Hofer, 1992) distinction between *vulnerable* abilities (Gf, Gsm, Gs) and *maintained* abilities (Gc), assigns fluid (vulnerable) abilities a 35 % relative advantage over crystallized abilities (0.575 vs. 0.425). We believe this represents a conceptually and empirically defensible approximation.

The WPC was constructed using the following weights: conscientiousness (0.375), emotional stability (0.375), openness to experience

(0.15), extraversion (0.05), and agreeableness (0.05). These weightings reflect a substantial body of research indicating that conscientiousness and emotional stability are consistently stronger predictors of important life outcomes, including occupational success, health, and psychological resilience, relative to the other three traits (Barrick & Mount, 2000; Roberts et al., 2007). To account for the context-dependent nature of extraversion and agreeableness in high-functioning roles, these latter two traits were not treated as linearly beneficial. Instead, deviations from the population mean ( $T = 50$ ) were penalized—reflecting the idea that moderate levels of extraversion and agreeableness are typically optimal for success, while very high or very low levels may undermine performance. Accordingly, the contributions of extraversion and agreeableness to the WPC were modeled as penalty terms based on the absolute deviation from the mean. Although this penalty-based approach could be considered debatable, the weights assigned to extraversion and agreeableness were relatively small, minimizing their overall influence on the composite.

The remaining seven dimensions were treated as individual indicators and, along with the WCAC and WPC (all expressed in T-score format), were used to compute two versions of the Cognitive–Personality Functioning Index (CPFI). The first, a *Conventional model*, emphasized core cognitive and personality traits, assigning weights of 0.55 to cognitive ability (WCAC) and 0.45 to personality (WPC). We acknowledge ongoing debates regarding the relative importance of intelligence and personality in predicting key life outcomes (e.g., Borghans et al., 2016; Golsteyn et al., 2022; Stankov, 2023; Zisman & Ganzach, 2022). Our weighting reflects a modest advantage for cognitive ability, consistent with its generally stronger and more pervasive predictive validity, while still recognizing the substantial and complementary contributions of personality traits across a wide range of domains.

The second, a *Comprehensive model*, incorporated a broader range of psychological capacities theorized to contribute to effective real-world functioning. In this model, cognitive ability (WCAC) and personality (WPC) were each weighted at 0.24, reflecting their continued importance but allowing room for additional constructs. Emotional intelligence was assigned a weight of 0.15, consistent with its demonstrated predictive utility across diverse domains (MacCann et al., 2020; O’Boyle Jr et al., 2011; O’Connor et al., 2019). Moral reasoning and financial literacy were each weighted at 0.08, reflecting their developmental ties to accumulated life experience, practical judgment, and real-world knowledge acquisition (Hastings et al., 2013; Okamoto & Komamura, 2021; Olsen et al., 2006; Sorokowski et al., 2024). Resistance to the sunk cost fallacy received a weight of 0.06, acknowledging its relevance as a decision-making competence that tends to improve with age and experiential learning (Bruine de Bruin et al., 2007). Cognitive flexibility, cognitive empathy, and need for cognition were each assigned smaller weights (0.05), acknowledging their relevance to adaptive functioning while recognizing limitations in unique predictive validity and generalizability. Together, these weights formed a balanced composite that aimed to reflect a multidimensional model of cognitive-personality functioning across the adult lifespan.

To execute the weightings and generate the CPFI plots, R code was used to apply the specified weights to each standardized (T-score) variable, multiply them accordingly, and sum the results to compute a composite score for each age. These values were then plotted against age using LOESS smoothing (see OSF for scripts: [https://osf.io/swz7f/?view\\_only=243dd6c69be54b1a9c48990b22eda374](https://osf.io/swz7f/?view_only=243dd6c69be54b1a9c48990b22eda374)).<sup>1</sup>

<sup>1</sup> Recognizing that the specification of weightings may be the most debated aspect of our approach, we have made available an interactive online application that allows users to apply custom weightings and generate their own CPFI estimates ([https://gegignac-lab.shinyapps.io/shinyapp\\_cpfi/](https://gegignac-lab.shinyapps.io/shinyapp_cpfi/)).

### 3. Results

Fig. 1 (Panel A) displays the age-related trajectories of four core cognitive abilities based on data from Salthouse (2019), smoothed and converted to T-scores for comparability. As expected, reasoning, memory span, and processing speed decline steadily across adulthood, with the steepest declines observed in speed and memory. In contrast, crystallized ability (vocabulary) increases into the 60s before plateauing. The Weighted Cognitive Ability Composite (WCAC), shown in black, reflects these trends with a modest decline across midlife, followed by a sharper drop in later adulthood.

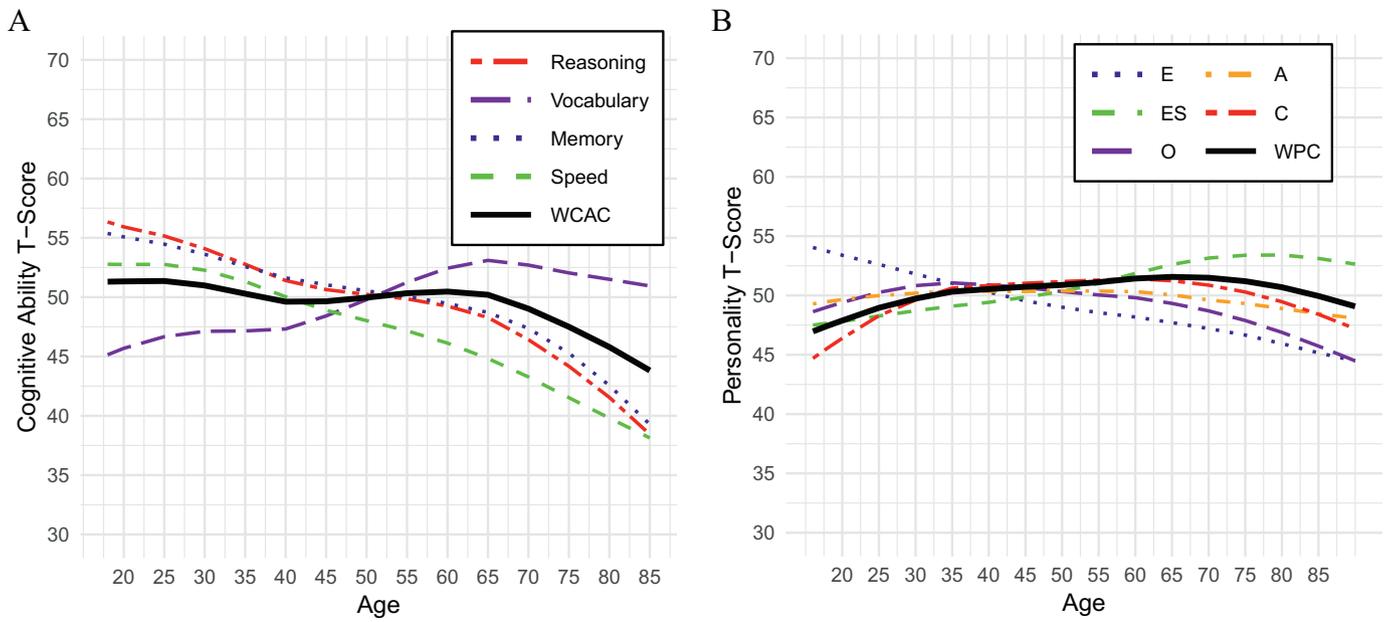
Fig. 1 (Panel B) presents the age-related trajectories of the Big Five personality traits, based on data from Seifert et al. (2024). Conscientiousness and emotional stability show the most pronounced increases from early to mid-adulthood, with emotional stability plateauing and conscientiousness declining moderately in later life. Extraversion declines steadily and approximately linearly across adulthood. Openness begins to decline moderately after about age 55, while agreeableness remains relatively stable until around age 60, after which it exhibits a modest decrease. The Weighted Personality Composite (WPC), shown in black, reflects these trends, rising from age 18 and peaking in the early 60s, followed by a slight decline in older adulthood.

Fig. 2 (Panel A) displays the age-related trajectories of four relatively applied, knowledge-based, and experience-sensitive psychological capacities, i.e., emotional intelligence (Gignac & Schlegel, 2025), financial literacy (Okamoto & Komamura, 2021), moral reasoning (Dawson, 2002), and resistance to the sunk cost fallacy (Karns, 2012), each transformed to T-scores and smoothed for interpretability. Emotional intelligence increases steadily through early and mid-adulthood, peaking around the mid-40s, and then gradually declines into older age. Financial literacy rises continuously across the adult lifespan, with peak levels occurring in the late 60s to early 70s. Moral reasoning shows a similar upward trend, although gains slow in later adulthood. Resistance to the sunk cost fallacy improves across the lifespan, reaching its highest levels in the oldest age groups. Collectively, these trends illustrate that several psychologically adaptive capacities either improve or remain stable well into later adulthood.

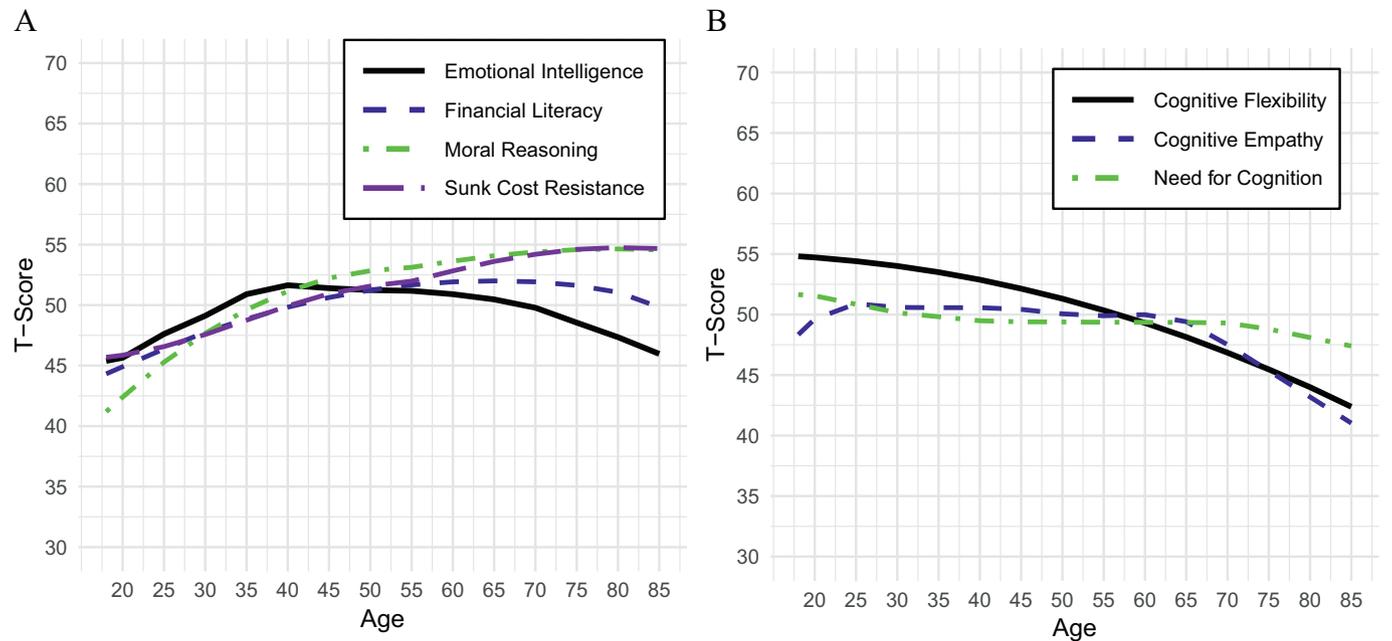
Fig. 2 (Panel B) presents the age-related trajectories of the final three dimensions: cognitive flexibility (Shan et al., 2008), cognitive empathy (Greenberg et al., 2023), and need for cognition (Soubelet & Salthouse, 2017). Each variable was smoothed and transformed to T-scores for comparability. All three show some degree of decline across adulthood. Cognitive flexibility decreases steadily beginning in early adulthood, with a more pronounced drop emerging after age 60. Cognitive empathy increases modestly in early adulthood, remains relatively stable through midlife, and then declines more noticeably after age 65. Need for cognition exhibits the most gradual pattern of change—declining slightly in early adulthood, remaining largely stable through middle age, and decreasing moderately in later life.

Fig. 3 (Panel A) presents the Cognitive–Personality Functioning Index (CPFI) based on the *Conventional Weighting* model. This model prioritizes traditional cognitive intelligence (weighting 0.55) and core personality traits (weighting 0.45). The resulting trajectory shows two distinct periods of growth: a modest increase from age 18 to 30, followed by a somewhat more pronounced rise from around age 40 to 60. After peaking near age 60, the composite score declines steadily into older adulthood. By age 85, overall functioning falls below early adult levels, largely reflecting the cumulative impact of age-related declines in fluid cognitive abilities.

Fig. 3 (Panel B) illustrates the Cognitive–Personality Functioning Index (CPFI) derived from the *Comprehensive Weighting* model. This version integrates a broader set of psychological dimensions, including emotional intelligence, moral reasoning, cognitive flexibility, and cognitive empathy, alongside more conventional cognitive abilities and core personality. The resulting trajectory displays three distinct phases: a relatively steep increase from age 18 to approximately 35, followed by



**Fig. 1.** Age-related trajectories of cognitive abilities (Panel A) and personality traits (Panel b) across the adult lifespan. Note. *Panel A:* Cognitive ability T-scores for four domains and the weighted cognitive ability composite (WCAC). *Panel B:* Personality trait T-scores for the Big Five traits and the weighted personality composite (WPC). E = extraversion; ES = emotional stability; O = openness to experience; A = agreeableness; C = conscientiousness.



**Fig. 2.** Age-related trajectories of cognitive and trait individual difference variables across the adult lifespan. Note. *Panel A:* Age-related trajectories of T-scores for cognitive flexibility, cognitive empathy, and need for cognition. Each line represents a loess-smoothed curve or interpolated trend based on published or digitized data. T-scores are standardized to a mean of 50 and standard deviation of 10.

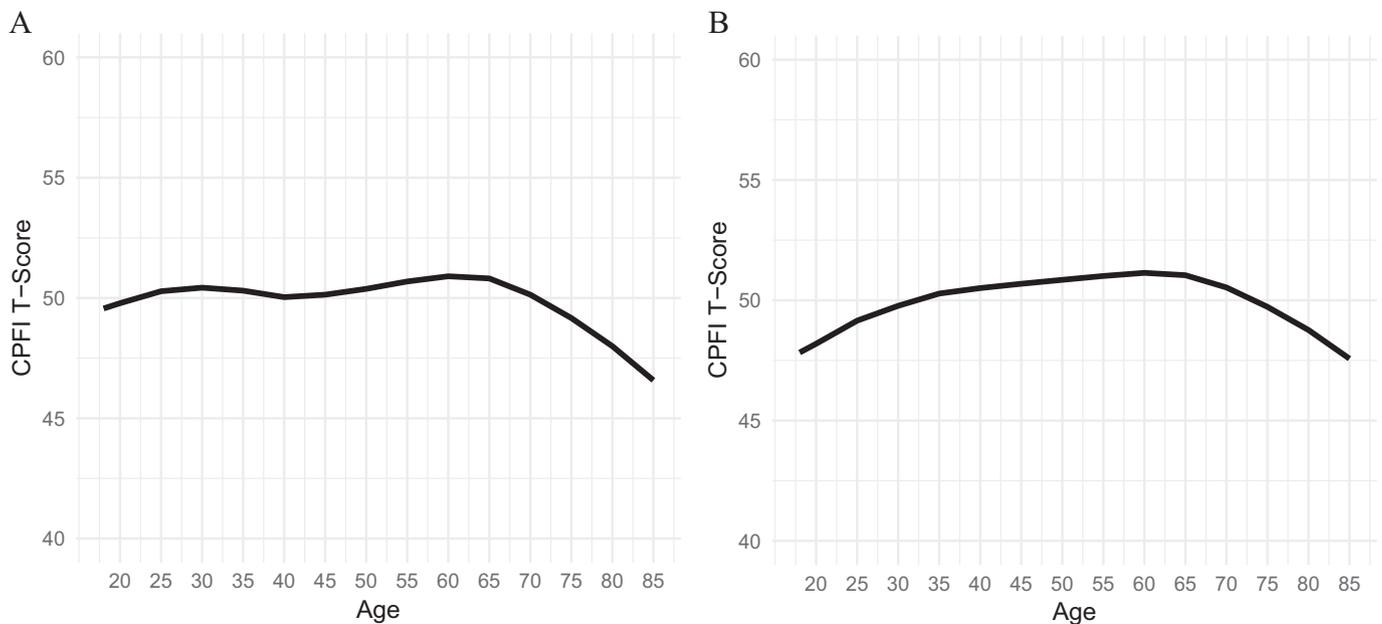
a slower but continued rise through to about age 60, and then a relatively sharp decline beginning after age 65.

Comparing the two models, the most notable difference lies in the early adulthood trajectory. Under the Conventional Weighting model, young adults begin with relatively high CPMI scores, and show only modest gains through their 20s and early 30s. In contrast, the Comprehensive Weighting model starts at a lower baseline in young adulthood but shows a steeper initial increase, reflecting the developmental nature of experience-based traits such as emotional intelligence,

financial literacy, and moral reasoning. Additionally, in the Comprehensive weighting model, young adults (age 18) and older adults (age 85) score relatively similarly, whereas in the Conventional weighting model, older adults score clearly lower than their younger counterparts.

**4. Discussion**

The present investigation examined age-related changes in a range of cognitive and personality traits to estimate when overall psychological



**Fig. 3.** Age-related trajectories of a composite Cognitive-Personality Functioning Index (CPFI) based on cognitive primacy weighting and comprehensive weighting models.

Note. Panel A: Cognitive-Personality Functioning Index (CPFI) *T*-scores across age based on the Cognitive Primacy Weighting, which emphasizes conventional cognitive intelligence and established personality traits. Panel B: CPFI scores based on the Comprehensive Weighting, which integrates broader cognitive, emotional, decision-making competencies, and personality traits. *T*-scores are standardized to a mean of 50 ( $SD = 10$ ), with higher values reflecting stronger overall function across combined domains.

functioning peaks across adulthood. By standardizing data from published studies and applying theoretically informed weightings, two versions of a Cognitive–Personality Functioning Index (CPFI) were constructed: one emphasizing conventional cognitive intelligence and core personality traits (Conventional model), and a second incorporating a broader array of experience-based capacities (Comprehensive model). Both models indicated that overall functioning peaks in late midlife, around the age of 55 to 60. However, the trajectory differed by model: the Conventional model showed relatively stable functioning from early to mid-adulthood followed by a relatively steeper decline, while the Comprehensive model exhibited a steeper rise from early adulthood and a more gradual return to baseline in later life.

#### 4.1. Individual dimensions

Although this study does not present new trait-level data, it offers a novel synthesis by charting age-related trajectories for 16 established psychological dimensions drawn from the differential psychology literature. By converting all variables to a common *T*-score scale and aligning them on the same age continuum, the study enables direct visual and analytic comparisons across traits rarely examined together. This integrative approach reveals that while some traits—like reasoning, memory, and cognitive flexibility—decline steadily with age, others—such as vocabulary, emotional stability, and financial literacy—improve into mid or later adulthood. Traits like conscientiousness, emotional intelligence, and moral reasoning follow an inverted U-shape, peaking in midlife before declining.

Dimensions that exhibit largely linear trends, such as the steady decline in reasoning and cognitive flexibility or the consistent rise in financial literacy, may reflect relatively ‘pure’ constructs with a dominant underlying mechanism, such as biologically constrained processing speed (Salthouse, 2000) or stable white matter pathways that supports crystallized knowledge (Góncora et al., 2020). In contrast, traits that follow non-linear or curvilinear developmental paths, such as conscientiousness, emotional intelligence, and need for cognition, likely represent multifaceted constructs whose expression reflects the shifting

balance of contributing neurophysiological mechanisms across the lifespan. This pattern aligns with Albert et al.’s (1987) conceptualization of age-related cognitive changes as products of multiple interacting mechanisms that unfold along non-linear trajectories. For example, conscientiousness may rise with the increasing demands of adult role investment before declining due to a deliberate reprioritization toward emotional well-being and relationships (Löckenhoff & Carstensen, 2004) and selective investment of diminishing energy (Baum, 1985; Pontzer et al., 2021). Similarly, emotional intelligence may benefit from accumulated social experience in midlife but decline later as cognitive processing slows (Gignac & Schlegel, 2025). These nonlinear patterns may therefore signal the presence of multiple, age-sensitive sources of construct variance, highlighting the complex interplay between biological maturation, environmental demands, and accumulated experience across the lifespan.

#### 4.2. Cognitive-Personality Functioning Index

Across both model weightings, humans appear to reach their peak in cognitive–personality functioning between the ages of 55 and 60. This aligns closely with evidence from modern societies showing that individuals tend to attain peak career outcomes, such as highest earnings and occupational prestige, between ages 50 and 55 (Bihagen et al., 2024; Luong & Hébert, 2009; Turner et al., 2020; Withisuphakorn & Jiraporn, 2017), and that political leaders are most commonly elected in their mid-50s to early 60s (Olenski et al., 2015). These converging patterns suggest that the late-midlife period may represent a high point not only in socioeconomic achievement but also in the underlying psychological capacities that support effective decision-making, leadership, and complex role performance more broadly, a view consistent with lifespan developmental theories that emphasize the coexistence of cognitive decline and growth across adulthood (Li et al., 2013; Staudinger et al., 1989).

While some research has found that peak contributions in fields like mathematics tend to occur in early adulthood, often in the late 20s to early 30s, when fluid reasoning is at its strongest (Simonton, 2003), such

findings apply to domains that rely heavily on abstract problem-solving. However, high-stakes decision-making in real-world contexts can be expected to typically draw upon a broader set of psychological resources. In addition to fluid reasoning, psychological dimensions such as crystallized knowledge, moral reasoning, emotional intelligence, and resistance to cognitive biases, continue to strengthen into midlife. Thus, the CPFI's midlife peak reflects a more comprehensive psychological readiness for complex, consequential roles that demand far more than fluid reasoning alone. Although brain volume begins to decline after the early 30s (Hedman et al., 2012), other neural characteristics may help offset these degenerative effects. Sun et al. (2025) found that global functional connectivity—reflecting the brain's integrative capacity—peaked around age 38, with only modest decline into the 50s. Meanwhile, interindividual variability in connectivity, a marker of functional specialization, peaked later, around ages 55–56. Taken together with the broader findings of this investigation, these neural trajectories support the hypothesis that human psychological functioning may reach a composite multivariate peak between the ages of 55 and 60.

It should be emphasized that not all individuals experience cognitive or personality change at the same rate or magnitude. Longitudinal research shows substantial variability in aging trajectories, with some people maintaining high levels of functioning well into late life (Salthouse et al., 2006). Furthermore, an analysis of the Wechsler Abbreviated Scale of Intelligence – II (WASI-II), revealed that individuals with higher intellectual ability reached peak full-scale IQ roughly a decade later, i.e., in the early to mid-40s, compared to those with average or borderline ability, who peaked in their early 30s; however, they also experienced steeper declines with age (Ryan et al., 2024). Similarly, 13 % of elderly adults (mean age 81) maintained stable financial literacy over six years, underscoring that for some cognitive capacities remain robust even in advanced age (Boyle et al., 2025). These findings highlight the importance of considering individual differences when interpreting age-related psychological change.

#### 4.3. Implications for high-stakes roles in late adulthood

The findings of the present investigation, indicating that overall cognitive-personality functioning peaks between ages 55 and 60, with clear declines emerging after the age of 65 to 70, have important implications for societal roles that demand high-level reasoning, emotional stability, and sound judgment. Notably, these roles often involve individuals well beyond this functional peak, including political leadership and the judiciary, for example.

Förstl (2020) discusses the underrecognized risk of cognitive decline among aging heads of state, emphasizing the diagnostic challenges of early-stage dementia and the reluctance to publicly address cognitive vulnerabilities in high-ranking officials. The author notes that although older leaders often benefit from accumulated experience and institutional knowledge, they may simultaneously face declining fluid cognitive capacities and executive control, deficits that are not easily offset by experience alone.

Similarly, Kaufman (2021) offers a pointed critique of lifetime judicial appointments, particularly within the U.S. federal court system. Drawing on evidence of age-related decline in reasoning and processing speed, Kaufman argues that the advanced age of many federal judges is inconsistent with the cognitive demands of complex legal decision-making. In Kaufman's (2021) view, the steep deterioration of fluid intelligence in late adulthood undermines the presumption of continued competence in such cognitively intensive roles.

The concerns expressed by Förstl (2020) and Kaufman (2021) align closely with the present findings. Although older adults maintain strengths across several dimensions, including crystallized intelligence, financial literacy, and moral reasoning, the Comprehensive CPFI shows a clear downturn after approximately age 65. By age 75, Comprehensive CPFI scores fall to levels comparable to those of young adults, suggesting

that both early and very late adulthood may be suboptimal for high-stakes roles requiring integrated cognitive-emotional functioning. Unlike prior critiques that focus primarily on fluid intelligence (Förstl, 2020; Kaufman, 2021), the present study incorporates a broader array of traits, including emotional intelligence, moral reasoning, and personality maturity, providing a more comprehensive and novel framework for assessing functional capacity across age.<sup>2</sup>

#### 4.4. Limitations

Although many of the developmental trajectories were based on cross-sectional data, which can be influenced by cohort effects (Glenn, 2003), this design is not necessarily inferior to longitudinal approaches. Salthouse (2019) found that longitudinal data often suffer from substantial practice effects, potentially obscuring true age-related declines. Moreover, some evidence suggests that age-related declines in fluid intelligence may be overstated in cross-sectional designs, with sharper reductions typically occurring only after age 65, following a plateau between ages 50 and 64 (Cornelis et al., 2019). Furthermore, longitudinal research evaluating the SOC model (Baltes & Freund, 2003; Staudinger et al., 1989) suggests that older adults often adopt compensatory strategies such as selection, optimization, and compensation to maintain adaptive functioning despite age-related declines (e.g., Knecht & Freund, 2017; Wiese et al., 2002). Accordingly, while we acknowledge the limitations of cross-sectional data, it is unlikely that the central finding of this investigation—that overall cognitive-personality functioning peaks in later midlife—would be substantially altered had comprehensive longitudinal data been available across all dimensions.

While conventional cognitive and personality traits were drawn from large-scale, representative datasets, some other dimensions, such as sunk cost resistance and moral reasoning, were based on more limited or non-representative samples. As a result, the CPFI estimates may be influenced to some extent by the uneven quality and representativeness of the underlying data. However, it is doubtful the variability in data quality would have introduced systematic bias, and the most heavily weighted dimensions were supported by robust, high-quality evidence. Accordingly, we believe the central findings of this investigation are unlikely to be meaningfully affected by the differences in data source quality.

Some may question the selection of the 16 dimensions included in the CPFI, suggesting that certain constructs should have been excluded or others added. For example, potentially relevant traits such as tolerance for ambiguity and temporal discounting were excluded due to conceptual overlap or inconsistent age-related trends, which may have modestly limited the comprehensiveness of the index. However, given that conventional intelligence and core personality traits, both well-established and heavily weighted, dominated the composites, the inclusion or omission of one or two minor dimensions is unlikely to have meaningfully altered the overall pattern of results. We also acknowledge that some selected measures may vary in validity; for example, the RMET has received particular criticism (Higgins et al., 2024; Oakley et al., 2016). Wherever possible, we prioritized measures that offered the best balance of construct validity and age-related data quality, though we recognize that future research using more robust or refined measures may yield different results.

The included datasets tended to be based on Western, educated,

<sup>2</sup> Although some may wonder about the connection between our CPFI and wisdom, it differs in key respects. The CPFI is grounded in empirically validated traits from differential psychology, emphasizing measurable individual differences and functional capacity. In contrast, lacking the same degree of psychometric tractability, wisdom is typically defined more broadly, incorporating prosocial values, existential insight, and reflective maturity (Dong et al., 2023; Jeste et al., 2010).

industrialized populations. Consequently, as there are known differences in differences in age-related changes in some differential psychology traits (Chopik & Kitayama, 2018; Labouvie-Vief & Diehl, 2000), caution is warranted in generalizing the observed trajectories to non-Western cultural contexts. Future research would benefit from incorporating more culturally diverse samples to determine whether the midlife peak identified here holds across varying sociocultural contexts.

For some dimensions, values at the extremes of the age range, particularly ages 18 and 75 to 85, were extrapolated from available data using regression or smoothing techniques. While extrapolation to age 18 was generally minor and anchored in nearby observed data (e.g., age 20), estimates in later adulthood often extended more appreciably beyond the empirical data range. As such, values for the oldest age groups may be less stable and should be interpreted with caution.

Finally, the weightings assigned to the two cognitive-personality function indices inevitably involve a degree of subjectivity. Different theoretical perspectives could reasonably yield alternative peak estimates. However, given the well-established validity of cognitive intelligence and core personality (Ashton, 2022), assigning substantial weight to these dimensions is both justifiable and difficult to dispute. Beyond these core traits, the appropriate weighting of other dimensions remains more open to interpretation. To promote transparency and support exploratory analysis, we have developed an online application that enables readers to experiment with their own weightings and observe how different assumptions influence the resulting estimates ([https://gegignac-lab.shinyapps.io/shinyapp\\_cpfi/](https://gegignac-lab.shinyapps.io/shinyapp_cpfi/)).

## 5. Conclusion

Although many studies emphasize early adulthood declines in fluid cognitive abilities (Horn & Cattell, 1967; Salthouse, 2019; Schaie, 1994), our findings suggest that when broader adaptive traits are considered, human functional capacity peaks in midlife. Accordingly, individuals best suited for high-stakes leadership, judgment, or executive roles are likely to be between 55 and 60—and unlikely to be younger than 40 or older than 65. This challenges many conventional assumptions about age and capability, and suggests that midlife may represent the true apex of psychological readiness for complex, consequential roles.

## CRedit authorship contribution statement

**Gilles E. Gignac:** Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization.  
**Marcin Zajenkowski:** Writing – review & editing.

## Declaration of generative AI and AI-assisted technologies in the writing process

During the preparation of this work the first author used ChatGPT, Gemini, and Perplexity to help with the generation of R scripts, as well as to suggest superior and more concise writing. After using these tools/services, the first author reviewed and edited the content as needed and takes full responsibility for the content of the publication.

## Declaration of competing interest

We declare that we have no conflicts of interest.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.intell.2025.101961>.

## Data availability

Data and scripts available on the OSF link

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