DISSERTATION

VIEWS OF AGING: THEIR MEASUREMENT, ASSOCIATIONS WITH THE PARADOX OF WELL-BEING, AND MALLEABILITY IN THE SECOND HALF OF LIFE

Submitted by

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In partial fulfillment of the requirements

For the Degree of Doctor of Philosophy

Colorado State University

Fort Collins, Colorado

Summer 2024

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ABSTRACT

VIEWS OF AGING: THEIR MEASUREMENT, ASSOCIATIONS WITH THE PARADOX OF WELL-BEING, AND MALLEABILITY IN THE SECOND HALF OF LIFE

As individuals age, they accumulate experiences that not only mark their position in the course of life, but also shape their feelings, beliefs, and attitudes towards aging, collectively known as subjective views of aging (VoA). Negative VoA, whether assessed explicitly through self-report questionnaires or implicitly via computer-administered subliminal priming tasks, consistently correlate with poorer self-rated health status, diminished functional outcomes, and reduced longevity in later life. Drawing upon the extensive VoA literature, this dissertation proposed three distinct yet related research themes of VoA, examining their measurement, their moderating role in buffering the impacts of declining health on subjective well-being (SWB), and their malleability via intervention. Specifically, the first manuscript in Chapter 2 validated a multidimensional VoA questionnaire, the Awareness of Age-Related Changes (AARC) scale, in a sample of Taiwanese older adults. This study also explored cross-cultural similarities and differences in AARC-gains and AARC-losses by examining measurement invariance with a comparable older adult sample in Germany. Chapter 3 investigated divergent trajectories of health and SWB from age 60s to 80s, known as the paradox of well-being in late life, using a 20-year longitudinal cohort study from Germany. To gain a more nuanced understanding of the well-being paradox, this manuscript explored the moderating role of VoA in the decoupled developmental trajectories of health and SWB. Chapter 4 focused on the malleability of adults' implicit and explicit VoA in the context of a randomized controlled trial (RCT). Whereas most

interventions targeting older adults' negative VoA typically evaluated their efficacy based on explicit, self-reported VoA, this manuscript contrasted the intervention effects of the AgingPLUS program on explicit and implicit VoA. This study also examined the extent to which positive intervention-induced changes in explicit VoA were contingent upon varying levels of implicit VoA. Overall, the results derived from the three manuscripts aimed to (1) enhance the assessment and research of VoA in non-Western cultures and societies, (2) provide empirical support for VoA as positive age-related psychosocial processes contributing to high levels of well-being, and (3) inform the design of future interventions leveraging VoA for promoting successful and optimal aging among middle-aged and older adults. Overall, these findings underscored the importance of culturally sensitive approaches to measuring VoA across diverse aging populations. They also highlighted the potential of interventions promoting more positive VoA foster resilience and well-being in the second half of life.

ACKNOWLEDGEMENTS

I am profoundly grateful to the many people who have made this dissertation possible. Although I cannot hope to mention everyone, I would be remiss if I did not thank the following individuals.

A thousand thanks to Dr. Manfred Diehl, for being an amazing advisor and mentor—not only a good researcher but also a good human being. All of us who have been fortunate enough to have him as an advisor have benefited from his steadfast commitment to improving the way our field conducts science. His dedication to training (and nurturing) rigorous, productive, and skilled researchers has been invaluable. His patience with my multiple drafts and his unwavering support got me through the toughest times of my Ph.D. journey. I am deeply indebted to him for fostering my strengths and accommodating my weaknesses. I owe him more than words can express.

I am also sincerely thankful to other faculty members. Drs. Allison Bielak, Kimberly Henry, and Gloria Luong, my dissertation committee members, deserve special thanks. Their insightful feedback significantly enhanced my initial dissertation draft. Also, their supportive presence made our meetings less daunting and helped keep me grounded.

I owe a debt of gratitude to Dr. Stephen Aichele, co-advisor for a research project that received the CHHS Dean's Fellowship, for his insightful and helpful comments on my research. His guidance on methodology bolstered my confidence in navigating complex data analyses.

Thanks to Dr. Hans-Werner Wahl, for his mentorship and support from Germany. His boundless enthusiasm and commitment to exploring big ideas during our research collaboration meetings have been incredibly inspiring.

I also extend my thanks to everyone involved in the ADAPT Lab and the AgingPLUS study. Working with them has provided me with invaluable training in intervention research and numerous opportunities to deepen my understanding of our field.

Heartfelt thanks to Dean Lise Youngblade, Dr. Matthew Hickey, Avery Martin, and Lee Nagle for the numerous networking and professional development opportunities provided throughout the fellowship year. It has truly been an honor to learn and grow with their support.

To Drs. Keng-Ling Lay, Ting-Yu Cha, Chun-Yao Yang, and my fellow graduate students at CSU: You have been more than colleagues; you have been true friends. Your companionship has made my graduate school experience at Colorado State University enjoyable and has been a comforting presence. Thank you for making me feel at home.

I am grateful to my parents and grandparents for instilling in me a love of learning for its own sake and for making higher education an expected rather than optional part of my life. Finally, I must thank my family—the best one in the world. Thank you for sticking with me through it all. Your unwavering love helps me to see the value in every moment spent studying and working far away from home and far away from you.

DEDICATION

For my dearest family, friends, and mentors in life, whom I wish a lifetime of healthy aging.

TABLE OF CONTENTS

CHAPTER 1

GENERAL INTRODUCTION AND REVIEWS OF THE LITERATURE

The world's demographic makeup is undergoing profound shifts. With increasing life expectancy and population aging, individuals aged 65 years and older now represent the largest proportion of the general population in many countries across the globe. This trend is expected to persist and even accelerate for decades, underscoring the urgent need to address the age-old challenge of enabling societies and individuals to age well (World Health Organization, 2020). Amidst these demographic transformations, for instance, as the postwar baby boom cohorts reach 65, the imperative of ensuring that the healthcare systems are equipped to adequately address the needs of this expanding demographic group emerges as a pivotal challenge and focal point of contentious deliberation within public health policies. Moreover, there arises a pressing question of how research can effectively motivate individuals, even from a younger age, to assume heightened agency for their well-being. This may entail initiatives such as adopting and sustaining physical activity regimens, eating healthy diets, and engaging in cognitively stimulating activities to successful aging.

Age, like gender and race, represents a salient social category. Consequently, both societal and individual dimensions of aging profoundly influence individuals' views of aging (VoA). VoA is an umbrella term, referring to how individuals think and feel about growing older and their perceptions of older people as a social group (Diehl et al., 2021). Given its relevance to critical developmental outcomes such as health, well-being, and longevity, VoA has garnered increasing attention within psychological aging research over the past five decades (Kastenbaum

et al., 1972; Lawton, 1975), reflecting an effort toward facilitating optimal adult development and aging (Diehl et al., 2014).

Since its inception, theoretical frameworks and empirical evidence have extensively documented the impact of VoA across various health-related domains (Chang et al., 2020). For example, VoA significantly predicted self-rated health (Brothers et al., 2017), physical functioning (Levy, Slade, & Kasl, 2002; Wurm et al., 2008), cognitive performance (Siebert et al., 2018), and life satisfaction (Wurm et al., 2008). Individuals with negative VoA in midlife have been shown to have, on average, a 7.5-year shorter life expectancy compared to those with positive VoA (Levy, Slade, Kunkel, et al., 2002).

Several systematic reviews and meta-analyses have indicated small to moderate effects of VoA on various health-related outcomes and longevity (Lamont et al., 2015; Meisner, 2012; Westerhof et al., 2014, 2023). To put it into perspective, the negative health effect of VoA is comparable to that of smoking and obesity (Westerhof et al., 2014). Moreover, the health effects of VoA are universal, observed in 45 countries across all six continents. Approximately 86% of the research was conducted in Europe and North America (Chang et al., 2020). Collectively, these studies contribute to a growing body of evidence that underscores a robust link between VoA and critical developmental outcomes across the adult lifespan. However, there remains a notable gap that necessitates expanding research efforts to include studies in non-Western cultures and societies.

Given the accumulating empirical evidence demonstrating VoA as a psychological factor shaping self-identity and influencing the course of aging (Diehl & Wahl, 2010), the manuscripts comprising this dissertation project aim to enhance our understanding on various conceptualizations of VoA and their impacts on different aspects of life in the second half of life.

This introduction to the dissertation has three major sections. First, to establish a clear taxonomy, I differentiate between generalized VoA and personal VoA, followed by a description of the explicit and implicit ways of assessing VoA. Second, I review pertinent theoretical and empirical literature for the dissertation research, outlining the health associations of VoA and the mechanisms through which VoA may influence developmental outcomes in later life. The third section entails a discussion on the potential for VoA to serve as motivational and attitudinal processes fostering better health and health promoting behaviors, with particular emphasis on how VoA could be utilized in applied and intervention endeavors. The introductory chapter concludes with a list of open research questions concerning VoA addressed empirically in Chapters 2, 3, and 4.

Conceptualizing and Measuring Adults' Views of Aging

The conceptualization of VoA is deeply embedded in the broader theoretical framework of lifespan developmental psychology, which characterizes aging as a dynamic process involving both developmental gains and losses (Baltes, 1987). Consequently, VoA encompass individuals' *positive* and *negative* perceptions and attitudes regarding older adults and aging, with negative ones often being more prevalent across different age groups (Hummert, 2011). VoA consist of two interrelated components: a top-down, socially and culturally influenced aspect, known as *generalized* VoA, and a bottom-up, individual-specific element shaped by a person's unique aging experiences, referred to as *personal* VoA. Adults' *explicit* VoA are typically assessed directly through self-report questionnaires or interviews. *Implicit* VoA, on the other hand, are indirectly inferred through tasks that are purposefully designed to bypass conscious or controllable thoughts and awareness about age-related cues (Hess, 2006). Despite their

conceptual relatedness, explicit and implicit VoA are empirically distinct constructs, being the least correlated pair of social concepts in the social psychology literature (Nosek et al., 2007).

Conceptually differentiating between explicit and implicit VoA, along with generalized and personal VoA, holds significant implications for empirically testing hypotheses related to the origins and effects of VoA (Brothers et al., 2017; Diehl & Wahl, 2014; Hess, 2006). From a practical standpoint, understanding these distinctions provides insights for policymakers and practitioners about the multifaceted nature of VoA and their potential impact on a broad spectrum of outcomes, including mental health, decision-making, and behavioral patterns in older adults.

Measuring Adults' Views of Aging

Various measures serve as indicators of VoA, each covering different aspects and following different conceptual rationales. Traditionally, individuals' VoA have been measured by asking the age in years that individuals feel most of the time (i.e., *felt age*; Kastenbaum et al., 1972). The difference between a person's felt age and chronological age is commonly used as a marker of individuals' subjective aging. That is, a negative difference score indicates that a person feels younger than their actual age, whereas a positive difference score indicates that a person feels subjectively older than their chronological age. Thus, this indicator of subjective age provides insight into how individuals anchor and adjust their VoA in response to age-related experiences (Montepare, 2009).

Another example is the *Attitudes Toward Own Aging (ATOA)* scale (Lawton, 1975), which captures evaluative components of attitudes towards old age and individuals' own aging experiences. Similar to felt age, the ATOA scale is time-referenced, asking participants to rate their agreement with statements that relate to changes in traits or states due to aging, such as "Do

you feel that as you get older you are less useful?" or "Do things keep getting worse as you get older?" Responses to the ATOA scale are typically recorded using a dichotomous (yes/no; better/worse) or a Likert scale that reflect varying degrees of agreement with these statements. Both felt age and ATOA exemplify earlier conceptualizations of VoA. Due to their brevity and robust psychometric properties, these scales have been widely used in numerous longitudinal studies since the 1970s, including the Ohio Longitudinal Study of Aging and Retirement (OLSAR) study.

Multidimensional Measures of Adults' Views of Aging

Although single-item ratings like felt age and unidimensional measures like the ATOA scale are useful in predicting a range of developmental outcomes, researchers have criticized that they are like a "black box" (Diehl et al., 2015). The criticism stems from the lack of clarity regarding the psychological and behavioral experiences underlying a numerical representation against the backdrop of chronological age and a global rating of aging attitudes. Specifically, the absence of explicit references to personal and behavior-specific aging experiences, which can vary across life domains, represents a significant limitation of these parsimonious yet powerful VoA measures (Diehl et al., 2014).

To address these limitations, several novel approaches have emerged to capture both positive and negative aspects of VoA across various life domains. For example, in a qualitative study, Keller et al. (1989) identified aging as perceived by middle-aged and older adults as a period of increased wisdom and maturity, as well as health concerns and social losses. Similarly, based on data from the population-based German Aging Survey (age 40 and older) and using factor analysis, Steverink et al. (2001) identified three distinct dimensions of subjective

experience of aging, namely perceptions of physical declines, social losses, and continued developmental growth.

The concept of Awareness of Age-Related Change (AARC; Diehl & Wahl, 2010) represents another and more recent multidimensional approach to studying middle-aged and older adults' subjective aging experiences. AARC encompasses subjective aging experiences across five behavioral domains, namely (1) health and physical functioning, (2) cognitive functioning, (3) interpersonal relationships, (4) social cognitive and socio emotional functioning, and (5) lifestyle and engagement (Brothers et al., 2019; Diehl & Wahl, 2010; Kaspar et al., 2019). Notably, the deliberate selection of these behavioral domains was based on a comprehensive review of the social gerontological literature (Diehl & Wahl, 2010), reflecting their significance in adults' everyday life. That is, research has shown that individuals' AARC is related to events that frequently occur in adults' daily lives (Miche et al., 2014). In addition, the exploratory and confirmatory factor analyses have shown that adults' responses to perceived age-related changes can be parsimoniously represented as two dimensions: perceptions of age-related losses (AARC-losses) and perceptions of age-related gains (AARC-gains; Miche et al., 2014). Thus, multidimensional measures that capture adults' age-related perceptions and experiences offer a more comprehensive and nuanced understanding by considering diverse aging experiences, whether positive or negative, in multiple and central domains of life.

Cross-Group Measurement Invariance of Views of Aging Measures

The growing availability of an array of reliable measures for assessing adults' VoA has significantly broadened the scope for psychologists interested in exploring individual differences and understanding how VoA evolve over time. Alongside this advancement, another critical consideration in measuring individuals' VoA, particularly when multidimensional measures are

used, is measurement invariance (MI). MI refers to the extent to which the same constructs are being measured consistently across time or across different groups of individuals, such as demographic groups or cultural populations (Meredith & Millsap, 1992). Assessing MI involves examining whether the items of a measure are interpreted similarly across groups. Multi-group confirmatory factor analysis (MGCFA; Jöreskog, 1971) is one of the commonly used methods to test the hypotheses of MI. The process of testing different levels of MI with MGCFA typically involves the following steps (Vandenberg & Lance, 2000):

Step 1 involves testing the assumption of *configural invariance*, which assumes that the same items load onto the same factors across groups or across time. If the model fit is not acceptable (i.e., CFI < .90; TLI < .90; RMSEA > .08 (Hu & Bentler, 1999), this would imply that items result in different factor structures across groups or across measurement occasions, rendering factor structures incomparable.

Step 2 assesses *metric invariance,* which examines whether the item loadings on the same factor are identical in size across groups or across time. If the fit of the model is not significantly worse than that of the configural model (i.e., a not significant chi-square difference test result or a decrease in CFI by less than .01), it indicates that the items are functioning identically and are interpreted in the same way across groups and across time. If full metric invariance cannot be achieved, partial invariance may be considered, allowing certain item loadings to vary across groups or across time (Vandenberg & Lance, 2000). Several researchers have argued that valid comparisons can still be made even if only a subset of indicators function invariantly (Byrne et al., 1989). However, there remains a lack of consensus regarding the criteria and procedures for properly handling partial invariance (Vandenberg & Lance, 2000).

Step 3 tests *scalar invariance*, which assumes that the intercepts of the items are equal across groups or across time. The fit of this model is compared to that of the metric invariance model. If the fit of the model is not significantly worse than that of the metric model, it suggests that individuals from different groups or at various life stages would be expected to have the same score(s) on the observed indictor(s). Thus, the comparison of the scores of a latent factor across groups or time is meaningful and valid. If full scalar invariance cannot be achieved, researchers may consider partial invariance as an alternative. In this scenario, allowing for variability in certain item intercepts across groups and over time can provide insights into cross-group or developmental differences.

Examining MI has become standard practice in psychometric research regarding VoA, ensuring measurement validity across various demographic characteristics and across occasions of measurement in longitudinal studies. For example, both a long and a short version of the AARC questionnaire have consistently supported a two-factor structures (i.e., AARC-gains and AARC-losses) and similar item loading patterns across gender, age, education, and marital status in multiple countries have been confirmed (Brothers et al., 2019; Kaspar et al., 2019; Nam & Kim, 2021; Neri et al., 2021; Sabatini et al., 2020; Testad et al., 2022). However, whereas evidence supporting configural and metric MI is robust across many sociodemographic groups, research on MI across cultures and countries remains limited.

Limited evidence on cross-cultural MI poses challenges in distinguishing genuine cultural variations from measurement biases. Consequently, there may be compromises in the measurement validity and the generalizability of research findings concerning VoA in different cultural and national contexts. Nevertheless, achieving full metric or scalar MI across various cultural and national groups presents significant challenges, given that respondents in cross-

national surveys come from diverse linguistic, economic, and cultural backgrounds. Hence, the same concept may have different meanings in different cultures and may be interpreted in different ways across cultures. These differences suggest that individuals may perceive concepts related to old age and aging in unique or culturally specific ways. Consequently, expecting some degree of measurement non-invariance may be more realistic and practical.

Nonetheless, such measurement non-invariance could offer valuable insights into how certain age-related experiences are understood and cognitively represented in different ways in different cultures and countries. This understanding could further illuminate the extent to which cultural factors moderate the link between VoA and developmental outcomes (Hess, 2006), and inform culturally sensitive policies and interventions aimed at leveraging individuals' VoA to promote healthy aging in adults from diverse cultural backgrounds.

Theoretical Framework and Empirical Evidence Linking Views of Aging and Health

Several theoretical frameworks have been proposed in social and lifespan developmental psychology to elucidate the mechanisms through which VoA influence behavior and health-related outcomes. Rather than aiming to provide an exhaustive overview of each existing theory, this section reviews three main theoretical frameworks due to their direct relevance for this dissertation research.

Stereotype Threat Theory

Stereotype Threat Theory (Steele & Aronson, 1995) sheds light on how transiently activated VoA, particularly negative ones, can impact older adults memory and behavioral performance in experimental settings. This theory posits that the fear of conforming to negative age stereotypes induces task-sabotaging feelings and cognitions of stress, leading to performance that is worse than otherwise could have been expected. Importantly, individuals must become

aware of and recognize that they belong to the stereotyped group to elicit the fear that the negative stereotypes may apply to their own person. Therefore, the effects of stereotype threat are more likely to occur among older adults, especially in experimental settings where tasks focus on specific functions that older adults are assumed to perform worse compared to younger individuals (e.g., cognitive processing speed vs. the volume of the vocabulary). The phenomenon where the impacts of stereotype threat are intensified when an experiment manipulates a behavioral domain that aligns with stereotypically negative expectations is known as the *stereotype matching effect* (Levy & Leifheit-Limson, 2009).

Empirical evidence supporting stereotype threat indicates that priming older individuals with positive VoA resulted in increased walking speed (Hausdorff et al., 1999) and better memory performance (Levy, 1996). Conversely, when primed with negative VoA, older individuals exhibited shakier handwriting (Levy, 2000), poorer postural instability (Levy & Leifheit-Limson, 2009), and poorer memory performance (Levy, 1996). In a meta-analysis of 32 studies, Lamont et al. (2015) found a small-to-medium effect size of negative VoA across various functional domains. Notably, Meisner (2012) found the effects of priming negative VoA on health were almost three times larger than those of priming positive VoA. The more significant effects of negative VoA over the positive ones were independent of prime awareness (i.e., explicit and implicit VoA) or study designs (e.g., observational studies or experimental manipulations).

In summary, stereotype threat theory explains how negative, transiently activated VoA can detrimentally affect behavioral performance in older adults, particularly in experimental settings. This occurs as older individuals become aware of belonging to a stereotyped group,

triggering stress and fear that they will confirm negative age-related stereotypes, thus impairing their performance.

Stereotype Embodiment Theory

Stereotype Embodiment Theory (Levy, 2009) offers insight into the processes through which VoA, particularly negative ones, influence long-term health-related outcomes (Levy, 2009). The theory adopts a lifespan perspective on the development of VoA, recognizing that (negative) VoA emerge early in life, gain increasingly self-relevance with aging, and eventually may become negative self-stereotypes in older age. Individuals who identify with "getting old" are more prone to manifest the internalized negative VoA compared to younger individuals for whom aging is not yet self-relevant. The self-stereotyping not only affects middle-aged and older adults' short-term outcomes in experimental contexts, but also influences long-term developmental trajectories through physiological, behavioral, and psychological pathways. Empirical evidence supporting these pathways is reviewed in the following sections.

Physiological Pathways. Experimental studies have demonstrated that negative VoA triggered stress responses, as indicated by elevated blood pressure and cortisol levels, which are significant physiological predictors of long-term cardiovascular health problems (Weiss & Weiss, 2016). Conversely, baseline positive VoA predicted lower levels of inflammation biomarkers (e.g., C-reactive protein) and cortisol, which, subsequently predicted higher survival rates (Levy & Bavishi, 2016). These findings support the theoretical hypothesis that the health effects of negative VoA may operate indirectly through heightened yet harmful physiological responses, rendering individuals more vulnerable to late-life deterioration.

Behavioral Pathways. At the behavioral level, negative VoA may undermine an individual's motivation to engage in health-promoting behaviors. Research has shown that

positive VoA predicted greater engagement in preventive health behaviors, such as eating a healthy diet, engaging in preventive health care, and being compliant in terms of taking prescribed medication (Levy & Myers, 2004). Similarly, middle-aged and older adults with more positive VoA were more likely to participate in sports and walking (Diehl et al., 2024; Wurm et al., 2010). Longitudinal research further indicated that positive VoA predicted healthier dietary patterns over time, independent of age, education, and gender (Klusmann et al., 2019). Thus, VoA may exert long-term effects on health and mortality through behavioral pathways.

Psychological Pathways. Psychological factors, such as perceived control, partially mediated the association between positive VoA and better health-outcomes over an extended period of time (Levy, Slade, & Kasl, 2002). Depression, on the other hand, explained the association between poor VoA and slower walking speed as well as hospitalization (Stephan et al., 2016). VoA also interact with psychological processes to predict health-related outcomes. For example, negative VoA ameliorated the beneficial effects of optimism on mental and physical health (Wurm & Benyamini, 2014). Conversely, individuals' with negative VoA were less likely to apply adaptive developmental regulation strategies such as selection, optimization, and compensation (SOC; Baltes & Baltes, 1990) to cope with serious health events (Wurm et al., 2008). Moreover, awareness of age-related gains significantly mitigated the negative impacts of a limited future time perspective on well-being (Brothers et al., 2016). These findings underscore the interplay between VoA and psychological mechanisms in shaping health-related outcomes.

In summary, stereotype embodiment theory elucidates how VoA begin to develop early in life and eventually evolve into negative self-stereotypes that influence long-term health outcomes. This theory synthesizes observations from decades of empirical research that link VoA to health-related outcomes. Moreover, it provides a clear, empirically testable framework

for researchers to examine the physiological, behavioral, and psychological processes through which VoA impact critical developmental outcomes such as health, well-being, and longevity.

A Heuristic Model of Awareness of Aging

More recently, Diehl and colleagues (Diehl et al., 2014; Diehl & Wahl, 2010; Westerhof & Wurm, 2015; Sabatini et al., 2024) proposed a heuristic model that acknowledges the multidimensional nature of VoA. Furthermore, these authors suggested that not all VoA constructs operate at the same level of consciousness. Therefore, it is essential to differentiate between various VoA and to examine how implicit and explicit VoA interact before further examining their unique and joint effects on health-related outcomes (Brothers et al., 2017).

Given that the lifelong internalization of VoA mostly occurs at the preconscious level and originates from socially and culturally shared sources (e.g., commercial ads of anti-aging cosmetic products), implicit VoA and generalized VoA are regarded as a broader cognitive schema that directs individuals' awareness and attention to certain age-related experiences over others (i.e., personal VoA; Hummert, 2011). In contrast, personal VoA, which operate at the more conscious and self-reflective level, are assumed to play a more significant and direct role in determining health and well-being compared to the overshadowing implicit and generalized VoA. Empirically, personal VoA have been found to consistently and significantly predict health-related outcomes above and beyond what implicit and generalized VoA (e.g., Brothers et al., 2017). The interaction of various VoA constructs were also empirically tested by chains of processes where personal VoA mediated the associations of implicit and generalized VoA with behavioral outcomes (Brothers et al., 2021).

Moreover, Diehl and colleagues (2014) proposed that the heuristic model could be effectively situated within the framework of lifespan developmental psychology. That is,

alongside objective aging indicator such as chronological age, adults' VoA may provide further insights into the rationale and inclination behind individuals' engagement in age-adaptive accommodation rather than assimilation processes (Brandtstädter, 2017), their navigation between secondary control strategies over primary control strategies (Heckhausen & Schulz, 1995), or their preferences for cultivating fewer yet emotionally significant social relationships over more but shallower relationships (Carstensen et al., 1999).

Additionally, VoA are expected to undergo development and transformation over time and across socio-historical contexts. Empirical evidence suggests that later-born cohorts tended to report more positive VoA compared to earlier-born cohorts at the same age (Wettstein et al., 2023). In the era of population aging, countries experiencing prolonged population aging tended to report more positive VoA, whereas those with rapidly growing aging populations, such as certain Asian countries, tended to exhibit more negative VoA (North & Fiske, 2015). Nevertheless, research investigating the extent to which VoA interact with age-adaptive psychological processes and the influences of cultural and socio-historical factors on VoA remains relatively scarce.

In summary, the reviewed theories elucidate how different conceptualizations of VoA converge to predict a host of developmental correlates and outcomes. These theories also shed light on the physiological, behavioral, and psychological mechanisms through which each VoA construct may independently and jointly determine behavior and health-related outcomes. They serve as pivotal conceptual frameworks that guide this dissertation to provide additional empirical evidence and implications to promote health and well-being in real-life contexts.

Health Implications of Views of Aging

Considering the significant impacts of (negative) VoA on health and well-being throughout the adult lifespan, the development of prevention and intervention strategies aimed at fostering positive VoA emerges as a promising avenue for advancement (Kotter-Grühn, 2015). In recent years, a variety of interventions have been devised to modify adults' negative VoA, thereby promoting better health and subjective well-being (Beyer et al., 2019; Brothers & Diehl, 2016; Levy et al., 2014; Sarkisian et al., 2005; Wolff et al., 2014). Most interventions have employed explicit approaches, meaning that they utilized psycho-educational materials to raise individuals' awareness of both their generalized VoA (e.g., negative age stereotypes) and their personal VoA (e.g., age-related gains and losses). Typically involving participatory discussions and lecture sessions, these interventions have addressed common misconceptions about aging, have underscored individual agency in active and successful aging, and have provided cognitive and behavioral strategies to combat or challenge negative VoA encountered in everyday life. The intervention effects on VoA and health outcomes were predominantly evaluated with self-report questionnaires, yielding intervention effects ranging from small to medium in size (Diehl et al., 2022).

Conversely, research exploring the malleability of implicit VoA through experimental manipulations has adopted a completely different approach compared to the aforementioned intervention studies. Some experiments, for instance, have involved the repeated exposure of participants to esteemed exemplars of older adults (e.g., Dasgupta & Greenwald, 2001), or encouraged participants to deliberately imagine positive interactions with older adults (Turner & Crisp, 2010). Recent meta-analyses have indicated the effectiveness of several of these strategies (FitzGerald et al., 2019; Forscher et al., 2019). However, the effect sizes ranged from trivial (*d*

= .08) to large (d = .80). Notably, changes in implicit VoA were found to be transient, failing to endure beyond short time intervals, such as overnight or beyond a few hours (Lai et al., 2016).

Even fewer studies have attempted to adopt purely implicit approaches to changing adults' implicit aging attitudes. An exception is the study by Levy et al. (2014), in which the researchers subliminally primed individuals with positive implicit VoA cues. The investigators deliberately programed the subliminal cues to operate at a speed that made participants aware of their presence yet left them with little or no conscious awareness of the specific details (i.e., positive words regarding older adults and aging). Path analyses showed that subliminal primes led to positive shift in older adults' generalized VoA immediately after the intervention, and in personal VoA one week post-intervention. Furthermore, study participants demonstrated improved physical functioning three weeks post-intervention. However, this study has remained unreplicated, leaving uncertainties about the generalizability of the findings to other samples using similar methodologies and measures. This gap in the literature underscores the need for further rigorous intervention research to verify and extend these promising findings.

The AgingPLUS Study: A Randomized Controlled Trial

The AgingPLUS program is a four-week psycho-educational curriculum focusing on adults' negative VoA and low control beliefs to enact positive behavior change, such as increasing engagement in physical activity and thereby improving adults' functional health (Brothers & Diehl, 2017; Diehl et al., 2020). A pilot feasibility study showed significant improvement in negative VoA and control beliefs, leading to increased physical activity levels from pretest (Week 0) to immediate (Week 4) and delayed posttest (Week 12; Brothers & Diehl, 2017). The program was well-accepted by community-dwelling middle-aged and older adults, showing consistent program effects observed among younger and older participants. Following

the pilot study, the AgingPLUS program underwent testing for efficacy on a larger scale with middle-aged and older adults aged 45 to 75 years living in the Front Range area in Colorado. The AgingPLUS study implemented the experimental medicine approach (Riddle, 2015) in the design of a randomized controlled trial (RCT) to assess change in physical activity resulting from reduced attitudinal and motivational barriers, particularly negative VoA, low self-efficacy, and low behavioral/exercise intention (Diehl et al., 2020).

The AgingPLUS study (Diehl et al. 2020) research design as an RCT featured two unique aspects. First, the study extended beyond conventional pre- and post-intervention designs to include multiple assessment occasions up to 32 weeks since randomization, a longer timeline than previous studies. The extended assessment occasions provide more flexibility in statistical modeling, potentially yielding more nuanced and robust estimates regarding program-induced effects over time and causal mediation analysis. Second, the evaluation of intervention effects considers the multidimensional nature of VoA by including assessments of generalized VoA (e.g., age stereotype scale; Kornadt & Rothermund, 2011), personal VoA (AARC-SF; Kasper et al., 2019), and implicit VoA (e.g., implicit association test; Greenwald et al., 1998). This approach enables researchers to understand which aspects of VoA are more malleable and could be the primary targets for robust and lasting effects of future adaptations of the AgingPLUS program and related successful aging interventions.

In summary, existing intervention studies indicated that adults' self-reported, explicit VoA are subject to change through explicit approaches where direct and clear messages relating age stereotype and health effects of self-perceptions of aging were delivered. Conversely, evidence on the malleability of implicit VoA has been relatively limited and inconsistent, and

whether explicit approaches like the one employed by the AgingPLUS program may be able to shift implicit VoA has remained unexamined.

Research Questions to be Addressed in the Dissertation Manuscripts

Upon literature review, several empirical research questions were identified, presenting opportunities for this dissertation to contribute new findings to the field. These opportunities include exploring measurement invariance (MI) across different social groups and countries, investigating the moderating role of VoA in sustained subjective well-being amidst health challenges, and examining the malleability of implicit VoA in conjunction with explicit VoA. The next three chapters delineate the research questions and objectives for each of the proposed studies.

Chapter 2: Psychometric Properties and Measurement Invariance of the Awareness of Aging-Related Change Short Form (AARC-SF) in Older Adults from Taiwan and Germany

The manuscript presented in this chapter assessed the applicability of the 10-item AARC Short Form scale (AARC-SF; Kaspar et al., 2019) for use in Taiwan and Chinese-speaking communities. Additionally, this study examined the MI between Taiwanese and German older adult samples. The research questions addressed include:

1) *Is the 10-item AARC-SF a psychometrically reliable and valid questionnaire for assessing individuals' awareness of age-related gains and losses in a sample of community-dwelling older adults in Taiwan?*
2) *Does the AARC-SF demonstrate invariance, specifically in terms of satisfactory model fits for a two-factor structure (configural invariance), consistent item loading pattern (metric*

invariance), and comparable item means (scalar invariance) across age and gender groups within the Taiwanese sample?

3) *Is the AARC-SF invariant regarding factor structure, item loadings, and item means between a Taiwanese and German adult sample?*

Chapter 3: The Paradox of Well-Being and the Moderating Role of Views of Aging: Results from a 20-Year Longitudinal Study

The aim of this study was to examine whether the longitudinal trajectories of physician-rated health and subjective well-being (SWB) diverged from age 60 to 80 and whether adults' VoA moderated the associations of health and SWB trajectories over 20 years. The research questions addressed in this chapter are as follows.

1) *Do the data from a 20-year longitudinal study support prior findings regarding the well-being paradox, wherein many older adults maintain high levels of SWB with advancing age despite declining physical health?*
2) *Do the trajectories of health and SWB follow distinct (i.e., uncorrelated) patterns of change from age 60 to 80 years?*
3) *Does the decoupling of health and SWB trajectories vary among adults' with different levels of VoA?*

Chapter 4: Malleability of Explicit and Implicit Views of Aging in Middle-Aged and Older Adults: Results from a Randomized Controlled Trial

This study compared the effects of the AgingPLUS intervention on explicit and implicit VoA over a 10-month study period. It also explored whether individuals with different levels of implicit VoA demonstrated varying intervention-induced improvements in explicit VoA. The research questions addressed were:

1) *Do participants in the AgingPLUS group exhibit greater improvements in their explicit VoA compared to those in an active control group?*
2) *Do participants in the AgingPLUS group show significant improvement in their implicit VoA compared to those in an active control group?*
3) *Are the intervention effects on explicit VoA contingent upon individuals' baseline levels of implicit VoA?*

CHAPTER 2

PSYCHOMETRIC PROPERTIES AND MEASUREMENT INVARIANCE OF THE AWARENESS OF AGE-RELATED CHANGE SHORT FORM IN OLDER ADULT SAMPLES FROM TAIWAN AND GERMANY[1]

Summary

This study examined the psychometric properties and measurement invariance of the 10-item Awareness of Age-Related Change Short Form (AARC-SF) questionnaire in a Chinese-speaking sample of older adults in Taiwan. Data from 292 participants (M_{age} = 77.64 years) in the Healthy Aging Longitudinal Study in Taiwan (HALST) cohort were used for Study 1, whereas data from young-old adult samples in Germany were used for Study 2. Study 1 showed that the AARC-SF had satisfactory reliability and validity for assessing adults' AARC in Taiwan. Analyses confirmed the two-factor structure of AARC-gains and AARC-losses. Study 2 demonstrated strong measurement invariance across men and women, whereas direct comparisons of the item scores between young-old adults and old-old adults need to be made with caution. Non-invariance of loadings indicated that certain items were more closely linked to AARC-gains and AARC-losses in Taiwan than in Germany. Non-invariance of intercepts suggested potential biases in comparing item scores between Taiwanese and German older adults. The AARC-SF emerged as a reliable and valid instrument for capturing positive and

[1] Tseng, H.-Y., Wu, C.-S., Lee, Lee, C.-Y., Wu, I.-C., Chang, H.-Y., Hsu, C.-C. , Hsu, C.-C., Hsiung, C., Kaspar, R., Wahl, H.-W., & Diehl, M. (2024). *Psychometric properties and measurement invariance of the Awareness of Age-Related Change Short Form in older adult samples from Taiwan and Germany.* Manuscript submitted for publication, Department of Human Development and Family Studies, Colorado State University.

negative subjective aging experiences among Taiwanese older adults. However, it is noteworthy that some items on the AARC-SF may solicit different responses from individuals of different ages and different countries of origin, requiring caution with age group and cross-cultural comparisons.

Introduction

The concept of Views of aging (VoA) has emerged as pivotal in understanding individuals' subjective experiences of aging, encompassing their attitudes, beliefs, and feeling toward growing older (Diehl et al., 2014; Palgi et al., 2019; Wurm et al., 2017). VoA serve as significant predictors of health and well-being, as evidenced by several systematic reviews and meta-analyses (e.g, Westerhof et al., 2014, 2023). Whereas VoA have been extensively studied in many Western countries, research in Eastern countries remains relatively scarce. In this pursuit, the manuscript underscores the importance of valid measurement tools to elucidate the development and changes of individuals' VoA across adulthood, accounting for potential variations by gender, age, and country.

Measures of Subjective Aging

Traditionally, individuals' VoA have been assessed with a single item question: "*How old do you feel most of the time"* (i.e., felt age; Barrett, 2003) which was originally developed to inform other measures of age (e.g., chronological age, biological age). VoA has also been frequently assessed with the unidimensional, five-item Attitudes Toward Own Aging (ATOA) scale, a subscale of the Philadelphia Geriatric Center Morale Scale (Lawton, 1975). This scale asks about individuals' global evaluation of their current life situation, including whether they feel their life is better compared to their younger years. Felt age and ATOA represent

unidimensional measures of VoA, and both indicators are important in understanding the relevance of VoA for developmental outcomes beyond chronological age (Barrett, 2003).

Although these unidimensional VoA measures are parsimonious and powerful in predicting developmental outcomes, one of the major shortcomings pointed out by Diehl and colleagues (2015) is the lack of explicit references to personal and behavior-specific aging experiences that may vary across life domains. In light of this, Diehl and Wahl (2010) introduced the concept of the *Awareness of Age-Related Change* (AARC) into the literature to increase researchers' understanding of the specific aspects of individuals' VoA that influence health and well-being in later life.

Awareness of Age-Related Change: A Multidimensional Subjective Aging Construct

By definition, AARC refers to a person's state of awareness "that his or her behavior, level of performance, or way of experiencing life has changed as a consequence of having grown older" (Diehl & Wahl, 2010, p. 342). In other words, adults' AARC is a product of physical, cognitive, interpersonal, and social processes that involve personal and interpersonal experiences and individuals' beliefs and expectations regarding aging and old age as a life stage. The construct of AARC, therefore, attempts to unpack what age-related experiences are involved when individuals contemplate their felt age and describe their attitudes toward their own aging.

Another advantage of the AARC construct is that it is conceptually rooted in lifespan developmental theory (Baltes, 1987). AARC includes both age-related gains and losses and explicitly focused these changes on key life domains. Therefore, AARC complements earlier conceptualizations of VoA and contribute to the burgeoning advocacy for multidimensional approaches to measuring VoA (e.g., the AgeCog Scales; Steverink et al., 2001; the Attitudes to Aging Questionnaire [AAQ]; Laidlaw et al., 2007) by encompassing both perceived gain- and

loss-related changes in several behavioral, psychological, and social domains that inform individuals' global ratings of VoA (Diehl et al., 2021).

Development and Validation of the Awareness of Age-Related Changes Short Form

The development of the AARC questionnaire began with a comprehensive 189-item version (Brothers et al., 2019; Study 1), with parallel forms in German and English. Over time, the number of items was reduced to a more parsimonious 50-item version (Brothers et al., 2019; Study 2). To make the AARC more suitable for use in large-scale surveys with community-dwelling adults, the 10-item AARC Short Form (Kaspar et al., 2019) was developed to capture adults' positive and negative VoA across the five specified life domains (i.e., health and physical functioning, cognitive functioning, interpersonal relations, social-cognitive and social emotional functioning, and lifestyle and engagement).

Since its availability, the psychometric properties of the AARC-SF have been validated in American, British, and German community-dwelling adults aged 40 and older (Kaspar et al., 2019; Sabatini et al., 2020). Research has confirmed that a two-factor structure of the AARC-SF (i.e., AARC-gains and AARC-losses) outperformed a one-factor model (Kaspar et al., 2019; Sabatini et al., 2020). In these adult samples, the AARC-SF also demonstrated good reliability (Kaspar et al., 2019), supporting the argument that positive and negative aging experiences coexist in adults' VoA.

In terms of validity, a recent meta-analysis indicated small but significant associations between AARC and physical and mental well-being (Sabatini et al., 2020), supporting its criterion validity. AARC has also been found to uniquely account for a significant amount of variance in adults' health and well-being, even after adjusting for global evaluations of VoA such as felt age and ATOA (Brothers et al., 2017). Essentially, these results support the

questionnaire's discriminant validity with other established VoA measures when it comes to predicting health and well-being in middle-aged and older adults.

Measurement Invariance across Gender, Age, and Cultures

Measurement invariance (MI) refers to the comparability of measured construct(s) across conditions such as time, gender and age groups, or individuals living in different countries. Lacking MI threatens meaningful comparisons across groups and may therefore make conclusions based on pooled data questionable. In light of this, prior research found that the 10 items in the AARC-SF contributed to the latent factors of AARC-gains and AARC-losses to a similar degree across groups of gender, age, educational levels, and marital status (i.e., metric invariance; Kaspar et al., 2019; Sabatini et al., 2020). However, scalar invariance where item intercepts or item difficulties were assumed to be equal did not hold between the young-old (age 65 to 80 years) and the old-old (age 80 and older; Kaspar et al., 2019), suggesting that comparisons of observed composite scores of AARC-gains and AARC-losses across different age groups and over time should be made with caution.

In terms of different countries, the psychometric properties of the AARC-SF were established in Brazil (Neri et al., 2021), Norway (Testad et al., 2022), and South Korea (Nam & Kim, 2021). Despite their unique cultural, language, and societal contexts, all three studies found that the AARC-SF demonstrated good internal consistency, test-retest reliability, and construct validity. These studies also revealed the best fit of a two-factor structure of AARC-SF, with one factor assessing age-related losses and the other factor measuring age-related gains. Overall, these studies provided some evidence supporting the country-specific applicability and usefulness of AARC-SF in understanding age-related changes in diverse adult populations.

However, evidence on MI across countries is limited. It is important to note that achieving full metric MI or scalar MI across countries may be difficult to achieve. Instead, it may be more realistic to expect a certain degree of measurement non-invariance. Such non-invariance may provide valuable information to what extent varying AARC in certain behavioral domains may be explained by culture-specific differences in shared values, beliefs, symbols, and meaning of aging. In practical terms, valid comparison of AARC scores across nations and cultures can only be made if MI is supported.

The Present Study

The study aimed to validate the Chinese version of the AARC-SF for use in Taiwan and investigate MI across gender, age groups, and countries. Study 1 examined (a) the item characteristics (e.g., item difficulty); (b) the internal consistency and reliability of the scale; (c) the scale's factor structure; and (d) the scale's convergent, discriminant, and criterion validity. Study 2 explored whether the same factor loading pattern (metric invariance) and item means (scalar invariance) held for (a) men and women, (b) young-old (aged 65 to 80) and old-old adults (aged 80 and older), and (c) young-old adults residing in Taiwan compared to young-old adults in Germany.

Study 1: Psychometric Properties of the AARC Short Form in Taiwan

Methods

Participants and Procedures

The study is based on analyses of cross-sectional data collected through the ongoing Healthy Aging Longitudinal Study in Taiwan (HALST; Hsu et al., 2017). The baseline sample was collected between 2009 and 2013 with community-dwelling older adults aged 55 and above. The AARC-SF scale was added to the study protocol for the third wave of the study beginning in

August 2020 in Miaoli, Taiwan. 378 participants responded to the AARC-SF from 2020 to 2021. Data of 86 participants were excluded because the responses from the home interview were from their proxies rather than the adults themselves. This resulted in a final sample size of 292 adults as shown in Figure 2.1.

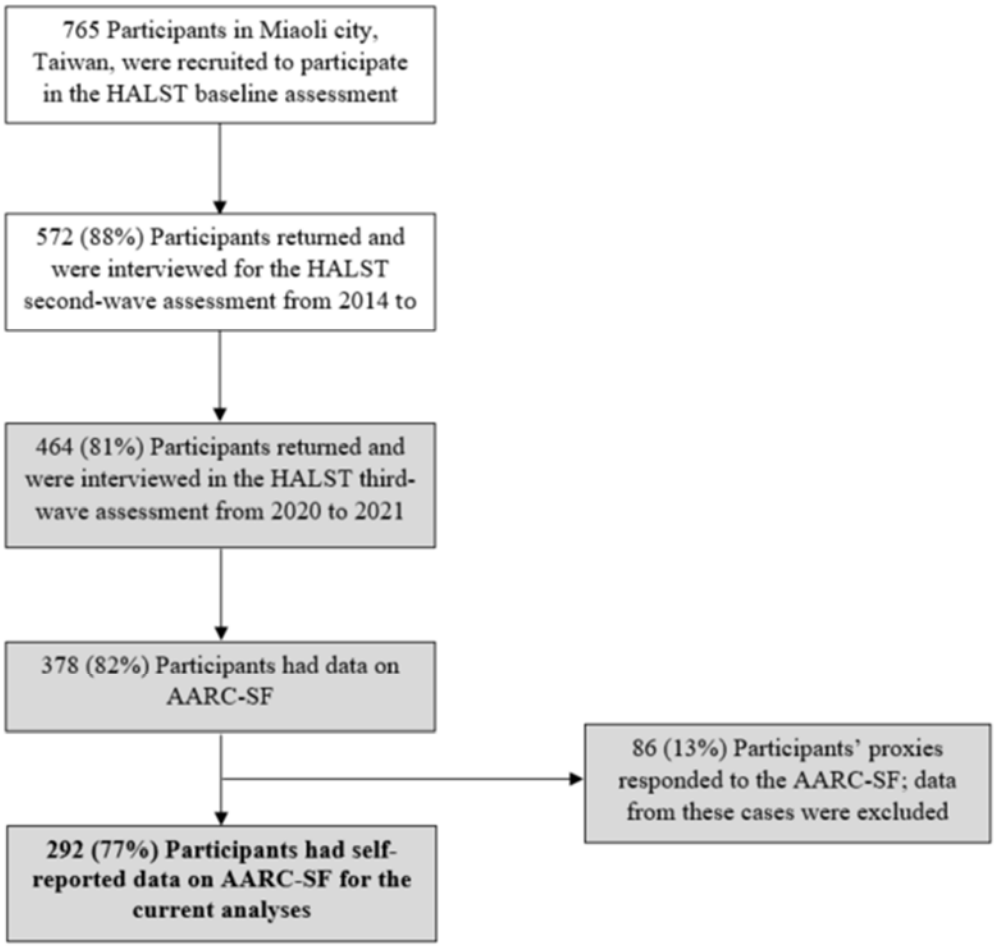


Figure 2.1. *Flow Chart of the Sample Selection for Data Analyses*

Table 2.1 summarizes the sample characteristics of sociodemographic status, health status, and the main variables of interest, including the mean scores of gain- and loss-related changes derived from the AARC-SF. 71% of the sample were young-old adults (M = 77.38 ± 6.24 years), 52% were women, and with various levels of education (M = 10.56 ± 9.11 years).

Table 2.1.

Samples Description

	Study 1	**Study 2 (age range: 65-80 years)**	
	Taiwan n = 292	Germany n = 118	Taiwan n = 207
Sociodemographic characteristics			
Age in years, mean (SD) **	77.38 (6.24)	71.12 (4.14)	74.26 (4.04)
Old-old (>80 years old), %	29.11	--	--
Women, % *	52	69	56
Education years, mean (SD)	10.56 (9.11)	11.51 (4.14)	10.79 (6.75)
Subjective aging			
AARC-gains, mean (SD)	3.07 (0.87)	3.63 (0.59)	3.24 (0.83)
AARC-losses, mean (SD)	2.28 (0.86)	2.11 (0.58)	2.18 (0.81)
Proportional felt age, mean (SD)	-0.03 (0.09)	--	--
ATOA, Mean (SD)	3.74 (0.94)	--	--
EBA, Mean (SD)	2.85 (0.95)	--	--
Health-related variables			
Chronic disease burden, mean (SD)	5.34 (2.4)	--	--
PCS, mean (SD)	49.87 (1.14)	--	--
MCS, mean (SD)	50.03 (1.01)	--	--
Self-rated health† mean (SD) **	--	2.73 (0.81)	3.24 (1.01)

Note. AARC = awareness of age-related changes; ATOA= attitude towards own aging; EBA = essentialist beliefs of aging; PCS = physical component score of the SF-12; MCS = mental component score of the SF-12; † Self-rated health ranged from 1 (*excellent*) to 5 (*extremely bad*); difference test between Taiwan vs. Germany.

* $p < .05$. ** $p < .001$.

Measures

AARC Short Form (AARC-SF) Taiwanese/Traditional Chinese Version

The 10-item AARC-SF scale assessed adults' awareness of age-related changes in five behavioral domains. Each domain was assessed with two items, with one item describing a gain-related experience, and one item describing a loss-related experience. The stem for the questions was: "*With my increasing age, I realize that …*," and the responses were on a five-point Likert scale from 1 = *not at all* to 5 = *very much.* Mean scores of the AARC-gains and AARC-losses were calculated, with higher scores indicating higher levels of self-perceived age-related gains or losses. A rigorous translation/back-translation process by four bilingual scholars in the United States and Taiwan was employed for the AARC-SF to ensure that the same meaning was conveyed in both English and Chinese. Prior studies reported sound reliability of the AARC-SF with the German and the US older adult samples, McDonald's omega (ω) = 0.72 for AARC-gains and α = 0.80 for AARC-losses (Kaspar et al., 2019).

Global Subjective Views of Aging Measures

Measures of other VoA constructs included felt age, ATOA, and the essentialist beliefs of aging scale (EBA; Weiss & Diehl, 2021). The measures of felt age and ATOA were selected to evaluate convergent validity, as both measures evaluate individuals' VoA with a reference to chronological age or their younger selves, similar to the question stem of AARC-SF, "*With my increasing age, I realized that….*" EBA was chosen to investigate discriminant validity because this construct measures individuals' generalized beliefs about the malleability of the human aging process (e.g., "To a large extent, a person's age biologically determines his or her abilities."). Reliability and validity of felt age, ATOA, and EBA have been established in prior

studies (e.g., Barak, 2009; Brother et al., 2017; Diehl et al., 2023), with α ranging from .62 to .69 with the US older adult samples.

Health-Related Variables

Self-reported chronic disease burden and health-related quality of life were used to examine the criterion validity of the AARC-SF. *Chronic disease burden* was operationalized as the number of chronic diseases checked on a medical diagnosis checklist, including hypertension, diabetes, heart disease, stroke, and cancer. A total of 12 chronic diseases were listed, and a higher number indicated greater chronic disease burden. *Health-related quality of life* was assessed with the 12-item Short Form survey (SF-12; Ware et al., 2002). The SF-12 assessed the impacts of physical and mental health on individuals' everyday functioning. Scoring followed standard SF-12 algorithms, yielding two aggregated measures of the physical summary score (PCS) and the mental summary score (MCS). Higher scores indicated better functioning in everyday life and being less impacted by physical and mental health constraints. Psychometric properties of the SF-12 were established in prior studies (e.g., Ware et al., 2002).

Sociodemographic Information

Participants' demographic and socioeconomic status were derived from a structured questionnaire collected in the third wave data collection.

Analytical Strategy

Item Characteristics and Reliability

At the level of individual items, classic item analysis indices, such as item difficulty, inter-item and item-total correlations were calculated. Cronbach's alpha (α) was used to assess the internal consistency of items that generated the sum scores of AARC-gains and AARC-losses. Due to restrictive assumptions for alpha (e.g., uncorrelated errors) and the fact that the

value of alpha is a function of the number of items included, McDonald's omega (ω) is also reported.

Factor Structure

Because a two-factor structure of gain-related (i.e., AARC-gains) and loss-related self-perceptions of aging (i.e., AARC-losses) was supported by most previous studies, this study used confirmatory factor analysis (CFA) to test this two-factor model in the Taiwanese sample. In addition to the Chi-square statistic, which is sensitive to sample size, alternative goodness of fit indices, including Comparative Fit index (CFI), Tucker-Lewis index (TLI), Root Mean Square Error of Approximation (RMSEA), and Standardized Root Mean Square Residual (SRMR), were used for evaluating model fit (Hu & Bentler, 1999). Missing item responses, though trivial with the current sample (< 0.8%), were handled by maximum likelihood (ML) estimation for continuous variable with Mplus v.8.0 (Muthén & Muthén, 2017).

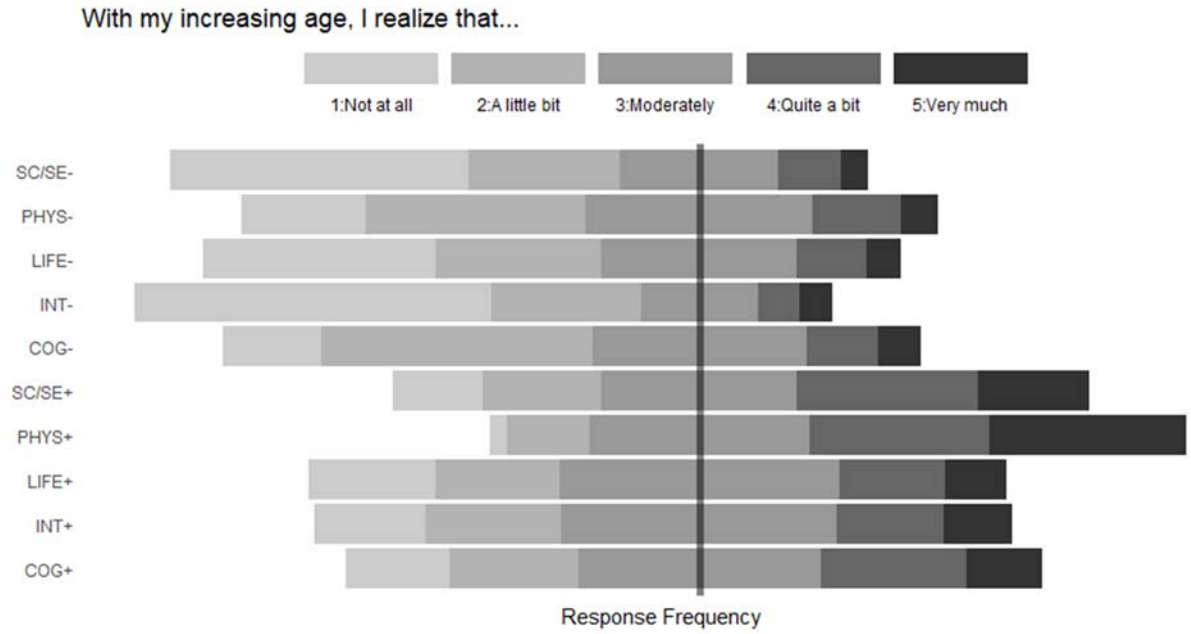
Evidence of Validity

Convergent and discriminant validity were evaluated by calculating correlations between AARC-SF and felt age, ATOA, and EBA. The correlation coefficients were expected to be higher with conceptually more similar VoA constructs (i.e., ATOA and felt age) and lower with substantively less similar VoA constructs (i.e., EBA). Criterion validity of AARC-SF was evaluated by examining the correlations of AARC with chronic disease burden and health-related quality of life, PCS and MCS. The correlation coefficients were expected to be in the small to moderate range. Potential non-linear associations between AARC and health correlates were also explored.

Results

Item Characteristics

Item analysis statistics for the 10-item AARC-SF are displayed in Table 2.2. On average, most respondents responded "*moderately*" to age-related gain experiences (AARC-gains) and "*not at all*" to "*a little bit*" to age-related loss experiences (AARC-losses) across the five behavioral domains. Overall, the items of age-related gains were more widely endorsed by the participants compared to items of age-related losses. In other words, the items of AARC-losses were, in general, more difficult than items of AARC-gains (Figure 2.2).



Note. INT = interpersonal relations; PHYS = health and physical functioning; COG = cognitive functioning; SC/SE = social-cognitive and social-emotional functioning; LIFE = lifestyle and engagement; + = positive aspect of AARC (gains); - = negative aspect of AARC (losses)

Figure 2.2. *Diverging Plot of Item Response*

The pairs plot displayed in Figure 2.3 shows the distribution of the item responses with the density plots (diagonal), as well as the values of the item-to-item correlations (the upper triangle) and graphical representations (the bottom triangle). The corrected item-total correlation coefficients for both AARC-gains and AARC-losses items were strong, indicating that these

items were able to give information regarding an individual's standing on each subjective aging experience. Item-total correlations also indicated that the items provided good internal consistency for the construct they were supposed to measure: all the gain-related items were moderately and positively associated with one another but not with most loss-related items.

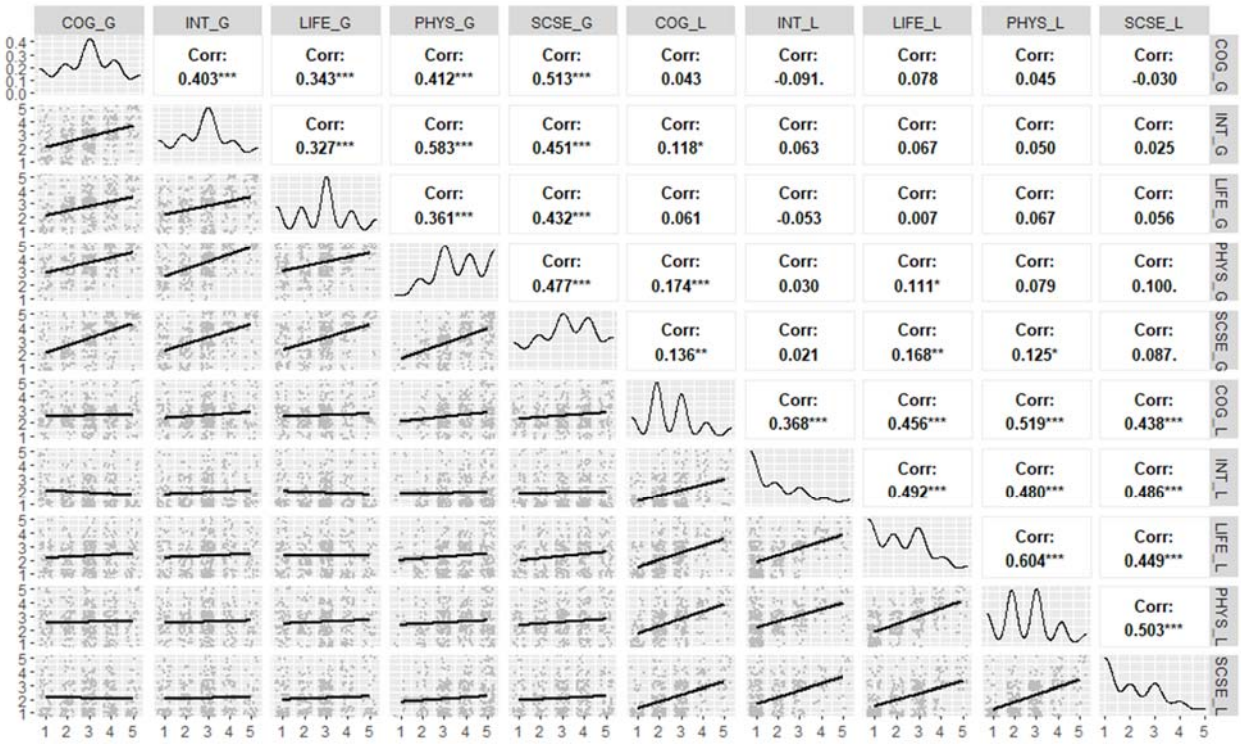


Figure 2.3. *Pairs Plot(s) of the AARC-SF Items*

Reliability and Factor Structure

The AARC-SF demonstrated satisfactory internal consistency, with α = 0.79 for AARC-gains and α = 0.82 for AARC-losses (Table 2.2). McDonald's omega (ω) also suggested the respective items for the factors of AARC-gains and AARC-losses were substantively homogenous, with ω = .79 and ω = .82 for AARC-gains and AARC-losses, respectively. The two-factor model fit the data well according to conventional fit criteria, $\chi^2(34) = 78.80$, $p < .001$, CFI = 0.96, TLI = 0.95, RMSEA = 0.06, SRMR = 0.03. The two-factor model also fit significantly better than the single-factor model, $\Delta\chi^2 = 607.00$, $p < .001$; ΔCFI = 0.51.

Standardized factor loadings showed that all items loaded well on the corresponding factors (Table 2.2).

Table 2.2.

Item Characteristics, Factor Loadings, and Reliability of AARC-SF with the Taiwanese Older Adult Sample (N = 292)

	隨著年紀增長, 我感覺自己… With my increasing age, I realize that…	Item difficulty	Item-total correlation	Factor Loading	Reliability	
		M (SD)	*r*		α	ω
AARC-gains						
INT+	更珍惜人與人之間的關係, 也更能欣賞別人 I appreciate relationships and people much more	2.84 (1.16)	.58	.69	.79	.79
PHYS+	更加注重我的健康 I pay more attention to my health	3.66 (1.08)	.61	.71		
COG+	有更多的經驗和知識來看待人與事 I have more experience and knowledge to evaluate things and people	2.94 (1.20)	.55	.64		
SC/SE+	更清楚知道什麼對我來說是重要的 I have a better sense of what is important to me	3.15 (1.25)	.63	.71		
LIFE+	有更多的自由按照自己想要的方式過日子 I have more freedom to live my days the way I want	2.79 (1.17)	.48	.53		
AARC-losses						
INT-	自己越來越依賴他人的幫助 I feel more dependent on the help of others	1.91 (1.15)	.58	.64	.82	.82
PHYS-	自己的精力更少了 I have less energy	2.56 (1.09)	.69	.79		
COG-	我的腦袋越來越不靈光 My mental capacity is declining	2.56 (1.05)	.56	.64		
SC/SE-	發現激勵自己去做一件事情變得更難了 I find it harder to motivate myself	2.09 (1.16)	.60	.66		
LIFE-	自己的活動受到限制 I have to limit my activities	2.29 (1.17)	.65	.73		

Note. Factor loadings are standardized coefficients. INT = interpersonal relations; PHYS = health and physical functioning; COG = cognitive functioning; SC/SE = social-cognitive and social-emotional functioning; LIFE = lifestyle and engagement; + = positive aspect of AARC (gains); - = negative aspect of AARC (losses).

Examination of Validity

The results partially supported the hypotheses of convergent and discriminant validity, such that higher AARC-gains and lower AARC-losses were associated with better ATOA and a younger felt age (Table 2.3). The magnitude of the correlations tended to be stronger for AARC-losses compared to AARC-gains. Regarding discriminant validity, the results were in the expected direction. That is, adults' EBA scores were positively associated with AARC-gains, and negatively associated with AARC-losses.

Examination of criterion validity showed that higher levels of AARC-gains were associated with better PCS, but not significantly associated with MCS or chronic disease burden. In contrast, AARC-losses demonstrated significant associations with all three health indicators, namely, higher chronic disease burden, lower levels of PCS, and lower levels of MCS (Table 2.3). The analyses of non-linear associations, specifically quadratic relationships, were statistically non-significant.

Table 2.3.

Convergent, Discriminant, and Criterion Validity of the AARC-SF Chinese Version (N = 292)

	AARC-gains			AARC-losses		
Convergent & Discriminant Validity	*r*	95% CI	*P*	*r*	95% CI	*p*
Felt age	-.20	[-.29, -.10]	<.001	.21	[.11, .30]	<.001
ATOA	.27	[.17, .36]	<.001	-.52	[-.59, -.44]	<.001
EBA	.12	[.02, .22]	.018	-.33	[-.42, -.24]	<.001
Criterion Validity						
Chronic disease burden	-.05	[-.15, .05]	0.333	.30	[.18, .37]	<.001
PCS	.17	[.07, .26]	0.001	-.43	[-.51, -.34]	<.001
MCS	-.05	[-.15, .06]	0.375	-.38	[-.46, -.28]	<.001

Note. AARC = awareness of age-related changes; ATOA= attitude towards own aging; EBA = essentialist beliefs of aging; PCS = physical component score of the SF-12; MCS = mental component score of the SF-12.

Study 2: Measurement Invariance Across Gender, Age Groups, and Countries

Methods

Participants

Two sets of the AARC-SF data from the Taiwanese adult sample were utilized to perform statistical test measurement invariance (MI) across groups. A full dataset of 292 participants' data used for Study 1 were employed to test MI across gender and age groups. To mitigate potential age biases in AARC, a subsample of 207 (70.90%) older adults aged 65 to 80 were selected for cross-country MI analyses, with the same-aged counterparts from Germany.

The German AARC-SF reference data were derived from the fourth measurement occasion of a larger longitudinal study focusing on VoA and well-being (Diehl et al., 2013). From an initial baseline assessment in 2012 involving 423 participants, 233 (55.08%) were followed up to complete the 10-item AARC-SF online in 2020. Data from a subset of 118 older adult Germans aged 65 to 80 were included in the MI analyses.

Overall, the Taiwanese sample was significantly older, $t(432) = 5.75$, $p < .001$, and reported significantly worse health compared to the German sample, $t(426) = 4.94$, $p < .001$. Compared to the Taiwanese sample, there were more women in the German sample, $\chi^2(1) = 8.59$, $p = .004$. Descriptive statistics of the German sample and comparisons with the Taiwanese sample are shown in Table 2.1.

Analytical Strategies

A series of multiple group confirmatory factor analysis (MGCFA) models was applied to explore measurement invariance (MI) between women and men, young-old and old-old adults , and between Taiwanese and German adults aged 65 and older (Vandenberg & Lance, 2000). The age group categorization was based on Kaspar et al. (2019), where the researchers found that

adults aged 80 and older may endorse certain items differently compared to younger adults, the reference group. To evaluate the fit of a more restricted model compared to a less restrictive one, the Chi-square difference test and the change in CFI by .01 or greater were used to determine whether the more restrictive model had a worse fit than the less restrictive one (Cheung & Rensvold, 2001).

Results

Measurement Invariance Across Gender

Compared to the configural invariance model, the metric invariance model between men and women did not substantially decrease the model fit. The results indicated that the items corresponding to each the AARC-gains and AARC-losses functioned equally well for men and women. The scalar invariance model did not yield a significantly worse model fit, either (Table 2.4). This meant that men and women responded to items of the AARC-gains and AARC-losses subscales in a similar way, and any differences observed in the group means were not due to measurement biases. Hence, comparisons of both observed composite scores and estimated factor means between men and women were permissible.

Measurement Invariance Across Age Groups

Compared to the configural invariance model, the metric invariance model did not show a significant loss in its model fit. Thus, the contributions of each item to the concepts of AARC-gains and AARC-losses appeared to be the same for young-old and old-old participants. However, the scalar invariance model yielded a significantly worse fit compared to the metric fit, suggesting that the assumption of equal item intercepts across age groups was not tenable (Table 2.4).

Table 2.4.

Goodness of Fit Indices for Measurement Invariance Models across Gender, Age, and Country

	χ^2	*df*	*p*	CFI	TLI	RMSEA	SRMR	$\Delta\chi^2$	Δdf	*p*	ΔCFI
Gender											
Configural	147.04	68	<.001	0.94	0.92	0.08	0.05				
Metric	152.61	76	<.001	0.94	0.92	0.07	0.06	5.57	8	0.695	0
Scalar	166.97	84	<.001	0.93	0.93	0.07	0.06	14.35	8	0.073	0.008
Age group											
Young-old vs. Old-old											
Configural	111.78	68	<.001	0.96	0.95	0.06	0.05				
Metric	117.98	76	<.001	0.97	0.96	0.05	0.05	6.22	8	0.622	0.007
Scalar	139.56	84	<.001	0.95	0.95	0.06	0.06	21.56	8	0.005	0.051
Partial Scalar [1]	130.83	80	<.001	0.96	0.95	0.06	0.06	12.85	4	0.012	0.002
Country											
Taiwan vs. Germany											
Configural	137.34	68	<.001	.94	.92	.07	.06				
Metric	162.56	76	<.001	.93	.91	.07	.08	25.22	8	.001	.01
Partial Metric [2]	143.97	72	<.001	.94	.92	.07	.07	6.63	4	.156	.002
Partial Scalar [3]	152.63	76	<.001	.93	.92	.07	.07	8.66	4	.070	.004

Note. [1] This partial scalar invariance model allows to freely estimate the intercepts of the four items belonging to AARC-gains (INT+, COG+, SC/SE+, LIFE+) and two items belonging to AARC-losses (INT-, SC/SE-) of the young-old and the old-old. [2] All the factor loadings were constrained equal across Taiwan and Germany, except for the loadings of PHYS+ and COG-. [3] This partial scalar model specified equality of the factor loadings of eight items included in partial metric invariance model and the intercepts of four items belonging to AARC-losses across Taiwan and Germany. All five items of AARC-gains and COG- were allowed to be freely estimated

Partial scalar invariance tests provided evidence of response shifts in four AARC-gains items related to interpersonal relations, cognitive functioning, social-cognitive and social-emotional functioning, and lifestyle and engagement when the latent AARC-gains value was set to 0 (Table 2.5). Substantial differences were also observed for two AARC-losses items related to interpersonal relations and lifestyle/engagement. Because of age biases in these items, old-old adults' composite AARC-gains score may be underestimated, whereas their AARC-losses score may be overestimated.

Measurement Invariances Across Countries

In comparing the AARC-SF between Taiwan and Germany, the configural invariance model displayed satisfactory fit (Table 2.4). However, the metric invariance model exhibited significantly poorer fit than the configural model, $\Delta\chi^2(8) = 25.22$, $p = .001$, ΔCFI = .01. Notably, the factor loadings of gains in physical health and losses in cognitive functioning were relatively larger for the Taiwanese group compared to the loadings of the other items, suggesting that Taiwanese older adults placed greater emphasis on the impacts of gains in physical health and losses in cognitive functioning when considering their AARC compared to German older adults.

Partial metric invariance models confirmed this hypothesis; that is, after allowing the factor loading of gains in physical health and losses in cognitive functioning to vary between groups, the partial metric invariance model did not show a significantly worse fit than the configural model, $\Delta\chi^2(4) = 6.63$, $p = .156$, ΔCFI = .002. There was no evidence that any of the other factor loadings were problematic.

The full scalar invariance model demonstrated significantly poorer fit than the partial metric invariance model, indicating distinct response patterns to some items between the two groups who were assumed to have the same absolute level of AARC-gains and AARC-losses.

Independent-samples t-tests revealed statistically significant differences in item scores related to AARC-gains between the two groups, with the Taiwanese group responding significantly lower in almost all items, except for gains in physical health. Conversely, the two groups did not show significant differences in item scores related to AARC-losses, except for losses in cognitive functioning (Table 2.5).

A follow-up step-by-step iterative process leading to the final partial scalar invariance model was employed to validate differences in item responses. When the constraints on all five item intercepts related to AARC-Gains and AARC-Losses in cognitive functioning were lifted, the partial scalar invariance model did not exhibit significantly poorer fit than the partial metric model, $\Delta\chi^2(4) = 8.66$, $p = .07$, ΔCFI = .004. This suggested that, at the same latent level of AARC compared to German same-aged adults, the age-related gains of Taiwanese young-old may be underestimated in most of the life domains, whereas their losses in cognitive functioning may be overestimated (Table 2.5).

Table 2.5.

Measurement Parameters and Tests of Measurement Invariance across Gender, Age, and Countries

	Factor Loading			Intercept; mean (SE)		
			Gender			
AARC-gains	Men	Women	Non-invariance	Men	Women	Non-invariance
INT+	.65	.74		2.69 (0.08)	3.02 (0.08)	
COG+	.70	.60		2.95 (0.08)	3.00 (0.09)	
PHYS+	.68	.73		3.54 (0.08)	2.68 (0.07)	
SCSE+	.72	.71		3.08 (0.09)	3.26 (0.09)	
LIFE+	.50	.54		2.64 (0.08)	2.94 (0.08)	
AARC-losses						
INT-	.73	.58		1.83 (0.08)	1.97 (0.08)	
COG-	.66	.62		2.43 (0.08)	2.68 (0.07)	
PHYS-	.78	.80		2.50 (0.07)	2.60 (0.08)	
SCSE-	.64	.67		2.05 (0.08)	2.12 (0.08)	
LIFE-	.77	.72		2.28 (0.08)	2.29 (0.08)	
			Age			
AARC-gains	Young-old	Old-old	Non-invariance	Young-old	Old-old	Non-invariance
INT+	.73	.62		3.03 (0.07)	2.57 (0.11)	x
COG+	.60	.63		3.14 (0.07)	2.67 (0.10)	x
PHYS+	.74	.71		3.77 (0.06)	3.56 (0.09)	
SCSE+	.73	.65		3.35 (0.07)	2.84 (0.11)	x
LIFE+	.49	.53		2.98 (0.07)	2.47 (0.09)	x
AARC-losses						
INT-	.67	.58		1.73 (0.06)	2.23 (0.11)	x
COG-	.63	.68		2.50 (0.06)	2.68 (0.09)	
PHYS-	.76	.84		2.49 (0.07)	2.67 (0.09)	
SCSE-	.67	.65		1.98 (0.07)	2.28 (0.10)	x
LIFE-	.72	.71		2.16 (0.07)	2.50 (0.10)	
			Country			
AARC-gains	Germany	Taiwan	Non-invariance	Germany	Taiwan	Non-invariance
INT+	.46	.68		3.43 (0.10)	2.98 (0.08)	x
COG+	.59	.59		3.72 (0.08)	3.10 (0.08)	x
PHYS+	.23	.74	x	3.28 (0.09)	3.80 (0.07)	x
SCSE+	.75	.80		3.88 (0.08)	3.31 (0.08)	x
LIFE+	.30	.49		3.80 (0.10)	3.03 (0.08)	x
AARC-losses						
INT-	.53	.61		1.77 (0.08)	1.73 (0.06)	
COG-	.36	.65	x	2.20 (0.09)	2.50 (0.07)	x
PHYS-	.79	.79		2.46 (0.08)	2.47 (0.09)	

SCSE-	.50	.63	1.84 (0.07)	1.98 (0.08)
LIFE-	.83	.70	2.31 (0.09)	2.21 (0.08)

Note. Factor loadings are standardized regression coefficients. INT = interpersonal relations; PHYS = health and physical functioning; COG = cognitive functioning; SC/SE = social-cognitive and social-emotional functioning; LIFE = lifestyle and engagement; + = positive aspect of AARC (gains); - = negative aspect of AARC (losses)

Discussion

Drawing on the theoretical concept of Awareness of Age-Related Change (AARC) and existing evidence regarding the psychometric properties of the AARC-SF scale, this study examined whether awareness of age-related gains and losses could be assessed in a reliable and valid way in Chinese-speaking older adults. Furthermore, this study explored measurement invariance (MI) across different social groups, encompassing gender, age, and countries. The findings further underscore the importance of accounting for age group- and country-specific influences in the interpretation and comparison of individuals' subjective aging experiences.

Psychometric Properties of the AARC-SF Taiwanese/ Traditional Chinese Version

The results pertaining to psychometric properties indicated that the Chinese version of the AARC-SF scale was adequate and reliable in assessing positive and negative age-related changes in five behavioral domains. This study also demonstrated convergent validity of the AARC-SF scale in the Taiwanese sample by showing that scores of both AARC-gains and AARC-losses were significantly associated with the unidimensional VoA measures of felt age and ATOA. On the other hand, results regarding discriminant validity also supported the study hypotheses; that is, higher awareness of age-related losses and lower awareness of age-related gains were associated with a stronger belief that changes with aging are biological and non-malleable in nature.

Criterion validity was evidenced by cross-sectional associations of AARC-gains and AARC-losses with health-related variables, aligning with prior findings indicating the greater

predictive relevance of AARC-losses for individuals' health and well-being (Brothers et al., 2017). These results were not entirely surprising, though. When individuals are asked about aging in their day-to-day lives, what most likely comes to mind are losses and declines, especially losing functional ability or mobility, rather than gains in emotional and social well-being (Heckhausen et al., 1989).

Measurement Invariance across Gender, Age Groups, and Countries

Results indicated that the AARC-SF is suitable for comparing AARC-gains and AARC-losses between men and women. Establishing measurement invariance in this case provided a foundation for meaningful gender comparisons, uncovering nuanced distinctions between men and women in their perceptions of age-related gains and losses free from concerns of measurement bias.

Achieving scalar variance between young-old and old-old adults proved challenging as has been shown in several other studies (e.g., Kaspar et al., 2019; 2024). This challenge was not unexpected because individuals may experience aged-related changes that are intrinsically and qualitatively different at different stages of later adulthood. For example, a 65-year-old might ponder on potential losses in social status and interpersonal relations and more gains in freedom for life as they approach retirement, whereas this is not relevant anymore for a person who has been retired for years. Conversely, an 85-year-old may experience more pronounced declines in physical and cognitive functioning, while placing greater value on interpersonal relations, a phenomenon well-documented as part of socioemotional selectivity theory (Carstensen et al., 2003). Consequently, the different life stages of older adults theoretically and empirically may result in different and meaningful response tendencies to specific items, resulting in higher or lower item means at the group level and non-invariance at the scalar level.

Cross-country comparisons revealed distinctions in the age-related experiences of older adults with different social and cultural backgrounds. Various factors, including item interpretations and mode of assessment, may contribute to these differences. First, the physical health item "*I pay more attention to my health*" may potentially be interpreted differently in Taiwan, specifically the word "attention" in this context. In Taiwan, this item very likely carried some negative connotations and could well be considered as an item dedicated to AARC-losses instead of AARC-gains. That is, in Taiwan, health declines may promote more attention to individuals' health and therefore this item may not capture the aspect of 'paying attention' -- taking more care of one's own health. A follow-up exploratory factor analysis would help shed light on this assumption.

Second, the consistent lower AARC-gains scores in the Taiwanese sample may also stem from a cultural context where older generations were socialized to be more reserved in their judgments and rather restrained in expressing subjective experiences and perceptions related to aging. This is supported by the more modest AARC-losses scores, the ATOA mean score, and a smaller discrepancy between actual age and felt age in the Taiwanese sample compared to the findings reported by Kasper et al. (2019).

Additionally, a potential mode of administration effect may have contributed to these patterns. Prior research found that older adult participants tended to report less negativity when they had direct contact with interviewers compared to self-report situations (Luong et al., 2015). Given that in the HALST, the AARC-SF was administered by interviewers rather than by independent self-report (electronic self-administration in Germany due to the COVID-19 pandemic), the mode of assessment in Taiwan may have influenced participants to respond in a

more conservative direction. Further investigation is needed to determine whether these cross-country differences may be attributed to the administration method of the AARC-SF.

Although there is an ongoing debate regarding the necessity of full or partial scalar measurement invariance as a prerequisite for meaningful group comparisons (Robitzsch & Lüdtke, 2023), future comparative studies might explore potential adjustments to the items that exhibit distinct meanings and intercepts for the purpose of valid comparisons across age groups, time, and countries (Kaspar et al., 2024).

Limitations and Conclusion

The study's samples comprised healthier community-dwelling older adults from a single rural region in central Taiwan, limiting the generalizability of findings to other Chinese-speaking populations. Similar concerns applied to the German sample, which included participants from a relatively affluent geographical area.

Despite these limitations, the concise and multidimensional nature of AARC-SF minimizes response burden on participating while allowing for the substantive exploration of adults' VoA across various life domains. Additionally, recognizing measurement non-invariance and differential item functioning across age groups and countries is imperative for ensuring valid longitudinal and group comparisons. This understanding, particularly from the cross-national measurement invariance results, is pivotal for future comprehensive investigations, examining country-specific and societal factors influencing VoA.

CHAPTER 3

THE PARADOX OF WELL-BEING AND THE MODERATING ROLE OF VIEWS OF AGING[2]

Summary

This study aimed to replicate and extend existing research on the paradox of well-being by investigating the age trajectory of subjective well-being and the associations between changes in subjective well-being (SWB) and health in the second half of life. It also explored whether adults' views of aging (VoA) moderated the associations with health and SWB trajectories over time. Data came from a 20-year longitudinal study following a sample of older adults from age 60 to age 80 years (baseline $N = 500$; $M_{age} = 62.46 \pm 0.96$ years; 52% women). SWB, operationalized as levels of negative affect, was assessed using the Zung Depression scale, whereas health was objectively assessed by physicians. VoA were measured using the Attitudes Toward Own Aging (ATOA) scale. Controlling for sociodemographic covariates and personality characteristics, latent growth curve modeling (LGCM) revealed a significant decline in SWB and a concurrent decline in physician-assessed health from age 60 to 80 years. Significant heterogeneity was observed in the SWB trajectory. Consistent with the paradox of well-being literature, deteriorating health with advancing age was not associated with changes in SWB. Notably, the decoupling of health and SWB over time was observed among individuals with more positive VoA, but not those with more negative VoA. These findings align with prior

[2] Tseng, H.-Y., Aichele, S., Wahl, H.-W., Schilling, O. K., & Diehl, M. (2024). *The paradox of well-being in late life and the moderating role of self-perceptions of aging.* Manuscript submitted for publication, Department of Human Development and Family Studies, Colorado State University.

evidence that SWB and health trajectories can diverge in later life and highlight the role of positive VoA in maintaining SWB despite declining health.

Introduction

A long-standing puzzle in psychological aging research is the 'paradox of well-being,' which refers to the observation that many older adults maintain high levels of subjective well-being (SWB) despite declines and losses in physical health and cognitive functioning (e.g., Kunzmann et al., 2000; Mroczek & Kolarz, 1998). Using data from a longitudinal study spanning two decades, this study extended earlier findings related to the paradox of well-being by examining the covariation of health and SWB trajectories. This study further examined the impact of adults' views of aging (VoA) on the well-being paradox.

Subjective Well-Being in the Second Half of Life

The concept of well-being, extensively studied across psychology, sociology, public health, and economics, encompasses both objective indicators, such as income, health, and life expectancy, as well as subjective measures that draw on individuals' perceptions and experiences of life (Diener & Suh, 1997). The latter approach is represented by the concept of subjective well-being (SWB), a multidimensional construct that is often operationalized in terms of two major dimensions: a hedonic dimension and a eudaimonic dimension (Deci & Ryan, 2008). The hedonic aspects of positive and negative affect, life satisfaction, and quality of life reflect individuals' thoughts and feelings as to what constitutes 'the good life' (Diener et al., 1999). In contrast, the eudaimonic aspect of psychological well-being (Ryff, 1989) emphasizes the realization of human potential of living a purposeful and flourishing life (Ryff et al., 1999).

Despite considerable prior research, the question of how SWB changes across adulthood remains a subject of debate within scholarly discourse. Reviews of cross-sectional studies

suggest a U-shaped or curvilinear relationship over the course of the adult lifespan, characterized by higher levels in young adulthood, a nadir occurring between the mid-30s and early 50s, followed by a subsequent increase in late adulthood (Steptoe et al., 2013). This age pattern has been consistently observed across various dimensions of SWB (McAdams et al., 2012), irrespective of gender (Hansen & Slagsvold, 2012), and after controlling for sociodemographic covariates (Blanchflower & Oswald, 2008). A recent meta-analysis of 152 longitudinal studies revealed a consistent positive trajectory of SWB from the age of 60 years onward; however, discontinuity was observed following age 80 years, indicating that declines were again evident (Buecker et al., 2023). Accumulated biocultural vulnerability may underpin these late-age declines in SWB, suggesting a complex interplay between biological, psychological, and sociocultural factors in shaping SWB trajectories across the lifespan (Baltes & Smith, 2003).

Association of Health and Subjective Well-Being in Late Life

The well-being paradox, indicative of a positive association between age and SWB in late life, aligns with several theoretical frameworks such as socioemotional selectivity theory (Carstensen et al., 1999), social comparison processes (Heckhausen & Krueger, 1993), and adaptive strategies of selection, optimization, and compensation (Marsiske et al., 1995). These process-oriented and motivation-inspired theories suggest possible psychosocial pathways through which older adults' SWB may remain intact despite challenging life events and functional difficulties that increase with advancing age.

However, as noted above, the post-midlife 'uptick' of well-being may be discontinuous after age 80 years (late life) contingent on the accumulation of functional disabilities and chronic/severe illness symptoms. In other words, the paradoxical decoupling of SWB with age/health may only hold up to a certain level of accumulated pathology. This view is consistent

with the disability hypothesis, which posits that declines in physical health and disabilities have substantial impacts on individuals' SWB (Watson & Pennebaker, 1989). It is also consistent with the strengths and vulnerabilities integration model (SAVI; Charles, 2010), which suggests that age-related vulnerabilities to chronic diseases and functional limitations can undermine the accumulated adaptive capabilities of older individuals to maintain SWB. Empirical evidence supports a strong association between SWB and objectively measured health in older adults (Smith et al., 2002). Particularly, strong (positive) associations between SWB and objective health measures have been observed in studies operationalizing time as a function of distance to death (Schilling, 2015). In other words, changes in health, rather than age per se, appear to be a more valid explanation for variations in concurrent and long-term SWB among older adult samples (Kunzmann et al., 2000).

Two studies applying the within-person perspective have corroborated the disability hypothesis and the SAVI model. The within-person analytical approach helps to shed light on how health and SWB co-develop across the adult lifespan at the level of the individual, and the extent to which the trajectories of health and SWB unfold at different rates and even in different directions (Curran & Bauer, 2011), potentially resulting in their decoupling at older age. These studies showed that a typical person would report lower SWB at the time when they also experienced greater constraints in health (Piazza et al., 2007; Schöllgen et al., 2016). However, empirical evidence supporting the paradox of well-being has been mixed. Some studies found that the strength of the association between health and SWB decreases with advancing age (e.g., Schöllgen et al., 2016), whereas others found that the coupling of health and SWB becomes much stronger among the older cohort compared to that of the young-old cohort (e.g., Kunzmann et al., 2019).

To summarize, theories and empirical evidence suggest that the continuation of the upturn in SWB observed following midlife may depend increasingly on health status in later life. Conflicting results regarding the role of age in explaining individual differences in between- and within-person associations of health and SWB in late life signal a need to identify additional factors that may contribute to the well-being paradox in late life.

Moderators of Health and Subjective Well-Being Associations

Associations between health and SWB may be moderated by variables at both macro (social, environmental) and micro (personal, psychological) levels. At the macro level, differences in economic development and policy priorities (e.g., pension systems) across regions may affect the resources and public health infrastructure available for older adults to maintain SWB despite differences in health status (Swift et al., 2014). At the micro level, psychological resources play a crucial role in enabling individuals to better adapt to age-related losses or changes in health (Marsiske et al., 1995). For example, high self-esteem, defined as a sense of self-worth and competence, buffered the longitudinal impact of health declines on SWB in older adults (Jonker et al., 2009). Personality traits (neuroticism and conscientiousness) have also been found to influence both objective and subjective reports of health and well-being with advancing age (Charles et al., 2001; Wettstein et al., 2020). Other psychological variables, such as individuals' views of aging (VoA), have also gained considerable attention in the empirical literature as they may reflect psychological adaptation to the aging process (Diehl & Wahl, 2010).

Views of Aging

Views of aging (VoA) refer to individuals' perceptions, feelings, or attitudes toward their own experiences of aging (Diehl et al., 2021; Wurm et al., 2017). Individuals' VoA may be

positive (age-related gains) or negative (age-related losses) and may vary across domains of life (e.g., familial relationships and friendships) and behaviors (e.g., cognitive or socioemotional; Miche et al., 2014). A multidimensional concept with significant intervention potential (e.g., Diehl et al., 2020), VoA have emerged as robust predictors of health-related outcomes in numerous experimental and longitudinal studies (Wurm et al., 2017; for meta-analysis, see Westerhof et al., 2023).

In line with stereotype embodiment theory (Levy, 2009), VoA function as a cognitive schema, directing older individuals' awareness and attention to age-related changes (Hummert, 2011). As a result, middle-aged and older adults who hold more negative VoA internalize and actualize these negative perceptions over time, akin to self-fulfilling prophecies (Wurm et al., 2013). Empirical findings from several studies also support the buffering effects of positive VoA against health-related risks to SWB (e.g., Witzel et al., 2022). In these studies, positive VoA represent a form of psychological resilience, empowering older adults to deploy acquired skills and capacities in coping with adversities (Wurm et al., 2008). These results suggest that the strength of the association between health and SWB trajectories in the second half of life may be contingent upon individuals' VoA.

The Present Study

To gain a more nuanced understanding of the well-being paradox, this study applied latent growth curve models to data from a 20-year longitudinal cohort study. The first objective was to describe the 20-year longitudinal trajectories of SWB. Informed by extant theoretical frameworks (e.g., SST; Carstensen et al., 1999) and the paradox of well-being literature (e.g., Charles et al., 2001; Kunzmann et al., 2000; Smith et al., 2002), it was expected that SWB would increase from age 60 to 80 years (Hypothesis 1).

A second objective was to test the association between age-based trajectories of SWB and objective health (based on physicians' exams from age 60 to 80 years). It was hypothesized that there would be a significant negative correlation between the mean levels (i.e., intercepts) of health and SWB (Hypothesis 2a) and a non-significant correlation (neither positive nor negative) between the rates of change (i.e., slopes) of health and SWB (Hypothesis 2b).

The third objective was to examine whether VoA moderated the longitudinal associations between health and SWB. Consistent with the literature supporting the protective role of positive VoA against the risk of health adversities (e.g., Wurm et al., 2008), it was expected that the paradox of well-being, where SWB is maintained despite declining health, would hold for individuals who reported more positive VoA (Hypothesis 3a). Conversely, individuals with negative VoA were hypothesized not to benefit from the buffering effect, such that SWB would decline with declining health (Hypothesis 3b).

Methods

Sample

Data for this study came from four measurement occasions of the Interdisciplinary Longitudinal Study of Adult Development (ILSE; Hildesheim et al., 2019). ILSE is an ongoing population-based study that recruited participants in the regions of Heidelberg (Southwest, former West Germany) and Leipzig (East-central, former East Germany). At the baseline in 1993 (T1), young-old adults who were born between 1930 and 1932 (Cohort 30) and middle-aged adults born between 1950 and 1952 (Cohort 50) were interviewed. Given that the paradox of well-being has been observed among adults aged 65 and older, analyses were applied to data from the Cohort 30 participants (N = 500, 52% women, 73% married, 61% middle-to-high household income, mean education = 12.9 years). The sample size was determined based on the

ILSE study (Hildesheim et al., 2019), and is considered sufficient for multivariate and multi-sample latent growth curve models (Duncan & Duncan, 2009; Hertzog et al., 2006). Ages by measurement occasion were: *M* = 62.46 years, *SD* = 0.96 years (T1: 1993-1996); *M* = 66.44 years, *SD* = 0.85 years (T2: 1997-2000); *M* = 73.89 years, *SD* = 0.89 years (T3: 2005-2008); *M* = 82.8 years, *SD* = 1.16 years (T4: 2014-2016). Of these participants, 37.2% (*n* = 186) completed four waves of data collection, 34.4% (*n* = 172) completed three waves, 20.2% (*n* = 101) completed two waves, and 8.2% (*n* = 41) completed only baseline. A detailed sample description and the attrition across four measurement occasions are shown in Table 3.1.

Table 3.1

Sample Description

Variables	Range	Time 1	Time 2	Time 3	Time 4
Sociodemographic characteristics		(1993-1996)	(1997-2000)	(2005-2008)	(2014-2016)
Number of participants		500	449	381	248
Heidelberg, *n* (%)		250 (50)	222 (49)	188 (49)	145 (58)
Age, *M (SD)*	60-86	62.46 (0.96)	66.44 (0.95)	73.89 (0.89)	82.8 (1.16)
Women, *n* (%)		260 (52)			
Household income, n (%)					
Low (25% and below)		182 (36.4)	--	--	--
Middle		211 (42.2)	--	--	--
High (75% and above)		94 (18.8)	--	--	--
Married, *n* (%)		365 (73)	--	--	--
Education, *Mean (SD)*	8-18	12.89 (2.76)	--	--	--
Neuroticism, *Mean (SD)*	0-4	1.56 (0.57)	--	--	--
Conscientiousness, *Mean (SD)*	0-4	2.94 (0.44)	--	--	--
Main variables					
SWB: Negative affect, *Mean (SD)*	1-4	3.46 (0.44)	3.52 (0.42)	3.53 (0.44)	3.56 (0.45)
OBH: Physician-rated health, *Mean (SD)*	1-6	4.53 (0.88)	4.44 (0.72)	4.48 (0.82)	4.19 (0.83)
VoA: Attitudes toward aging, *Mean (SD)*	1-2	1.71 (0.30)	1.78 (0/26)	1.68 (0.28)	1.60 (0.31)

Note. SWB = Subjective well-being; OBH = Physician-rated health; VoA = Views of aging

Measures

Subjective Well-Being

SWB was operationalized in terms of negative affect. Specifically, negative affect was estimated as a latent variable (factor) as indicated by four items from the Self-Rating Depression Scale (Zung, 1965).[3] These items were: bad mood, crying, restlessness, and irritability affect (Table 3.2). Item-level responses ranged from 1 (*never*) to 4 (*always*). Item responses were reverse coded so that the higher score indicated lower negative affect (higher SWB). Reliability indices were in the lower range of acceptability for a scale with four items, with Cronbach's alphas (α) ranging from .56 to .67 and McDonald's omega (ω) ranging from .57 to .68 across the four measurement occasions.

Table 3.2.

Exploratory Factor Analysis of the Zung's Depressive Symptoms Scale (Baseline N = 500)

	Factor/ Dimension						
Items	Energy Level	Negative Affect	Purpose in Life	4	5	Somatic/ Weight	7
Feel down, blue	0.001	**0.454**	-0.11	-0.258	-0.029	0.1	0.064
Feel good	0.105	-0.047	0.2	0.035	-0.097	-0.056	0.218
Crying spells	0.04	**0.378**	0.008	-0.137	0.089	0.041	-0.117
Trouble sleeping	-0.016	0.141	0.085	-0.27	0.195	0.064	0.217
Eat as much	0.016	-0.042	-0.05	0.2	0.048	**0.614**	0.012
Enjoy sex	0.028	0.185	0.012	**0.607**	-0.074	0.082	-0.033
Lose weight	0.097	0.066	-0.146	0.085	0.173	**-0.351**	-0.032
Constipation	0.071	-0.032	-0.071	-0.089	**0.696**	-0.063	-0.135
Fast heart beats	-0.185	**0.365**	0.163	0.168	0.153	0.007	0.111
Clear mind	**-0.329**	0.119	0.15	-0.027	0.171	-0.064	0.116
Get tired	**0.672**	0.089	-0.005	-0.043	0.022	-0.037	0.041
Do things easily	**0.686**	-0.1	0.058	-0.041	0.05	0.065	0.04
Restless	-0.019	**0.585**	0.091	0.088	-0.154	-0.095	-0.009

[3] Using Kaiser's criterion of eigenvalues greater than 1, the result of an exploratory factor analysis with Promax rotation is presented. The seven factors accounted for 57.76% of the variance. Upon examining the items and their corresponding factors, it became apparent that the five items making up the second factor represented a dimension of negative affect. Of the five items, the item related to "faster heart beats" was dropped because a faster heartbeat can be indicative of both negative and positive affect. Thus, the resulting scale consisted of four items.

Hopeful	0.258	-0.203	0.234	0.12	0.14	0.023	0.029
Irritable	0.056	**0.648**	-0.185	0.251	0.075	-0.04	0.019
Decision-making	**0.571**	-0.034	0	0.078	0.011	-0.101	0.141
Useful	0.295	0.27	**0.62**	-0.047	-0.035	-0.005	-0.163
Life is full	-0.088	-0.086	**0.744**	0.019	-0.021	0.053	-0.056
Only if I die	0.155	0.031	-0.123	-0.051	-0.11	0.028	**0.601**
Enjoy things	0.289	-0.056	0.157	0.152	-0.023	0.021	0.017

Note. Extraction Method: Principal Axis Factoring; Rotation Method: Promax with Kaiser Normalization. Absolute values for the loadings larger than .32 are in bold.

Physician-Rated Health

Participant's objective health (OBH) was rated by trained geriatricians based on four in-depth clinical examinations of self-reported medical history, medical check-ups (e.g., medical history of the participant, hearing, and vision test, etc.), a laboratory test (e.g., blood glucose measurement), and a geriatric assessment of functional status. Two geriatricians aggregated the different pieces of information per measurement occasion from each participant into a global physician-rated health score, ranging from 1 (*very good*) to 6 (*very bad*). Here, the rating was reverse coded so that a higher score indicates better OBH. A detailed description of the ratings and assessment can be found in Wettstein et al. (2020).

Views of Aging

Participants' VoA were assessed with the 5-item attitude toward own aging (ATOA) scale, a subscale of the Philadelphia Geriatric Center Morale Scale (Lawton, 1975). The five items asked for participants' self-evaluation of their aging processes that they either *agreed* (0) or *disagreed* with (1). The scores were recoded, so that a higher score is indicative of more positive VoA. At baseline, the mean score of the VoA was 1.71 (SD = 0.30) out of 2, suggesting relatively positive VoA at the group level. Cronbach's alphas (α) ranged from .64 to .70 and McDonald's omega (ω) from .65 to .70 across the four measurement occasions, suggesting the five-item ATOA scale could reliably evaluate participants' VoA.

Covariates

For additional sensitivity analyses, several time-invariant sociodemographic and personality variables were controlled in the analyses as they were found to be significant predictors of older adults' SWB, health, or VoA. Sociodemographic factors included years of education, location (0 = Leipzig region; 1 = Heidelberg region), and gender (0 = men; 1 = women). The personality traits neuroticism and conscientiousness were assessed at baseline with the NEO-Five-Factor Inventory (NEO-FFI; Costa & McCrae, 1992) on a scale of 0 (*not at all*) to 4 (*very much*).

Statistical Analyses

Preliminary Confirmatory Factor Analysis. Confirmatory factor analysis (CFA) was used to estimate scores for negative affect, first testing for measurement invariance (Widaman & Reise, 1997) to ensure consistency of item-factor representation and scaling (i.e., strong invariance at minimum) across assessments. The more constrained models were evaluated against the less restricted models, and a significant change in chi-square values and a difference in CFI by .01 or higher (Cheung & Rensvold, 2001) were used as indications of failure to achieve that level of measurement invariance. Individuals' factor scores (latent negative affect) were then extracted.

Latent Growth Curve Models. Three latent growth curve models (LGCMs) were estimated. To describe the longitudinal trajectories of SWB and objective health (Objective 1), a univariate LGCM was fitted respectively, with time clocked in years from study inception. Univariate LGCMs allowed for the examination of the initial level (intercept), the rate of change (slope), and the association between the initial level of the variable of interest and its rate of

change (Curran & Hussong, 2003). No-growth and linear associations of time with SWB and OBH were examined.

To describe the associations of the baseline level and change between SWB and OBH (Objective 2), an unconditional bivariate LGCM was applied, using scores of SWB and OBH across the four waves. The bivariate LGCM model not only estimated the intercepts and slopes, but also the associations among these parameters, allowing for consideration of a wide range of tests among the growth constructs (Figure 3.1). In this study, the focus was on the association between the rate of change in SWB and the rate of change in OBH, with and without adjusting for covariates.

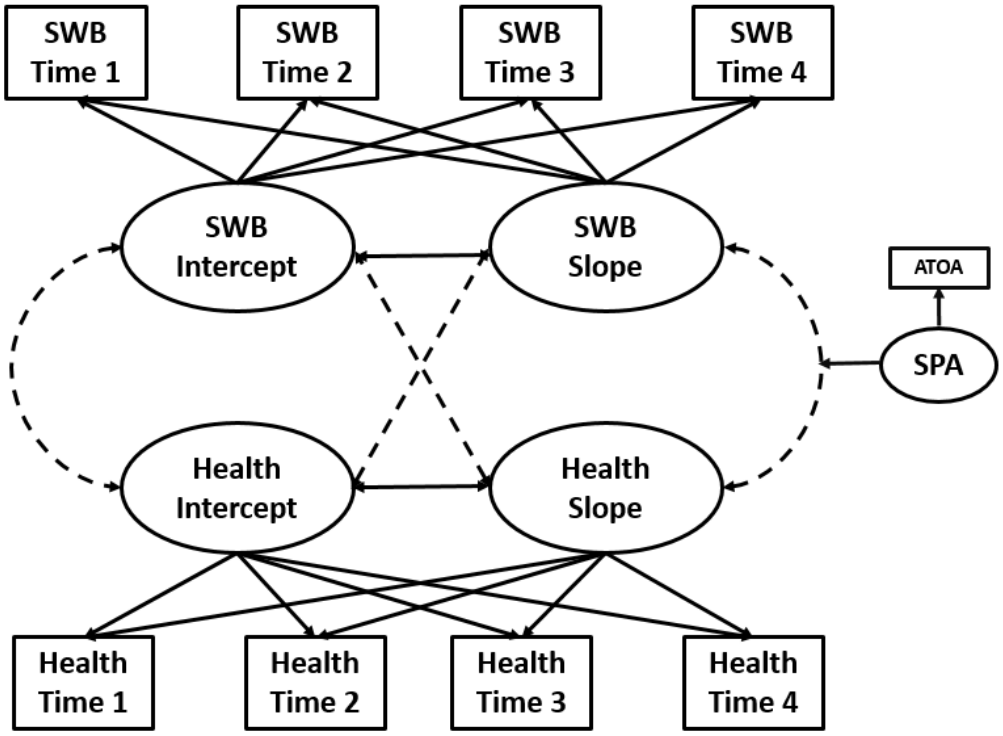


Figure 3.1. *Conceptual Path Diagram of a Bivariate Latent Growth Curve Model of the Current Study, Represents Simultaneous Growth/Decline in Health and Subjective Well-Being (SWB), with Self-Perceptions of Aging (SPA) as Moderators of the Associations of 20-year Changes in Health and SWB*

Finally, conditional bivariate LGCM was applied to investigate the moderating role of VoA on the associations between latent intercepts and slopes of the longitudinal SWB and OBH (Objective 3), with and without adjusting for covariates. VoA was operationalized as latent trajectory classes (profiles) in preliminary analyses using growth mixture modeling (GMM).

Model Fit. Models were fit using full information maximum likelihood (FIML) estimation to account for missingness and attrition over time (Enders & Bandalos, 2001). Several model fit indices were used to evaluate the model fit: the chi-square value, the Comparative Fit Index (CFI; acceptable models > .90; good models > .95), the Tucker-Lewis Index (TLI; acceptable models > .90; good models > .95, and the Root Mean Square Error of Approximation (RMSEA; acceptable models < .08; good models < .06; Hu & Bentler, 1999). All analyses were performed using Mplus 8.6 (Muthén & Muthén, 2017).

Results

Descriptive Statistics

Table 3.1 summarizes the descriptive statistics for personality covariates, the main variables of SWB and OBH, and the moderator variable of VoA. The mean scores were 1.56 (*SD* = 0.58) for neuroticism and 2.94 (*SD* = 0.44) for conscientiousness, with a higher score indicating a higher level of the personality trait. At baseline, the mean score of SWB was 3.46 (*SD* = 0.44) out of a possible score of 4, suggesting a relatively high level of SWB among participants in their early 60s. OBH had an average score of 4.53 (*SD* = 0.88) out of a possible score of 6 at baseline, indicating that the sample was in a fair to good health at the beginning of the study. The average VoA was 1.71 (*SD* = 0.30) out of a possible score of 2, indicating a relatively positive VoA at age 60 years.

Table 3.3 presents the bivariate correlations of covariates with baseline SWB and OBH, as well as the correlations between SWB and OBH across measurement occasions. As expected, SWB and OBH were significantly and positively correlated across four measurement occasions, with effect sizes falling within a small range.

Table 3.3.

Correlations between Study Variables, N = 500 (T1), 449 (T2), 381 (T3), and 248 (T4)

	T1 SWB	T1 OBH	T2 SWB	T2 OBH	T3 SWB	T3 OBH	T4 SWB	T4 OBH
T1 SWB	--	**.15****	.51**	.19**	.52**	.16**	.38**	-.002
T1 OBH		--	.15**	.48**	.17**	.38**	.20*	.11
T2 SWB			--	**.20****	.50**	.13	.36**	.03
T2 OBH				--	.20**	.37**	.20*	.16*
T3 SWB					--	**.25****	.60**	.03
T3 OBH						--	.30**	.01
T4 SWB							--	**.26****
T4 OBH								--
Location	-.08	-.03	-.001	.15**	-.08	.09	-.05	.18*
Gender (Women)	.14**	-.01	.08	.05	.03	-.08	.04	.10
NEO-Conscientiousness	.14**	.15**	.11*	.13**	.15*	.11	.15*	.08
NEO-Neuroticism	-.57**	-.15**	-.43**	-.21	-.33**	-.09	-.33**	-.004

Note. SWB = Subjective well-being; OBH = Physician-rated health; T1 = Time 1; T2 = Time 2; T3 = Time 3; T4 = Time 4. Location: 0 = Leipzig; 1 = Heidelberg.
$^{*}p < .05$. $^{**}p < .01$.

Univariate Latent Growth Curve Modeling

Results from the preliminary CFA showed that scalar (strong) measurement invariance was achieved for the 4-item negative affect scale, allowing meaningful comparisons of its means across time (Table 3.4).

Table 3.4.

Longitudinal Measurement Invariance Fit Indices for the Negative Affect Factor Derived from Zung's Depression Scale

	χ^2	*df*	*p*	CFI	TLI	RMSEA	SRMR	$\Delta\chi^2$	Δdf	*p*	ΔCFI
Configural	103.1	74	.014	0.98	0.96	0.03	0.05				
Metric	120.6	83	.004	0.97	0.96	0.03	0.06	17.6	9	.13	0.007
Scalar	131.1	92	.005	0.97	0.96	0.03	0.06	10.5	9	.31	0.001

Model fit indices for univariate growth models are presented in Table 3.5. Compared to the no-growth models, the linear models of change in SWB and OBH resulted in better model fits in terms of ΔCFI. The quadratic models of change in SWB and OBH did not converge. Therefore, the linear slope models were considered the better-fitting models. In general, the model fits for the linear unadjusted and covariate-adjusted univariate, bivariate, and conditional bivariate models of SWB and OBH were satisfactory.

Table 3.5.

Summary of Model Fit Indices of Univariate, Bivariate, and Conditional Bivariate Latent Growth Curve Models (LGCM)

Without covariates			χ^2	*Df*	CFI	TLI	BIC	RMSEA	$\Delta\chi^2$	Δdf	*P*	ΔCFI
Univariate LGCM	SWB	No-growth	20.41	8	0.96	0.97	3638.67	0.06				
		Linear	14.46	5	0.98	0.98	3647.36	0.05	5.95	3	.114	0.02
	OBH	No-growth	58.53	8	0.73	0.80	3404.87	0.11				
		Linear	17.31	5	0.94	0.92	3382.294	0.07	41.22	3	<.001	0.12
Bivariate LGCM (linear)			39.81	25	0.97	0.97	6985.37	0.04				
Conditional bivariate LGCM (linear)			86.68	48	0.91	0.89	6976.39	0.06				
With covariates			χ^2	*Df*	CFI	TLI	BIC	RMSEA	$\Delta\chi^2$	Δdf	*P*	ΔCFI
Univariate LGCM	SWB	Linear	24.91	13	0.97	0.96	3384.28	0.04				
	OBH	Linear	26.82	13	0.94	0.9	3277.98	0.05				
Bivariate LGCM (linear)			80.81	45	0.95	0.93	6583.96	0.04				
Conditional bivariate LGCM (linear)			113.88	70	0.90	0.88	7000.10	0.05				

Note. SWB = Subjective well-being; OBH = Physician-rated health; Covariates = Location (0 = Leipzig 1 = Heidelberg), gender (0 = men; 1 = women), neuroticism, and conscientiousness.

The analysis did not support Hypothesis 1, with findings suggesting a maintenance, instead of an increase, of affective well-being into old-old age, b = -0.01, SE = 0.01, β = -0.06, p = .517 (Table 3.6). Additionally, no significant associations were found between the initial level and change in SWB, p = .054, pointing to considerable adaptability of late-life SWB. The data also revealed significant heterogeneity in the intercept and slope of SWB (ps < .05), emphasizing the necessity of considering individual differences in the developmental trajectory of SWB. When sociodemographic covariates such as location, years of education, and gender were controlled, the slope estimate for SWB remained non-significant (p = .072). However, the introduction of additional personality covariates, specifically neuroticism and conscientiousness, shifted the slope estimate of SWB to negative (b = 0.35, SE = 0.13, β = -2.34, p = .009), indicating a decrease in SWB over time. These findings further highlighted the complex interplay among sociodemographic factors, personality characteristics, and age, which collectively influence the trajectories of SWB over extended periods.

The linear slope for OBH was significant and negative, b = -0.02, SE = 0.003, β = 7.69, p < .001, indicating a significant decline in health by 0.02 units every year. The negative covariance between intercept and slope revealed that individuals who initially rated better in health exhibited a more rapid decline over time. The patterns with respect to the intercept and the slope of OBH remained consistent after adjusting for a range of covariates.

Bivariate Latent Growth Curve Models

The model fits for the linear bivariate and covariate-adjusted bivariate were satisfactory (Table 3.5). In line with Hypothesis 2a, at baseline, better health was associated with a higher level of SWB, b = 0.16, SE = 0.04, β = 0.34, p < .001 (Table 3.6). This pattern persisted after adjusting for covariates, b = 0.07, SE = 0.03, β = 0.23, p = .016. Notably, there was no significant

association between the rates of change in SWB and OBH, consistent with Hypothesis 2b. Moreover, cross-domain associations were not significant, such that the initial level of SWB was not associated with the rate of change in OBH, and the initial level of OBH was not associated with the rate of change in SWB, either, *p*s > .05. The results persisted after controlling for covariates. The absence of significant associations between the slopes and cross-domain intercepts and slopes of SWB and OBH suggested that changes in one domain might not necessarily be influenced or accompanied by the other.

Table 3.6.

Estimates for Univariate Linear Latent Growth Curve Models (LGCM) and Bivariate Linear LGCM

Univariate		Unadjusted				Covariates-adjusted			
		B	SE	*B*	*P*	*B*	SE	*β*	*p*
SWB	Mean								
	Intercept	-0.002	0.04	-0.002	.965	1.88	0.31	2.44	<.001
	Slope	-0.01	0.01	-0.06	.517	-0.35	0.13	-2.34	.009
	Variance								
	Intercept	0.58	0.06	--	<.001	0.06	0.01	--	<.001
	Slope	0.02	0.01	--	.003	0.001	0.0002	--	.007
	Covariance	-0.03	0.02	-0.31	.054	-0.01	0.01	-0.18	.359
OBH	Mean								
	Intercept	4.51	0.03	7.69	<.001	4.35	0.31	7.44	<.001
	Slope	-0.02	0.003	-1.02	<.001	-0.24	0.11	-4.19	.029
	Variance								
	Intercept	0.35	0.04	--	<.001	0.31	0.04	--	<.001
	Slope	0.001	0.002	--	.561	0.0003	0.002	--	.872
	Covariance	-0.03	0.01	-0.64	.010	-0.30	0.01	-0.66	.026
Bivariate		Unadjusted				Covariates-adjusted			
		B	*SE*	*B*	*P*	*B*	*SE*	*β*	*p*
$I_{(SWB)} \leftrightarrow I_{(OBH)}$		0.16	0.04	0.34	<.001	0.07	0.03	0.23	.016
$S_{(SWB)} \leftrightarrow S_{(OBH)}$		0.003	0.03	0.03	.911	0.02	0.02	0.22	.406
$I_{(SWB)} \rightarrow S_{(OBH)}$		0.13	0.08	-0.27	.075	-0.07	0.05	-0.20	.177
$I_{(OBH)} \rightarrow S_{(SWB)}$		-0.02	0.01	0.21	.186	0.02	0.01	0.33	.101

Note. SWB = Subjective well-being; OBH = Physician-rated health; Covariates = Location (0 = Leipzig 1 = Heidelberg), gender (0 = men; 1 = women), neuroticism, and conscientiousness; I = intercept; S = Slope.

Conditional Bivariate Latent Growth Curve Models with Views of Aging as Moderator

Preliminary latent class analysis of VoA. Intercept-only (χ^2 = 182.7, *df* = 11, CFI = 0.49, TLI = 0.62, RMSEA = 0.13) and linear (χ^2 = 22.83, *df* = 5, CFI = 0.93, TLI = 0.90, RMSEA = 0.09) models of VoA across four measurement occasions were examined, and the linear model yielded better model fit, $\Delta\chi^2$ = 159.87, Δdf = 6, $p < .001$, ΔCFI = 0.44. A 4-class model was the best fitting of five GMMs based on model fit indices (Table 3.7), with 2- and 3-class models also showing relatively good model fit. However, the 2-class model was preferred for substantive interpretability. Specifically, the 3- and 4-class models included a class with only 42 participants (8% of the total sample), and the 42 participants were likely a subset of the second class of the 2-class model (*n* = 96). Thus, the 2-class model was chosen for the moderation analysis (Table 3.7).

Participants in the first class (High VoA; *n* = 403; 81%) had an average VoA score of 1.89 out of 2 at baseline and their VoA scores showed trivial but statistically significant declines by .005 units every year. Participants in the second class (Low VoA; *n* = 96, 19%) had an average VoA of 1.43 at baseline, and there was no statistically significant change over time (Table 3.7). Additionally, High VoA and Low VoA groups did not differ in terms of location (Heidelberg or Leipzig), gender, years of education, and conscientiousness, *p*s > .05, but the Low VoA showed significantly higher scores on neuroticism compared to the High VoA group, $t(483) = 7.52$, $p < .001$.

Table 3.7. *Model Fit Indices and Parameter Estimate of Growth Mixture Modeling (GMM) with Views of Aging*

	1-Class	**2-Class**	3-Class	4-Class	5-Class*
saBIC	137.604	**70.295**	2.09	-102.46	
Entropy	1	**0.84**	0.88	0.98	
ALC-Prob.		**0.98**	0.96	0.99	
% sample/class					
1	499 (100%)	**403 (81%)**	337 (68%)	223 (45%)	
2		**96 (19%)**	120 (24%)	120 (24%)	
3			42 (8%)	114 (22%)	
4				42 (8%)	
		353.61	73.39	107.87	4.59
LRM (*p* value)		**(*p* < .011)**	(*p* = .011)	(*p* = .016)	(*p* = .320)
Class 1 Intercept		**1.89**	1.93	1.998	
Slope		**-0.04**	-0.05	-0.07	
Class 2 Intercept		**1.43**	1.59	1.8	
Slope		**ns**	ns	-0.04	
Class 3 Intercept			1.16	1.54	
Slope			0.11	ns	
Class 4 Intercept				1.11	
Slope				0.12	

Note. ns = Not significantly different from 0. *Model did not converge.

The latent classes (High VoA, Low VoA) were added to the bivariate LGCM as moderators of associations between SWB and OBH. The model fits for conditional bivariate LGCMs were satisfactory (Table 3.5). As shown in Table 3.8, the results revealed significant differences between individuals with positive vs. negative VoA regarding the association between slopes of SWB and OBH, Wald $\chi^2(1) = 3.89$, $p = .049$ (covariate-unadjusted model) and Wald $\chi^2(1) = 4.13$, $p = .042$ (covariate-adjusted model). Specifically, individuals who reported more negative VoA were more likely to experience concurrent declines in health and SWB from age 60 to 80 years, whereas changes in health and SWB of individuals with more positive VoA were more likely to follow diverging paths.

Table 3.8.

Estimates for Bivariate Linear LGCM Models by Views of Aging

	Lower VoA $n = 96$				Higher VoA $n = 403$						
	B	*SE*	*β*	*p*	*B*	*SE*	*β*	*p*	Wald χ^2	*df*	*p*
Unadjusted											
$I_{(SWB)} \leftrightarrow I_{(OBH)}$	0.17	0.08	0.31	.037	0.08	0.04	0.22	.049	1.14	1	.286
$S_{(SWB)} \leftrightarrow S_{(OBH)}$	0.03	0.01	0.68	.036	0.00	0.01	-0.04	.952	3.89	1	.049
$I_{(SWB)} \rightarrow S_{(OBH)}$	-0.5	0.03	-0.32	.122	-0.01	0.01	-0.08	.597			
$I_{(OBH)} \rightarrow S_{(SWB)}$	0.003	0.03	0.02	.936	0.00	0.01	0.02	.97			
Covariate-adjusted											
$I_{(SWB)} \leftrightarrow I_{(OBH)}$	0.16	0.08	0.29	.049	0.07	0.04	0.22	.050	0.94	1	.332
$S_{(SWB)} \leftrightarrow S_{(OBH)}$	0.02	0.01	0.70	.037	-0.001	0.01	-0.16	.800	4.13	1	.042
$I_{(SWB)} \rightarrow S_{(OBH)}$	-0.05	0.03	-0.33	.114	-0.002	0.01	-0.03	.860			
$I_{(OBH)} \rightarrow S_{(SWB)}$	0.01	0.03	0.04	.874	0.00	0.01	0.01	.976			

Note. SWB = Subjective well-being; OBH = Physician-rated health; VoA = Views of aging; I = intercept; S = Slope; Covariates = Location (0 = Leipzig 1 = Heidelberg), gender (0 = men; 1 = women), neuroticism, and conscientiousness.

Discussion

To investigate the paradox of well-being, this study applied latent growth curve models to data from a 20-year longitudinal cohort of older adults. Specifically, it estimated age-related changes in subjective well-being (SWB), examined their associations with changes in health (OBH), and investigated the moderating role of views of aging (VoA) on OBH-SWB associations.

Twenty-Year Trajectory of Subjective Well-Being in Late Life

In contrast to earlier findings that reported age-related increases in SWB (e.g., Buecker et al., 2023; Charles et al., 2001; Jivraj et al., 2014), our analysis revealed a decrease in SWB from age 60 to 80. A significant factor that might account for this departure is the difference in how SWB was measured in the present study. Unlike prior studies that typically used self-report measures of life satisfaction and positive/ negative affect, our study utilized the Zung Depression Scale, a clinical tool primarily assesses levels of depressive symptoms. This focus on depressive symptoms may have captured declines in subjective well-being that other measures (e.g., life satisfaction and affect) might have overlooked. Additionally, the differences observed between the raw and various covariate-adjusted models underscore the importance of integrating both sociodemographic and psychological factors in examining the effect of time on SWB trajectories in late life.

Associations of Health with Subjective Well-Being

The subsequent analyses explored how a time-varying factor like health were associated with the SWB trajectory. Health and SWB intercepts (i.e., baseline scores at study inception) were positively correlated. Health and SWB slopes, which were individually significant after adjusting for covariates (i.e., showing evidence of age-related changes), were not significantly correlated. The finding is consistent with outcomes from prior studies that showed that the

relation between health and SWB decreases in strength with advancing age (e.g., Piazza et al., 2007; Schöllgen et al., 2016).

However, the results of the present study contrast with those of Kunzmann et al. (2019), who applied a modified, multi-group dual-change score model to the same ILSE dataset (but to both age cohorts, whereas this study only examined the older cohort). They found that assessment-to-assessment changes in negative affect and in physical illness were not significantly correlated in younger adults, whereas for older adults there was a non-significant correlation during the first (4-year) interval but then significant positive/weak correlations (r = .11 and r = .22, respectively) between negative affect and physical illness during the subsequent two (8-year) intervals.

The results from this study and Kunzmann et al.'s study likely differ insofar as this study tested correlations between changes estimated across the entire study period, which may have had the effect of further 'diluting' the weak but significant correlations in the later assessment intervals observed by Kunzman and colleagues. The models in the present study also partitioned stable individual differences (intercepts) and changes (slopes) in a way their model did not, with a similar (in direction and significance) health-SWB association 'pushed' onto the level-level association rather than the slope-slope association. Overall, the discrepancies in research findings underscore the importance of considering methodological variations when assessing whether and to what extent the well-being paradox holds in the face of health constraints.

The Moderating Role of Views of Aging

Prior studies have established that VoA are directly associated with both long-term health and SWB (e.g., Westerhof et al., 2023). Here, this study further investigated the moderating role of VoA on health-SWB change associations. The current findings align with those of previous

research showing that successful aging (in terms of SWB) can be achieved despite health declines, particularly for those individuals with more positive VoA (e.g., Witzel et al., 2022; Wurm et al., 2008). One potential explanation for this outcome is that individuals with higher VoA are more likely to invest time and energy in relationships that contribute to SWB during a life stage (older adulthood) when others (presumably lower in VoA) are more likely to engage in relationship 'pruning' (i.e., socioemotional selectivity; Carstensen et al., 1999). Further investigation of VoA in relation to motivational factors may provide additional insights into its role in the maintenance of SWB in later life.

From a translational perspective, a growing body of intervention research has shown that adults' VoA are malleable and can be made more positive (e.g., Diehl et al., 2023). While it may not always be feasible to alter an older adults' current health status, our results suggest that promoting stable, positive VoA may assist older adults in maintaining, or even improving, SWB irrespective of differences in health-related changes.

Limitations and Future Directions

This study has several limitations that warrant consideration in future research. With respect to measures, relying solely on negative affect as an indicator of SWB did not fully capture the multidimensional nature of SWB. Similarly, although the ATOA provided valuable insights into the global evaluative component of VoA (Hess, 2006), it may not fully capture nuanced personal beliefs, attitudes, and feelings toward aging (Diehl & Wahl, 2010). This leaves open the question of whether a stronger buffering effect of VoA would emerge with the use of multidimensional measures. Employing established SWB measures, such as the PANAS (Watson et al., 1988), as well as multidimensional measures of VoA encompassing both gain-

and loss-related aspects of VoA (e.g., awareness of age-related changes, Diehl & Wahl, 2010) may enhance the likelihood of uncovering stronger associations.

Regarding the sample, its cultural homogeneity potentially restricts its generalizability to more diverse populations of older adults. Subsequent research should aim to replicate these findings in datasets that are culturally and economically diverse, such as the Health and Retirement Study in the United States, to determine the broader applicability of the current results. Additionally, selection effects attributable to study dropout, common to most longitudinal studies of aging, may have influenced the results. Although sensitivity analyses indicated that dropout-related selection effects were within the small to medium range for this sample (result not shown), the possibility of survivor bias cannot be ruled out entirely.

Conclusion

The present study underscores the significance of aligning analytical approaches and considering personality characteristics when exploring and interpreting the paradox of well-being in late adulthood. The findings provide empirical support for this paradox by revealing a divergence between trajectories of health and SWB from age 60 to 80. Furthermore, the findings offer preliminary evidence suggesting that positive VoA may serve as a psychological asset, buffering against the impact of adverse effects of age-related declines in physical health on SWB. Taken together, this study contributes to the existing body of literature by elucidating the intricate interplay among health, SWB, and VoA in later life, thereby setting the stage for further investigations into the implications of VoA for enhancing SWB in aging populations.

CHAPTER 4

MALLEABILITY OF EXPLICIT AND IMPLICIT VIEWS OF AGING IN MIDDLE-AGED AND OLDER ADULTS: RESULTS FROM A RANDOMIZED CONTROLLED TRIAL[4]

Summary

Negative views of aging (VoA) present barriers to healthy aging. Although prior interventions have demonstrated success in shifting adults' negative VoA through educational programs, the reliance on self-report-based explicit measures is insufficient to examine whether these interventions also affected individuals' implicit VoA. Thus, this study assessed the impacts of the AgingPLUS program on both explicit and implicit VoA among middle-aged and older adults in the context of a randomized controlled trial. Participants aged 45 - 75 years (M_{age} = 60.1 ± 8.3 years) were randomized to either the AgingPLUS program (n = 162) or a health education control group (n = 173). Assessments of VoA included self-report questionnaires and computerized tasks for assessing implicit age-related attitudes. Participants' pre- and post-intervention VoA data spanning from baseline to 32 weeks were analyzed on an intention-to-treat basis using linear mixed effects regression analysis. Findings indicated that the AgingPLUS group reported significant improvements in explicit VoA, specifically, more positive age stereotypes, higher expectations regarding aging, lower essentialist beliefs of aging, and lower awareness of age-related losses over time. In contrast, the results provided limited evidence on either the temporal shifts or group differences regarding participants' implicit VoA measures.

[4] Tseng, H.-Y., Chasteen, A. L., & Diehl, M. (2024). *Examining the malleability of explicit and implicit views of aging in middle-aged and older adults: Results from a randomized controlled trial.* Manuscript submitted for publication, Department of Human Development and Family Studies, Colorado State University.

Explicit intervention approaches, such as the AgingPLUS program, may result in considerable changes in adults' explicit VoA; however, they may not automatically and simultaneously result in shifts in implicit VoA. Tailoring intervention designs according to specific outcome variables (i.e., explicit vs. implicit VoA) is essential to ensure robust and enduring program effects on promoting adults' VoA.

Introduction

Interventions addressing counterfactual age stereotypes and adults' negative views of aging (VoA) are emerging as an approach to promote more positive VoA and, in turn, more health-promoting behaviors (Beyer et al., 2019; Brothers & Diehl, 2017; Levy et al., 2014; Sarkisian et al., 2007; Wolff et al., 2014). Although the field of VoA and their implications for promoting more positive health behaviors show considerable growth, several issues remain relatively unexplored. One question that has not been addressed very widely is whether an intervention to improve adults' negative VoA needs to address both explicit and implicit VoA to yield lasting effects. To this end, this study compared and contrasted the effects of an explicit intervention (i.e., providing clear, direct, and structured information regarding the topic of negative VoA) on the self-report based explicit and computer administered implicit VoA among middle-aged and older adults.

Views of Aging

Views of aging (VoA) refer to how individuals think and feel about growing older and how they perceive older adults as a social group (Diehl et al., 2021). Adults' VoA contain positive and negative aspects, but negative ones predominate among young, middle-aged, and older adults (Hummert et al., 1997). Adults' VoA consist of at least two major dimensions (Shrira et al., 2022). The first dimension, termed *generalized* VoA, refers to top-down, culturally,

and socially shared beliefs about the process of aging. The second dimension, termed *personal* VoA, are bottom-up, person-centered and idiosyncratic aging attitudes shaped by individuals' personal expectations and awareness of their own aging experience (Shrira et al., 2022). Generalized and personal VoA are assumed to be moderately correlated, reflecting that both are products of dynamic co-development of individual, interpersonal, societal, and cultural influences across the lifespan.

Another important distinction in the VoA literature is that between explicit and implicit VoA (Hess, 2006). Conceptually, *explicit* VoA are consciously verbalized and are often assessed using self-report questionnaires (Levy, 2009). The explicit attitudes, beliefs, or feelings of aging and older adults are characterized as controlled, analytical, deliberate, and reflective. In contrast, implicit VoA operate without conscious awareness, shaping individuals' automatic associations or reactions related to aging topics (Bargh, 1999). Implicit VoA are typically inferred from individuals' performance on response latency measures, such as the Implicit Association Test (IAT; Greenwald et al., 1998) or sequential priming tasks, such as Lexical Decision-Making Tasks (LDMT; Wittenbrink et al., 1997).

Empirically, explicit VoA and implicit VoA have shown the lowest correlation ($r = .13$, $p < .05$) out of 17 social attitudes (Nosek & Hansen, 2008). On socially sensitive topics, such as racial or sex-based discrimination, individuals' implicit attitudes may deviate more from their explicit attitudes than less controversial topics (Kawakami et al., 1998). Some researchers, for example, have argued that self-reported, explicit attitudes are prone to response biases because individuals are unlikely to admit that they may hold racist, sexist, or ageist attitudes (Fazio et al., 1995; Greenwald & Lai, 2020). Whether individuals' VoA are subject to social desirability is debatable and remains an unresolved issue (Richeson & Shelton, 2006). Nevertheless, given that

(a) explicit and implicit VoA are related but distinct mental constructs and (b) implicit measures should be less prone to social desirability effects, implicit VoA should be a valuable addition to explicit VoA when assessing the effect of a structured intervention that targets adults' negative VoA.

Health Effects of Explicit and Implicit Views of Aging

It is well documented that adults' explicit negative VoA are associated with a range of health-related outcomes, including lower self-rated health, physical functioning, cognitive performance, life satisfaction, and a shorter life expectancy, as comprehensively reviewed in two meta-analyses by Westerhof and colleagues (Westerhof et al., 2014, 2023). Implicit VoA have also been found to support or constrain older adults' behaviors, decisions, and performance, as shown in short experimental sessions (Diehl et al., 2022; Meisner, 2012), which, subsequently, are assumed to influence health and well-being in the long run (Levy, 2009). These studies are part of the growing body of empirical evidence demonstrating the prevalence and robust links of VoA with health outcomes across the adult lifespan. Considering the profound associations of VoA with health outcomes, there is also a burgeoning interest in developing interventions targeting negative VoA as a motivational and attitudinal barrier to optimal aging. For example, several investigators (e.g., Beyer et al. 2019, Brothers & Diehl, 2017; Wolff et al., 2014) have started to examine whether explicitly addressing middle-aged and older adults' VoA may result in greater improvements in lifestyle behavior interventions (e.g., engagement in physical activity).

Malleability of Implicit Views of Aging

Prior effective interventions targeting adults' negative VoA to improve health-related outcomes have been mostly evaluated with explicit VoA (Diehl et al., 2022). Explicit VoA have

been targeted because they can be more directly confronted and potentially reshaped through clear messages, persuasive information, and conscious reflections (Diehl et al., 2022). In contrast, implicit VoA seem to be less straightforward to influence or modify. Historically, individuals' implicit attitudes have been considered too habitual and deeply entrenched, viewing individuals as having no control over them once activated (Bargh, 1999; Macrae et al., 1994). The dominant view of stability and non-mutability was then challenged by a growing number of empirical studies reporting changes in implicit attitudes (Gawronski & Bodenhausen, 2006). For example, according to the initial model of implicit social information processing, Blair (2002) argued that implicit attitudes could be influenced by individual or social level factors, such as attention, motives, strategies, attention, as well as the configurations of the cues eliciting implicit attitudes. The authors argued that, instead of being immutable, implicit attitudes could change rather quickly following experimental manipulations (Gawronski & Sritharan, 2010).

To date, five studies have published results regarding the malleability of adults' implicit VoA as a study outcome of interest (Busso et al., 2019; Dasgupta & Greenwald, 2001; Joy-Gaba & Nosek, 2010; Karpinski & Hilton, 2001; Turner & Crisp, 2010). These studies used strategies, such as repeatedly exposing the participants to positive, admired exemplars of older adults and negative exemplars of young adults, to form or strengthen the associations of old with positive characteristics and young with negative characteristics (Dasgupta & Greenwald, 2001; Joy-Gaba & Nosek, 2010). Some studies asked the participants to either deliberately imagine positive interactions with older adult members of society and the lessons they could learn from their wisdom (Turner & Crisp, 2010), or subliminally exposed participants to positive words paired with elderly and negative words paired with youth in a computerized program (Karpinski & Hilton, 2001). One study used positively framed messages such as age-related wisdom and the

societal contributions made by the older groups (Busso et al., 2019). The efficacy of the manipulation was usually determined by pre- and post-intervention differences in the Implicit Association Test.

Despite documented positive results regarding the malleability of implicit VoA, the existing literature presents a mixed picture of findings. Whereas some studies reported noteworthy improvement in implicit VoA with an effect size of up to 0.80 standard deviation (Cohen's *d*; a large effect according to Cohen, 1988) following a targeted intervention (Dasgupta & Greenwald, 2001); others found only a marginal effect of $d = 0.08$ (Joy-Gaba & Nosek, 2010). This difference in the effect sizes could be due to various experimental procedures. For example, utilizing highly admired and more well-known exemplars as conditioned stimuli could have provided stronger effects on shifting individuals' implicit social attitudes (Joy-Gaba & Nosek, 2010). Furthermore, the majority of the findings were based on data from college student samples. Thus, less is known as to whether and to what extent these experimental manipulations could also be effective with middle-aged and older adults. Additionally, despite positive results in short-term experimental manipulations, the durability of such effects is currently mostly unknown. In fact, most documented effective strategies leading to short-term implicit attitude change tended to not persist beyond a few hours after the experiment (Lai et al., 2016).

In summary, available evidence suggests that new implicit associations can be formed in just one experimental session. However, the effects seem rather volatile and quickly disappear if no further efforts are deployed. The wide range of effect sizes and inconsistent findings with short-term and follow-up data may partially explain the scarcity of empirical studies on the malleability of implicit social attitudes. This fact may account for the void in research on the

downstream effects of implicit attitudes on behavioral changes, the main targets of intervention programs (Lai et al., 2013).

The Need to Examine Implicit VoA in an Intervention Study

Despite a couple of gaps and conflicted findings in the literature, at least three more reasons make implicit VoA worth exploring in the context of an intervention study. First, negative VoA, when induced implicitly, have *direct* and significant influences on adults' performances in several behavioral domains, including walking speed (Hausdorff et al., 1999), posture and balance (Levy & Leifheit-Limson, 2009), and memory performance (Levy, 1996), the main outcomes of interest of an intervention. However, evidence has been mostly derived from short-term pre- and post-data situated in a brief experimental session. Second, positive VoA, when induced implicitly, have been shown to have *indirect* and positive influences on adults' health outcomes through changes in adults' explicit VoA. For example, in a randomized controlled trial, Levy and colleagues (2014) found that an implicit-positive age stereotype intervention significantly improved adults' self-report age stereotypes and self-perceptions of aging, which, in turn, accounted for significant improvements in adults' physical functioning over time. Third, as shown in a meta-analysis, implicit and explicit measures of social attitudes independently accounted for a significant amount of variance in criterion behaviors (Greenwald et al., 2009). One caveat, however, was that the greater predictive validity of behaviors is expected when explicit and implicit social attitudes were at least moderately correlated, which seems less likely in the case of explicit and implicit VoA (Nosek & Hansen, 2008).

In summary, the findings regarding the direct, indirect, and conditional effects of implicit measures on health-related outcomes indicated that they are useful and valuable additions to explicit measures in the context of intervention studies, especially when the interventions aim to

explore the potential mechanisms of change in adults' VoA for other behavioral outcomes of interest (e.g., engagement in healthy lifestyle behaviors).

The Present Study

Given this overall background, the present study had two objectives. The first one was to examine whether the AgingPLUS program was successful in modifying adults' implicit VoA over the course of a 10-month study period in a randomized controlled trial (RCT). By contrasting changes in implicit VoA with changes in explicit VoA and comparing these changes to the participants in the control group, the study tested the following hypotheses: (1) Participants in the AgingPLUS group would show significant improvements in their explicit VoA from pretest to posttest and compared to the control group. (2) In terms of their implicit VoA, participants in the AgingPLUS group would show significant changes from pretest to posttest and compared to the control group.

The second objective was to explore whether and to what extent changes in explicit VoA were influenced by participants' implicit VoA. Despite limited evidence, theoretical and empirical research suggested that when the participants were subliminally primed with positive VoA cues over an extended period of time, significant changes in both generalized and personal VoA would follow (Levy et al., 2014). Therefore, it was hypothesized that changes in explicit VoA would not only be a function of the intervention but also participants' varying implicit VoA levels. Although this objective was exploratory in nature, investigating the role of implicit VoA in changes in explicit VoA could be essential to provide conceptual and practical insights into whether interventions should address both explicit and implicit VoA, either through assessment or modification, to achieve robust program effects.

Methods

Design and Procedure

The data were derived from the baseline and follow-up assessments of a randomized controlled trial (RCT), the AgingPLUS Study (Diehl et al., 2020). This study targeted adults' negative VoA to promote greater involvement in physical activity. The study sample consisted of community-dwelling adults aged 45 to 75 living in northern Colorado. Upon meeting the eligibility criteria of (1) age (45 – 75 years), (2) English speaking, (3) living a sedentary lifestyle (not exceeding 30 minutes of moderate-intensity physical activity for three days per week), and (4) physician clearance to participate in the psychological and physical assessment components, the enrolled participants were randomly assigned to the AgingPLUS or the active control group. The curriculum in the control group was a generic health education program, whereas the curriculum of the AgingPLUS focused on adults' negative age stereotypes and associated health risks, along with other psychological mechanisms promoting behavioral change, including self-efficacy and goal planning (Diehl et al., 2020).

Participants in both groups were invited to an in-person assessment where they filled out a set of questionnaires regarding generalized and personal VoA. In the same session, they also worked on two computer-administered psychological tasks to assess their implicit VoA: The aging-related Implicit Association Test (IAT) and a Lexical Decision-Making Task (LDMT). One month (week 8; delayed posttest) and six months (week 32, long-term posttest) after the end of the intervention, the participants were invited to the lab to complete follow-up assessments with the same measures of VoA questionnaires and the same implicit VoA tasks as at baseline. In summary, there were three occasions of explicit and implicit VoA data (i.e., week 0, 8, and 32) available over the course of the 10-month intervention study.

Participants

335 participants residing in the Front Range area of Colorado, United States, were recruited for the RCT conducted between 2018 and 2022. Power analysis indicated that for the study design involving (a) two between-individual groups at Level 2 and (b) three repeated measurement occasions at Level 1, a sample size of approximately 300 would be adequate to detect small to medium effect sizes with the power set at 0.80 and at a significance level of $\alpha = .05$.

The mean age of the sample was 60.15 years (*SD* = 8.24 years). 83.5% of the participants were women; 57.5% had bachelor's degrees and higher; 84.8% were White; 55.3% were married; 34.7% had household annual income equal to or higher than $100,000; 43.2% were full-time workers, and 31.7% were retired. Thus, the sample was relatively healthy, well-educated, and racially and ethnically homogenous. Independent samples *t*-test showed that the two groups of the AgingPLUS and the health education control group did not differ in terms of age and gender, among other sociodemographic characteristics, *p*s > .05 (Diehl et al., 2020).

Measures

Explicit Views of Aging

Generalized Views of Aging. The study employed three measures to assess generalized VoA: the Age Stereotypes Scale (AS; Kornadt & Rothermund, 2011), the Expectations Regarding Aging (ERA; Sarkisian et al., 2002) questionnaire, and the Essentialist Beliefs about Aging Scale (EBAS; Weiss & Diehl, 2021). Overall, these three measures allowed for a comprehensive evaluation of participants' generalized VoA.

AS consists of 27 items and assesses participants' age stereotypes across eight domains (e.g., family and partnership, friends and acquaintances, religion and spirituality, leisure

activities and social engagement, personality and ways of living, financial situation, work and employment, and physical and mental fitness and health). Each item consisted of two opposite statements of an aging stereotype for evaluation (e.g., "old persons have few friends vs. old persons have many friends"). Participants' responses were recorded on an 8-point scale, with a higher score indicating more positive age stereotypes. The reliability coefficients (Cronbach α's) ranged from α = .89 to .91 across the three measurement occasions.

ERA comprises 12 items that assess participants' expectations regarding positive and negative age-related changes. Responses were recorded on a 4-point scale (1 = *Definitely true*; 4 = *Definitely false*), with higher scores reflecting more positive expectations regarding aging. The reliability coefficients ranged from α = .86 to .88.

EBAS uses four items to assess adults' beliefs about the fixed or malleable nature of aging, with responses solicited on a 6-point scale (1 = *Do not agree*; 6 = *Absolutely agree*). A total score was calculated after reverse scoring, with higher scores indicating individuals' beliefs that aging is, to some extent, under their control rather than completely biologically determined. The reliability coefficients ranged from α = .62 to .74. Although the reliability coefficient of the week 32 data was in the lower range of acceptance, prior research has shown that EBAS is reliable and valid in assessing adults' general beliefs about old age and aging (Weiss & Diehl, 2021).

Personal Views of Aging. Participants' personal VoA were assessed using the 10-item Awareness of Age-Related Change (AARC) questionnaire (Kaspar et al., 2019). Respondents were asked to rate their perceptions of their age-related changes on a 5-point scale (1 = *Not at all*; 5 = *Very much*) in each of the following five life domains: (1) health and physical functioning, (2) cognitive functioning, (3) interpersonal relations, (4) social-cognitive and social-

emotional functioning, and (5) lifestyle and engagement. One of the two items in each domain assesses a positive age-related change experience (AARC-gains), whereas the other one assesses a negative age-related change experience (AARC-losses). The reliability coefficients across the three assessments ranged from α = .64 to .69 for AARC-gains and α = .75 to .79 for AARC-losses.

Implicit Views of Aging

Brief Implicit Association Test (IAT). The computer-administered Implicit Association Task (IAT; Greenwald et al., 1998) was used to assess participants' implicit views of aging. This study used the brief version of the original IAT (Nosek et al., 2014). An age-focused IAT requires participants to quickly sort two target concepts (i.e., old or young) and two attributes (i.e., good or bad) with two keys on the keyboard. Half of the task trials ask participants to press the "*I*" key when seeing either an old face and a good word and press the "*E*" key when seeing a young face and a bad word. The other half of the trials asks participants to press the "*I*" key when seeing a young face and a good word and to press the "*E*" key when seeing an old face and a bad word. When participants make an error in their responses, the program will automatically add 300 milliseconds (ms) in latency as a penalty, and the participants must correct the error to proceed. The error rate at baseline was 4.43%, comparable to the one obtained in another study with a sample of older adults (Hummert et al., 2002).

A pre-programmed algorithm is applied to calculate an IAT *d* score. The *d* score is based on the differences between (a) the reaction times (RTs) when "young and good" or "old and bad" are presented as pairs sharing the same response key, and (b) RTs when "old and good" or "young and bad" are presented as pairs sharing the same response key. A *d* score can range from -2 to 2. In our study, a positive *d* score suggests a preference for the social concept of "young,"

whereas a negative *d* score indicates a preference for the social concept of "old." An absolute *d* value equal to or above 0.65 suggests that a participant holds a strong preference, whereas an absolute *d* value below .15 represents no preference in either young or old. Implicit association tests have typically yielded good internal consistency (Nosek et al., 2007), have not been influenced by familiarity with the IAT stimuli (Dasgupta & Greenwald, 2001), and are relatively robust to procedure variations (Greenwald et al., 1998).

Lexical Decision-Making Task (LDMT). The word stimuli in the LDMT included five types of traits (old positive, old negative, young positive, young negative, and nonwords), which were paired with three primes (young, XXXX, and old). The trial sequence was based on a procedure used in prior research (Kawakami et al., 1998). On each trial, a fixation point (+) appeared in the center of the computer screen for 300 ms and was followed by a blank screen for 500 ms; the prime then appeared for 250 ms, followed by a blank screen for 50 ms before the onset of the stimuli word or nonword. Key-press responses were counterbalanced across participants: half of the participants were instructed to press the "*Z*" key if the stimulus was a word and to press the "/" key if the stimulus was a nonword. The other half were instructed to do the opposite. Participants completed a total of 186 trials, which were divided into one block of 10 practice trials, four blocks of 33 real-word trials each, and one block of 44 nonword trials. The words and nonwords were randomly presented. Participants were told to decide whether the stimulus word was a real word or a nonsense word.

Each participant's RTs from the LDMT were checked for errors and outliers. Outliers were defined as a latency that was 2.5 standard deviations (SD) above and below the mean. Incorrect responses (i.e., misclassifying a nonword as a real word and vice versa) were excluded from the analyses. Outliers were replaced by the value of mean ± 2.5*SD. The baseline mean

error and outlier rates were 3.4% and 2.12%, respectively, which was comparable to another study that had used the same LDMT (Chasteen et al., 2002). All analyses regarding LDMT were conducted on the log-transformed latencies, although the untransformed means are presented in the text, Tables, and Figures to facilitate interpretability.

Statistical Analyses

Tests of baseline differences in explicit and implicit VoA between the AgingPLUS and the control group were examined using independent samples *t*-tests for the continuously distributed variables. According to the intent-to-treat (ITT) principle, the models made use of all available data and retained all randomized participants (n = 335). Figure 4.1 displays the flow of participants throughout the study.

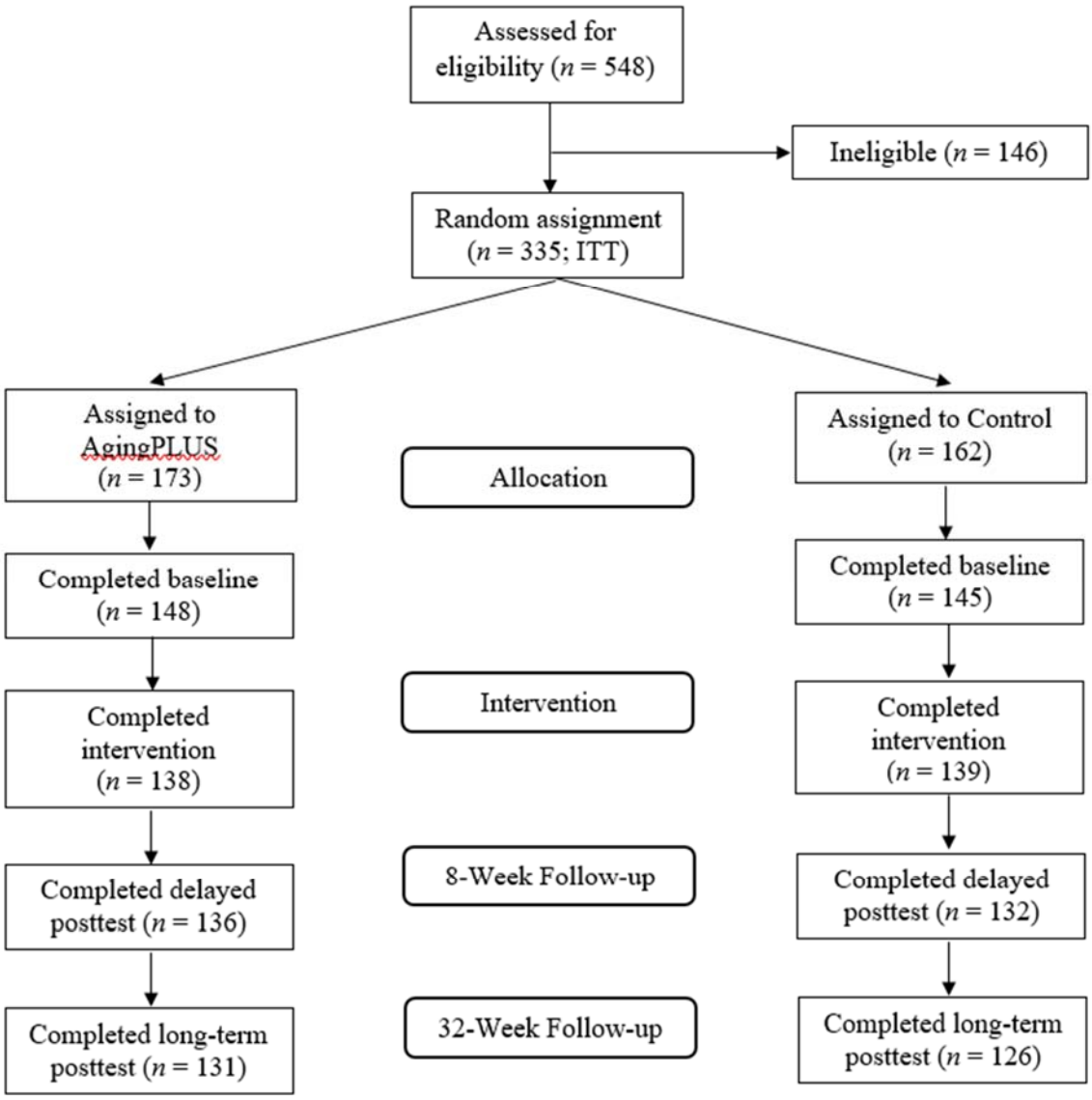


Figure 4.1. *Flow of Participants through Each Stage of the Trial*

Attrition analyses showed that there was no significant difference in the dropout rate between the AgingPLUS (14%) and health education control group (10.5%), $\chi 2$ (1) = 2.13, p = .145. No significant differences were observed in the baseline explicit and implicit VoA between individuals completing and dropping out from the AgingPLUS and those in the control condition, Fs < 3.44, ps > .065. With regard to missing data, the overall response rates were 99% and 95% at the delayed posttest (Week 8) and 96% and 93% at the long-term posttest (Week 32)

for AgingPLUS and the health education control group, respectively. The analyses showed that the baseline characteristics were mostly not related to data missingness, with the exception of AARC-losses at long-term posttest. That is, the participants who completed long-term posttests had reported lower AARC-losses at baseline compared to those who withdrew at any time points before the end of the study, $t(90.99) = 2.08$, $p = .04$.

Given these results, and the small amount of missing data, this study relied on statistical assumptions of missing at random (MAR), with some cautions for AARC-losses. Continuous outcomes were then analyzed with linear mixed effects models, fitted with full information maximum likelihood estimation (Verbeke & Molenberghs, 2000). The maximum likelihood approach, which models all available observations without imputation, provides unbiased estimates under the assumption that data are missing at random (Little & Rubin, 2002).

Linear mixed effect models of explicit and implicit VoA were specified to model change across the three assessment points (baseline, delayed posttest, and long-term posttest) over the study course of 10 months. The regression-based mixed effect approach was chosen due to its capability to accommodate the nonindependence of observations in repeated measures data and its flexibility in parameterizing time. Furthermore, it accounts of between-individual differences by incorporating fixed effects such as group randomization and implicit VoA, while also considering person-specific growth parameters, or random effects, which may vary among individuals.

Different models were fitted to decide on the number of random effects needed to capture change across measurement points. The best model was determined analytically by the likelihood ratio test for nested models. Random effects of the intercepts, slopes, or their covariance were retained when significant. For comparison of the AgingPLUS and the health

education control group regarding their explicit and implicit VoA (Objective #1), the fixed effects included were Time clocked in weeks (0, 8, and 32), Condition (0 = active health education control group; 1 = AgingPLUS group), and Time × Condition interactions. For an individual *i* at a given week of *j* since baseline, their changes in VoA can be modeled as follows.

$$\text{Level 1: VoA} = \beta_{0i} + \beta_{1i}(Time_{ij}) + \varepsilon_{ij}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01}(Condition) + \sigma_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(Condition) + \sigma_{1i}$$

For examination of the role implicit VoA played in changes in explicit VoA (Objective #2), an additional fixed effect of Implicit VoA was added to the Level 2 equations to predict changes in explicit VoA:

$$\text{Level 1: Explicit VoA} = \beta_{0i} + \beta_{1i}(Time_{ij}) + \varepsilon_{ij}$$

$$\text{Level 2: } \beta_{0i} = \gamma_{00} + \gamma_{01}(Condition) + \gamma_{02}(Implicit\ VoA) + \sigma_{0i}$$

$$\beta_{1i} = \gamma_{10} + \gamma_{11}(Condition) + \gamma_{12}(Implicit\ VoA) + \sigma_{1i}$$

The primary interests were to test whether (1) the linear interaction of Time × Condition (representing the average difference in temporal linear change of the outcome variables between the AgingPLUS and control group) and (2) the linear interaction of Time × Implicit VoA (representing the average difference in temporal linear change of the explicit VoA between individuals of varying levels of implicit VoA) were significantly different from zero.

Results

Baseline Characteristics

In addition to demographic characteristics, Table 4.1 also presents the baseline characteristics of interest. Overall, the AgingPLUS and the health education control group did not differ significantly on most explicit VoA measures at baseline, with the exception of AARC-

gains, $t(319) = -2.23$, $p = .026$. The two groups did not differ in their implicit VoA measures of IAT, $t(270) = -1.16$, $p = .246$, and LDMT, $F(1, 272) = 0.163$, $p = .687$.

Table 4.1.

Descriptive Statistics for the Demographic Characteristics and Explicit and Implicit Measures of Views of Aging by Intervention Group

Baseline characteristics	All	AgingPLUS	Control	*p*
n	335	173	162	
Age	60.1 (8.30)	60.0 (8.40)	60.1 (8.20)	.92
Women, n (%)	280 (84.0)	142 (82.1)	138 (85.2)	.44
White, n (%)	284 (85.1)	141 (81.5)	143 (88.2)	.36
Explicit VoA				
Generalized VoA				
AS, mean (SD); [range = 1-8]	5.25 (0.82)	5.3 (0.90)	5.2 (0.80)	.05
ERA, sum (SD); [0 -100]	54.82 (15.70)	55.1 (15.0)	54.4 (16.50)	.67
EBAS, sum (SD); [0 - 24]	17.21 (3.87)	17.3 (3.80)	17.1 (4.20)	.69
Personal VoA				
AARC-G, mean (SD); [1- 5]	3.85 (0.64)	3.95 (0.65)	3.75 (0.61)	.04
AARC-L, mean (SD); [1- 5]	2.19 (0.64)	2.17 (0.69)	2.21 (0.58)	.89
Implicit VoA				
IAT, *d*	0.40 (0.41)	0.43 (0.41)	0.37 (0.41)	.25
LDMT-OP, mean in ms (SD)	839.85 (249.12)	846.26 (247.27)	833.53 (251.67)	.67
LDMT-ON, mean in ms (SD)	857.06 (263.18)	868.93 (263.78)	845.37 (263.02)	.40
LDMT-YP, mean in ms (SD)	834.36 (250.43)	834.19 (235.62)	834.54 (265.09)	.99
LDMT-YN, mean in ms (SD)	884.46 (292.01)	879.52 (263.48)	889.33 (318.53)	.78

Note. AS = Age stereotypes; ERA = Expectations regarding aging; EBAS = Essentialist beliefs of aging; AARC-G = Awareness of age-related gains; AARC-L = Awareness of age-related losses; IAT = Brief Implicit Association Test; LDMT-OP = Lexical decision-making task old positive word condition; LDMT-ON = Lexical decision-making task old negative word condition; LDMT-YP: Lexical decision-making task young positive word condition; LDMT-YN = Lexical decision-making task young negative word condition; ms = millisecond.

On average, the participants, regardless of their group assignments, showed a moderate implicit preference for the young, according to cut-off points for the IAT *d* score (Greenwald et

al., 1998). They also responded faster to stereotypically old words relative to stereotypically young words, $F(1, 272) = 4.34$, $p = .038$, and faster to positive words relative to negative words of the LDMT, $F(1, 272) = 46.25$, $p < .001$. A significant Stereotypicality (young vs. old) × Valence (positive vs. negative) interaction, $F(1, 262) = 10.21$, $p = .002$, necessitating analyses of the LDMT word conditions in the following 2 × 2 forms: old and positive (OP), old and negative (ON), young and positive (YP), and young and negative (YN) words. In sum, the descriptive result of the IAT indicated an implicit preference for the young relative to the old. The descriptive results of the four word conditions in LDMT also suggested that the association between "young" and "negative" was not as strong relative to other combinations of age-based category and valence evaluation (e.g., old and positive) in participants' minds.

Table 4.2 presents bivariate correlations within and between the explicit VoA measures and implicit VoA tasks. Overall, the associations among the explicit VoA measures were in the expected directions. Correlations ranged from no to moderate associations (Cohen, 1988). Cross-domain associations of generalized and personal explicit VoA showed that generalized VoA had small, positive associations with gain-related personal VoA (i.e., AARC-gains; *r*s ranging from .20 to .27, $p < .001$), and moderate, negative associations with loss-related personal VoA (i.e., AARC-losses, *r*s ranging from -.33 to .42, $p < .001$). AARC-gains and AARC-losses, as expected, showed no significant association with each other ($r = -.07$, $p = .206$). Despite the significant correlations among the explicit generalized and personal VoA, their magnitudes underscored the need to analyze the program effects on these explicit VoA measures separately. Cross-domain correlations also showed that there was no statistically significant association between explicit VoA and implicit VoA (*p*s > .05) in the current sample.

Table 4.2.

Correlations among Explicit and Implicit Views of Aging at Baseline (N = 335)

Variable	AS	ERA	EBAS	AARC-G	AARC-L	IAT	OP	ON	YP	YN
AS	--									
ERA	.44**	--								
EBAS	.37**	.51**	--							
AARC-G	.21**	.20**	.27**	--						
AARC-L	-.33**	-.42**	-.34**	-.07	--					
IAT	-.05	.01	.08	.03	-.003	--				
LDMT-OP	-.02	.06	.06	.06	.06	.02	--			
LDMT-ON	.04	.08	.08	.08	-.005	-.01	.89**	--		
LDMT-YP	.03	.07	.10	.12	.03	-.02	.92**	.89**	--	
LDMT-YN	.01	.08	.08	.09	.03	-.04	.91**	.90**	.91**	--

Note. AS = Age stereotypes; ERA = Expectations regarding aging; EBAS = Essentialist beliefs of aging; AARC-G = Awareness of age-related gains; AARC-L = Awareness of age-related losses; IAT = Brief Implicit Association Test; LDMT-OP = Lexical decision-making task old positive word condition; LDMT-ON = Lexical decision-making task old negative word condition; LDMT-YP = Lexical decision-making task young positive word condition; LDMT-YN = Lexical decision-making task young negative word condition.

** $p < .01$.

Contrasting Temporal Changes in Explicit and Implicit VoA Between Groups

Explicit Views of Aging

Table 4.3 provides the intraclass correlation (ICC) and the model fit index of -2 log-likelihood (-2LL) ratio based on which the best model(s) was selected for report. The ICC, calculated from the intercept-only model, indicated that 51% to 63% of the total variance in explicit VoA measures remained to be explained by between-person variable(s), warranting mixed effect modeling that considers between-person variable(s) such as Condition. Overall, the model(s) including a Level 2 variable (Condition), namely Model 3, was the best-fitting one compared to unconditional model(s) for all explicit VoA measures, suggesting Condition helped to explain part of the variance observed in the intercepts and slopes (if any) that were

significantly greater than 0. By contrast, the model(s) including a random effect of slopes, namely Model 2, appeared to be over-parameterized, yielding either non-convergence or negligible change in the fit statistic (i.e., Δ-2LL, *p*s > .05). The results suggested that the rates of change in explicit VoA were similar for the participants regardless of where they stood in explicit VoA measures at baseline.

Table 4.3.

Intraclass Correlation (ICC) and Log Likelihood Ratio (-2LL) for Nested Mixed Effect Models

	ICC	Model 1: Fixed Time + Random intercepts	Model 2: Fixed Time + Random intercepts and slopes	Model 3: Model 1 + Condition	Model 4: Model 3 + IAT at Week 0
Df		4	5	6	8
Explicit VoA					
AS	.51	1864.82	1862.02	**1837.94**	**1763.27**
ERA	.60	6942.73	not converged	**6917.68**	**6697.91**
EBAS	.53	4574.68	not converged	**4551.62**	**4402.10**
AARC-G	.54	1347.74	not converged	**1333.92**	**1300.77**
AARC-L	.64	1348.16	not converged	**1335.68**	**1298.06**
Implicit VoA					
IAT: *d*	.30	865.23	860.72	**858.86**	
LDMT-OP	.33	**11012.44**	not converged	11010.79	
LDMT-ON	.71	**11219.48**	not converged	11214.43	
LDMT-YP	.68	**11179.93**	11179.94	11179.67	
LDMT-YN	.73	**11307.70**	11305.94	11304.90	

Note. VoA = Views of aging; AS = Age stereotypes; ERA = Expectations regarding aging; EBAS = Essentialist beliefs of aging; AARC-G = Awareness of age-related gains; AARC-L = Awareness of age-related losses; IAT = Brief Implicit Associate Test; LDMT-OP = Lexical decision-making task old positive word condition; LDMT-ON = Lexical decision-making task old negative word condition; LDMIT-YP = Lexical decision-making task young positive word condition; LDMIT-YN = Lexical decision-making task young negative word condition. Bolded values represent the best-fitting model for each VoA measure.

Table 4.4 provides the observed means and standard deviations (SD) for each explicit VoA measure at each assessment occasion by Condition, along with the results of the linear mixed effect regression analyses based on the best-fitting model. A significant positive effect of Time was found for AS, $b = 0.01$, $SE = 0.002$, $p < .001$, ERA, $b = 0.32$, $SE = 0.04$, $p = .002$, and

a marginal effect for EBAS, $b = 0.05$, $SE = 0.01$, $p = .05$, indicating significant improvements across occasions of measurement in these generalized VoA measures for both groups. The analysis also revealed a significant positive time effect for personal VoA, AARC-gains, $b = 0.01$, $SE = 0.002$, $p < .001$. However, the effect of Time was not significant for AARC-losses, $b = -.01$, $SE = 0.001$, $p = .067$.

A significant Time × Condition effect was found for AS, $b = 0.008$, $SE = 0.003$, $p = .01$, ERA, $b = 0.21$, $SE = 0.06$, $p < .001$, and EBAS, $b = 0.04$, SE = 0.02, $p < .001$ (Figure 4.2, Panels A to C), as well for AARC-losses, $b = -.001$, $SE = 0.002$ $p < .001$ (Figure 4.3, Panel B). Thus, these results suggested that the participants in AgingPLUS exhibited significant improvements in all explicit generalized VoA and the personal VoA regarding age-related losses compared to the participants in the health education control group.

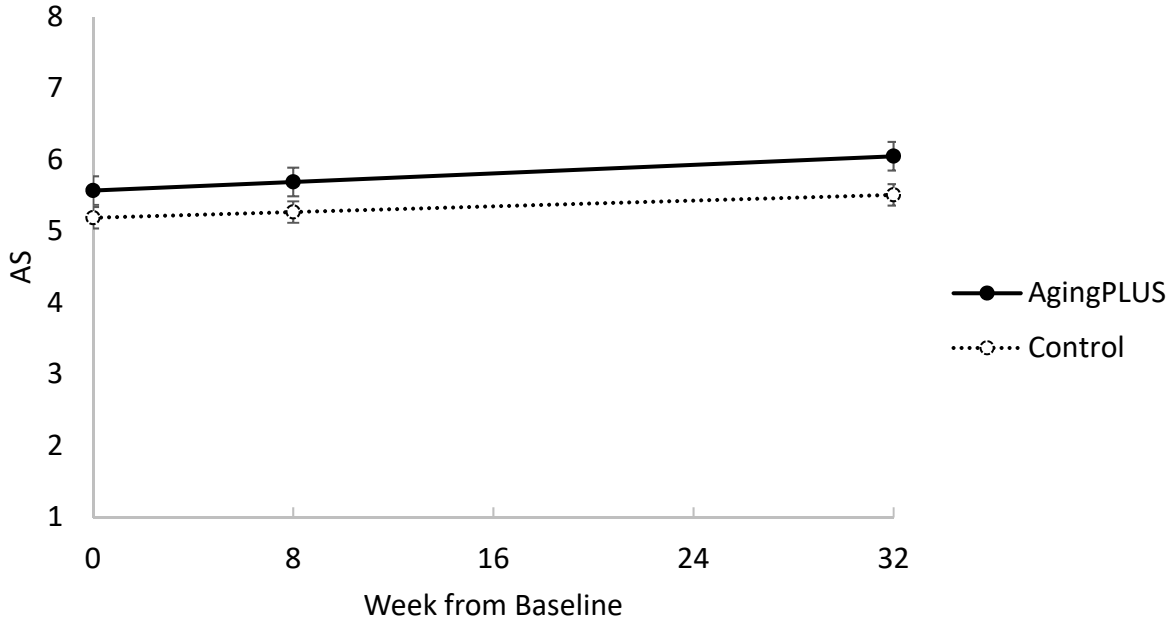
Table 4.4.

Observed Means and SD of the Explicit Views of Aging by Intervention Group Over Time and Results of Linear Mixed-Effects Regression Analyses

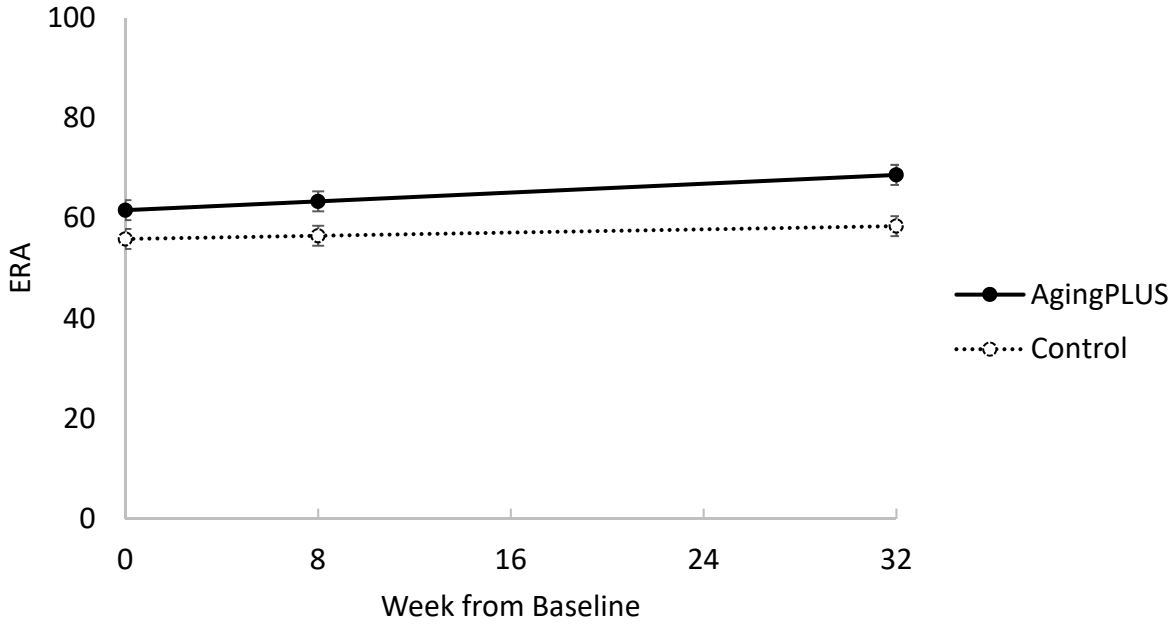
Variable	Week 0	Week 8	Week 32	Predictor	*b*	*SE*	*p*
Generalized VOA							
AS							
Control group	5.15 (0.72)	5.37 (0.78)	5.41 (0.76)	Time (γ_{10})	0.01	0.002	<.001
AgingPLUS	5.35 (0.90)	5.90 (0.81)	5.96 (0.88)	Time × Condition (γ_{11})	0.008	0.003	.01
ERA							
Control group	54.62 (16.13)	56.83 (17.93)	59.19 (16.07)	Time (γ_{10})	0.32	0.04	.002
AgingPLUS	55.02 (15.42)	67.43 (19.43)	67.61 (16.92)	Time × Condition (γ_{11})	0.21	0.06	<.001
EBAS							
Control group	17.25 (4.06)	17.18 (4.79)	17.18 (4.79)	Time (γ_{10})	0.05	0.01	.05
AgingPLUS	17.18 (3.70)	20.27 (3.24)	20.27 (3.24)	Time × Condition (γ_{11})	0.04	0.02	<.001
Personal VOA							
AARC-G							
Control group	3.75 (0.61)	4.01 (0.59)	3.99 (0.60)	Time (γ_{10})	0.01	0.002	<.001
AgingPLUS	3.95 (0.65)	4.30 (0.50)	4.25 (0.56)	Time × Condition (γ_{11})	0.002	0.002	.330
AARC-L							
Control group	2.21 (0.58)	2.10 (0.63)	2.08 (0.57)	Time (γ_{10})	-0.01	0.001	.067
AgingPLUS	2.17 (0.69)	1.92 (0.63)	1.85 (0.58)	Time × Condition (γ_{11})	-0.01	0.002	<.001

Note. AS = Age stereotypes; ERA = Expectations regarding aging; EBAS = Essentialist beliefs of aging; AARC-G = Awareness of age-related gains; AARC-L = Awareness of age-related losses.

Panel A: Age Stereotypes (AS)



Panel B: Expectations Regarding Aging (ERA)



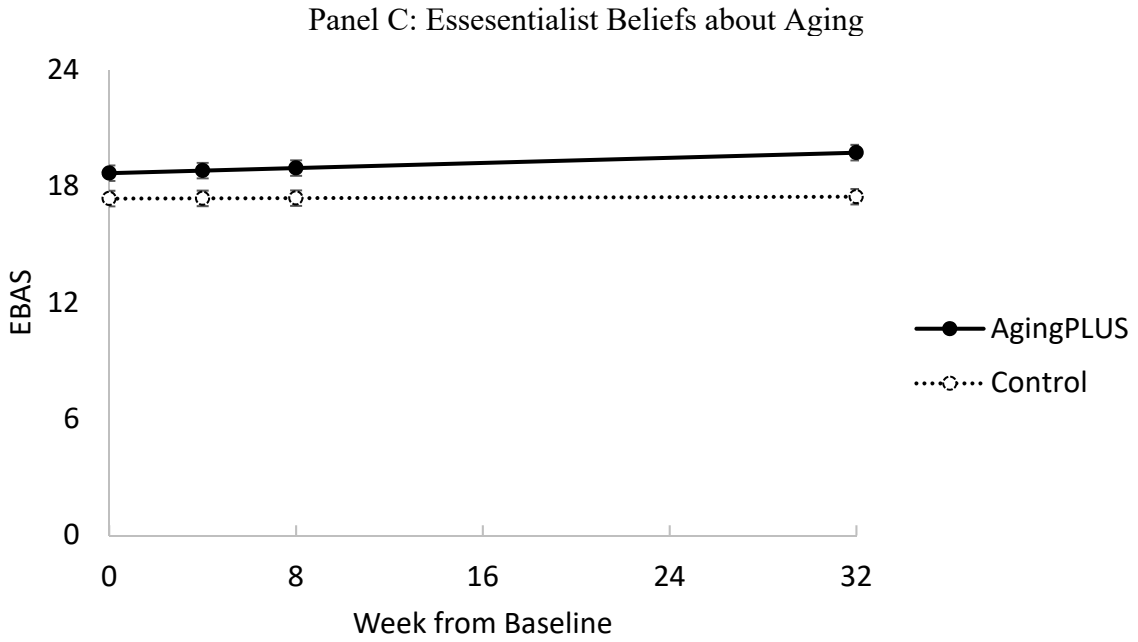


Figure 4.2. *Predicted Means and Standard Error of Explicit Generalized Views of Aging for Each Group over Time after Baseline*

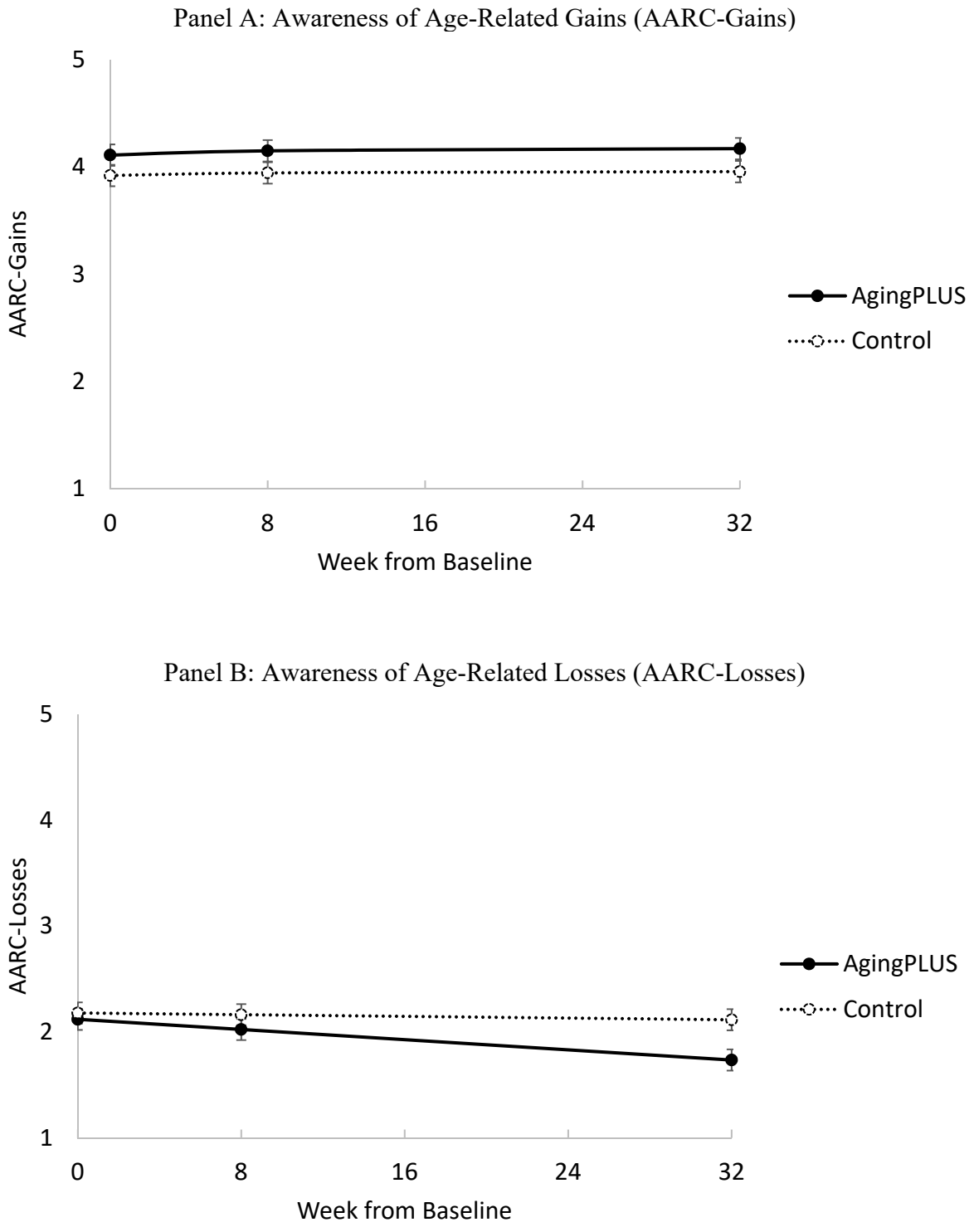


Figure 4.3. *Predicted Means and Standard Error of Explicit Personal Views of Aging for Each Group over Time after Baseline*

Implicit Views of Aging

ICC from the intercept-only model indicated that there was 30% to 73% of the total variance in implicit measures remaining to be explained by between-person variable(s), warranting mixed effect modeling (Table 4.3). Table 4.4 provides the observed means and standard deviations for each implicit VoA measure at each assessment occasion by Condition, along with the results of the linear mixed effect regression analyses.

The linear mixed effect analysis did not show a significant effect of time for IAT, b = -0.002, SE = 0.001, p = .741, even though the participants responded significantly faster to the trials over time, b = -2.60, SE = 0.93, p = .005 (results not shown). The two groups also did not differ in either changes in RTs, b = 1.20, SE = 1.85, p = .516 (results not shown), or their IAT d scores, b = 0.002, SE = 0.002, p = .479 (Table 4.5; Figure 4.4).

Regarding results with the LDMT, there were significant negative effects of time on three out of four RTs assessed with various word conditions, namely old positive words (OP), b = -2.25, SE = 0.50, p = .006, old negative words (ON), b = -2.40, SE = 0.55, p < .001, and young positive words (YP), b = -1.72, SE = 0.52, p = .003 (Table 4.5). In terms of the group differences in changes over time, the analysis revealed a significant Time × Condition effect for old negative words (ON), b = -1.69, SE = 0.79, p = .032, suggesting that, after the intervention, the participants in AgingPLUS responded significantly faster to old negative words than the participants in the health education control group by 1.69 seconds per week (Figure 4.5, Panel B).

Table 4.5.

Observed Implicit Views of Aging by Condition over Time and Results of the Linear Mixed-Effects Regression Analyses

Variable	Week 0	Week 8	Week 32	Predictor	*b*	*SE*	*p*
IAT							
Control group	0.37 (0.41)	0.36 (0.43)	0.36 (0.42)	Time (γ_{10})	-0.002	0.001	.741
AgingPLUS	0.43 (0.41)	0.39 (0.38)	0.34 (0.48)	Time × Condition (γ_{11})	0.002	0.002	.379
LDMT-OP							
Control group	833.53 (251.67)	757.93 (205.40)	801.92 (238.10)	Time (γ_{10})	-2.25	0.50	.006
AgingPLUS	846.25 (247.27)	786.11 (250.25)	769.93 (204.39)	Time × Condition (γ_{11})	-0.93	0.72	.091
LDMT-ON							
Control group	845.37 (263.02)	756.41 (172.61)	769.76 (224.93)	Time (γ_{10})	-2.40	0.55	<.001
AgingPLUS	868.93 (263.78)	785.31 (218.70)	765.64 (246.53)	Time × Condition (γ_{11})	-1.69	0.79	.032
LDMT-YP							
Control group	826.07 (250.43)	814.10 (219.90)	769.76 (224.93)	Time (γ_{10})	-1.72	0.52	.003
AgingPLUS	840.95 (250.03)	826.35 (234.83)	765.64 (246.53)	Time × Condition (γ_{11})	-0.29	0.75	.51
LDMT-YN							
Control group	889.33 (318.53)	797.37 (221.26)	838.44 (330.75)	Time (γ_{10})	-2.24	0.61	.072
AgingPLUS	879.52 (263.48)	826.56 (243.80)	795.48 (220.23)	Time × Condition (γ_{11})	-1.44	0.87	.129

Note. IAT = Brief Implicit Associate Test; LDMT-OP = Lexical decision-making task old positive word condition; LDMT-ON = Lexical decision-making task old negative word condition; LDMT-YP = Lexical decision-making task young positive word condition; LDMT-YN = Lexical decision-making task young negative word condition.

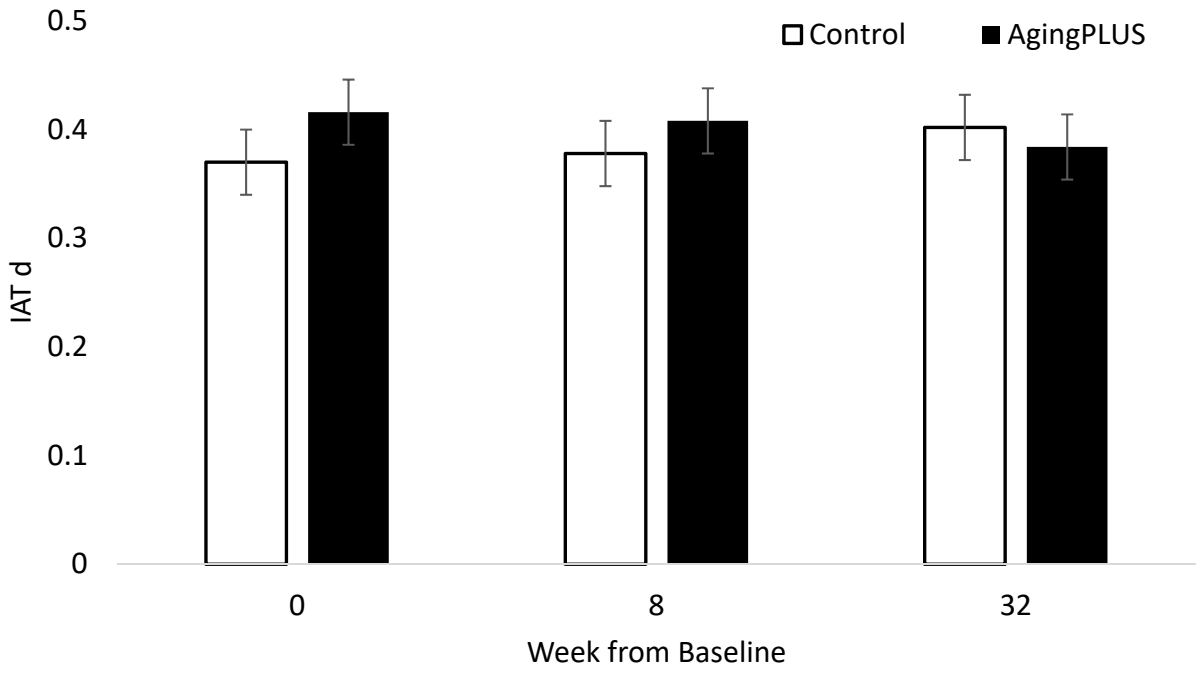
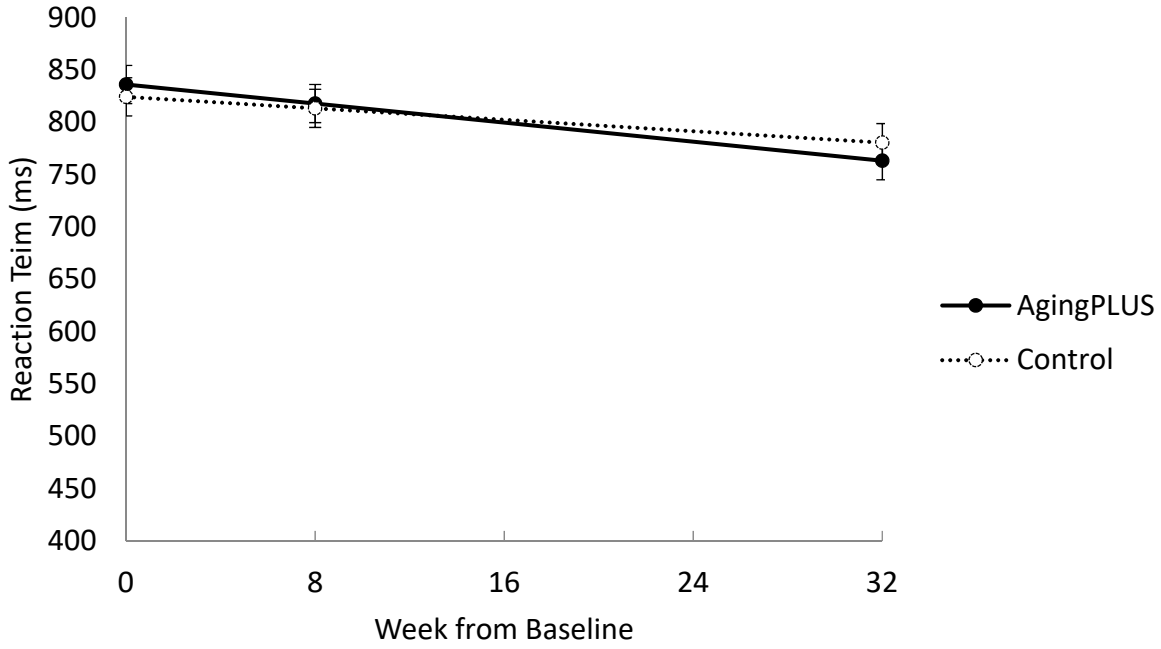
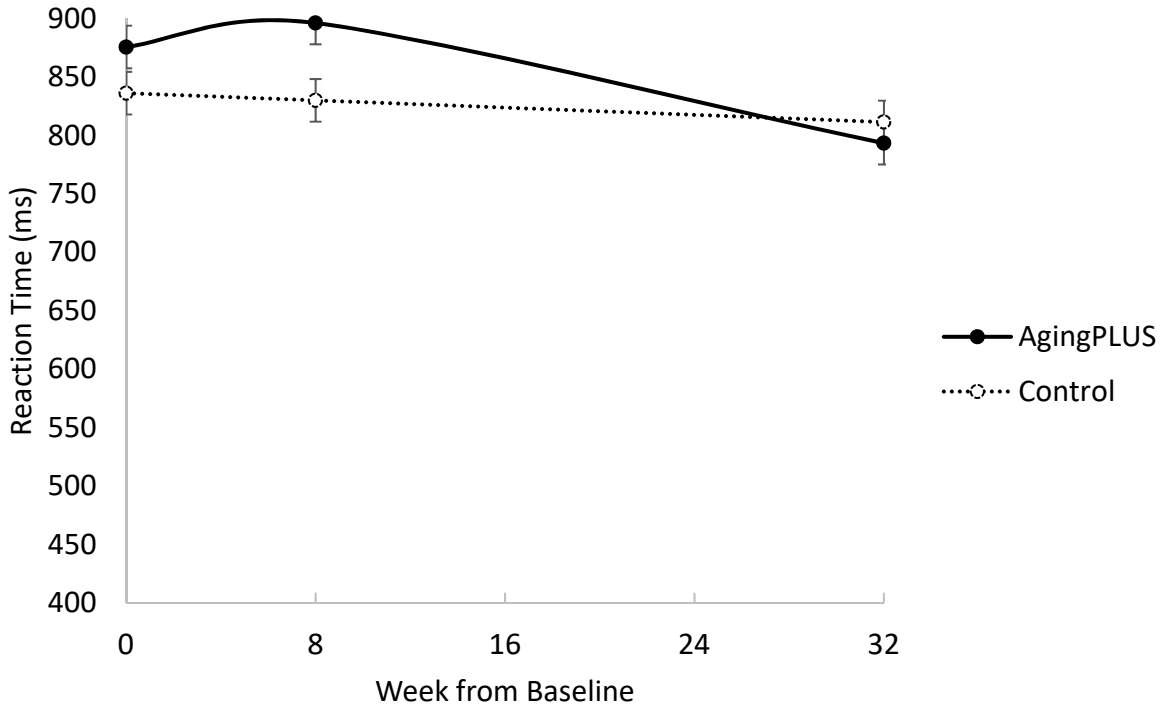


Figure 4.4. *Predicted Means and Standard Error of Implicit Views of Aging for Each Group over Time after Baseline, Implicit Association Test (IAT)*

Panel A: Old Positive Words



Panel B: Old Negative Words



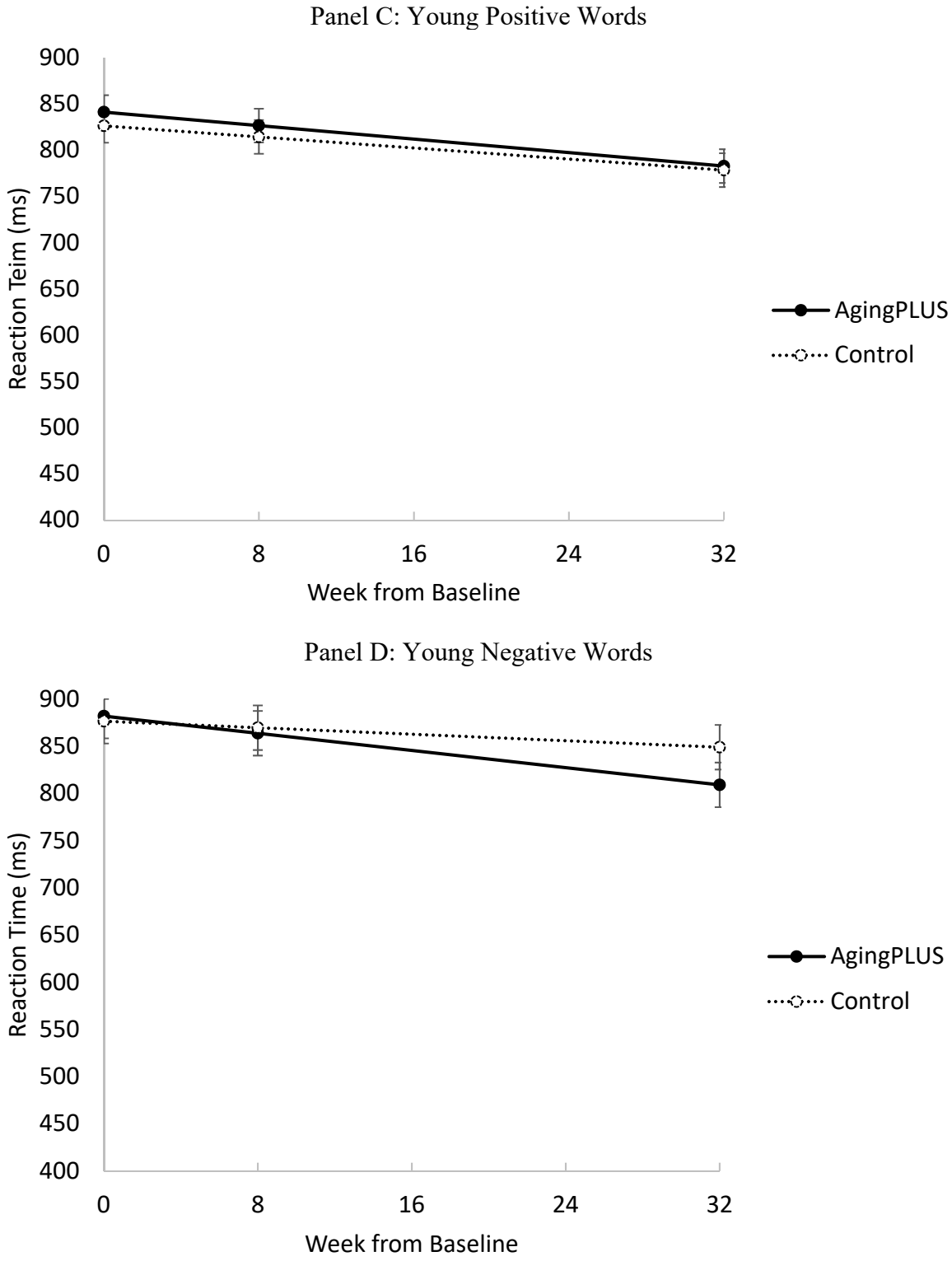


Figure 4.5. *Predicted Means and Standard Error of Implicit Views of Aging for Each Group over Time after Baseline, Lexical Decision-Making Task (LDMT)*

The Effects of Time × Implicit Views of Aging on Changes in Explicit Views of Aging

Table 4.6 presents the linear mixed effect analysis for Model 4, where the Brief IAT *d* scores assessed at baseline were included to examine whether participants with varying implicit VoA would show differential temporal changes in their explicit VoA. Notably, adding an additional predictor of IAT *d* scores significantly improved all model fit for predicting explicit VoA measures, *ps* < .01 (Table 4.3). This suggests it is worth considering the between-person differences in implicit VoA, in addition to randomization, when estimating changes in explicit VoA. Whereas IAT *d* scores were not significantly associated with all explicit VoA measures assessed at baseline, *p*s > .05, the participants who scored higher in IAT (i.e., showing relatively stronger implicit preferences for the young) showed significantly slower improvement for gain-related personal VoA (i.e., AARC-gains) by 0.006 units per week, $b = -0.006$, $SE = 0.003$, $p = .036$. In contrast, there was no sufficient evidence suggesting that changes in generalized VoA were contingent upon baseline implicit IAT, *p*s > .05.

Table 4.6.

Parameter Estimates of Mixed Effects Models Predicting Explicit Views of Aging, Estimated Mean (SE)

Effect	AS	ERA	EBAS	AARC-G	AARC-L
Fixed effect					
Intercept (γ_{00})	5.52 (0.07) ***	58.47 (1.42) ***	18.1 (0.34) ***	4.00 (0.05) ***	2.12 (0.05) ***
Time (γ_{10})	0.01 (0.002) ***	0.34 (0.05) ***	0.06 (0.01) ***	0.01 (0.002) ***	-0.01 (0.002) ***
Condition (γ_{01})	0.28 (0.09) **	3.43 (1.79) **	1.15 (0.42) **	0.20 (0.06) **	0.05 (0.07)
IAT(γ_{02})	-0.04 (0.08)	0.08 (1.61)	0.38 (0.40)	0.08 (0.06)	0.04 (0.06)
Time × Condition (γ_{11})	0.008 (0.003) **	0.22 (0.06) **	0.04 (0.02) **	0.001 (0.002)	-0.01 (0.002) **
Time × IAT (γ_{12})	-0.002 (0.004)	-0.04 (0.08)	-0.20 (0.02)	-0.01 (0.003) *	0.00 (0.003)
Random effect					
Residual (ε_{ij})	0.27 (0.02) ***	127.35 (8.06) ***	7.94 (0.50) ***	0.17 (0.01) ***	0.15 (0.01) ***
Variance of intercept (σ_{0i})	0.42 (0.05) ***	162.32 (17.46) ***	8.53 (0.96) ***	0.19 (0.02) ***	0.26 (0.03) ***

Note. AS = Age stereotypes; ERA = Expectations regarding aging; EBAS = Essentialist beliefs of aging; AARC-G = Awareness of age-related gains; AARC-L = Awareness of age-related losses; IAT = Brief Implicit Association Test.

* $p < .05$. ** $p < .01$. *** $p < .001$.

Discussion

This study examined the impact of an intervention targeting explicit aging attitudes on adults' implicit VoA and also explored variations in explicit VoA changes among adults with varying levels of implicit VoA. The present study was distinct from prior research in the context of a randomized controlled trial in three major ways. First, it assessed the intervention effects on explicit and implicit VoA over a 32-week period, which is considerably longer than previous studies. Second, it employed multiple measures to comprehensively assess adults' explicit and implicit VoA (Diehl et al., 2020). This approach has the advantage that it accounts for the multidimensional nature of adults' VoA and avoids the limitation that observed effects may be measure specific (i.e., method artifact). Lastly, the mixed effects modeling approach represents an optimal analytical approach to examine the intervention effects across multiple time points. Specifically, the mixed effects approach is more flexible regarding several assumptions required by linear regression or analysis of variance (ANOVA) type analyses (e.g., equal time intervals and the independence of repeated observations). Thus, mixed effects analyses tend to produce more dependable and precise estimations of the coefficients of interest.

Malleability of Explicit Views of Aging

The positive changes observed in adults' explicit VoA not only corroborate previous findings (Beyer et al., 2019; Brothers & Diehl, 2017; Levy et al., 2014; Sarkisian et al., 2007; Wolff et al., 2014), but also highlighted the significant efficacy of the AgingPLUS intervention (Diehl et al., 2020). Specifically, linear mixed effect models revealed substantial improvements in explicit VoA in the AgingPLUS group compared to the health education control group, particularly in generalized VoA. These findings, indicating the differential impact of the program on generalized vs. personal VoA, emphasize the need for an investigation into potential factors

contributing to divergent program effects across different explicit VoA measures. For example, when assimilating educational materials centered on generalized VoA (e.g., negative age stereotypes and beliefs that the human aging process is rather biologically predetermined), participants may require additional effort and prolonged exposure to the intervention to begin noticing and prioritizing positive aging experiences relevant to themselves (i.e., AARC-gains).

Malleability of Implicit Views of Aging

Contrary to the hypotheses, study participants' IAT *d* score, the indicator of the strength of implicit age biases, remained unchanged by the four-week intervention. However, implicit VoA indicators using response latency (i.e., LDMT) did show a significant effect of time. Although this is a promising finding, it needs to be interpreted with caution, as it cannot be ruled out that this effect may be due to practice effects on the LDMT. Practice effects, in general, refer to improved task performance because of repeated exposure to a test. Given the recurrent nature of the LDMT procedure in our study, the increased familiarity and resultant proficiency with the task may have resulted in faster reaction times in the follow-up assessment(s). This phenomenon could be mistakenly identified as an authentic shift in implicit aging attitudes when it was actually a byproduct of participants acclimating to this task. Such intricacies of practice effects underscore the need for caution when interpreting the results relating to response latencies, ensuring that any genuine changes in implicit measures are independent of measurement biases introduced by repeated task exposure.

Significant Condition × Time Effect on Implicit Views of Aging

A significant interaction effect of Condition × Time for implicit VoA was identified for the old negative word condition (ON) in the LDMT (Figure 4.5, Panel B). This significant Condition × Time interaction was due to the following observed changes. First, a minor upward

change in averaged RT from week 0 to week 8 followed by a steeper downward change in averaged RT from week 8 to week 32 for the AgingPLUS group. Second, a relatively unchanged RT for the control group across the 32-week observation period. Given the observed piecewise trajectory across the 8-month intervention period, more in-depth examination of non-linear changes in RTs, incorporating additional assessment occasions, would provide nuanced insights into the temporal effects on the implicit mental associations of old age and negative stereotypes.

In practice, the significant Time × Condition interaction could be interpreted in the following way. Because the AgingPLUS program contained several effective strategies (e.g., deliberate efforts to overcome age biases; FitzGerald et al., 2019; Forscher et al., 2019) designed to sensitize participants regarding negative implicit aging attitudes in their environment. Therefore, compared to the health education control group, participants in the AgingPLUS group may have become more attuned and sensitive to negative age-stereotypical cues, potentially resulting in quicker response to negative words related to aging in the LDMT task. This finding, albeit limited in its reach, suggests that explicit approaches may need to be more sustained or may need to be complemented by implicit (subliminal) methods (e.g., Levy et al., 2014).

In summary, whereas the results in modifying explicit VoA were in the expected direction, findings from this study suggest that it remains a challenge for interventions using psycho-educational approaches to demonstrate their impact on adults' implicit VoA This suggests that divergent mechanisms may be at work when it comes to the modification of explicit and implicit VoA.

Significant Implicit VoA × Time Effect on Explicit Views of Aging

Preliminary evidence suggested a potential moderating effect of initial levels of implicit VoA (as assessed by IAT) on the rates of improvement in explicit VoA, particularly gains-

related VoA (AARC-gains). It seems plausible that implicit positive VoA, functioning as overarching cognitive schemata at a preconscious level, may subliminally direct individuals' attention toward personal positive age-related changes (Hummert, 1999). That is, the participants with more positive implicit VoA may be more primed to notice age-related gains compared to those who hold more negative implicit VoA. Further path analysis could shed light on this hypothesis, examining the extent to which implicit VoA influence subsequent changes in generalized or personal VoA within the context of an intervention study (e.g., Levy et al., 2014). Theoretically, such efforts would also provide empirical support for the hypothesized underlying mechanisms driving shifts in explicit VoA and their associations with health-related consequences (Westerhof & Wurm, 2015).

Limitations

Several limitations of the current study need to be noted. First, the absence of immediate posttest data for implicit VoA data limited direct comparisons with other studies reporting significant immediate malleability of implicit VoA (e.g., Bossa et al., 2019; Dasgupta & Greenwald, 2001). Nevertheless, the results derived from longer follow-up data like the present study remain pivotal as they contribute the discussion on whether any significant short-term effects may persist over time (Lai et al., 2016).

Second, the present study might have been underpowered to detect small group differences regarding changes in implicit VoA. Given the wide range of effect sizes documented in literature, it is possible that the sample size in this study may not have been sufficiently large to detect subtle yet meaningful changes. For example, with an effect size as small as Cohen's *d* = .08 reported in prior research (e.g., Joy-Gaba & Nosek, 2010), a power analysis indicated the necessity for a much larger sample size, potentially in the thousands.

Third, although LDMTs and the IAT remain among the most commonly used measures in implicit social attitudes research, concerns remain regarding their reliability and validity in capturing implicit aging attitudes (Fazio & Olson, 2003; Greenwald & Lai, 2020). One promising strategy to address potential measurement biases involves employing latent variable analysis within a structural equation modeling (SEM) framework. For example, Cunningham and colleagues (2001) pioneered the utility of generating latent variables based on the RTs derived from various implicit measures to infer implicit social attitudes. The latent variables of implicit attitudes indeed showed improved test-retest reliability (Cunningham et al., 2001). Although this approach may not offer an optimal solution for resolving construct validity issues across multiple implicit measures, their study showed that a latent implicit variable derived from several implicit measures improved predictive validity compared to situations where the predictive validity of each implicit measure was evaluated individually (Cunningham et al., 2001).

Future Directions

Understanding the malleability and stability of various implicit and explicit VoA constructs is pivotal for informing effective intervention strategies. Future interventions aiming to promote positive VoA in middle-aged and older adults may consider the following points. First, they should tailor their intervention strategies to the targeted VoA construct(s). If a *sustained* modification of adults' implicit VoA is the goal of the intervention, an efficacious intervention would require multiple conditioning sessions and multifaceted approaches (Wilson et al., 2000), on top of the proven practices. Although evidence is yet to be established, a couple of intervention studies have shown promising lasting effects for the programs that provided extensive experiences, such as multiple conditioning sessions distributed over an extended period, usually for several months (e.g., McNulty et al., 2017; Shook & Fazio, 2008). Second,

incorporating a range of VoA measures, immediate as well as long-term follow-up assessments are needed to facilitate the exploration of dynamic associations of explicit and implicit aging attitudes with downstream behavioral outcomes. Findings from such studies may offer insights for future program designs, such as which specific aspects of VoA should be the targeted psychological mechanisms to achieve desired and robust intervention effects.

CHAPTER 5

GENERAL DISCUSSION

The objective of this dissertation was to contribute to the research in the field of views of aging (VoA) by addressing research topics across three thematic areas: (1) examining the psychometric properties, the cross-cultural validity, and measurement invariance of a multidimensional VoA measure capturing adult's awareness of age-related gains (AARC-gains) and losses (AARC-losses); (2) the moderating role of VoA in sustaining subjective well-being amidst health declines, addressing the paradox of well-being; and (3) the concurrent examination of the malleability of implicit and explicit VoA through a 4-week psycho-educational program. This chapter provides a concise overview of the main findings detailed in Chapters 2 to 4, discusses the strengths and limitations of the dissertation research, explores future research directions, and concludes with a discussion on the implications of the findings for gerontological research and practice.

Summary of the Dissertation Manuscripts

Summary of Chapter 2

This study investigated the psychometric properties and measurement invariance of the 10-item Awareness of Age-Related Change Short Form (AARC-SF) questionnaire, a multidimensional VoA scale, with a sample of Chinese-speaking older adults in Taiwan. The results indicated that the AARC-SF reliably and validly assessed AARC-gains and AARC-losses across five behavioral domains: health and physical functioning, cognitive functioning, interpersonal relations, socio-cognitive and socioemotional functioning, lifestyle and

engagement. Analyses confirmed the two-factor structure of AARC-gains and AARC-losses. However, caution was advised when directly comparing item scores between young-old and old-old adults in the Taiwanese sample. Specifically, measurement invariance tests indicated that among individuals of the same latent levels of AARC-gains, the old-old adults tended to report lower scores on most items related to age-related gains. Cross-national partial measurement invariance tests at the metric and scalar invariance levels suggested that direct comparison of the AARC-gains scores between older Taiwanese older and German adults could potentially be subject to biases. These biases arose from different interpretations and standards between adults' of different countries when responding to items about their age-related gains in various behavioral domains.

Overall, the concise and multidimensional nature of the AARC-SF minimizes the response burden on participants while allowing for the substantive exploration of adults' VoA across various life domains. Additionally, recognizing lack of measurement invariance and differential item functioning (Kaspar et al., 2024) across age groups and countries is imperative for ensuring valid group and culture comparisons.

Summary of Chapter 3

This study aimed to replicate and extend existing research on the paradox of well-being, the consistent observation that despite declines in physical and cognitive health, older adults tend to show high levels of life satisfaction and subjective well-being. Specifically, this study investigated the age trajectory of subjective well-being (SWB), its associations with changes in physical health, and whether adults' VoA moderated the associations of health and SWB trajectories over time. Data came from a 20-year longitudinal cohort study, which followed a sample of older adults in Germany from age 60 to 80 years. SWB, operationalized as level of

negative affect, was assessed using the Zung depression scale, whereas participants' physical health was objectively assessed by physicians. Study participants' VoA were measured using a unidimensional measure, the Attitudes Toward Own Aging (ATOA) scale.

Controlling for sociodemographic covariates and personality characteristics of neuroticism and conscientiousness, univariate latent growth curve modeling (LGCM) revealed a significant decline in SWB and a concurrent decline in physician-assessed health from age 60 to 80 years. Consistent with the paradox of well-being literature, bivariate LGCM showed that deteriorating health with advancing age was not necessarily reflected or accompanied by changes in SWB. However, the decoupling of health and SWB trajectories over time was observed only among individuals with more positive VoA, but not those with more negative VoA. These findings are consistent with prior evidence of the well-being paradox that SWB and health trajectories diverge in later life. The significant moderation effect for older adults with more positive VoA suggests that positive VoA represent a psychological resources that helps to support psychological well-being in the face of potential physical declines. The results were also consistent with other research that documented the beneficial effects of positive VoA on older adults' health and longevity (e.g., Levy et al., 2002).

Summary of Chapter 4

Chapter 4 examined the effects of the AgingPLUS program on the explicit and implicit VoA in middle-aged and older adults in the context of a randomized controlled trial. AgingPLUS is a community-based intervention program designed to help middle-aged and older adults become more aware of negative VoA that may negatively impact their behavior and actions. Upon meeting eligibility criteria, participants aged 45 to 75 years were randomized into either the AgingPLUS group or an active control group where a generic Health Education program was

given to control for the amount of social contact. Assessments of explicit VoA included a broad range of generalized and personal VoA questionnaires. Implicit VoA were assessed with two computerized tasks: a lexical decision-making task and the age version of the implicit attitudes test (IAT). Participants' pre- and post-intervention VoA data at baseline, Week 8, and Week 32 were analyzed, using an intention-to-treat approach. Linear mixed effects regression analyses revealed that the AgingPLUS group reported significant improvements in explicit VoA across 32 weeks. In contrast, the results provided limited evidence on either the temporal shifts or group differences regarding participants' implicit VoA measures. Furthermore, positive intervention-induced changes in explicit VoA were contingent upon adults' baseline implicit VoA.

In summary, explicit intervention approaches such as the one offered in the AgingPLUS program may result in considerable changes in adults' explicit VoA. However, the effects may not automatically and simultaneously result in shifts in adults' implicit VoA. Tailoring intervention designs according to specific outcome variables (i.e., explicit vs. implicit VoA) is essential to ensure robust and enduring program effects on changing adults' negative VoA.

General Strengths and Limitations

A significant strength of this dissertation is its use of a diverse array of methods, study designs, and samples tailored to address specific research questions in each chapter. For instance, the longitudinal datasets in Chapters 3 and 4 were analyzed using advanced statistical methods, such as latent growth curve modeling and multilevel modeling, which enhanced the statistical power for hypothesis testing regarding systematic interindividual differences in intraindividual changes. Furthermore, the dissertation utilized a comprehensive range of VoA measures, facilitating an in-depth investigation of the multifaceted nature of VoA and their interactions, ensuring that the observed effects were not measure-specific but generalized across measures.

Additionally, the inclusion of datasets from three different countries broadened the scope for cross-cultural generalizability of the findings, opening avenues for future studies to examine the extent to which cultural factors may influence the development and consequences of adults' VoA across diverse aging populations.

Nevertheless, despite the extensive coverage of datasets spanning almost the entire second half of life, a notable limitation, alongside several others mentioned throughout Chapter 2 to Chapter 4, is the absence of clarification regarding the critical time during which VoA are most susceptible to change or bear stronger relevance for developmental consequences. Although the literature and the present findings underscore the importance of promoting positive VoA at all ages, there may be compelling reasons to hypothesize that midlife, approximately from age 40 to 60, represents a critical period when VoA are particularly influential in shaping later development and critical developmental outcomes, such as physical, cognitive, and mental health.

One rationale for this hypothesis is that age and aging become increasingly salient in midlife (Levy, 2009), a period in life when individuals begin to notice age-related changes and construct personal narratives around these experiences. This suggests higher modifiability of VoA during this period compared to later stages of life when such awareness and attitudes toward aging have already become integral parts of the aging individual's self-identity. Furthermore, unlike in old-old adulthood where individuals' psychosocial resources gradually become less effective in compensating for biological constraints (Baltes & Smith, 2003), most middle-aged adults have not yet experienced significant normative declines. This may afford middle-aged adults more time to cultivate and utilize both internal and external resources to counteract the potential functional and cognitive declines that become more normative in later

life. Although the hypothesis that midlife represents a unique window of opportunity for setting optimal aging trajectories in motion is plausible, it remained unexplored in this dissertation and requires further examination.

Moreover, although the dissertation research acknowledges the multifaceted nature of VoA and has employed a wide range of measures to assess them, another significant limitation is the need for more consideration of the potential interactions among various VoA constructs. Prior research, for instance, demonstrated that individuals who maintained an optimistic outlook on the future (positive VoA entailing growth and opportunities in late life) while also having a heightened awareness of functional declines (negative VoA entailing age-related physical losses) were more likely to maintain higher physical functioning and exhibit fewer depressive symptoms later on (Wurm & Benyamini, 2014). These findings revealed a complex interplay between positive and negative VoA in determining developmental outcomes. Further research is needed to elucidate how valence-based and domain-specific VoA independently and jointly influence health and well-being. Such insights could guide researchers in determining whether it is more crucial to focus on minimizing negative VoA, maximizing positive VoA, or fostering a more balanced VoA that encourages strengths and opportunities while also acknowledging realistic age-related losses. These considerations could greatly enhance intervention designs, leading to more effective strategies that leverage adults' VoA to promote health and well-being in later life.

Practical Implications

The practical implications drawn from this research underscored the significant and pervasive influences of individuals' VoA on various aspects of well-being and health outcomes (Westerhof et al., 2023). Across three studies, more positive VoA, operationalized as the AARC-gains (Chapter 2) and based on the ATOA (Chapter 3), consistently showed significant

associations with enhanced physical functioning and subjective well-being. Conversely, negative VoA, assessed via the AARC-losses scale (Chapter 2), were associated with increased chronic disease burden and diminished overall well-being. Moreover, preliminary findings (Chapter 4) indicated that individuals with more negative implicit VoA tended to derive less benefit from an psycho-educational program like the AgingPLUS compared to those with more positive implicit VoA. The evidence suggested that negative VoA significantly impaired an individual's engagement in positive behaviors that otherwise would help to promote healthy aging. As a result, individuals' with more negative VoA may become increasingly vulnerable to adverse mental and physical health outcomes.

Given that individuals' personal VoA are strongly influenced by societal and cultural stereotypes and views of aging (Brothers et al., 2021; Diehl et al., 2014; Levy, 2009), there emerges a clear and urgent need to develop more comprehensive intervention strategies across all ages. These strategies may simultaneously address negative VoA at both the individual and societal levels by reshaping negative perceptions and normative expectations regarding old age and aging. For instance, interventions may present research-backed evidence that the later years are a stage of life abundant with opportunities for growth, similar to other life stages. This dual approach of shifting both generalized and personal VoA and incorporating a broader range of age groups in interventions may hold the potential to foster lasting improvements in well-being that extend into the later years, benefiting not only older adults today but also generations of middle-aged adults in the future.

Conclusion

The research presented in this dissertation made four primary contributions to the literature on adults' VoA. First, it established that the AARC-SF is a psychometrically sound and

culturally sensitive measure for capturing behavioral experiences that signify individuals' awareness of their own aging. Second, a series of measurement invariance tests conducted across sociodemographic groups and nations highlighted significant influences of sociocultural factors in shaping aging subjective experiences across various critical behavioral domains. Third, the dissertation provided empirical support for the theoretical proposition that positive VoA act as a psychological resource, enabling individuals to maintain high levels of subjective well-being despite objective declines in health (Levy et al., 2002). Finally, this dissertation shed light on the varying malleability of explicit and implicit negative VoA in response to a psycho-educational intervention, indicating that long-term shifts in implicit VoA may not be achievable with explicit intervention strategies as suggested in prior experimental studies. Additional intervention strategies at the pre-conscious level may be necessary to also achieve significant and lasting changes in individuals' implicit VoA (Levy et al., 2014).

The research questions and hypotheses throughout the dissertation research are anchored within the meta-theoretical framework of lifespan developmental psychology, which posits that human development is dynamic and can be strategically influenced and optimized throughout adulthood. Evidence concerning the diverse age trajectories and malleability of critical developmental outcomes, including VoA and subjective well-being, serves as a compelling illustration of personal agency in fostering optimal aging processes (Brandtstädter, 1999) and lifelong developmental plasticity (Baltes, 1987). Overall, the results derived from the dissertation research highlighted the potential for substantial growth and opportunities in the second half of life.

Overall, the findings underscore the importance of continued exploration into the contextual and individual factors shaping intraindividual changes in VoA and their implications

for successful aging (Sabatini et al., 2024). This line of research is also critical for developing and complementing effective intervention strategies aimed at empowering older adults to actively engage with and take control over their own aging process. By leveraging these insights, future interventions may capitalize on the demographic changes and challenges of aging, transforming them into opportunities for growth, resilience, and high levels of subjective well-being for both individuals and societies.

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