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Abstract

Over the course of history, aging has been considered a period of progressive physical, cognitive, and psychosocial declines, yet more recently there is growing evidence that challenges this purely deficit-driven view of aging. In fact, numerous studies have documented improvements in psychological well-being across the life-span, despite age-related declines in physical and cognitive functioning. This subjective well-being in the face of physical limitations is thought to reflect successful aging. Here, we review the definitions, predictors, and biobehavioral mechanisms of successful aging. There are numerous perspectives on what constitutes successful aging and as such a consensus regarding its definition is lacking. Nonetheless, a number of studies have characterized the biologic, environmental, and social determinants of successful aging using often overlapping operational definitions. Of particular interest are positive traits such as resilience and wisdom, which appear to have particular relevance in understanding the counterintuitive relationship between successful aging, even in the presence of poor health status. In addition to characterizing various facets of successful aging, there has been a growing interest in investigating strategies to promote well-being, many of which are discussed here. The ongoing technological revolution has great promise for enabling older adults to age successfully and safely in their own homes and communities despite declines in physical ability.

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Introduction

At present there are over 40 million individuals over the age of 65 living in the United States and by 2030 that number is expected to grow to 72 million. Across the literature, this tidal wave of aging baby boomers has been referred to as the “Silver Tsunami” and deemed the number one public health issue faced by the developed world. In line with this rapidly shifting distribution of older adults, disease and disability related to normative and accelerated aging has received much empirical attention. Traditionally, aging has been considered a period of progressive decline in physical, cognitive, and psychosocial functioning. More recently, there is growing evidence to suggest that in contrast to a purely deficit-driven view of aging, older adults often experience increased levels of psychological well-being as they age. In addition, social and emotional functioning not only remains stable but appears to improve with age. Thus, there has been a contradiction between findings that establish a decrease in biological, physiological, and cognitive capacity in older adults and those that demonstrate that older adults are generally satisfied and report high levels of emotional well-being as they age. This contrast has been designated “The Paradox of Aging” and is described as the ability to maintain high levels of well-being and life satisfaction, despite age-related losses in physical and cognitive functioning. Based on this paradox, theories of aging have deviated from unidimensional decline models to focus on life-span developmental models that consider the notion of *successful aging*.

Earlier research on the aging process has concentrated on the way that disease and disability affect older adults. More recently, research has begun to focus on successful aging across multiple domains. Successful aging is thought to be a multidimensional construct that has been defined in numerous ways, often with reference to a variety of factors including, but not limited to, physical health, psychological health, and social health. The construct of successful aging argues against the popular notion that aging invariably involves a decline in functioning; research in this area suggests the presence of various factors that may extend the duration of positive biopsychosocial health and

meaningful experiences as we age. Within this chapter we will discuss definitions of successful aging, components of successful aging, mechanisms underlying successful aging including biological factors, as well as social and environmental factors, and predictors of successful aging.

Definition of Successful Aging

Over the last 50 years, numerous studies have attempted to define successful aging; unfortunately, outside the nonexistence of disability, there still does not appear to be a consensus on the optimum definition of successful aging or the best way to determine if someone is aging successfully. Cicero (106-43 B.C.) a Roman philosopher and statesman was believed to be the first individual to assert the notion of aging successfully through his essay *De Senectute* (44 B.C.) (Baltes and Baltes 1990). In Cicero's work, he was able to exemplify that as one grows older, they do not necessarily decline and can live their life productively and positively. One of the most commonly cited models of successful aging was proposed by Rowe and Kahn (1987); they suggested a three-tier model that integrated freedom from disability along with high cognitive, physical, and social functioning. In their view, successful aging is the opposite end of the continuum from pathological aging, which is characterized by disease and debility. Other definitions suggest that successful aging reflects the degree to which older adults adapt to age-related changes, view themselves as aging successfully, or avoid morbidity until the latest time point before death (see Depp and Jeste 2006 for review). These complementary theories view successful aging from the perspective of life-span development and emphasize psychological, social, and behavioral processes that are involved in adapting to age-related declines, disabilities, and losses. These theories also highlight the relevance of maintaining independence in everyday functioning despite physical limitations.

Given the variability in the definition of the construct of successful aging, it is not surprising that there is a wide range of prevalence estimates of successful aging. Across the literature, the reported proportion of successful agers ranges from 0.4% to 95%. This wide range is likely driven by multiple factors such as differing operational definitions of successful aging, sampling issues, as well as the psychometric properties of the instruments chosen to measure the construct. Furthermore, the prevalence of successful aging may also differ across age groups and settings. For example, in a recent study by Meng and D'arcy (2013), almost 50% of individuals over the age of 50 were classified as aging successfully, whereas only 37.2% of those aged 65 and older were classified as successful agers. The authors also reported that the predicted probability of being a successful ager was 41% for those aged 65–74 years compared to 22% for those aged 85 years and over. Taken together, these data suggest that there is a sizable minority of older adults who demonstrate characteristics of successful aging: a finding that highlights the need to carefully elucidate this construct in aging cohorts.

Further support for the construct of successful aging comes from studies of various disease groups. For example, a study by our group found a linear improvement in various attributes of mental health beginning in young adulthood and progressing into older age. This improvement in well-being was noted despite an accelerated deterioration in physical and cognitive functioning across the same life period (Thomas et al. 2016). These data suggest that it is possible to be happy and subjectively rate oneself as having a good quality of life despite poor physical health. In a study of successful aging in schizophrenia, Cohen et al. (2009) found that in their sample, 13% of older adults with schizophrenia rated themselves as aging successfully. This finding suggests that even in individuals with severe mental illness, subjective successful aging is possible. Similarly, successful aging has also been demonstrated in cohorts of HIV-infected persons. In fact, a recent study found that despite worse physical and mental functioning among HIV+ individuals, their self-rated levels of successful aging were comparable to demographically matched HIV-uninfected individuals (Moore et al. 2013). Across disease groups, evidence supporting the potential for aging successfully highlights the continued need to characterize the components and predictors of this construct.

Components of Successful Aging

Over time there has been an increasing interest in factors that predict successful aging or positive health outcomes in older adults. Although there are multiple definitions of successful aging and diverging estimates of its prevalence, this construct has received increasing empirical attention with numerous studies investigating the nature and predictors of positive states of health and well-being in older adults. As with the definition of successful aging, there is no consensus regarding which components are central to the definition of this construct, nor is there agreement about whether successful aging should be measured objectively by persons other than the individual or be rated subjectively by older adults themselves. Not only is this broad construct defined using diverse parameters, but also across the literature there has been a wide range of suggested designations including “successful aging,” “healthy aging,” or “aging well.” Given these noted discrepancies, there is a clear need to attain consensus to inform and enhance empirical study of this construct. These efforts will also have clinical implications, directly impacting interventions to support successful aging across the life-span. As policy directives mandate investment in health programs that focus on promoting positive health states, there is a growing clinical impetus to better understand the components, mechanisms, and interventions for successful aging.

Biopsychosocial components: A number of biopsychosocial components of successful aging have been identified across cohorts of older adults. However, the manner in which successful aging is operationalized in these studies differs greatly, which impacts the variables that researchers choose to investigate. In the literature regarding successful aging, disability and/or physical functioning (commonly measured by self-reported activities of daily living) is the most frequently discussed

component. Markers of physiological functioning (e.g., physical and cognitive functioning/impairment, illness and health status, longevity, mental health) have also received considerable empirical attention (Cosco et al. 2014).

To complement the data regarding biological components, researchers have examined psychological, social, and environmental variables that may relate to successful aging. These include well-being and life satisfaction, social engagement, personal resources (e.g., level of independence), and extrinsic factors (e.g., environmental and financial resources). For instance, ratings of life satisfaction and well-being, as well as social and productive functioning, are commonly measured components of successful aging (Depp and Jeste 2006). Factors such as hardiness, coping skills, active social participation, number of friendships, and life satisfaction appear to be key psychosocial elements of successful aging. These factors speak to the importance of an individual's perseverance, social engagement, and sense of well-being in promoting positive health states. Similarly, behavioral or physical components of successful aging include participating in healthy behaviors (e.g., exercising) while avoiding poor health habits (e.g., tobacco use).

In addition to objective measures of successful aging (as noted above), understanding older adults' subjective experience of what it means to age successfully is paramount in developing interventions and policy. Self-rated successful aging is a commonly used variable across research studies and has been positively linked to greater physical, mental, and emotional health. A focus group study of older adults' opinions regarding the contributors of successful aging revealed four major factors related to successful aging: attitude/adaptation (e.g., having a positive attitude, realistic perspective, and the ability to adapt to change); security/stability as related to one's living environment, social support, and financial resources; engagement/stimulation (e.g., feeling a sense of purpose in life and being useful to others); and health/wellness. Interestingly, the participants had mixed opinions regarding the necessity of general physical health and wellness for successful aging. Altogether, these data suggest that from the perspective of older adults, psychosocial factors may be more salient components of successful aging as compared to longevity, absence of disease/disability, and independence (Reichstadt et al. 2007).

Clearly, the construct of successful aging is multidimensional, nuanced, and more complex than mere survival. Successful aging may be best thought of as developing and maintaining one's social, cognitive, and emotional functioning. Despite the diversity in how the components of successful aging have been investigated across the literature, there is a growing evidence base regarding the mechanisms underlying successful aging and its various facets.

Mechanisms Underlying Successful Aging

Biological factors: Growing knowledge regarding the biologic mechanisms of normal and pathological aging has sparked an interest in characterizing the genetic, immunologic, and hormonal determinants of successful aging.

Studies in longevity have provided insights into genetic bases of aging outcomes. Different approaches have been used, such as examining predictors of individual life-span, as well as early and late mortality. For example, as noted by Christensen et al. (2006), late deaths (after 90–100 years old) are thought to be indicative of successful aging. There appears to be a familial component to longevity as suggested by the clustering of late deaths in families with many extremely long-living individuals. However, it is unclear whether this reflects a genetic component or environmental impact (e.g., unique environmental exposures during a long life may exert a positive influence on life-span and health at older ages). Data from twin studies indicate that genetic differences account for almost a quarter of the variation in life-span. Interestingly, the magnitude of genetic influences on life-span increases after age 60, suggesting that certain genes may affect longevity especially in older age. Candidate genes associated with longevity include the 641C allele in the APOC3 promoter (with the 641C homozygote status being associated with survival) and microsomal triglyceride transfer protein (MTTP). In the Framingham cohort, PON1 was related to outcomes such as walking speed, living past 65 years of age without chronic illness, and biological age based on osseographic index (Rana 2010). Preliminary data also suggest that IGF1R and HFE, two metabolism-related genes, might be involved in genetic variation in human life-span. Telomere length is another promising predictor of longevity, with findings of longer telomere length being associated with late death in humans. However, these results have not been consistently replicated (Christensen et al. 2006).

The genetic correlates of successful aging have also been explored through the lens of the stress response. Resilience, or resistance to developing psychological disorders despite exposure to trauma or stress, is a key facet of successful aging. The serotonin transporter polymorphism (5-HRRLPR) is a genetic risk factor that is related to the development of depression and anxiety symptomatology in response to stress. As such, it is a promising target for studies investigating the genetic underpinnings of resilience and successful aging. The short form (but not the long form) of this gene is associated with reduced serotonin transcription and reuptake efficiency and appears to play a role in various psychological disorders including depression and anxiety. Interesting, at older ages, the relationship between the 5-HTTLPR s allele and a psychopathologic response to stress is weaker; this raises the question of whether the s allele exerts a detrimental effect on resilience in older adults. In a recent study, O'Hara and colleagues (2012) reported that although the 5-HTTLPR s allele was not associated with lower emotional resilience in older adults, s allele carriers had lower cognitive abilities and self-ratings of successful aging. Their findings suggest that rather than emotional resilience, intact cognition may be more salient with regard to the subjective experience of aging successfully in older s allele carriers.

Biological processes such as apoptosis, neurotoxicity, oxidative stress, and inflammatory dysregulation may occur with greater frequency in older adults and have been shown to play a role in the pathophysiological mechanisms of neurodegenerative diseases such as Alzheimer's disease. There is growing evidence to suggest that in successful biological agers, these processes may be slowed down. This supports the notion that in these older adults, chronological age is not the same

as “biological age” (i.e., physiologically, their functioning is comparable to younger individuals). A recent study of 3,044 older adults suggested that maintaining low levels of systemic inflammation over 5 years may facilitate successful biological aging by mitigating the likelihood of impaired musculoskeletal and respiratory functioning and decreasing the risk of developing diabetes (Akbaraly et al. 2013).

Many studies examining the physiological substrates of aging have focused on the role of stress and stress-related chronic overactivation of the hypothalamic-pituitary-adrenal (HPA) axis. Stress-induced chronic secretion of cortisol appears to damage the hippocampus as well as other brain structures. This is particularly relevant to the aging brain, as hippocampal abnormalities may manifest in impaired learning and consequent declines in everyday functioning. Not only does chronic stress contribute to neuroanatomical abnormalities, but it is also related to shortened telomere length, as well as the upregulation of proinflammatory cytokines. Changes in telomere length and cytokine levels are risk factors for cellular damage in the central nervous system (Eitan et al. 2014). While chronically elevated stress levels have been associated with poor health outcomes in older adults, the same is not true for mild levels of stress. In fact, low levels of stress may produce positive changes in the aging brain. This has been demonstrated in studies examining the effects of physical activity, caloric restriction, and cognitive stimulation; these activities produce low-grade stress, which activates neurotrophic factors such as brain-derived neurotrophic factor (BDNF). BDNF plays an important role in learning and higher-order cognitive functioning; as such, these data suggest that there is a nonmonotonic relationship between stress and cognitive functioning in the elderly that may be modulated by neurobiological changes. In summary, these findings showcase the complexity of the various biologic substrates of aging.

Brain and cognitive reserve: The age-related neurobiological changes described above have notable implications for the construct of brain reserve, which refers to the amount of neural damage that can be tolerated while preserving functioning (Stern 2002). It is thought that structural neural characteristics (e.g., density and number of neurons) determine peak brain volume, which in turn may be associated with brain injury outcomes such that individuals with greater brain volumes are more resistant to neurological insults. As such, greater brain reserve may delay the onset of a host of brain disorders and perhaps slow normal brain aging. The mechanism underlying the acquisition of brain reserve is not fully characterized, but findings from twin studies suggest that brain reserve may be heritable. Thus, it is possible that gene expression may drive neuroarchitectural changes (e.g., cortical thinning, brain shrinkage; Esiri and Chance 2012) and neurobiological changes (e.g., apoptosis) that impact peak brain volume.

Cognitive reserve is related to brain reserve and refers to the ability of the brain to adapt to neural damage via compensation by recruiting alternate brain regions to perform tasks (Stern 2009). The construct of cognitive reserve is thought to underlie the preserved cognition noted in individuals who have significant neuropathological abnormalities postmortem (Snowdon 2003). Compared to brain reserve, cognitive reserve appears to be a modifiable factor. Individuals who participate in cognitively stimulating activities, hold intellectually demanding jobs, and have higher levels of

education typically show greater cognitive reserve (Fratiglioni et al. 2004). In fact, individuals who participate in cognitively enriching physical, mental, or social activities appear to have lower risk of Alzheimer's disease. Relatedly, preliminary evidence suggests that higher cognitive reserve and brain integrity are linked to successful aging. It appears that cognitive reserve may be a neuroprotective factor and promote neural efficiency and neural compensation in the aging brain. Universally, brain and cognitive reserve theories point to the plasticity of aging brains, a particularly salient issue with regard to research into the mechanisms of successful aging. The existing literature suggests that the accumulated effects of exposure to enriching environments over the course of a lifetime impact brain and cognitive reserve in older adults. This relationship between neural, behavioral, and environmental factors appears to impact the trajectory of aging across the life-span. Accordingly, this relationship is of considerable scientific interest and foundational to a multidimensional understanding of successful aging.

Social and environmental factors: A growing body of research suggests that social and environmental variables may have effects on various aspects of successful aging. The impact of these factors may have a direct or indirect influence on aging. For instance, environmental surroundings may influence accessibility to safe areas for physical activity. A lack of exercise, in turn, may predispose individuals to obesity and other health-related issues. Low physical activity and obesity have both been shown to be associated with reduced reports of successful aging (Hodge et al. 2013). The environment (e.g., air quality) may also modulate risk for health conditions such as asthma or respiratory infections. In addition, the environment (i. e., neighborhood) has also been demonstrated to impact access to education (e.g., quality of schools) and quality of nutrition (e.g., food deserts, i.e., urban areas with poor access to fresh, healthy food). Educational resources may drive the extent to which cognitive stimulation is available and the level of cognitive reserve attained, whereas access to primarily unhealthy food vendors may alter risk for chronic, metabolic diseases such as diabetes. In this manner, the environment exerts direct and indirect effects on various components of successful aging. Consistent with this theory, exposure to resource-limited settings in childhood appears to have an impact on adult health. For example, Brandt et al. (2012) found that in a sample of 22,464 European men and women, childhood living conditions were independently associated with elders' odds of aging well even after controlling for demographic variables and later life risk factors. This suggests the importance of examining environmental resources available to an individual across the life-span when investigating predictors of successful aging.

The environment also has a direct impact on social functioning. Many investigators have emphasized the important influence of social factors on the capacity of individuals to age successfully. These include personal characteristics such as race, gender, sexual orientation, and socioeconomic status. The individual's interpersonal environment (e.g., friendships and family structure) also exerts influence on social functioning (Rowe and Kahn 2015). Previous studies have suggested that social connectedness (e.g., the number of close personal contacts or relationships) may predict successful aging and a lack of physical disability. In addition to social

interaction, participation in social activities has been shown to have a beneficial effect on happiness and everyday functioning while reducing risk of mortality (Hodge et al. 2013). Additionally, important social relationships such as family and friends may serve to boost an individual's sense of self-worth and mastery, both of which promote health maintenance and well-being. There are many reasons that may explain the association between social relationships and aging successfully. Supportive social networks may facilitate an individual's efforts to reach health-related goals and promote healthy behaviors (Cherry et al. 2013). It is also thought that the relationship between social functioning and successful aging may be mediated by factors such as cardiovascular health and systemic inflammation. For example, higher levels of social engagement appear to be related to lower C-reactive protein concentrations (Loucks et al. 2006), which signals lower levels of inflammation. These findings, taken in the context of prior studies that demonstrated the relationship between social engagement and coronary heart disease, suggest a biologic mechanism for the negative health outcomes associated with low social integration (Loucks et al. 2006). As a whole, there is growing evidence supporting the notable impact that social and environmental factors encountered throughout the life-span have on successful aging in late life.

Predictors of Successful Aging

Demographic predictors: The identification of the predictors of successful aging has the potential to guide future intervention approaches. As such, a great deal of research has focused on identifying characteristics that are associated with aging successfully. It appears that the subjective experience of well-being is critical for successful aging. In fact, Jeste and colleagues (2013) found that older age was associated with higher self-ratings of successful aging, despite worse physical and cognitive functioning. Their results suggested the role of key mental health factors (e.g., resilience) that may modulate the relationship between age and perceived successful aging. Other demographic variables such as social economic status, level of education, marital status, gender, and ethnicity have also been investigated. There is reason to believe that these factors interact in a complex manner to impact the course of aging. For instance, individuals with higher levels of education may have better employment opportunities and therefore better financial and social status as adults. Higher levels of education and consequent access to improved occupational opportunities may also have a positive effect on health by reducing exposure to hazardous environments and physical strain. Similarly, income appears to be associated with better health in older age; however, it is not clear whether income is a mediator of health rather than a predictor of unhealthy aging (White et al. 2015). Also of interest is the impact of gender on successful aging. Although women typically have longer life expectancies, they have higher rates of illness and disability. The differential rates of healthy aging across genders may be partially driven by socioeconomic differences between men and women, which are possibly a function of educational, occupational, and financial disparities (White et al. 2015).

Cognitive functioning: Cognition is another predictor that has received empirical attention in the successful aging literature. Although it has been investigated as a predictor of successful aging, it has often also been used as a marker of this construct. For example, a number of studies have operationalized successful aging as the absence of moderate to severe cognitive impairments into older age. To date, we know more about the predictors of preserved cognition rather than the various trajectories of cognitive decline and how they are related to healthy aging markers downstream.

It is well known that the lifetime risk of cognitive impairment increases with age; there is growing interest in characterizing the heterogeneity of longitudinal patterns of cognitive changes in adulthood. In fact, there appear to be three subgroups of older adults: one group with long-term maintenance of cognitive function into old age, a second group with mild declines akin to normal aging that do not progress to dementia, and finally a third group with dementia (Barnes et al. 2007). The presence of these varied trajectories raises an interesting question: can modifying key factors earlier in life can alter an individual's course of aging? For this reason, identifying the predictors of intact cognition has been an area of continued empirical study. Preliminary evidence suggests that better physical health, fewer medical comorbidities, engaging in healthy behaviors, and a high level of social engagement are associated with maintenance of optimal cognitive function at a future time point.

With regard to the association between cognition and successful aging, we know that the maintenance of intact cognition in older age is essential to preserving independence and quality of life, avoiding disability, and attaining longevity. It is likely that this relationship is reflective of necessary higher-order cognitive skills that support the execution of complex everyday functioning tasks such as medication management, social participation, and driving. These activities, in turn, contribute to improved health-related quality of life and physical functioning, which are both markers of successful aging. As such, it is not surprising that groups of individuals who show normal aging, mild cognitive impairments, and dementia would also differ on indices of successful aging. While we know that global cognitive functioning is related to successful aging, it is still unclear whether specific domains of cognition are differentially important for aging successfully. For example, it may be the case that preserved executive functioning and memory are more salient in terms of maintaining a robust quality of life into older age, while declines in processing speed or motor functioning can be compensated for, to some extent, and have a lesser detrimental effect on markers of successful aging. This issue has received limited empirical attention and warrants a closer analysis given the implications for developing interventions to target specific cognitive domains.

Physical functioning: In addition to demographic variables and cognition, much attention has been devoted to health-related predictors. Markers of physical functioning such as the absence of arthritis and hearing problems, hypertension, and medical comorbidities appear to be strong predictors of aging successfully. This relationship likely reflects the positive impact of the absence of disability on maintenance of independence in activities of daily living and robust quality of life, which in turn is associated with greater subjective experience of successful aging

(Montross et al. 2006). In addition to health-related predictors, lifestyle factors such as preserved daily functioning, physical activity level, and being a nonsmoker are also related to aging successfully.

It has long been known that engaging in multiple unhealthy behaviors (e.g., lack of exercise, smoking) is associated with a higher risk of early mortality, chronic disease, and cognitive impairment. The critical question is whether participation in healthy behaviors has a protective effect on the course of aging. Recent studies have demonstrated that engaging in healthy behaviors (e.g., increased physical activity, consumption of nutrient dense food) is associated with greater odds of aging successfully. In a large cohort of the British men and women, never smoking, moderate use of alcohol, daily consumption of fruits and vegetables, and participating in some physical activity predicted how successfully the participants aged over a 16-year time period (Sabia et al. 2012). Healthy behaviors impacted all four aspects of successful aging that were examined (i.e., cognitive, mental, respiratory, and cardiovascular health). These findings indicate the positive impact of modifying lifestyle variables, not only to reduce mortality and morbidity but also to improve quality of life in older adults (Jeste et al. 2015).

Participation in leisure activities is related to physical health and is a predictor of well-being. Leisure is typically defined as an enjoyable activity performed in one's free time; leisure activities may include physical activities like walking, cognitive activities like crossword puzzles, creative activities such as painting, or passive activities such as watching television. It may also include social activities such as spending time with friends. Many studies have demonstrated the negative impact that physical illness has on leisure activities, but there is a growing interest in characterizing the benefits of continued leisure participation into older age. Montross and colleagues (2006) found that the number of close friends, as well as frequency of reading, listening to the radio, and visiting family, was associated with self-ratings of successful aging, thus highlighting the relationship between leisure activities and subjective well-being.

These findings are complemented by prospective studies of older adults, which have shown that engaging in various leisure activities such as visiting restaurants or playing cards is associated with positive outcomes such as lower mortality, morbidity, and increased longevity. It has been theorized that the playfulness that stems from leisure activities buffers against sadness and stress. Additionally, the social support obtained by participating in group leisure activities may provide older adults with a rich, protective feeling of belonging and increased resilience when coping with age-related stressors (e.g., losing a spouse; Son et al. 2007). Hutchinson and Nimrod (2012) demonstrated that older adults were more likely to seek out leisure activities depending on (1) their beliefs in personal responsibility for their health, (2) their beliefs in personal abilities to care for their health, (3) acceptance of their health, and (4) their history of participating in leisure activities. The authors found that even older adults with chronic conditions were motivated to find ways in which they could compensate for their physical limitations and continue to participate in leisure activities. The level of participation was associated with markers of successful aging such as maintaining engagement with life. Altogether, these data support

the important role that preserved physical functioning, whether through leisure or healthy behaviors, can play in promoting successful aging.

Mental health functioning: The role of sustained positive mental health in aging successfully is also of great interest, as it is a potentially modifiable factor. There appears to be an association between age and depressive symptoms. Older adults often experience clinically significant depressive symptomatology, even though they may not meet criteria for major depressive disorder. Often, these nonmajor forms of depression are classified as “subthreshold depression” or “subsyndromal depression.” The prevalence of subthreshold depression ranges from 8.8% to 21.3% (Vahia et al. 2010). Subthreshold depression is associated with numerous negative outcomes. These include increased healthcare utilization, risk of future major depressive disorder, suicide, disability, as well as declines and overall functioning and health-related quality of life (Vahia et al. 2010). In cohorts of older adults, higher prevalence of depressive symptoms also appears to be associated with increased incidence of cognitive impairment (i.e., both mild cognitive impairment and dementia; Goveas et al. 2016).

With regard to successful aging, one study showed that in a group of older women, subthreshold depression was associated with lower scores on various markers of successful aging. The components of successful aging examined in this study included optimism, resilience, health-related quality of life, and subjective cognitive difficulties (Vahia et al. 2010). There was a stair-step relationship between depression and successful aging such that the nondepressed group had the highest scores on markers of successful aging, the group with subthreshold depression had intermediate scores, and the depressed group showed the lowest rates of successful aging. The above finding that individuals with subthreshold depression have higher levels of disability and are aging less successfully than individuals who do not demonstrate any depressive symptoms has significant clinical implications. While subthreshold depression is considered prevalent in older adults, it frequently goes unrecognized by clinicians, and, consequently, individuals do not receive the treatment they need to alleviate their mood symptoms. Vigilant detection and management of mild depressive symptomatology is crucial for overall health in older adults and has the potential to reduce morbidity and improve the likelihood of aging successfully.

In addition to depression, resilience is another aspect of mental health functioning that is closely associated with successful aging. Resilience is conceptualized as an internal psychological resource or the “ability to bounce back from the variety of challenges that can arise in life” (Campbell-Sills and Stein 2007; p. 1026). It is theorized as comprising the characteristics of equanimity (i.e., a balanced perspective of life), meaningfulness (i.e., a sense of purpose in life), perseverance, existential aloneness (i.e., recognizing one’s unique path and accepting one’s life), and self-reliance (Wagnild 2003). Across cohorts of different ages and disorders, resilience has been found to be a buffering factor that protects against psychological distress. In a large, community-based study of self-rated successful aging, the positive effect of resilience on successful aging was comparable to that of physical health (Jeste et al. 2013). This suggests that increasing resilience may be as effective as physical health with regard to facilitating

successful aging. Similarly, higher levels of resilience have also been reported to protect against the negative influence of new medical disorders in older adults (Manning et al. 2014). Not only does resilience protect against declines in physical health, there is some evidence to suggest that high levels of resilience contribute to longevity; in fact, centenarians have been shown to be more resilient than any other age group (Zeng and Shen 2010).

The construct of resilience has particular relevance in understanding the counter-intuitive relationship between health status and self-reported successful aging. Across studies, researchers have found that regardless of suboptimal health status, older adults often report that they are aging successfully. (This concept was briefly noted earlier in the chapter and is coined *The Paradox of Aging*.) Over the past two decades, there has been a growing effort to characterize the moderators of this unexpected relationship; resilience appears to be a central factor. One study demonstrated that in older adults, resilience influenced the role perceived stress played in the relationship between mental health status and self-rated successful aging (Moore et al. 2015). The authors found that higher levels of resilience appeared to have an intervening role on perceived stress, reducing the strength of the relationship between poor mental health and decreased levels of self-rated successful aging. Clinically, these findings suggest that experiencing high levels of stress can have a detrimental effect on physical health and indirectly decrease subjective well-being. In addition, these data highlight the important role of resilience as a moderator of poor health status and psychological well-being. Resilience has also been linked to higher cognitive functioning and more positive views of aging. Accordingly, increasing one's ability to adjust and adapt to stressful situations (increase resilience) may have an impact on both physical and mental health. Such interventions may target goals such as increasing social connectedness, increasing a sense of mastery, and promoting spiritual grounding.

Positive traits: As evidenced by the growing interest in characterizing the role of resilience in promoting well-being, the focus of research is now shifting from deficit models focused on mental illness toward strength-based models focused on mental health as predictors of successful aging. As such, constructs such as optimism, spirituality, and wisdom are getting closer empirical attention. Optimism refers to an individual's expectation of positive outcomes across different situations and over time. Multiple studies have shown that optimism is associated with reduced number and intensity of physical symptoms, lower depressive symptoms, and better post-surgical outcomes. In older adults, data supporting the relationship between optimism and positive outcomes are mixed. Brenes and colleagues (2002) demonstrated that pessimism (i.e., the expectation that things will consistently go badly) but not optimism was correlated with daily activities such as walking, climbing stairs, and lifting. This study suggests that pessimism and optimism are two orthogonal dimensions, not just polar opposites of the same trait. It also suggests that pessimists may choose less adaptive coping strategies or behaviors (e.g., seek treatment less often or not adhere to treatment). In contrast, Bowling and Iliffe (2011) found that an individual's level of optimism as well as perceived self-efficacy predicted ratings of quality of life at a 7–8-year follow-up. Comparing these two contrasting findings

raises the possibility that older adults who are optimistic about future outcomes may not necessarily engage in specific health-promoting behaviors, but they may continue to perceive themselves as having a high level of well-being despite physical difficulties associated with aging. On the other hand, individuals who take a pessimistic view may engage in less healthy behaviors that lead to poor health outcomes and worse quality of life as they age.

Similar to the buffering role of resilience and optimism in moderating stress, religious involvement has also been shown to facilitate adjustment to stressful situations. Participating in active spiritual coping strategies such as private prayer has been associated with greater levels of optimism and may result in improved quality of life (Ai et al. 2010). Religiosity and spirituality appear to promote a sense of purpose, value, and meaningfulness in older adults, all of which are important aspects of well-being (Lawler-Row and Elliott 2009). Independent of demographic factors (e.g., age, gender), religious participation, social support, and spirituality or existential well-being (not necessarily tied to an organized religion or practice) predicted health outcomes in a study of older adults (Lawler-Row and Elliott 2009). The authors also found that individuals with higher levels of existential well-being had lower rates of depression and higher levels of subjective well-being. These data suggest that having a sense of purpose and meaning that comes from spirituality and religious practice may positively contribute to physical and mental health. Whether the relationship is mediated by social support or engaging in healthy behaviors or some other aspects remains to be fully characterized.

Wisdom, which in folk psychology is thought to increase with age, has also been examined in the context of successful aging. Wisdom is a holistic, multidimensional trait thought to encompass knowledge, good decision-making abilities, and also prosocial values and actions. Specifically, the subcomponents of wisdom include:

- (1) Social decision-making and pragmatic knowledge of life as related to social reasoning, ability to give good advice, life knowledge, and life skills
- (2) Prosocial attitudes and behaviors such as empathy, compassion, warmth, and a sense of fairness
- (3) Reflection and self-understanding, which encompasses introspection, insight, intuition, and self-awareness
- (4) Acknowledging and coping with uncertainty
- (5) Emotional homeostasis, i.e., affect regulation and self-control (Bangen et al. 2013)

Biological studies of wisdom suggest that aspects of this construct (e.g., pragmatic life knowledge, emotional homeostasis, and processing ambiguity) may be subserved by brain regions associated with emotionality and immediate reward dependence (e.g., prefrontal cortex, anterior cingulate cortex, and amygdala; see Meeks and Jeste 2009 for review). Importantly, the relative weighting of the different subcomponents of wisdom may depend on the individual's culture (e.g., depending on the cultural context, the importance of introspection or social decision-making may vary). In older adults, wisdom appears to be related to multiple positive states including better physical health, greater quality of life, and better quality of social

relationships (Ardelt 1997; Ardelt and Edwards 2001). Wise elders identify the importance of recognizing the physical declines that accompany old age and yet continuing to engage with life. As such, wisdom may promote successful aging by facilitating the acceptance of the realities of aging and mortality while continuing to live a meaningful life (Ardelt et al. 2013).

This review of the literature regarding the varied predictors of successful aging clearly demonstrates the complex relationships among these factors. For example, participating in leisure activities may exert a positive influence on aging by boosting resilience (a positive psychological trait), building cognitive reserve through engagement, and/or by promoting physical activity and thus improving physical health. These complex interactions have not yet been disentangled, and future research should clarify the associations among these variables and their relative influence on successful aging.

Strategies and Interventions to Promote Successful Aging

While much of the research in the area of successful aging has focused on the underlying factors that promote this construct, a growing body of work has begun to assess interventions to improve upon the typical trajectory of aging. A major limitation in examining the evidence base regarding the effectiveness of various successful aging strategies is the lack of consensus regarding the definition of successful aging. Taking this into consideration, Harmell et al. (2014) defined a “successful aging strategy” as an intervention or potentially modifiable characteristic that is intended to enhance the functioning of normally aging older adults. Numerous strategies for successful aging have received empirical attention, and they are described below.

Physical activity: The benefits of physical activity in aging cohorts have been long established, with longitudinal studies demonstrating that greater exercise participation predicts lower risk of mortality, disability, cardiovascular disease, osteoporosis, and certain types of cancer. As such, the American College of Sports Medicine recommends at least 30 min of exercise 5 days/week to obtain health benefits. Not only is physical activity associated with improved health, it is also a predictor of better cognitive outcomes. Research findings have shown a relationship between higher levels of physical activity and lower levels of cognitive impairment concurrently and also at an 18-month follow-up (Harmell et al. 2014). Additionally, physical exercise also appears to enhance emotional functioning in older adults. Overall, there is substantial support to suggest that physical activity across the lifespan has beneficial effects on various facets of successful aging.

Numerous randomized controlled studies have examined the effectiveness of increasing physical activity on a variety of markers of successful aging in older adults. The exercise modalities studied have included aerobics, strength training, and resistance exercises. In a recent study, Klusmann and colleagues (2012) demonstrated that engagement in physical exercise reduced dissatisfaction in a cohort of older women. This is a promising finding that supports participation in new physical

activity programs as a strategy to positively modulate negative mood. Similarly, moderate exercise in mid- and late life may reduce the risk of mild cognitive impairment and dementia (Ahlskog et al. 2011).

Exercise appears to have the most prominent benefit on executive functioning and verbal memory; however, it remains to be seen how long these effects persist and whether there is a dose effect with regard to benefit in other cognitive domains. There is also evidence suggesting that exercise results in neuroanatomical changes such that sustained aerobic activity over 6 months was shown to increase gray and white matter volume in previously sedentary older adults (Colcombe et al. 2006). It is likely that exercise improves brain functioning by promoting neurotrophic factors and reducing inflammation as well as oxidative stress. With regard to the antidepressant effect of exercise, it has been theorized that exercise may increase levels of neurotransmitters such as serotonin and norepinephrine, boost dopaminergic activity, and elevate endogenous opioids. From a psychological perspective, exercise is thought to boost a sense of mastery and self-efficacy. It may also improve mood and psychological functioning via behavioral activation.

Although there is growing empirical and clinical attention to the benefits of physical activity for older adults, this segment of the population continues to have low rates of physical exercise. Indeed, older adults have unique barriers (e.g., pain, fear of injury or falls, lack of a peer group to exercise with) that lower their participation in physical activity. These issues warrant consideration prior to implementing public health interventions to increase physical activity in older adults. Another issue that must be addressed in future research pertains to improving the adherence of older adults to exercise and sustainment over time. Addressing these barriers has implications for how physical activity may be deployed as an intervention for successful aging in the future.

Dietary change: Diet and nutrition-based interventions are the most frequently studied strategies for extending the life-span in animal models of aging. In humans, studies have demonstrated that high calorie diets and obesity are risk factors for dementia. As such, it is not surprising that there has been an increase in the empirical attention given to dietary interventions. Of note, the findings supporting the use of dietary supplements have been mixed. For example, diets supplemented with folic acid, omega-3 fatty acids, and antioxidants have been associated with better cognitive functioning, while other supplements such as ginkgo biloba and vitamin D have not shown significant benefit for cognition. On the other hand, dietary patterns such as the Mediterranean diet, which includes high consumption of fruits and vegetables, high ratio of polyunsaturated to saturated fats, and foods with low glycemic load, have been shown to be associated with reduced depressive symptoms and lower risk for cognitive impairment.

Based on findings from animal research that support the relationship between caloric restriction and longevity, small trials among humans involving reduced caloric intake compared to baseline have shown improvements in markers such as blood pressure, cholesterol levels, body mass index, and triglycerides (Bordone and Guarente 2005). It is thought that caloric restriction reduces oxidative stress produced by energy metabolism and also changes insulin sensitivity. Furthermore,

caloric restriction may trigger the release of neurotrophic factors such as BDNF that are positively associated with longevity. The exact mechanism through which dietary changes impact successful aging is yet to be characterized, and it is very likely that other factors such as genetic makeup and gut microbiota will play a role in explaining this complex relationship between diet and aging outcomes.

Cognitive stimulation: The growing evidence regarding neuroplasticity being preserved as people age has driven the development of cognitive interventions to delay or slow the progression of cognitive decline. Consequently, older adults are increasingly being encouraged to engage in cognitively stimulating activities such as reading, solving crossword puzzles, and playing board games. In individuals without cognitive impairment, there does appear to be a positive effect of cognitive interventions on cognitive functioning (Vahia et al. 2010). Reijnders and colleagues (2013) reviewed 35 cognitive intervention studies and found that cognitive training in older adults with or without cognitive impairment can be effective in improving objective cognitive functioning. The authors reported a varied range of approaches that were used in these studies, including computerized training, teaching memory strategies, training metacognitive skills, or promoting selective attention skills. Overall, they found improvements in the domains of memory, executive functioning, processing speed, attention, and fluid intelligence. As a result of these interventions, participants' subjective cognitive complaints also appeared to decrease.

Investigators have also explored computerized approaches to improve cognition; however, the results supporting this modality are mixed. In some studies computerized training via videogame-like platforms appeared to have a beneficial effect on multitasking and processing speed, although in others such an approach did not improve visuospatial navigational skills or memory (Pieramico et al. 2014).

Despite these interesting preliminary findings, a major gap in the literature is whether these improvements on laboratory measures of cognition generalize to real-world settings where individuals must execute everyday functioning tasks that tap multiple aspects of these cognitive domains. Another concern is the rapid increase in commercially available products that claim to improve cognition in older adults; many of these tools lack rigorous empirical studies regarding their validity, reliability, and efficacy. Taken as a whole, there are some important issues that are yet to be thoroughly examined in the context of cognitive interventions. First, we need to increase our understanding of the causal effects of these cognitively stimulating activities on slowing or delaying cognitive decline. Second, future research should investigate what types of cognitive activities have the best cognitive outcomes, and relatedly, what frequency of interaction is necessary for cognitive gains. Finally, the mechanisms of the interventions and stimulating activities, whether through structural changes in the brain or alteration in neural activity and circuits, should be characterized.

Social engagement: Across the life-span, social engagement has been found to have positive effects on health and well-being. Social engagement can be defined as being socially and emotionally connected with others such as family members, friends, or the community (e.g., fellow religious organization members). A recent meta-analysis found that social engagement was a strong protective factor for multiple levels of health (i.e., physical, mental, emotional; Holt-Lunstad et al. 2010).

The level of social engagement appears to have a positive effect on health-related quality of life (Cherry et al. 2013). Promoting social engagement and reducing social isolation have been the target of multiple intervention studies. Across studies, different approaches have been including improving social skills, enhancing social support, and facilitating access to peer groups. An important issue to consider when implementing such social engagement interventions is environmental barriers (e.g., limited mobility, transportation resources) that older adults encounter. A novel intervention program called *The Seniors Centre Without Walls* targets the social needs of older adults who are socially isolated due to financial, geographical, or physical restrictions (Newall and Menec 2013). As part of this program, older adults participate in a phone conference, which is facilitated by a leader who provides general aging-related educational information. The conference provides the participants with an avenue to connect with others in the community and make new friends. Participation in this program was associated with increased happiness and lowered loneliness and depression. These findings suggest that even remote or non-face-to-face approaches to social interaction can have a beneficial effect on aspects of successful aging.

Given the strong relationship between environmental and social factors and successful aging, it is critical that these variables be considered when planning and developing communities for older adults. As such, there is a growing interest in establishing community-wide projects to change built (physical) and social environments so that older adults do not encounter barriers to social participation (Scharlach and Lehning 2013). These modifications may include establishing transportation assistance, providing sidewalk benches, creating community senior centers, and hosting social, cultural, or recreational events. Such approaches are critical to building age-friendly cities that promote active aging and enhance quality of life by providing resources for health, social participation, and security to older adults. The development of age-friendly cities reflects a large-scale intervention aimed at providing resources to individuals across the life-span that target critical facets of successful aging (Jeste et al. 2016).

Technology: Another avenue to address the social and environmental aspects of successful aging may be through technology. The ongoing technological revolution shows promise with regard to transforming experience of aging by addressing key social and environmental issues that are salient to older adults. For instance, new computer-based technologies have the potential of helping older adults communicate with relatives and friends who live far away, thus enhancing their social functioning. Another approach to maintaining existing social ties and engagement is by enabling older adults to age safely and successfully in their own homes. Novel technologies such as sensors and monitors are also being used to ensure that older adults can continue to live safely in their own homes despite declines in physical ability. An important issue, of course, is whether older adults can or will adapt to these new technologies. Early data suggest that older adults do in fact adopt novel information and communication technologies and they are increasingly proficient in using these services. These are promising findings that support the development and deployment of exciting new technological approaches to promote well-being in older adults.

Conclusion

In this chapter, we have attempted to deconstruct the various components of successful aging and the underlying mechanisms of successful aging including biological, social, and environmental factors and reviewed predictors of successful aging and various strategies that may increase the likelihood of aging successfully. At present, there is no consensus regarding the definition of successful aging, nor is there a gold-standard measure to assess this construct. Nonetheless, researchers agree that this multidimensional concept that includes physical, cognitive, social, and psychological well-being warrants close attention. The mechanisms of successful aging appear to be reciprocal in nature, and there is a great need to study the interplay between the observable environmental and biological substrates. The predictors of aging successfully also have a complex relationship with one another and various facets of this construct. Further disentangling these relationships has the potential to inform future interventions to promote successful aging across the life-span.

Cross-References

- ▶ [Depression in Late Life: Etiology, Presentation, and Management](#)
- ▶ [Sociology of Aging](#)

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