PATHWAYS TO SUCCESS: MEASURING AND EXPLAINING SUCCESSFUL AGING

by

Matt Manierre

A dissertation submitted to the Faculty of the University of Delaware in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Sociology

Spring 2016

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PATHWAYS TO SUCCESS: MEASURING AND EXPLAINING SUCCESSFUL AGING

by

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ACKNOWLEDGEMENTS

I owe a lot of people for helping me to shape this dissertation into what it is today, and I hope that I’ll be able to pay back the many favors I’ve pulled in during the dissertation writing process. First, a special thanks to Barret Michalec for agreeing to chair this thesis when I had very little idea of where it was even going yet. His fast feedback and patience with a few less than stellar drafts kept my focus sharp and strengthened this project greatly. Ronet Bachman served a similar role, helping me to overcome a few major methodological hurdles and, at times, encouraging me to accept some imperfections and move forward with what I could do within my data. Veronica Rempusheski also provided a number of insights that have been useful to developing this dissertation following my initial defense. Steve Martin from the Center for Drug and Health Studies also provided a great deal of insight while I was developing my initial ideas, and this dissertation was partly funded via an award provided through a project that Steve brought me on to help with\(^1\). My biggest thank you of all goes out to Victor Perez, who assisted in this dissertation with his comments but also has acted as a mentor to me throughout my entire graduate career. We’ve worked together since my first few weeks of grad school and he’s been involved in more or less everything I’ve done in some way or another. So thanks, Victor, I owe you.

\(^1\) Work supported by an Institutional Development Award (IDeA) from the National Institute of General Medical Sciences of the National Institutes of Health under grant number U54-GM104941 (PI: Binder-Macleod)
Many people outside of my committee played an integral role in helping me keep my sanity and drive throughout the dissertation process. Both of my parents have donated countless hours to listening to me ramble aimlessly about half-baked ideas and frustrations. I thank them for their endless reassurance that, eventually, this too shall pass. I’d also like to give a special shout out to my dissertation/job market buddy Kristen Hefner for always being there as a sounding board during this process, talking me off a few ledges and generally just reminding me that we all feel like imposters a lot of the time. Lastly, there’s Katrina Gearhart. We started dating during my thesis, where I acknowledged her as an “unexpected source of motivation.” Now, I not only expected her support but I depended on it on more occasions than I can possibly list. Thank you for helping to make this happen, everyone!
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ABSTRACT

This dissertation examined several issues surrounding the definition, measurement and prediction of successful aging. First, it presented a novel conceptualization that defines successful aging as aging well relative to one’s peers along lines of physical health, mental functioning and outlook, and social engagement. Using the Americans’ Changing Lives dataset, I presented a methodology for operationalizing this conceptual model as a scale, as well as a validation study. Group based trajectory modeling was used to identify individuals with consistently high scores on the successful aging scale over time, allowing for a coherent estimate of the incidence of successful aging (as well as usual and sub-optimal aging) to be derived. An array of regression models were then used to predict successful aging. These regression analyses tested a model that described the direct and indirect effects of social conditions and childhood stress on aging outcomes, with special emphasis being given to how health behaviors and psychosocial factors (stress, support, mastery) mediate the effects of social and life course experiences on successful aging. The validation study was generally supportive of the successful aging scale, and it was found that most respondents clustered around one of three aging trends over time: 32.6% were aging successfully, 48.3% were usually aged, and 19.1% were sub-optimally aged. Each of these aging trajectories followed a downward trend over time, suggesting that future research should be careful to accommodate this normal downward trend. In terms of predictors, it was found that
socioeconomic status, childhood stress, race, and gender were either nonsignificant or less strongly associated with successful aging than physical activity, chronic stress, and mastery. However, it was further found that activity, stress, and mastery mediated the effects of socioeconomic status, race, and (less consistently) sex, but not childhood stress. This suggests that the effects of race, class, and gender are often understated in the successful aging literature, and subsequent studies should carefully examine the direct and indirect pathways through which social conditions influence successful aging.
Chapter 1

INTRODUCTION

This dissertation focuses on three prominent issues in the “successful aging” literature: a) What does it mean to age successfully; b) do our current operationalizations accurately reflect that conceptualization; and c) why do some individuals age successfully and not others? I begin this section of the dissertation with an overview of Rowe and Kahn’s (1987; 1997) model of successful aging. I then summarize various critiques regarding the conceptualization, operationalization, and prediction of successful aging. This is followed by a discussion of how this dissertation contributes to these ongoing debates, as well as this project’s specific goals, research questions, and methodology. The introduction closes with an outline of how the remainder of this dissertation will be organized.

To briefly summarize, within this dissertation, I incorporate criticisms of a popular conceptualization of successful aging by expanding the criteria for “success” to include both mental health and life satisfaction. Regarding measurement, I apply new statistical methods that classify individuals as aging successfully differently than most prior research, which might produce more accurate estimates by better accounting for heterogeneity and normal age related decline. I elaborate on current explanations of why individuals age successfully and discuss how sociodemographics and early childhood
experiences may operate on successful aging directly and indirectly through health
behaviors and psychosocial risk factors (e.g. stress, social support, mastery).

1.1 Successful Aging

Prior to the 1980’s, the (social) gerontological literature was primarily centered on
identifying the differences between the sick and the “normal” (Bülow and Söderqvist
2014; Rowe and Kahn 1987). In 1987 Rowe, a physician, and Kahn, a social
psychologist, suggested that researchers’ focus on this sick versus “normal” dichotomy
concealed individuals who had aged unusually well relative to their peers (Rowe and
Kahn 1987). This was problematic, as it ignored individuals who aged especially well
while also overemphasizing the inevitability of disability and disease in old age. To
remedy this, Rowe and Kahn (1997) identified a third group - the “successfully aged” -
defined as having exceptional physical health, cognitive functioning, and social
participation relative to their peers. Compared to what has been termed the “misery
perspective,” (Tornstam 1992) which focused on depression, disability and disease,
studying successful aging was an optimistic paradigm shift that encouraged the
exploration of resilience in old age (Scheidt, Humpherys, and Yorgason 1999). Since its
initial appearance in 1987 Rowe and Kahn’s framework has gained substantial traction in
the gerontology literature, as evidenced by a combined total of 6,353 citations for the two
flagship publications (Rowe and Kahn 1987; 1997).

Rowe and Kahn (1998) went on to suggest that almost anyone has the ability to
age successfully. They argued that successful aging is primarily determined by individual
health behaviors (e.g. diet, exercise) and psychosocial factors (e.g. self-efficacy, support)
rather than genetics. It was therefore possible that doctors and public health departments
could increase the incidence of successful aging in the population through interventions that encouraged individuals to modify their health behaviors.

The idea that successful aging could be promoted in the population had strong implications in light of a tripling of the proportion of adults over age 65 during the past century (Administration on Aging 2013). This ongoing demographic shift is expected to bring a one-fifth increase in per-capita health expenditures in the next fifty years (Alemayehu and Warner 2004). Enabling more individuals to age successfully serves as a way of controlling these booming costs, since successful agers avoid disease, disability, and cognitive decline. Average estimates across 109 studies suggest that only 26% of adults age successfully, suggesting that substantial gains can be made in this area (Cosco et al. 2014). In addition, encouraging successful aging empowers individuals to independently maintain a high quality of life in old age by maximizing functional autonomy and social engagement. Given these benefits, researchers and policymakers have been interested in raising the number of individuals who age successfully.

1.1.1 Defining Success: A Point of Contention

Rowe and Kahn (1997) defined successful aging as the presence of cognitive functioning and high social engagement, as well as the absence of disease and disability. However, some argued that these criteria are insufficient, contending that this conceptualization depended on a biomedical definition of health that ignored the individual’s own perception of how their lives are going (Phelan and Larson 2002; Pruchno, Wilson-Genderson, and Cartwright 2010; Strawbridge, Wallhagen, and Cohen 2002). Others have argued that it is important to also consider mental health and emotional adjustment as components of successful aging (Depp and Jeste 2006; Jeste,
Depp, and Vahia 2010; Young, Frick, and Phelan 2009). Similarly, a number of other scholars have proposed various other criteria for success such as spirituality, leisure activity, and self-efficacy (Crowther et al. 2002; Lee, Lan, and Yen 2011; Martinson and Berridge 2014; Young, Frick, and Phelan 2009). It has been further suggested that Rowe and Kahn’s conceptualization pathologizes natural age related losses by encouraging binary thinking about successful aging, resulting in the labeling of the old-old as “failures” for not meeting arguably unattainable standards (Cosco, Stephan, and Brayne 2014; Cosco, Stephan, and Brayne 2015; Holstein and Minkler 2003; Martinson and Berridge 2014; Minkler 1990). These criticisms suggest that incorporating modifications to Rowe and Kahn’s original three criteria conceptualization might be important for improving its comprehensiveness.

1.1.2 Measuring Success: A Challenging Task

Rowe and Kahn’s three broad criteria (avoiding disease, cognitive functioning, social engagement) provided researchers with a set of measurable dimensions that could be used to identify who ages successfully. Although the broad scope of these three dimensions could be considered a strength (e.g. easily available in major datasets), there is still little agreement on how to classify individuals as successfully aged. For instance, a recent review of 84 studies of successful aging found a total of 105 different operational definitions (Cosco et al. 2014). This proliferation of approaches reflects the challenges researchers have faced in deciding the dimensions that make up successful aging and where the line between successful and not successful should be drawn. To the former point, some have omitted the multidimensional aspect of Rowe and Kahn’s conceptualization entirely, focusing on only physical health in lieu of cognitive
functioning and social engagement (Cosco et al. 2014). Critics have argued that this is problematic because successful aging was intended to reflect excelling in a wide array of areas, rather than just one (Bowling 2007; Cosco et al. 2014; Grundy and Bowling 1999).

Yet, even when all three dimensions of Rowe and Kahn’s conceptualization are considered, operationalizing successful aging presents two additional challenges. Both of these relate to the classification of individuals as having aged successfully or not. To begin with, Rowe and Kahn (1987) specify the existence of at least three distinct aging groups that summarize how “well” individuals have aged - the successfully aged, the usually aged\(^2\), and (more implicitly) the sick. In addition to this, they argue that successful aging is relative to one’s age group. That is, according to Rowe and Kahn, successful aging reflects variation within a particular age group, not between. This nuance is important to consider, as it prohibits holding the young-old and old-old to the exact same standard, such as an average for all individuals. Therefore, an accurate operationalization of Rowe and Kahn’s conceptualization should try to account for both the presence of multiple aging groups (i.e. heterogeneity) and age-varying criteria for success.

The approaches that researchers have applied in response to these measurement challenges (multidimensionality, heterogeneity, age dependence) leave room for further development. To illustrate, one common method is to classify individuals into a successful/unsuccessful dichotomy (e.g. Brandt, Deindl, and Hank 2012; Feng, Son, and Zeng 2015). This method can account for multiple dimensions, but it ignores

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\(^2\) Rowe and Kahn (1987) distinguish successful and usual aging as: “Usual aging, in which extrinsic factors heighten the effects of aging alone, and successful aging, in which extrinsic factors play a neutral or positive role (143).” The “extrinsic factors” they are referring to are diet, exercise, and psychosocial factors such as stress and coping.
heterogeneity and age dependence. As a result, dichotomous classifications can result in an overestimation of individuals who “fail” to age successfully (Cosco et al. 2014; Cosco, Stephan, and Brayne 2015). This is largely because ignoring heterogeneity means that the “unsuccessful” group’s size is inflated and its contents are obscured, as it includes both the near-successful and the very sick in a single category (Cosco et al. 2014; Cosco, Stephan, and Brayne 2014). Binary classification risks further bias in estimating the size of the “successful” group, as all age groups are held to a universal standard of success rather than an age specific standard that would reflect the idea of “aging well, which is very different from not aging at all (Rowe and Kahn 1998:48-49)”. For example, a 90 year old who ages well compared to other 90 year olds may be classified as failing if held to the same standard as a 70 year old, while in reality s/he should be classified as aging successfully.

Alternatives to the binary method have been proposed, but their validity needs to be further established and results need to be replicated (e.g. Cosco, Stephan, and Brayne 2015; Hsu and Jones 2012; Young et al. 2009). It is therefore important that these promising alternative operationalizations be applied and thoroughly assessed, as they may provide a better assessment of heterogeneity and a broad spectrum of aging quality. Until the challenges of operationalizing successful aging are resolved there is a risk of biased estimates and mistaken conclusions.

1.1.3 Conflicting Perspectives: Why Do Some Succeed and Not Others?

Regardless of how successful aging is defined or measured, if effective interventions promoting successful aging are to be developed, it is important to understand how successful aging is achieved. Rowe and Kahn’s account of how
successful aging is achieved focuses on the individual, stating, “Our main message is that we can have a dramatic impact on our own success or failure in aging. Far more than is usually assumed, successful aging is in our hands (1998: 18),” and “In short, successful aging is dependent upon individual choices and behaviors. It can be attained through individual choice and effort (Rowe and Kahn 1998: 37).” Hence, it is clear that according to Rowe and Kahn, “success” (and implicitly, failure) is attained through individual choices surrounding diet, exercise, and smoking habits.

This individual agency emphasized in Rowe and Kahn’s explanation of why individuals age successfully is a key point of debate within the successful aging literature (Bowling 2007; Bülow and Söderqvist 2014; Dillaway and Byrnes 2009; Goodwin 1991; Katz and Calasanti 2015; Minkler 1990; Moody 2001; Riley 1998; Scheidt, Humpherys, and Yorgason 1999; Schmeekle and Bengston 1999; Stowe and Cooney 2015). For example, Katz and Calasanti (2015) suggest that by emphasizing individual behaviors as the primary source of successful aging, Rowe and Kahn’s model downplays the impact of social structure on the individual’s opportunities, choices, and behaviors. Stowe and Cooney (2015) further argue that Rowe and Kahn’s causal narrative would be strengthened by not only considering social (meso- and macro-level) conditions but also exploring if exposure (or lack thereof) to various risk factors throughout the life course can influence a person’s ability to age successfully. The criticisms raised spotlight the current lack of attention paid to how the social and life course determinants of successful aging, and the avenues through which they operate, may be distracting from more

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3 This explanation of why individuals successfully age is often referred to as Rowe and Kahn’s causal narrative in this dissertation. The phrase Rowe and Kahn’s model is used when referring to the combination of the conceptualization (i.e. the three dimensions) of successful aging alongside this causal narrative. A diagram of this model can be found in figure 2 in chapter 2.
effective and efficient interventions for promoting successful aging (Brandt, Deindl, and Hank 2012; Katz and Calasanti 2015; Stowe and Cooney 2015). Recently, Rowe and Kahn (2015) acknowledged this limitation in both their own framework and the successful aging literature more broadly, calling for expanded consideration of the social and life course determinants of successful aging.

There is also room for integrating both these “upstream” explanations (e.g. social inequality, the life course) with the immediate individual explanations that Rowe and Kahn proposed. Individual exposures to health risks are shaped by their surrounding social environment, but that unequal access to opportunity was not acknowledged by Rowe and Kahn until very recently (Katz and Calasanti 2015; Riley 1998; Rowe and Kahn 2015; Scheidt, Humpherys, and Yorgason 1999). Studies that have looked at the social determinants of successful aging are similarly limited because they do not test the mechanisms through which they ultimately operate on health (Brandt, Deindl, and Hank 2012; Britton et al. 2008; McLaughlin et al. 2009). In other words, these studies identify poverty as a correlate to successful aging, but they do not test the pathways through which poverty indirectly influences successful aging (i.e. behavioral choices, unequal risk exposure). Therefore, to create a more satisfying explanation it may be useful to treat proximate risk factors for successful aging as mediators for the effects of social conditions. One such mediator is the health lifestyles that the successful aging literature has focused on. Other mediators that place less emphasis on individual agency may also need to be examined to fully understand the routes through which successful aging is influenced by distal factors.
Another set of potential mediators that Rowe and Kahn proposed are psychosocial factors such as stress and coping. However, little research has examined these psychosocial mechanisms as mediators for the effects of sociodemographics and early life course experiences in the context of successful aging. It is likely that they will be strong mediators, as the unequal distribution of stress throughout society along lines of race, class, and gender is frequently cited as a mechanism through which these upstream factors exacerbate health disparities (Aneshensel 2015; Lantz et al. 2005; Longest and Thoits 2012; Marmot 2004; Pearlin et al. 1981; Thoits 2010; Turner and Avison 2003). Unequal exposure to stress and coping resources is therefore likely to help explain both why some individuals age successfully and how social conditions influence successful aging. Integrating both distal (i.e. social and life course determinants) and proximate determinants (lifestyle, stress) of success in a single framework will help to unify the two sides of this debate while also highlighting individual level sites for intervention that may be specific to, for instance, a certain sex.

1.1.4 What Has Been Done, What Is Still Needed

The challenges of conceptualizing, measuring, and predicting successful aging have yet to be fully resolved in the literature. Few studies have sought to simultaneously incorporate criticisms regarding these three components of the study of successful aging, instead focusing on just one at a time. For example, some studies have advanced our understanding of the social causes of successful aging by looking at how social inequality and early childhood conditions influence successful aging, but they depended on binary operationalizations (Brandt, Deindl, and Hank 2012; Britton et al. 2008; Wickrama et al. 2013). Others have used sophisticated methods such as latent trajectory models that allow
for the assessment of multiple aging groups instead of depending on a successful/unsuccessful binary (Hsu and Jones 2012; Wickrama et al. 2013; Tang 2014). However, those studies depended on only sociodemographics to predict successful aging, save one notable exception that included childhood conditions (Wickrama et al. 2013). Therefore, given these gaps in the successful aging literature, a logical direction for future research is the simultaneous application of new group specification methods with a robust predictive model that integrates both individual level, social, and life course elements. In addition to this, it is important to incorporate new developments that have been made in the conceptualization of successful aging in order to keep analyses relevant. Integrating improved classification methods with a broader conceptualization and predictive model will facilitate a more thorough understanding of both who ages successfully and why then is currently available.

1.2 This Dissertation

The current dissertation aims to address these issues of conceptualization, measurement, and prediction in a number of ways. In terms of conceptualization, this study adopts Rowe and Kahn’s original three dimensional conceptualization while also adding new dimensions in response to criticisms that suggest the conceptualization is too narrowly specified. Specifically, life satisfaction and mental health, which are commonly incorporated in the literature, are considered in addition to the original three dimensions (Cosco et al. 2013; Depp and Jeste 2006; Jeste, Depp, and Vahia 2010; Kahng 2008; Ng et al. 2009; Pruchno, Wilson-Genderson, and Cartwright 2010; Vaillant and Mukamal 2001). This results in a more holistic conceptualization that gives greater weight to mental health and self-appraisal than was previously possible. I also place stronger
emphasis on the idea that successful, usual, and sick aging reflect trajectories over time, with the criteria for success varying with age (Hsu and Jones 2012; Stowe and Cooney 2015). For example, an individual must remain consistently healthy and engaged over time to be considered aging successfully, though the meaning of “good health” and “high engagement” may vary with age. This reemphasizes Rowe and Kahn’s original assertion that successful aging reflects heterogeneity within age groups, discouraging comparisons of the young against the old. Following prior research (Bowling 2007; Cosco, Stephan, and Brayne 2015; Young et al. 2009), I also consider successful aging as a continuum ranging from success to isolated, unhappy, and unhealthy, rather than a simple successful/unsuccessful binary. This has the advantage of enabling individuals with chronic illness to still rank highly if other dimensions are flourishing, rather than immediately classifying them as unsuccessful. Like Rowe and Kahn, (1987; 1998), I place strong emphasis on successful aging being relative to one’s age group, rather than any universal standard.

I present a methodological approach that borrows the strengths of two methods for estimating successful aging groups. First, I use a recently proposed method to construct a successful aging continuum (Cosco, Stephan, and Brayne 2015). The advantage of this strategy is that it allows for successful aging to be operationalized as a broad spectrum, as compared to binary or ordinal approaches of the past (e.g. Grundy and Bowling 1999; Young et al. 2009). This approach is very new, however, and needs to be further validated to ensure that it’s accurately capturing the essence of the conceptualization. Therefore, I examine the predictive validity of this continuum
empirically and also assess how it correlates with three other operationalizations from the literature.

After the continuum is validated, group based trajectory modeling will be used to identify the life course trajectories around which individuals cluster on the continuum over time (Nagin 2005). This is an ideal method since it is specifically designed to identify multiple developmental (e.g. aging) trajectories that exist within a sample, as would be expected in the case of Rowe and Kahn’s successful, usual, and sick aging (Hsu and Jones 2012). After these groups are estimated, membership in each aging group can be predicted to test theoretical models.

I also propose a predictive model that moves towards integrating research on the social and individual level determinants of successful aging. This model, simplified in Figure 1, is based on Pearlin and colleagues’ (1981) stress process model. Rowe and Kahn (1987) briefly consider stress and coping as antecedents of successful aging, and the stress process model is a natural extension of those ideas. The original stress process model also explicitly considers stress and coping as mediators for the effects of social conditions, meaning it is well suited to the goals of this dissertation. Pearlin’s original stress process model is adapted for this study in two ways. First, this study’s model incorporates modifications to the stress process model that account for stress over the life course (Aneshensel 2015; Kahn and Pearlin 2006; Pearlin et al. 2005; Pearlin 2009). For instance, stress is allowed to accumulate over time and unexpected major life events are predicted to produce additional chronic stress in other parts of one’s life. Second, it accounts for health behaviors such as smoking and exercise, which have been found to be important predictors of successful aging (Franklin and Tate 2009). Accounting for these
behaviors is key, as it integrates the stress process model more fully with existing research and theorizing on the causes of successful aging.

![Simplified Explanatory Model](image)

Figure 1  Simplified Explanatory Model

Put briefly, the proposed model posits that some social positions (e.g. low SES, minority status) increase risk of stress exposure in terms of both chronic stress and sudden undesirable events. These exposures begin in childhood and accumulate over time, with repeat exposure decreasing one’s odds of aging successfully. Individuals can cope with those stressors by deploying positive coping resources such as a sense of mastery and social support. Individuals can also employ negative stress coping strategies such as substance use. Physical activity also acts as a mediator for the effect of social conditions while also reducing chronic stress levels.

This proposed model requires the consideration of how factors outside an individual’s control can alter his/her ability to age successfully. This contrasts against Rowe and Kahn’s individual-focused narrative and aligns with empirical studies of the
direct effects of social inequality on successful aging (Brandt, Deindl, and Hank 2012; Britton et al. 2008; Wickrama et al. 2013). Testing this explanatory model will also reveal if researchers need to refocus their attention onto the how inequality impacts individual level behaviors and choices. Social hierarchies and the ways they attenuate risk are made explicit in this model, rather than assuming all individuals have equal risk.

Based on previous literature and these proposed elaborations, this study has three main aims:

1) Can predictive validity be established for the successful aging continuum being used in the current study, and does it correlate with other operationalizations of successful aging?

2) Are there at least three latent aging trajectory groups that reflect Rowe and Kahn’s expectation of successful, usual, and sick aging groups?

3) Does the proposed explanatory model accurately describe the direct and indirect pathways (e.g. stress, health behaviors) through which social and life course determinants influence successful aging?

1.2.1 Key Contributions

The implications of this study can be broken into three broad categories-theoretical, methodological, and policy/practical. In terms of theoretical contributions, this analysis integrates Rowe and Kahn’s model of successful aging with a modified stress process model to test both if and why social and life course conditions influence successful aging. In doing so, it provides useful contextualization and elaboration on the mechanisms that may facilitate successful aging. Health lifestyles are often considered in the study of successful aging, but they are rarely thought of as a mediator for the effects of social characteristics and stress exposure over the life course, as well as early life experiences such as childhood poverty. This model explicitly identifies and spotlights that mediating role and tests it. In all, stress and its associated mediators are only rarely
explored as an antecedent of successful aging, and their consideration here is a useful contribution. The use of stress as a mediator for the effects of social characteristics further enhances that contribution by providing important context to what would otherwise be a purely proximate measure.

The explanatory model presented here may have implications for Rowe and Kahn’s individualistic account of the causation of successful aging. On one hand this proposed mediating model may not be supported, validating Rowe and Kahn’s assertion that individual level interventions are sufficient to promote successful aging. On the other hand, if the proposed mediators are found to be both unequally distributed throughout society and predictive of successful aging, it would confirm the concerns of many critics of Rowe and Kahn’s causal narrative. Specifically, it would suggest that to promote successful aging, policies need to alleviate the effects of social hierarchies (e.g. racial and class stratification). The narrative surrounding the promotion of successful aging would have to shift from individual reeducation to a discussion of the implications of social inequality and the avenues through which it influences health.

Methodologically, this dissertation may be able to overcome some of the measurement challenges that have made it difficult to determine who is and is not aging “successfully.” The construction the continuum will allow for the assessment of a wide range of experience that can then be validated with external indicators. This validation and comparison to other approaches is a contribution of its own, as it will help to verify the utility of the operationalization proposed by Cosco and Colleagues (2015). The more valid continuum is also stepping stone to an improved method for the actual classification of individuals as successfully aged. The method used to perform this classification can
identify multiple aging trajectories without making unnecessary assumptions about their shape over time or size. Though both of these methods have been used separately in studies of successful aging, combining the two methods will create a stronger measure.

Specifically, these modifications may strengthen conclusions in three ways. First, the successful aging continuum will be validated against other measures, increasing confidence that this measure is both reflective of the concept and comparable to alterative operationalizations. Second, this method allows for the eligibility criteria for successful aging to be age dependent, as opposed to holding the young-old and old-old to the same metric. The latter comparison is arbitrary and would bias measures against the old-old by pathologizing what may be normal decline. Third, these methods enable the empirical assessment of multiple groups. This is useful because it allows estimates of the prevalence of successful, usual, and sick aging groups instead of lumping non-successful individuals into a binary. It also establishes a more meaningful reference group against which to compare successful agers. A comparison against everyone that is “not successful” does not lend much insight into where interventions should be focused to help those that are most in need.

Practically, this analysis has the potential to contribute to policy and public health discussions in several ways. As noted earlier, identifying multiple aging groups (e.g. successful, usual, sick) means it is possible to examine not only who has aged successfully but also how much the population is truly in need of assistance. This analysis can also identify different risk factors for each group separately, helping to set intervention priorities. For example, if having a stressful childhood is predictive of belonging to the least successful group then interventions interested in promoting
successful aging should target early life conditions. Conversely, if a stressful childhood predicts only being in a “usual” aging group then perhaps interventions do not need to prioritize childhood as highly as other influences. If stress is a key predictor of successful aging then various manifestations of stress would be another site for intervention. On the individual level, stress management and mindfulness interventions may serve as a way to alleviate the threat stress poses to successful aging. Finally, if health behaviors, stress, support, and/or mastery are found to be mediators for the effects of social conditions then the target for interventions would need to be refocused to the root of the problem in addition to the mediators. Policies about promoting successful aging would have to address the effects of systemic inequality or structural racism that may lie at the root of the problem. So for instance, a policy that reduces the amount of time a person spends in poverty would be supported because it would be addressing the source of stress rather than the stress itself.

1.3 Organization of this Dissertation

The remainder of this dissertation is organized into seven chapters. Chapter 2 delves more deeply into both the successful aging literature and the literature on stress and health. This discussion is broken into three sections- the first reviews the conceptualization of successful aging in detail, as well as some supporting research. The second section addresses core criticisms of the conceptualization, operationalization, and prediction of Rowe and Kahn’s model of successful aging. Finally, in response to these criticisms I propose the conceptual, operational, and predictive stress process models to be used in this study.
Chapter 3 describes the proposed methods for the current study. I begin by describing the Americans’ Changing Lives dataset, which provides the five waves of data for this study, and how data are structured for this analysis. All measures are described and descriptive statistics are presented. Then a three step analytic plan is presented. The first step involves constructing a successful aging continuum based on Cosco and colleagues’ (2015) work and validating it against related indicators and alternative operationalizations. The second step uses those scores on the continuum to map multiple aging trajectories over the life course. The final step tests the explanatory stress process model’s assertions piece by piece using a series of regression models.

The remaining chapters will address results and their implications. The first of these chapters presents the results of the validation study, which assesses the predictive and convergent validity of the successful aging continuum. The next chapter covers the results of the group based trajectory models, which identify the aging groups that will be used in tests of the explanatory model. This chapter also focuses on integrating these results with the broader stress process literature and making policy recommendations. The final analytic chapter presents results of the stress process model, identifying the direct and indirect pathways through which successful aging is influenced. The conclusion chapter summarizes all prior chapters and their implications for the successful aging literature more broadly. Key limitations and directions for future research are also addressed here.
Chapter 2

LITERATURE REVIEW

2.1 A Brief History of “Successful Aging”

The term “successful aging” emerged in the 1960’s (Martin et al. 2015), with Havighurst (1961) broadly defining it as the conditions under which both an individual and society maximize life satisfaction and happiness. He drew on two major gerontological theories of aging to present competing definitions of the circumstances that constitute successful aging:

1. The Activity Theory.—successful aging means the maintenance as far and as long as possible of the activities and attitudes of middle age.
2. The Disengagement Theory.—successful aging means the acceptance and the desire for a process of disengagement from active life (Havighurst 1961: 8)

In both of these conceptualizations, successful aging is defined in terms of a person’s engagement, or lack thereof, in different social roles. Havighurst’s hope was that the correct conceptualization could be determined empirically by comparing life satisfaction among individuals who were actively engaged versus disengaged. The definition of successful aging that was supported (i.e. it was linked with higher life satisfaction) could then be used as an end goal for gerontology as a field (Havighurst 1961). The notion gained little scholastic traction, and in the years that followed many gerontologists focused their attention on ideas such as life satisfaction, which were related but not identical to successful aging (Martin et al. 2015).
A quarter of a century later, the concept reemerged through Rowe and Kahn’s (1987) discussion of successful aging, which does not cite or resemble any of the previous work on the topic. This version was devised in the early phases of the Macarthur Foundation’s Research Network of Successful Aging, which was established to invigorate the theoretical frameworks of gerontology and conduct a longitudinal study of over a thousand 65+ adults who had exceptionally good physical health (Bülow and Söderqvist 2014). Kahn (2003) notes that they did not intend for this 1987 piece to present a finalized conceptualization of successful aging. Rather, their goal in this particular work was to draw attention to heterogeneity in the aging process. They contended that previous research was fixated on comparing only the sick and disabled with the “normal” (i.e. anyone who was not sick or disabled). This fixation concealed that some individuals in the “normal” group had exceptionally good health compared to their peers (Rowe and Kahn 1987). Focusing on only the sick was problematic because it downplayed the possibility for strength and resilience in old age, implying that old age could be characterized by nothing but disease, depression, and decline (Scheidt, Humpherys, and Yorgason 1999).

To rectify this oversimplified understanding of the aging process, Rowe and Kahn suggested that a distinction could be made between the successfully aged and the usually aged. They described successful agers as having exceptional health, avoiding physical disability and disease in spite of their older age (Rowe and Kahn 1987). However, successful aging did not entail complete avoidance of changes due to aging- instead it reflected “aging well” relative to one’s peers (Kahn 2003; Rowe and Kahn 1987). On the other hand, the usually aged “show the typical non-pathologic age-linked [physiologic]
losses (Rowe and Kahn 1987: 144).” The usually aged gravitate towards the average, while successful agers perform substantially higher than the norm.

The identification of this heterogeneity in aging outcomes (successful vs usual vs sick) also contained a critique of the nature of aging itself. Prior to this point, many gerontologists argued that the onset of disease and disability was an unavoidable part of the biological aging process (Bülow and Söderqvist 2014). Rowe and Kahn (1987) disagreed, pointing out that the existence of “successful” agers who (largely) avoid disease and disability at old age contradicts this, suggesting that “the effects of the aging process itself have been exaggerated, and the modifying effects of diet, exercise, personal habits, and psychosocial factors underestimated (143).” In other words, while chronological age itself produced some physical and cognitive decline, they suggested that this deterioration was accelerated a great deal by external factors. Some of these external factors were modifiable, and therefore disease and disability might no longer be as inevitable as was previously thought. This opened up the possibility that old age could be a time of health and vibrancy for a larger number of adults, if the appropriate changes were made.

Rowe and Kahn maintained that in order to maximize successful aging in the population, health officials would need to focus less on treating disease and disability and more on preventing them. They specified several extrinsic (i.e. non-genetic) pathways through which risk is increased, and thereby successful aging is decreased. They posited that good diet, exercise, and elimination of both smoking and heavy drinking are likely to prevent the onset of physical illness and disability. Education was also presented as a protector against cognitive decline. In addition, several psychosocial factors were
suggested in the form of a sense of autonomy and control, the presence of positive social support, and stress caused by bereavement and relocation. Social support was expected to mitigate the effects of stressors to some extent as well.

Rowe and Kahn’s initial discussion of successful aging stimulated a broad interdisciplinary conversation. Some scholars expressed skepticism towards the biomedical slant of Rowe and Kahn’s conceptualization, which they felt unfairly labeled the permanently disabled as failures (Minkler 1990). Others argued that Rowe and Kahn pathologized normal physical decline by labeling it as preventable, when in reality it may not be (Goodwin 1991). Most, however, took to the concept with enthusiasm, using it as a launching point for new theories and empirical work in social gerontology and psychology (e.g. Baltes and Baltes 1990; Berkman et al. 1993; Bülow and Söderqvist 2014; Garfein and Herzog 1995; Martin et al. 2015).

For example, Baltes and Baltes’s (1990) argued that successful aging should be considered as an ongoing *process* of adaptation to one’s circumstances, rather than Rowe and Kahn’s idea of considering one’s *state* of health at a given time. According to Baltes and Baltes, physical decline was unavoidable and therefore what mattered was how well the individual was able to respond to those losses (i.e., goal selection, skill optimization, and/or compensation). Therefore, for Baltes and Baltes, successful aging is the effective engagement of these responses to prevent and/or mitigate the effects of loss and decline.

A decade later, Rowe and Kahn (1997) presented a review of empirical research, mostly from the Macarthur Foundation Research Network of Successful Aging. These studies found empirical support for the previously proposed lifestyle and psychosocial mechanisms, though few studies had been conducted on the effects of self-efficacy and
stress at the time. Rowe and Kahn also added income as a predictor of physical functioning based on this literature. They also elaborated on how they conceptualize successful aging: to be classified as successfully aged, individuals must a) avoid disease and disease-related disability while also having low risk for future diseases; b) retain high cognitive and physical functioning; and c) demonstrate “active engagement with life.” This last dimension is defined in terms of maintaining interpersonal relationships and engaging in productive activity (e.g. social supportive behaviors, caregiving, working, volunteering). These empirical and conceptual developments are summarized in conjunction with the predictors in the original 1987 article in Figure 2.

Figure 2  Rowe and Kahn’s (1997) Model (Conceptualization and Predictors) of Successful Aging

Rowe and Kahn (1998) later reiterated their emphasis on the role of lifestyle choices in producing success in aging. For instance, they argue that: “In short, successful aging is dependent upon individual choices and behaviors. It can be attained through
individual choice and effort (Rowe and Kahn 1998: 37).” Commenters have noted that this places a strong emphasis on the role of individual agency in producing successful aging (Bülow and Söderqvist 2014; Katz and Calasanti 2015; Stowe and Cooney 2015). Their emphasis on this agency reflects Rowe and Kahn’s optimism that individual level interventions would be sufficient for maximizing successful aging.

In sum, Rowe and Kahn’s model of successful aging presented a challenge to the idea that old age was always a time of decline. Instead, they presented a hopeful image of old age where, under the right circumstances, individuals could retain physical health, cognitive functioning, and social engagement well into old age. The following section reviews some of the work that has been done in support of Rowe and Kahn’s model.

2.2 Support for Rowe and Kahn’s Model

A great deal of research has examined the lifestyle predictors of successful aging that Rowe and Kahn proposed (e.g. smoking, drinking, exercise) (Depp and Jeste 2006; Franklin and Tate 2009). The most consistent finding thus far is that smoking is a major threat to successful aging, decreasing longevity and increasing risk of many diseases (e.g. Britton et al. 2008; Burke et al. 2001; Depp and Jeste 2006; Franklin and Tate 2009; Jorm et al. 1998; Leveille et al. 1999). Excessive alcohol consumption has been found to reduce one’s chances of successfully aging as well, but moderate consumption has been found to have a fairly positive impact (e.g. Brandt, Deindl, and Hank 2012; Feng, Son, and Zeng 2015; Pruchno, Wilson-Genderson, and Cartwright 2010). Engaging in consistent vigorous exercise is also a strong and consistent predictor of successful aging (e.g. Brandt, Deindl, and Hank 2012; Britton et al. 2008; Depp and Jeste 2006).
Compared to lifestyle predictors, the psychosocial factors that Rowe and Kahn proposed (e.g., social support, self-efficacy, stress) have been studied in less depth. For instance, Depp and Jeste’s (2006) review found fourteen studies that assessed the effects of smoking, drinking, or exercise compared to only three that looked at self-efficacy, two that examined stressful life events, and none that looked at chronic stress. More recently, the impact of stress exposure on successful aging has been studied using major life events (e.g. bereavement, trauma) and chronic stress exposure as predictors. The studies that exist suggest that both chronic stress (Kahana, Kelley-Moore, and Kahana 2012; Moore et al. 2013; Seeman et al. 2004) and recent negative life events (Garfein and Herzog 1995; Grundy and Bowling 1999; Kahana, Kelley-Moore, and Kahana 2012; Moore et al. 2013) are linked to a decrease in a person’s likelihood of successfully aging. Few studies have examined both life events and chronic stress simultaneously, however, and the two that were found (Kahana, Kelley-Moore, and Kahana 2012; Moore et al. 2013) were not able to control for health behaviors and depended on limited samples of either community dwelling elderly or HIV patients. The promising results from this handful of studies give substantial motivation for further research on how both stress and various coping resources (e.g. self-efficacy, support) influence successful aging.

Phelan and Colleagues (2002) suggest that one way to assess the face validity of Rowe and Kahn’s conceptualization of successful aging is to ask elders how they define the concept. Cosco and colleagues (2013) reviewed 27 qualitative studies that asked older adults what successful aging meant to them. They found that all three of Rowe and Kahn’s criteria were mentioned as elements of successful aging, with primary emphasis being placed on social engagement. Bowling and Dieppe’s (2005) study of 854 British
elders’ perceptions of successful aging also corroborates Rowe and Kahn’s criteria, finding that physical health, mental health, and maintenance of social roles were the most frequently mentioned elements of successful aging. However, both Cosco and colleagues, and Bowling and Dieppe also found support for other components of successful aging such as a sense of perspective or financial stability. These particular results suggest that other factors beyond Rowe and Kahn’s criteria may be important to consider in defining successful aging.

2.3 Critiques of Rowe and Kahn’s Model

While there is extant support and appreciation for Rowe and Kahn’s model of successful aging, there are specific critiques as well. The critiques can be categorized by their primary focus: a) conceptualization, b) operationalization, c) the de-emphasis of social determinants, and d) the lack of a life-course approach. Each of these categories of critiques are discussed in depth in the sections that follow.

2.3.1 Conceptualization

In their review of critiques of Rowe and Kahn’s conceptualization, Martin and colleagues (2015) note that many critics have argued that important criteria for “success” are omitted when successful aging is defined as only the avoidance of disease, cognitive functioning, and social engagement. For instance, Young and Colleagues (2009) call for the consideration of measurements of mental health (outside of cognitive ability). Their key point is that strong physical and mental functioning are relatively meaningless if the individual is too depressed to engage that functionality. Studies have shown that risk of depression coincides with the aging process, specifically after 65 (Clarke et al. 2011), indicating that depression reflects an age related risk much like other factors in Rowe and
Kahn’s conceptualization. To address this suggested limitation, a number of scholars have added specific mental health measures to Rowe and Kahn’s original conceptualization, such as absence of depression and emotional adjustment (Britton et al. 2008; Cheng 2014; Depp and Jeste 2006; Jeste, Depp, and Vahia 2010; Kahng 2008; Lee, Lan, and Yen 2011; Parslow, Lewis, and Nay 2011; Strawbridge, Wallhagen, and Cohen 2002; Vaillant and Mukamal 2001; Young, Frick, and Phelan 2009; Young et al. 2009).

While not all conceptualizations include a mental health component, it is one of the most common additions to Rowe and Kahn’s conceptualization (Bowling 2007; Cheng 2014; Depp and Jeste 2006; Jeste, Depp, and Vahia 2010).

It is also argued that Rowe and Kahn’s conceptualization of successful aging imposes the criteria for success upon the elderly, rather than allowing the aged and aging to provide an evaluation of their own lives and aging processes (Martinson and Berridge 2014; Pruchno, Wilson-Genderson, and Cartwright 2010; Strawbridge, Wallhagen, and Cohen 2002). To illustrate this point, Strawbridge and colleagues (2002) present results from a survey of 867 adults aged 65 or older. Two measures of successful aging were used: a self-rated successful aging measure and a classification based on Rowe and Kahn’s three criteria. They found that only 18.8% of elders were classified as aging successfully by Rowe and Kahn’s criteria, but almost 50.3% rated themselves as aging successfully. In response to this disconnect researchers have frequently incorporated indicators of life satisfaction or questions asking if the respondent views themselves as aging successfully (Bowling 2007; Cosco et al. 2014; Depp and Jeste 2006; Pruchno, Wilson-Genderson, and Cartwright 2010).
Others have argued that Rowe and Kahn’s criteria for success are overly restrictive, leading to misclassification of individuals who age well as “unsuccessfully” aged (Goodwin 1991; Holstein and Minkler 2003; Minkler 1990; Schmeekle and Bengston 1999; Strawbridge, Wallhagen, and Cohen 2002; Young, Frick, and Phelan 2009; Young et al. 2009). This is problematic in light of studies of centenarians that find that almost none had completely avoided either chronic disease or physical disability (Goodwin 1991; Martin et al. 2015; Schmeekle and Bengston 1999; Young, Frick, and Phelan 2009). As a result, researchers have called for conceptualizations of successful aging with a less biomedical slant that are realistically attainable among both the young-old and old-old (Bowling 2007; Depp and Jeste 2006; Young, Frick, and Phelan 2009). Young and colleagues (2009) present one approach to this problem, defining successful aging in terms of physical, social, and psychological dimensions that place an individual along a continuum. Because a broader range of experience is accounted for in this approach it is possible for the chronically ill to age successfully if they score highly on dimensions that are not based on physical health.

2.3.2 Operationalization

The second set of criticisms focus on the various operationalizations of Rowe and Kahn’s conceptualization of successful aging. Kahn (2003) comments that both of their discussions of successful aging lacked detail on the operationalization of the concept. The most specific information they provide is that successful aging is composed of three overlapping dimensions (cognitive and physical functioning, avoidance of disease, and social engagement), but little information is provided on how these dimensions should be measured or where the line between “successful” and “not successful” should be drawn.
Along with multidimensionality, two other measurement considerations can be identified from their conceptualization. First, measures of successful aging should try to allow for the identification of heterogeneity in the form of multiple aging groups (e.g. successfully aged, usually aged, sick). Second, measures should be age sensitive to some degree when possible—Rowe and Kahn’s conceptualization specifically focuses on individuals who excel within an age group, rather than relative to all age groups.

In light of the lack of clear guidelines on operationalization, a wide array of strategies have been used to classify individuals as aging successfully. The most recent review of measurement approaches found 84 studies on successful aging that presented 105 different operational definitions (Cosco et al. 2014). This diverse array of methods can produce challenges: “Differences in the definition of successful aging and the cut-offs chosen to classify successful agers make cross-study comparison difficult and limit research in the field of successful aging (Cosco et al. 2014: 6).” For instance, depending on the definition and cut-off used, studies have found that anywhere from .4% to 95% of individuals have aged successfully (Cosco et al. 2014; Depp and Jeste 2006). While the median across 115 study groups estimates 23.1% of adults as having aged successfully (26% on average), the high rate of variability raises concerns about the precision of these estimates (Cosco et al. 2014).

A more specific criticism of these disparate methods is that the multidimensionality of Rowe and Kahn’s conceptualization is not always captured (Bowling 2007; Cosco et al. 2014; Hsu and Jones 2012; Jeste, Depp, and Vahia 2010; Ng et al. 2009). Cosco and colleagues’ (2014) review found that, on average, only 2.2 of as many as 5 proposed dimensions are used (of these, physical health was the most common by a large margin).
While results from such studies are insightful, Grundy and Bowling (1999) caution against omitting necessary dimensions:

Studies … have tended to focus on the analysis of separate domains, such as functional ability, or mental health [citations omitted]. Such approaches do not reveal what proportions of older people have multiple problems or, conversely, few or no difficulties on a range of domains (201).

If the intent is to measure successful aging, than excluding major dimensions goes against the purpose of the construct, and skews conclusions of the incidence of successful aging towards whatever criterion are used.

Even after these dimensions have been measured, they need to be composited into an indicator that identifies successful agers. Some scholars have been critical of the most common approach to this, which is to collapse all indicators into a single dichotomous classification as “successful” or “not successful” (Bowling 2007; Cosco et al. 2014; Cosco, Stephan, and Brayne 2014; Cosco, Stephan, and Brayne 2015; Young, Frick, and Phelan 2009). For example, Cosco and colleagues (2014) argue that:

Dichotomizing successful versus usual agers within the framework of a unidimensional model of successful aging is unrealistic. … The difficulty in dichotomizing successful aging is highlighted by the profound heterogeneity of successful aging prevalence. Depending on the definition, individuals could be classified as successfully aged or not (6).

Researchers have also criticized dichotomous approaches to measuring successful aging because they do not adequately capture heterogeneity in the aging process (Hsu and Jones 2012; Tang 2014; Wickrama et al. 2013). That is, a binary operationalization accounts for only successful and unsuccessful aging groups, ignoring that the “unsuccessful” group can be broken into, at minimum, usually aged and sick individuals (Cosco et al. 2014). Hsu and Jones’s (2012) results illustrate the implications of omitting this heterogeneity. Taken as a binary, their results would suggest that 29.1% had aged
successfully and 70.9% “failed” to do so. When the “unsuccessful” individuals are broken into more specific groups, it is revealed that only 11.4% of respondents can be reasonably thought of as “failing” to age decently. Not only does this binary classification overestimate “failure,” but it also leads to an imprecise description of who most needs assistance and how they differ from successful agers.

A final concern about dichotomous indicators of successful aging echoes conceptual criticisms that suggest that Rowe and Kahn’s conceptualization is overly restrictive, pathologizing “normal” age related decline by holding the old to the standards of middle age (Cho, Martin, and Poon 2012; Goodwin 1991; Holstein and Minkler 2003; Schmeekle and Bengston 1999; Young, Frick, and Phelan 2009). Cosco and colleagues (2014) demonstrate this point empirically and argue that “as a result of the inability of this binary model to articulate the nuances of successful aging in the oldest old adults, it is suggested that better methods of capturing successful aging be implemented: continuum based successful aging models (1598).” Because the old-old and young-old are held to the same universal cut-offs in a binary measure it is likely that members of the old-old are misclassified as aging unsuccessfully even when they have aged exceptionally relative to their age group. This possibility is further evidenced by Depp and Jeste’s (2006) systematic review of the literature, which found that being young-old was the most consistent predictor of successful aging across the 29 studies reviewed.

2.3.3 A De-Emphasis on Social Determinants of Health

Critics have argued that Rowe and Kahn need to further consider the social contexts that produce successful aging. These scholars contend that Rowe and Kahn’s explanation of successful aging ignores social structure, as well as the cultural and political climate
that unequally distributes the resources, opportunities, risks, and experiences that can influence one’s chances of aging successfully (Bowling 2007; Bülow and Söderqvist 2014; Dillaway and Byrnes 2009; Goodwin 1991; Hank 2010; Katz and Calasanti 2015; Minkler 1990; Moody 2001; Riley 1998; Scheidt, Humpherys, and Yorgason 1999; Schmeekle and Bengston 1999; Stowe and Cooney 2015). Schmeekle and Bengston (1999) argue this point in the context of health behaviors, which they feel are important predictors that lack social context:

What about the social contexts in which lifestyle decisions are made by aging individuals? … What might the 12% [living in poverty in 1992] think when reading Successful Aging? Taking walks in one’s neighborhood implies a safe neighborhood to walk in. Eating nutritiously implies enough money and adequate ways to transport food. Consulting one’s doctor about supplement and exercise protocols implies that one has a doctor to go to, and money for supplements and exercise equipment (88-89).

Critics have argued that by ignoring this important context and its influence on health behaviors and risk factors, Rowe and Kahn’s causal narrative implies that each individual gets an equal chance to “choose” if they will age successfully (Dillaway and Byrnes 2009; Katz and Calasanti 2015; Minkler 1990). Some have suggested that this (arguably unintended) implication “may result in a belief that elders with preventable chronic conditions somehow ‘brought it on themselves (Minkler 1990: 247).’” The sociopolitical consequence of this focus on the individual is that safety nets such as Medicare and Supplemental Social Security become open to challenges under the rationale of not giving handouts to individuals who are responsible for their own situation (Martinson and Berridge 2014; Minkler 1990). As a result, an ageist tendency to “blame the victim” for their chronic illnesses is reinforced and efforts to address social
inequalities and health disparities through policy are slowed (Dillaway and Byrnes 2009; Katz and Calasanti 2015; Martinson and Berridge 2014; Minkler 1990).

Political implications aside, there is also strong empirical support behind critiques that call for consideration of how social context influences successful aging. Recent research exploring the link between social inequality and successful aging found that citizens of countries with higher levels of income inequality are less likely to age successfully (Brandt, Deindl, and Hank 2012), and Britton and colleagues (2008) found strong evidence of socioeconomic differences that were exacerbated if the respondent was also brought up in a low socioeconomic status household. These findings are common, as other studies have found that having low socioeconomic status, being black, and/or being female are all associated with lower probabilities of overall successful aging (Bowling and Iliffe 2006; Hank 2010; Hsu and Jones 2012; Kahng 2008; McLaughlin et al. 2009; Ng et al. 2009; Tang 2014; Wickrama et al. 2013). Studies utilizing only a single dimension of successful aging (physical functioning, cognitive functioning, or social engagement) have also found income, education, race, and gender disparities (Andreescu et al. 2008; Dodge et al. 2006; Ferraro and Shippee 2008; Haas 2008; Haas and Rohlfsen 2010; Hybels et al. 2010; Thomas 2011). In light of this empirical support, some commentators have noted that future research should empirically investigate the specific mechanisms through which factors such as socioeconomic status operate (Brandt, Deindl, and Hank 2012; Britton et al. 2008).

2.3.4 Lack of an Integrated Life-Course Approach/Perspective

Critics have argued that Rowe and Kahn’s successful aging model also overemphasizes the effect of recent behaviors and statuses, which conceals their
relationship to past behaviors, statuses, and experiences (Aldwin et al. 2006; Schulz and Heckhausen 1996; Stowe and Cooney 2015). Stowe and Cooney (2015) articulate this limitation and their solution, which is to integrate successful aging models with a life course perspective:

One problem with Rowe and Kahn’s model, however, is its sole focus on late adulthood as a point to make a static assessment of an individual’s ‘successful aging’.” Thus it fails to capture developmental process and trajectories of continuity and change in function over time. A life course perspective, in contrast, is a dynamic perspective that considers development, history, and the importance of relationships over time. In application, a life course perspective combats the static “snapshot” created by Rowe and Kahn’s conceptualization and offers enhanced opportunity to understand successful aging as a developmental process (44).

Put differently, this criticism suggests that researchers should consider successful aging as the product of an entire life’s worth of changes, rather than the product of only immediate exposure to risk factors. Researchers should therefore investigate not only if an exposure to a risk factor occurs, but also its timing and accumulation over the life course (Berkman 2009; Elder, Johnson, and Crosnoe 2003; Pearlin 2009). Similarly, it challenges researchers to look at how lives are linked, influencing one another’s path throughout life.

2.3.5 Summary of Critiques

Rowe and Kahn’s model has been highly influential, yielding a wide array of critiques, alternatives, and commendations. From this review, three key points are important to explore. First, critics have suggested a wide array of criteria that could be considered in addition to Rowe and Kahn’s original three. The addition of criteria such as mental health and life satisfaction are points of relative agreement in the literature and they could be incorporated. Second, there is a need for non-binary methods of identifying successful
agers to be developed. Ideally these measures should allow for multiple aging groups (e.g. usual, successful, sick) to be identified while also allowing group classification criteria to vary with age. Finally, some contend that Rowe and Kahn may overemphasize individual agency as the cause of successful aging. These criticisms point out that rather than focus on just immediate health behaviors and (less commonly) psychosocial factors, these risk factors should be considered in light of both social and life course antecedents.

2.4 The Current Dissertation

2.4.1 Conceptual Framework

The conceptual model for this study uses several aspects from Rowe and Kahn’s model as a launching point, such as their emphasis on physical health, cognitive functioning, and social engagement. This proposed conceptualization also addresses several prominent criticisms and places greater emphasis on variation within age groups.

As noted earlier, critics have suggested that Rowe and Kahn’s model of successful aging can make it unreasonably difficult for the chronically ill and old-old to be classified as aging successfully, even if they are happy and socially engaged. Within this dissertation, I address this critique by proposing a model of successful aging that follows the suggestion of several prior authors by placing individuals along a multidimensional continuum before grouping them into successful, usual, and sick categories (Bowling 2007; Cosco et al. 2014; Cosco, Stephan, and Brayne 2014; Young, Frick, and Phelan 2009). This continuum ranges from being less happy, less healthy, and/or disengaged to completely healthy and engaged. Placement on this continuum is determined by a consideration of multiple components, all of which will be elaborated on in a moment. Taken collectively, scores on indicators for each component create a distribution of
individual’s health and engagement which can then be broken into groups that classify each person as successfully aged, usually aged, or sick.

As a hypothetical example of why this continuum is preferable, assume the top third of scorers will be classified as aging successfully. A person with chronic illness might still be able to place on the top third of the continuum if they have are doing excellent psychosocially. Therefore, the end result is a fairer and more holistic estimation of who ages successfully that does not bar the chronically ill from aging successfully. Compare this to a binary all-or-nothing approach that has been used to conceptualize successful aging in many studies (Cosco et al. 2014), which would require individuals to have perfect scores on all dimensions to classify as aging successfully. Some degree of physical decline is no longer an immediate classification as having aged “unsuccessfully” in this revised conceptualization, which is important in light of concerns that normal age
related losses have been pathologized by the concept of successful aging since the old-old can almost never meet all three of Rowe and Kahn’s dimensions (Katz and Calasanti 2015; Martin et al. 2015; Minkler 1990; Young, Frick, and Phelan 2009).

The physical health and functioning domain reflects the individual’s ability to avoid disease, maintain high self-rated health, and to retain high physical functioning (e.g. mobility, energy). Like other researchers, I cluster the criteria that are used to place individuals along the continuum into three overarching domains (Kahng 2008; Young, Frick, and Phelan 2009). These domains and the successful aging continuum are illustrated in Figure 3. Two of these domains are comparable to Rowe and Kahn’s 1997 model, capturing physical health/functioning and social engagement. The social engagement domain is comprised of two components that are comparable to Rowe and Kahn’s and Thomas’s (2012) conceptualization of social engagement. The first element of social engagement is the maintenance of existing social connections and the creation of new ones if desired. The second component is that the individual voluntarily maintains some degree of formal or informal participation in productive or group activities. This involves situations where the individual is contributing to a goal or community, such as attending meetings, religious ceremonies, volunteering, lending support, or mentoring.

The third and final domain, mental functioning and outlook, is based in part on Young and colleagues’ (2009) successful aging model, which suggested a broad category that encompasses life satisfaction, mental health, cognitive functioning, and self-efficacy as components. I retain all but the self-efficacy component of Young’s model, which is generally classified as an antecedent to health outcomes rather than a part of health itself (Zarit, Pearlin, and Schaie 2003). This domain incorporates life satisfaction as an
additional component of successful aging in light of criticisms that suggest that Rowe and Kahn’s model lacked consideration of individuals’ evaluation of their own life (Martinson and Berridge 2014; Pruchno, Wilson-Genderson, and Cartwright 2010). Mental health is included in this domain in response to critiques that note Rowe and Kahn’s lack of consideration of conditions such as geriatric depression (Jeste, Depp, and Vahia 2010; Young, Frick, and Phelan 2009).

Consistent with Rowe and Kahn’s (1987) emphasis on within age group variability, classification as successful aged, usually aged, or sick in this conceptualization should be determined based on criteria that are relative to one’s age group. This classification process is necessary even when the continuum is used, as high scores on the continuum are likely be correlated with younger age, as evidenced by the strong and consistent correlation between young age and aging successfully (Depp and Jeste 2006). In order to capture within age group variability, the continuum for each age must be examined and aggregated separately. Figure 4 illustrates one approach to doing this, which is to (arbitrarily) divide each age group into thirds, a cut off value that has been used in prior studies with continuum conceptualizations (Grundy and Bowling 1999; Vaillant and Mukamal 2001). Note how the cut-offs for successful aging on the continuum become more lenient with age to accommodate for changes in the overall distribution. Addressing this within age group variability may help to ameliorate some of the concerns that successful aging pathologizes normal age-related loss and decline (Goodwin 1991; Kahn 2002; Katz and Calasanti 2015; Schmeekle and Bengston 1999). Other approaches that do not require assumptions of cutoff values or group sizes can be
used to classify individuals along this continuum, such as the latent trajectory models that will be used in this study.

This classification scheme can, and ideally should, be extended into a longitudinal or life course framework using an approach and conceptual expansion suggested by Hsu and Jones (2012) and Wickrama and colleagues (2013). These authors argue that successful aging can reflect not only a discrete state but also a consistent trajectory that individuals follow over time. In the context of the continuum used in this approach, trajectories that age successfully would be consistently higher scoring on the continuum relative to their age group over time. An illustration of this is presented in Figure 5. Note that the Y-axis reflects individual’s rank on the continuum, while the lines reflect how
averages for each of the three trajectory groups change with age. This addresses Stowe and Cooney’s (2015) concerns that successful aging is not considered from a life course perspective. Usual aging reflects consistently middling scores over time, and the sick/unhappy group reflects individuals with consistently low scores. Individuals can have brief low or high points and still age successfully—what is key here is their average aging trajectory.

In sum, for the current study successful aging reflects an ongoing aging trajectory (or, cross-sectionally, a discrete state) in which an individual has consistently achieved high levels of physical health and functioning; strong mental functioning and a positive evaluation of one’s own life; and strong social engagement. “High” performance on each of these components is relative to one’s age group, with successful aging reflecting a continuum placement that is well above the age group’s average across all dimensions. Similarly, usual aging reflects scores that are in line with the trajectory group’s average, and sick/unhappy/disengaged aging reflects a continuum placement that is well below the average.
2.4.2 Operationalizing Successful Aging

2.4.2.1 Non-Binary Operationalizations of Successful Aging

Some have criticized the successful aging literature’s tendency to operationalize successful aging as a successful/unsuccessful dichotomy (Bowling 2007; Cosco et al. 2014; Young, Frick, and Phelan 2009). This dichotomy approach would also be inappropriate for the conceptualization in this study, which explicitly specifies the presence of multiple aging groups. Two main alternatives to the dichotomy method have been used in other studies. The first is to construct a continuum using an array of indicators using either an additive scale (Cosco, Stephan, and Brayne 2015; Grundy and Bowling 1999; Young et al. 2009) or structural equation modeling (e.g. Kahng 2008;
Parslow, Lewis, and Nay 2011). This method has the strength of capturing successful aging as a more inclusive spectrum. However, a key limitation is that cut-off scores or group sizes must be assumed by the author in order to classify individuals into different groups. This sacrifices potentially useful information, such as the proportion of individuals in a sample who can be considered to have aged successfully.

A second classification approach applies various forms of latent class analysis such as growth mixture modeling (Wickrama et al. 2013) and group based trajectory modeling (Hsu and Jones 2012; Tang 2014). These longitudinal methods look for underlying groupings in these data using sophisticated estimation methods that determine the most common developmental trajectories that individuals follow over time. They have the advantage of capturing multiple groups without making assumptions about the group’s trajectory over time or composition. The shapes of trajectories can also vary over time, meaning that the average score for “success” can vary across age groups as well (Nagin 2005). A key limitation to this approach is that handling multiple dimensions lacks parsimony, requiring estimation of separate trajectories for each dimension. For example, a model with six indicators and three groups would require eighteen graphs to convey.

2.4.2.2 The Current Study

This dissertation leverages the strengths of an a priori continuum construction method and group based trajectory modeling to classify individuals into different aging groups. Following Cosco and colleagues’ (2015) proposed operationalization, the conceptual model for the current study will be constructed such that each dimension is equally weighted and contributes to a broad continuum. Creating a single continuum is useful to the current study because it captures far more variation than binary measures,
and its validity can be assessed in advance. This specific operationalization is selected because it allows for the widest range of variability to be assessed—other continuum approaches have still resulted in no more than nine outcome values (Bowling and Iliffe 2006; Grundy and Bowling 1999; Young et al. 2009). An SEM approach also captures a wide spectrum of variation but was determined to be inappropriate for the current conceptualization after preliminary experimentation.

Because this continuum approach is so new it is important to first replicate validation analyses that have been conducted to demonstrate its predictive validity. Cosco and Colleagues (2015) validated their scale primarily against external indicators of physical health and independence, possibly to the omission of a psychological dimensions of successful aging that are specified in this model. Their conceptualization is also distinct from the one used in the current study, sporting five dimensions in total. The successful aging continuum constructs and the model proposed in the current study are, by definition, unreliable since high performance on one dimension does not necessarily coincide with high scores on other dimensions. Given this lack of reliability, limited validation, and the clear differences between this conceptual models and others, it is

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To elaborate on the reasoning, initially this dissertation approached estimating the continuum using a Confirmatory Factor Analysis (CFA) based approach, but the results were very underwhelming. Model fit was poor, and many factor loadings were extremely weak. As a result, the psychosocial dimensions were weighted so lightly that they were nearly irrelevant, which would have reproduced the problems in the literature that suggested that successful aging was often viewed as only a biomedical construct. In hindsight, it is clear that this approach was not appropriate for this conceptualization. Successful aging as defined here does not reflect a construct with high orthogonality. High scores on one dimension do not necessarily mean high scores on others. Furthermore, a person does not need high scores on all dimensions to age successfully. Therefore, a CFA model would not fit well. CFA does not speak to the “realness” of a construct so much as it tells us about the covariance structure of a number of indicators. If the dimensions cannot be assumed to correlate uniformly then it is not an ideal approach. Obviously this points to a further reliability problem that comes from combining these disparate dimensions together. The lack of correlation between the dimensions of successful aging has been discussed by several prior authors (e.g. Young et al. 2009, Brandt et al. 2012). Assessing the predictive and convergent validity of the instrument used in the current study is important for precisely this reason.
important that this current study’s continuum be validated in a similar manner to what has been done in prior studies (Cosco, Stephan, and Brayne 2015; Young, Frick, and Phelan 2009). It should also be compared against alternative operationalizations of successful aging to ensure that the current study’s measure behaves in a manner that is consistent with the literature.

After the continuum has been validated, group based trajectory modeling (Nagin 2005) is used to identify aging trajectories over time by tracking how continuum scores change as individuals age. This allows for the empirical identification of the overall aging trajectories that individuals tend to follow over the life course. These trajectories reflect the successful aging, usual aging, and sick (and possibly other) groups that are expected in the conceptual model for this analysis. The previously presented figure 5 provides an illustration of how this might look. Utilizing this validated continuum and group based trajectory models in conjunction with one another allows measurement quality to be determined before groups are identified, which is not possible if group based trajectory modeling is used independently.

2.4.3 An Expanded Predictive Model

A number of critiques center on the need to consider both the effects of social and life course determinants of successful aging, as well as the mechanisms through which both operate. One mechanism that has been discussed is health behaviors (e.g. diet, exercise, smoking), which critics argue are linked to a person’s social status (Holstein and Minkler 2003; Katz and Calasanti 2015; Martinson and Berridge 2014; Schmeekle and Bengston 1999). However, focusing solely on health behaviors may downplay other key mechanisms. Studies of successful aging have found that health behaviors do not
sufficiently account for the association between successful aging and both social conditions and life course determinants (Brandt, Deindl, and Hank 2012; Britton et al. 2008). This echoes a common finding in the medical sociology literature, which is that health behaviors and healthcare use are often not sufficient to account for socioeconomic, race, and gender disparities in health (House 2002; Lantz et al. 2001; Marmot 2004; Williams and Sternthal 2010).

Therefore, it is important that other possible mechanisms be considered. Rowe and Kahn suggested the importance of stress in the form of bereavement, but research on stressful events and chronic stress is still uncommon in the successful aging literature (Bowling 2007; Depp and Jeste 2006). When stress has been studied, researchers have depended on limited samples while also omitting controls for health behaviors. Research indicates that stress holds potential as a mechanism through which social and life course factors operate. This is evidenced by the repeated finding that exposure to stress is unequally distributed throughout society and that the effects of stress both accumulate and proliferate over the life course (Aneshensel 2015; Pearlin et al. 2005; Shippee, Wilkinson, and Ferraro 2012; Thoits 2010; Turner 2010; Turner and Lloyd 1995; Turner and Lloyd 1999; Turner and Avison 2003). Based on this, it would be useful to consider if stress acts as a mediator for the effect of life course effects and social statuses while also accounting for health behaviors as another potential mediator.

To this end, I propose a modified version of Pearlin and colleagues’ (1981) stress process model to predict successful aging. In its recent incarnations (e.g. Aneshensel 2015; Wheaton 2010), the stress process model hypothesizes that social positioning (race, class, gender, etc) generates unequal exposure to different stressful scenarios. These
stressors come in two main forms. There are chronic stressors, which are strains related to one’s status, (or lack thereof) status attainment, and/or repeated exposure to unwanted experiences due to racism, sexism, and poverty. Life events are acute changes that disrupt social networks and/or require major behavioral or cognitive adjustment in a short period of time, such as the death of a spouse (Pearlin et al. 2005). The effect of these stressors is mediated by a person’s access to different coping resources such as social support and a sense of control over one’s life (mastery). High stress exposure degrades these resources, presenting an avenue for stress to exert an indirect effect on the outcome in question. While stress and social positioning are likely to exert direct effects in this model, their total effect is even greater after considering the indirect avenues through which they influence health (Aneshensel 2015; Pearlin et al. 1981; Thoits 2010).

The proposed explanatory model for this dissertation is summarized in Figure 6. I will refer to this as the successful aging explanatory model (SAEM). Each line indicates a hypothesized relationship, with more distal antecedents on the left, proximate mediators in the center, and successful aging on the right. The “+” and “-” signs denote hypothesized directions for associations. The SAEM incorporates several expansions from the original stress process model that maximize its ability to explain successful aging.

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5 It should be noted that this model implies only unidirectional relationships for convenience. While the directions specified in this model are consistent with the literature, it should be emphasized that there is a definite possibility that reciprocal effects might also occur. For instance, drinking heavily may lead to family problems and increased chronic stress. Identifying and testing the recursive elements both between mediators and end points will be an important direction for future research to pursue.
This SAEM accounts for the life course in several ways that have been used in contemporary versions of the stress process model (Aneshensel 2015; Pearlin et al. 2005; Pearlin 2009; Wheaton 2010). To begin with, stressful childhood conditions (e.g. abuse, family conflict, poverty) are expected to influence health through direct and indirect paths. On one hand, developmental sensitivities in childhood can create heightened vulnerabilities to threats such as malnutrition and trauma (Berkman 2009; Pearlin 2009). On the other, a stressful situation like childhood poverty can block opportunities for social advancement such as not being able to afford college, increasing risk of financial stress in the future (Ferraro and Shippee 2008).

Two other life course elements are incorporated into the SAEM. First, while stressful in and of themselves, unexpected/disruptive/mistimed life events can also lead to future stressors through the process of stress proliferation wherein one stressful situation produces subsequent stressors (Pearlin et al. 2005; Pearlin 2009). For example, while a divorce is a stressful life event, it can lead to further stress by straining relationships with...
children and friends due to divided loyalties for years to come. Second, the cumulative impact of stress is expected to be substantially stronger than discrete exposures (Ferraro and Shippee 2008; Pearlin et al. 2005; Pearlin 2009; Turner and Lloyd 1999). For instance, studies have found that prolonged exposure to financial stress, as well as other stressors, is associated with a stronger negative effect on mental and physical health than a single exposure (Kahn and Pearlin 2006; Shippee, Wilkinson, and Ferraro 2012; Turner and Lloyd 1999).

The primary modification made to the contemporary stress process model for this study is that it considers health related behaviors such as exercise, smoking, and drinking. It is important to include these predictors in the SAEM because they have been found to significantly predict successful aging in a wide array of other studies (Depp and Jeste 2006; Franklin and Tate 2009; Rowe and Kahn 1987; Rowe and Kahn 1997). In the SAEM, exercise is predicted by a person’s social positioning because access to walkways, availability of time, and a safe environment are all linked to predictors such as socioeconomic status (Cockerham 2007; Cockerham 2005; Schutzer and Graves 2004). Reviews of the literature on stress and exercise describe an inverse relationship where higher levels of physical activity are protective against stress, which is specified in this model alongside a direct effect on successful aging (Edenfield and Blumenthal 2011; Scully et al. 1998).

Unhealthy behaviors such as drinking and smoking are integrated into the SAEM in two ways. First, they can manifest as negative coping behaviors to stress, as theorized by prior stress process researchers (Rutters et al. 2014; Umberson, Liu, and Reczek 2008). Unlike positive coping behaviors (e.g. social support, mastery/self-efficacy), these
behaviors exacerbate the effects of stress. Smoking and alcohol consumption have both been documented as coping mechanisms used to respond to high stress situations. Problem drinking has been linked to the accumulation of stress prior to puberty, and high consumption later in life is similarly associated with stress (Adams et al. 2015; Casement et al. 2015; Enoch 2011; Fox et al. 2010; Grieger et al. 2003; Lloyd and Turner 2008; Moos et al. 2004; Mulia and Zemore 2012). Similarly, onset of smoking, amount smoked, and difficulty quitting are linked to both childhood and adult stress (Cheney et al. 2014; Fletcher and Sindelar 2012; Kassel, Stroud, and Paronis 2003; Lloyd and Taylor 2006). Second, engagement in these unhealthy behaviors is also not evenly distributed throughout society, with low income, low education, and nonwhite individuals being substantially more likely to smoke and engage in pathological drinking (Cockerham 2007). Capturing this link between sociodemographics and unhealthy behaviors is important because it helps to account for drinking and smoking outside of the context of stress coping. In light of this, the SAEM model for this study predict that stress and certain sociodemographics will increase a person’s probability of engaging in these unhealthy behaviors.

2.4.4 Summary and Significance

The proposed dissertation works to address a number of criticisms that have been leveled against the conceptualization, operationalization, and prediction of successful aging. This is done by proposing some small modifications to Rowe and Kahn’s conceptualization based on the literature; leveraging the strengths of new methods for identifying successful agers; and presenting a model that links individual proximate predictor to social positioning and childhood experiences. Approaching these three issues
simultaneously is key in light of the breadth of criticisms that have been raised. Addressing only one or even two at a time will leave this study vulnerable to criticism for either a narrow conceptualization, weak operationalization, and/or a decontextualized explanatory model.

To summarize some of the key contributions of this study, the modified conceptualization of successful aging makes successful aging more feasible for the old-old and chronically ill, avoiding criticisms that have suggested that successful aging risks pathologizing normal age related decline. The operationalization strategy presented here enables the estimation of heterogeneous aging trajectories while also minimizing a priori assumptions about who does and does not age successfully. Identifying this heterogeneity in aging trajectories will help researchers to better understand what differentiates successful agers from others while also providing useful information on the individuals who are struggling most. The continuum from which successful aging groups are derived is validated against a wide array of existing measures and other operationalizations, enhancing the certainty that successful aging is being adequately captured.

Lastly, the integration of social and life course conditions into a predictive model for successful aging will give context to our understanding of why individuals age successfully. Placing focus on stress and health behaviors as mediators for these distal factors will give a clearer understanding of how much of successful aging comes down to individual choice of health behaviors and how much is socially determined. This provides a more realistic picture of the determinants of successful aging that highlights not only sites for individual intervention but also the social conditions that may lie at the root.
2.5 Research Aims and Hypotheses

Based on the criticisms reviewed and the proposed directions for this dissertation, I state the following research aims and their associated hypotheses.

Based on critiques of the methods and criteria used to classify individuals as aging successfully:

RA1 Can predictive validity be established for the successful aging continuum being used in the current study, and does it correlate with other operationalizations of successful aging?

H1.1 Happiness, use of health services, and mental health (among other indicators reported by respondent and interviewer) will be significantly associated with the successful aging continuum in wave 1 and 2 cross-sectionally.

H1.2 Indicators from wave 1 should be correlated with wave 2 happiness, use of health services, and mental health (among other indicators reported by respondent and interviewer).

H1.3 The different operationalizations of successful aging will be strongly correlated with one another.

RA2 Are there at least three latent aging trajectories that reflect Rowe and Kahn’s expectation of successful, usual, and sick trajectories?

H2.1 There will be three aging trajectories, each characterized by different intercepts and/or slopes.

Based on the successful aging explanatory model (SAEM), as presented in Figure 6.

RA3 Does the proposed explanatory model accurately describe the direct and indirect pathways (e.g. stress, health behaviors) through which social and life course determinants influence successful aging?

H3.1 The effect of increases in SES on successful aging trajectory membership are hypothesized to:

H3.1.1 Have a direct protective effect on successful aging trajectory membership

H3.1.2 Have indirect mediated effects on successful aging trajectory membership through the following routes

1. Decreasing average stress
2. Decreasing number of life events
3. Increasing support levels
4. Increasing mastery
5. Decreasing risk of drinking
6. Decreasing risk of smoking
7. Increasing exercise
H3.2 The effect of being white (vs nonwhite) on successful aging trajectory membership is hypothesized to:

H3.2.1 Have a direct positive effect on successful aging trajectory membership

H3.2.2 Have indirect mediated effects on successful aging trajectory membership through the following routes

1. Decrease average stress
2. Decrease number of life events
3. Increasing support levels
4. Increasing mastery
5. Decreasing risk of drinking
6. Decreasing risk of smoking
7. Increasing exercise

H3.3 The effect of being male (vs female) on successful aging trajectory membership is hypothesized to:

H3.3.1 Have a direct positive effect on successful aging trajectory membership

H3.3.2 Have indirect mediated effects on successful aging trajectory membership through the following routes

1. Decrease average stress
2. Decrease number of life events
3. Increasing support levels
4. Increasing mastery
5. Decreasing risk of drinking
6. Decreasing risk of smoking
7. Increasing exercise

H3.4 The effect of increases in childhood stressors on successful aging trajectory membership is hypothesized to:

H3.4.1 Have a direct positive effect on successful aging trajectory membership

H3.4.2 Have indirect mediated effects through the following routes

1. Increasing average stress
2. Increasing number of life events
3. Decreasing support levels
4. Decreasing mastery
5. Increasing risk of drinking
6. Increasing risk of smoking

H3.5 Increases in the number of life events experienced is hypothesized to:

H3.5.1 Have a direct positive effect on successful aging trajectory membership

H3.5.2 Have indirect mediated effects on successful aging trajectory membership through the following routes
1. Increasing average stress
2. Decreasing support levels
3. Decreasing mastery
4. Increasing risk of drinking
5. Increasing risk of smoking

H3.6 Increases in accumulated stress is hypothesized to:
H3.6.1 Have a direct positive effect on successful aging trajectory membership
H3.6.2 Have indirect mediated effects on successful aging trajectory membership through the following routes
   1. Decreasing support levels
   2. Decreasing mastery
   3. Increasing risk of drinking
   4. Increasing risk of smoking

H3.7 Increases in physical activity are hypothesized to:
H3.7.1 Have a direct positive effect on successful aging trajectory group membership
H3.7.2 To have an indirect effect on successful aging trajectory membership through the reduction of chronic stress levels.

H3.8 Increases in average support are hypothesized to have a direct positive effect on successful aging trajectory membership

H3.9 Increases in average mastery are hypothesized to have a direct positive effect on successful aging trajectory membership

H3.10 Higher levels of drinking behavior are hypothesized to have a direct negative effect on successful aging trajectory membership

H3.11 Higher levels of smoking (e.g. smoker, former smoker) are hypothesized to have a direct negative effect on successful aging trajectory membership.
Chapter 3

DATA AND METHODS

3.1 Data

Data for this study came from the Americans’ Changing Lives (ACL) survey (House 2014), an accelerated cohort study that was administered by the University of Michigan’s Institute for Social Research for five waves over a span of 25 years from 1986 through 2011. The dataset was explicitly focused on studying the way health changes over the adult life course, with an emphasis on differences between black and white Americans in mid to late life. The initial survey wave used a stratified, multi-stage area probability sample of Americans 25 years or older who lived in the United States. To maximize statistical power for subgroup analyses blacks and individuals over 60 were oversampled at 2 to 1 ratio. With weighting for sample design and non-response the ACL is representative of the 1986 United States population. The sample for the current study is described in Table 1. Each wave has a strong response rate and deaths are tracked using the National Death Index with 99% of reported deaths being verified.

<table>
<thead>
<tr>
<th>Table 1</th>
<th>Summary of ACL Data for Subsample of White and Black Respondents That Are 50 or Older by Wave 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>1,968</td>
</tr>
<tr>
<td>% of study sample dead</td>
<td>0</td>
</tr>
<tr>
<td>Survivor response rate (%)</td>
<td>70.0</td>
</tr>
</tbody>
</table>
Three restrictions were made for the purposes of this study. First, respondents were required to have completed at least the first two waves of data. This was because respondents were not asked about early life conditions until the second wave of the survey. Given the importance of early life circumstances in the explanatory model it is not acceptable to omit these variables. Having both waves of data also strengthened measures of physical activity, stress, support, mastery and incidence of life events by allowing for pooling of measures across two waves. Second, this analysis tracked respondents from only age 50 onward, as this is explicitly a study of aging trajectories from mid to late life. Individuals who were 50 at wave two were included in the study, although their data from wave one (e.g. pre-50) was not used. All measures that would otherwise be measured at baseline were measured at wave 2 for these respondents, since it was the first wave that they contributed to the aging trajectories being studied. Lastly, this study only looked at white and black respondents, as too few respondents from other ethnic groups were sampled to be studied.

3.1.1 Data Structure

The ACL has an accelerated cohort design that has been administered at five separate time points- 1986, 1989, 1994, 2002, and 2011. Accelerated cohort studies follow several adjacent cohorts of individuals over a relatively short period of time. This design allows investigators to pool data from multiple cohorts to look at developmental trajectories based on age rather than survey year (House, Lantz, and Herd 2005; Miyazaki

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5 The possibility that this decision will introduce measurement bias is tested later in this chapter.
6 Individuals from wave 3 onward are not used even though they do eventually turn 50. This is because of missing data in many study variables. In particular, the multi-wave variables for stress, support, mastery, physical activity, and life events require response across two waves. This is not guaranteed from wave two onward since respondents need only complete wave 1 and 2 surveys.
and Raudenbush 2000). This was done by structuring the data so its time scale is based along age rather than wave. This approach has been used in the ACL and other similar multi-cohort datasets (Bushway, Thornberry, and Krohn 2003; House, Lantz, and Herd 2005; Miyazaki and Raudenbush 2000; Nagin 2005; Sautter 2010). Data were broken into fourteen three-year age groups starting at age 50 and truncating at 89+ in order to ensure that each group has enough cases. For example, over the span of five waves a respondent who is 50 at baseline would contribute to the 50-52 age group at wave 1, 53-55 age group at wave 2, 56-58 age group at wave 3, 65-67 age group at wave 4, and 74-76 age group at wave 5. The average size of one of these age groups was 379 cases, with the smallest number of cases being 107 in the 89-91 group. The overlapping design of this study means that while not everyone contributes to every three year age group, every age group contains responses from multiple birth cohorts. This can be leveraged to test for cohort differences later in the analysis. The end result of this approach is the ability to look at age specific trends over time, rather than survey wave. This data structure is illustrated in appendix A—it is admittedly difficult to visualize but viewing the way birth cohort, age group membership and survey wave interact should clarify any confusion.

3.2 Measures

3.2.1 Successful Aging

Successful aging was operationalized as a three dimensional construct. Each dimension- physical health, mental functioning and outlook, and social engagement, was operationalized with multiple indicators. These indicators were weighted in a relatively similar fashion to Cosco and Colleagues’ (2015) approach to measuring successful aging, which was itself reminiscent of the construction of frailty indices (Searle et al. 2008). A
sensitivity analysis (see appendix B) was conducted to assess how different approaches to truncating and collapsing different indicators influenced substantive conclusions. This analysis found that associations for most indicators were relatively consistent regardless of weighting, but in some cases it was preferable to use uncollapsed indicators to avoid biasing estimates in the name of methodological convenience.

The precise weighting scheme for each indicator and dimension is summarized in table 2. Every indicator ranges from 0 to 100, and was averaged across other indicators within the dimension. Each dimension has a total of 100 points to contribute to the successful aging continuum, which were ultimately added together for a continuum ranging from 0 to 300 where high scores indicate a higher degree of success across each dimension. To minimize the effect of outliers and skew on the weights used for different indicators categories were truncated at the lowest 1st and the highest 99th percentiles to occur across all waves. Averages for each successful aging indicator, each dimension and the successful aging scale are presented in table 3 further in the manuscript.
Figure 7  Distributions for Each Wave's Successful Aging Continuum
Table 2  Summary of Calculations for Successful Aging Continuum

<table>
<thead>
<tr>
<th>Dimension/Variable</th>
<th>Coding Scheme</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Physical health (Average of 3 items below)</strong></td>
<td></td>
</tr>
</tbody>
</table>
| A. # of conditions | 0= 100  
1 condition= 75  
2 conditions= 50  
3 conditions= 25  
4+ conditions=0 |
| B. Physical limitation rating | No limitations=100  
Cannot do heavy work=66.66  
Cannot climb stairs or walk a few blocks=33.33  
In bed or chair most of day, or cannot bathe=0 |
| C. Self-rated health | Excellent=100  
Very good=75  
Good=50  
Fair=25  
Poor=0 |
| **Mental Functioning and Outlook (Average of 3 items below)** | |
| A. Cognitive impairment test | 0=100  
1 error=75  
2 error=50  
3 error=25  
4+ errors=0 |
| B. CES-D/depression | Min depression score (100)=0.27  
Max depression score (0)=1.81  
Increases at an interval of 65 points for a one unit increase |
| C. Life satisfaction | 100=completely satisfied  
75=very satisfied  
50=somewhat satisfied  
25= not very satisfied  
0= not at all satisfied |
| **Social Engagement (Average of A and B)** | |
| A. Informal interaction scale | Ranges from 0 to 10; increasing at intervals of 10 with a range of 0 to 100. |
| B. Formal engagement scale (going to religious gatherings, meetings, and volunteering) | Ranges from 0 to 18; increasing at intervals of 5.5 with a range of 0 to 100 |
| **Final successful aging continuum score**: | Average each dimension separately. Then, add together each dimension for a scale ranging from 0 to 300. |
3.2.1.1 Physical Health and Functioning

The physical health domain is measured with the average of three indicators of physical health and functioning. First, self-rated health was measured with a single item ranging from poor (0) to excellent (100). Second, a count of the number of chronic conditions experienced in the 12 months prior to the survey was constructed. The conditions included in this were: hypertension, diabetes, heart attack, stroke, cancer, arthritis/rheumatism, broken bones, loss of urinary control, and chronic lung disease. This indicator was truncated such that four conditions or more equals 0 points, as less than 1% of respondents in any wave reported five or more conditions. Third, a measure of individual physical limitations was constructed. This measure had four categories: in bed/chair for most of the day due to health or cannot bathe self (0); has a lot of difficulty climbing stairs or walking a few blocks because of health (33.33); cannot do heavy work around the house such as shoveling snow because of health (66.6); the respondent reports no physical limitations (100).

3.2.1.2 Mental Functioning and Outlook

The mental functioning and outlook domain’s indicator reflected the average of an individual’s cognitive functioning, health, and perception of circumstances. Cognitive functioning was measured as the sum of five items from the Short Portable Mental Status Questionnaire (Pfeiffer 1975). Respondents were asked the date, what day of the week it was, the name of the current and previous president, and to subtract 3 from 20 consecutively until reaching two or less. Each incorrect response was summed, with higher scores indicating increased cognitive limitation. The indicator was truncated such that 4 or more errors was coded to 0, as fewer than 1% of respondents in any wave had
five errors. Mental health was measured with an abridged 11-item version of the Center for Epidemiologic Studies Depression Scale (CES-D). All questions were in reference to the past week. Responses were averaged, resulting in a scale that ranged from never/hardly ever (1) to most of the time (3). Example statements include “I felt depressed” and “I felt everything was an effort.” Reliability coefficients for each wave were strong, ranging from .79 to .81. The scale was truncated at average scores of .27 (100) and 1.81 (0), as fewer than 1% of all respondents had scores that were lower or higher than these respective minimum and maximum values. Lastly, life satisfaction was measured with a single item that asked “How satisfied are you with your life as a whole these days?” with responses ranging from completely satisfied (100) to completely dissatisfied (0).
Table 3  Weighted Descriptive Statistics for Successful Aging Measures

<table>
<thead>
<tr>
<th>Variable</th>
<th>50-59 (n=690)</th>
<th>60-69 (n=1,709)</th>
<th>70-79 (n=1,740)</th>
<th>80+ (n=891)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Successful Aging Continuum</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>200.9 (34.4)</td>
<td>202.7 (49.7)</td>
<td>196.8 (54.3)</td>
<td>186.9 (59.2)</td>
</tr>
<tr>
<td><strong>Physical Health (overall)</strong></td>
<td>75.7 (19.8)</td>
<td>69.6 (27.9)</td>
<td>63.2 (29.8)</td>
<td>57.8 (31.5)</td>
</tr>
<tr>
<td></td>
<td>63.2 (29.8)</td>
<td>57.8 (31.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of Chronic Conditions</td>
<td>73.1 (25.7)</td>
<td>63.4 (35.8)</td>
<td>55.6 (37.3)</td>
<td>54.1 (39.7)</td>
</tr>
<tr>
<td></td>
<td>55.6 (37.3)</td>
<td>49.7 (42.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Physical Limitations</td>
<td>89.3 (23.8)</td>
<td>85.6 (36.0)</td>
<td>78.2 (42.6)</td>
<td>66.3 (49.0)</td>
</tr>
<tr>
<td></td>
<td>78.2 (42.6)</td>
<td>66.3 (49.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Self-Rated Health</td>
<td>61.7 (25.3)</td>
<td>59.3 (35.5)</td>
<td>55.85 (34.2)</td>
<td>52.8 (35.8)</td>
</tr>
<tr>
<td></td>
<td>55.85 (34.2)</td>
<td>49.7 (42.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mental Functioning and Outlook (overall)</strong></td>
<td>75.6 (13.8)</td>
<td>79.1 (18.8)</td>
<td>77.9 (19.4)</td>
<td>75.0 (23.0)</td>
</tr>
<tr>
<td></td>
<td>77.9 (19.4)</td>
<td>75.0 (23.0)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive impairment</td>
<td>84.6 (20.4)</td>
<td>85.3 (25.8)</td>
<td>82.0 (30.6)</td>
<td>76.0 (36.2)</td>
</tr>
<tr>
<td></td>
<td>82.0 (30.6)</td>
<td>76.0 (36.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CESD</td>
<td>75.60 (21.6)</td>
<td>79.9 (25.4)</td>
<td>77.6 (26.4)</td>
<td>75.5 (29.5)</td>
</tr>
<tr>
<td></td>
<td>77.6 (26.4)</td>
<td>75.5 (29.5)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Life satisfaction</td>
<td>66.6 (20.8)</td>
<td>72.2 (29.4)</td>
<td>74.0 (29.9)</td>
<td>73.5 (33.1)</td>
</tr>
<tr>
<td></td>
<td>74.0 (29.9)</td>
<td>73.5 (33.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Social Engagement (overall)</strong></td>
<td>50.5 (18.5)</td>
<td>54.0 (24.3)</td>
<td>55.7 (27.0)</td>
<td>54.2 (29.6)</td>
</tr>
<tr>
<td></td>
<td>55.7 (27.0)</td>
<td>54.2 (29.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Informal Engagement</td>
<td>66.4 (21.7)</td>
<td>70.2 (26.2)</td>
<td>71.2 (29.3)</td>
<td>69.3 (33.1)</td>
</tr>
<tr>
<td></td>
<td>71.2 (29.3)</td>
<td>69.3 (33.1)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Formal Engagement</td>
<td>50.5 (18.6)</td>
<td>54.0 (24.3)</td>
<td>55.7 (27.0)</td>
<td>54.2 (29.6)</td>
</tr>
<tr>
<td></td>
<td>55.7 (27.0)</td>
<td>54.2 (29.6)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

1This table summarizes 14 age groups worth of data that will be used in the all trajectory models. Standard deviations are in parentheses.
3.2.1.3 Social Engagement

Social engagement was based loosely on Thomas’s (2011; 2012) analysis of the ACL. Five items assessed engagement in different activities. Two focused on informal interaction, asking how often the respondent talked on the phone with friends, neighbors or relatives, and how often they visited each other’s homes. These items were averaged (average α=.65) into a scale ranging from 0 to 100, increasing at increments of 10. The other three asked about formal participation—attending meetings or groups, religious services, and volunteer work in the past year. Response categories for the volunteering measure ranged from never (1) to 160 hours or more (6). Response categories for all other items ranged from never (1) to several times a day (6). This resulted in a social engagement scale with a range of 0 (0) to 18 (100). This scale was left untruncated both due to results of a sensitivity analysis (see appendix B) that found that truncation biased estimates and because over 1% of respondents had scores of 18 in all waves. The final social engagement domain estimate was the average the informal and formal engagement scales.

3.2.2 Stressors

One of the key issues studied in this dissertation was how exposure to stressful situations and different life events influence successful aging. Descriptive statistics for these measures and all other time invariant measures are presented in Table 3. Time invariant measures were used to predict trajectory membership since trajectory membership cannot vary over time (Nagin 2005). While time varying predictors can be used in trajectory models, they are used as estimators of trajectory shape over time rather than membership. Since this study’s goal is to predict group membership/classification,
only time invariant measures are used, with one exception that is discussed later\(^8\).

Exposure to stressful situations is measured in three ways- stressful childhood circumstances, accumulated life events, and accumulated adult chronic stressors.

### 3.2.2.1 Childhood Stress

Stressful circumstances during childhood were measured following Umberson and colleagues’ (2005) analysis of the ACL. A count variable was constructed based on a series of seven family related stressors that occurred before age 16: the respondent’s parents had serious marital problems, at least one parent had drinking problems, at least one parent had mental health problems, at least one parent was violent, one or more parents died, parents were divorced/separated, and if the respondent did not grow up with both parents for other reasons (e.g. raised in institution, ran away, never knew father/mother). In addition, family economic hardship was counted for those who reported that their family was either somewhat or a lot worse off than the average family in their community. Some respondents reported as many as seven of eight possible stressors, but the measure needed to be truncated at five due to small cell sizes.

\(^8\) It is important to emphasize, however, that many of the baseline predictors in this model may actually vary over time in reality. A smoker may cease smoking, for instance. Given the structure of the current data, which combines partial aging trajectories for many individuals over time, including time varying covariates is inadvisable. Instead different methods, such as growth curve models or following a single cohort over time with group based trajectory models. Examining these time varying behaviors would reveal interesting results about the amount of change a person can induce on their successful aging trajectory over time, but they are well beyond the scope of the current study.
<table>
<thead>
<tr>
<th>Variable</th>
<th>%</th>
<th>Variable</th>
<th>Mean or %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Controls (%)</strong></td>
<td></td>
<td><strong>Employment</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>54.6</td>
<td><strong>Employed</strong></td>
<td>47.3</td>
</tr>
<tr>
<td>Black</td>
<td>11.6</td>
<td><strong>Retired</strong></td>
<td>32.6</td>
</tr>
<tr>
<td>Has child(ren)</td>
<td>89.2</td>
<td><strong>Not working for any other reason</strong></td>
<td>20.1</td>
</tr>
<tr>
<td>Uninsured at wave 2</td>
<td>5.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>In retirement community</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Birth Cohort</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;=1910</td>
<td>12.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1911-1920</td>
<td>26.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1921-1930</td>
<td>32.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1931-1940</td>
<td>28.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SES Composite</strong>^1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>16.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low middle</td>
<td>22.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td>21.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High Middle</td>
<td>19.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>20.67</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Marital Status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Married</td>
<td>68.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Separated/divorced</td>
<td>9.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Widowed</td>
<td>18.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never married</td>
<td>3.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>BMI</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normal Weight</td>
<td>40.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overweight</td>
<td>40.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obese</td>
<td>18.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Health Behaviors (%)</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Smoker at wave 2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never smoked</td>
<td>40.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Former smoker</td>
<td>39.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Current smoker</td>
<td>20.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Drinking status</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never drinks in waves 1+2</td>
<td>46.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-59 drinks at most</td>
<td>43.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>60+ drinks in either wave</td>
<td>9.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Coping Resources (means)^2</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Wave 1+2 avg mastery (-2.3 to 2.0)</td>
<td>-0.00</td>
<td></td>
<td>(1.00)</td>
</tr>
<tr>
<td>Wave 1+2 avg support (-2.3 to 1.3)</td>
<td>-0.00</td>
<td></td>
<td>(1.00)</td>
</tr>
<tr>
<td>Childhood stressors (0 to 5)</td>
<td>0.91</td>
<td></td>
<td>(1.52)</td>
</tr>
<tr>
<td># of events up to wave 2 (0 to 11)</td>
<td>4.39</td>
<td></td>
<td>(2.33)</td>
</tr>
<tr>
<td>Wave 1+2 avg stress (-1.8 to 2.3)^2</td>
<td>0.00</td>
<td></td>
<td>(1.00)</td>
</tr>
</tbody>
</table>

^1Proportions shown for imputed variable
^2Standardized variables
Minimum, maximum, and standard deviations are shown in parentheses when appropriate
3.2.2.2 Chronic Stress

Chronic stress measures were assessed at both waves 1 and 2, focusing on stress from four different sources: Financial stress, marital stress, parenting stress, and job stress (Umberson et al. 2005). Financial stress was measured with three items asking how hard it was to pay bills, how well finances worked out at the end of the month, and their satisfaction with their current financial situation (α=.79 in wave 1 and α=.73 in wave 2). Stress from one’s marriage was measured with seven items (α=.77 in wave 1 and α=.80 in wave 2), including a count of marital problems such as cheating and a measure of how often the respondent reported fighting with their spouse. Parenting related stress was measured with three items (α=.63 in wave 1 and α=.66 in wave 2) that asked if a respondent felt upset as a parent, if they were unhappy with how their child turned out, and how satisfied they were with being a parent. Lastly, job stress was measured with a single item that asked how often the respondent felt bothered or upset by their work. Each scale was constructed by first standardizing individual items. The measure used in this analysis is the respondent’s average stress exposure across waves 1 and 2. This finalized indicator is built by taking the average of all available standardized stress scales in both waves 1 and 2 separately. Then scores across both waves are averaged and restandardized9. This measure was truncated at 2.5 standard deviations above the mean and standardized one last time, reclassifying 26 outliers. The end result was a measure with high values only if a respondent was highly stressed during both waves.

9 One immediate concern with this measure is that respondents with fewer sources of stress may score on either extreme of the scale. This is because a respondent with one source of stress only needs to have extreme values on one measure while a person with fours sources needs extreme values on all four. There is no evidence that scores on the stress variables are correlated with the number of stress dimensions available. This is evidenced by the poor explanatory power of a regression model predicting overall stress scores with the number of questions used a linear and square term (R²<.01).
3.2.2.3 Life Events

Life events were, for this study, major disruptive incidents that can alter life course trajectories and generate immediate and future stressors (Pearlin 2009). Exposure to life events prior to wave one was measured as a count of if the person had experienced: the death of a parent\textsuperscript{10}, the death of a child; the death of a spouse; having a divorce; and having ever been assaulted. In addition to these, respondents were asked if in the past three years they had been robbed, had an involuntary job loss, been the victim of a serious attack or assault, had major financial difficulties, or if they had anything else happen to them that was very upsetting. The measures of parent, spouse, and child death were counted multiple times if multiple deaths were reported. The same set of questions was asked in wave 2 in reference to the time between waves 1 and 2. For this study the sum of all events from 16 years old up to wave 2 was used, combining results from both survey waves in order to allow for a more thorough measure. The final measure was relatively normally distributed and truncated at 11 events, which affected 13 outliers with high life event counts.

3.2.3 Health Behaviors

The ACL provided useful data for the health behaviors that a respondent engages in. Physical activity was measured with three items that ask how often the respondent does work in the garden or yard, takes walks, and engages in active sports or exercise. Response categories range from “often” (4) to “never” (1)\textsuperscript{11}. Data from both waves 1 and

\textsuperscript{10} If a parent died before the respondent was younger than 16 then it was counted in the childhood stressor measure instead the later life events count.

\textsuperscript{11} Though technically a scale measure, tests for reliability are not appropriate for these items. As argued in Shaw and colleagues’ (2010) analysis of the same measures, it is not appropriate to assume a tight intercorrelation between these items. Instead, they are assumed to behave like a count variable.
2 were averaged together and standardized to better capture activity over a longer period of time. A respondent’s status as a smoker at wave two is coded into three categories indicating if the respondent is a current smoker, former smoker, or had never smoked at all. Drinking behaviors were broken into a three category measure where respondents did not drink in either wave, drank 1-59 drinks per month in at least one wave, or 60 or more drinks in at least one wave. While combining both wave 1 and 2 drinking behaviors raised the possibility of predicting wave 1 behaviors with wave 2 stressors, substantive associations remained unchanged when only wave 2 drinking was predicted by accumulated and wave 1 stress.

### 3.2.4 Coping Resources: Mastery and Social Support

For the current study, two coping resources were assessed. Mastery, which reflects the person’s perceived ability to control their life’s path (Pearlin and Schooler 1978), was measured with a six item index in the first two waves. Responses to the 4-point Likert scale items were averaged and standardized such that high scores indicate increased mastery. Scores from both waves were then averaged and restandardized, with a small number of extreme outliers being truncated at the 98th percentile. Although the alpha for either wave was less than desired (α=.64 in wave 1 and α=.67 in wave 2), these measures have been found to perform as expected in other studies with similarly low alphas, including the study that pioneered the measure (House et al. 1994; House, Lantz, and Herd 2005; Pearlin and Schooler 1978).

Social support can be thought of as the emotional, informal, and instrumental functions that were performed for the individual by their formal and, to a lesser extent, informal social groupings (Berkman 2000; Thoits 2011). Positive social support from the
respondent’s friends, mother, father, children, and spouse was assessed with two items for each source of support in both waves one and two\textsuperscript{12}. These questions asked how often each source made the respondent feel loved and how much he/she was willing to listen when the respondent needed to talk about worries. Scale construction followed Turner and Lloyd’s (1999) approach to similar measures. First, averages for each pair of measures were calculated. Then, an average support score was calculated by adding together available support scores and dividing by the number of support sources available. The measure was then standardized, averaged across both waves, and standardized a final time. This yields an interpretable measure of the respondent’s average level of support from all available sources across both waves. Higher values indicate increased levels of support, in standard deviations.

### 3.2.5 Other Controls\textsuperscript{13}

Several other important demographics were included in testing the explanatory stress process model. Birth cohorts were grouped into four categories, before 1910, between 1911-1920, before 1921-1930, and 1931-1940. These categories were used in the trajectory models to predict differences in trajectory shape across cohorts and in the models predicting membership in a particular trajectory group. Insurance status was only asked in wave 2, responses from that wave were coded 1 if uninsured 0 if otherwise. Sex was included as a male/female binary. Because the ACL had only a very small number of

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\textsuperscript{12} For wave 1 average $\alpha= .66$ for each two item index, for wave 2 average $\alpha=.68$.

\textsuperscript{13} Preliminary models also included an indicator for the highest level attained by a respondent’s mother or father. While this can be a useful proxy of the environment that the respondent grew up in, it is also strongly linked to period and cohort differences. For instance, while an 8\textsuperscript{th} grade education with highly educated in earlier years, it now indicates the opposite. Parent education was not associated with any dependent variables, but it is likely that this lack of association is confounded by the aforementioned cohort effects instead of a “real” null relationship. Therefore the measure was excluded from final analyses.
non-black minority respondents, this analysis used only a black (1)/white (0) dummy indicator to test for racial differences.

Employment status was broken into three categories: employed, retired, and not working for any other reasons such as keeping house or unemployment. Ideally these would be broken down further but very few respondents were unemployed and almost all respondents keeping house were female, which would lead to collinearity with the sex indicator. Marital status was measured with four categories: married, separated/divorced, widowed, and never married\(^\text{14}\). Parental status was coded with a dummy variable indicating whether the respondent had at least one child\(^\text{15}\) of any age at wave one.

Respondent body mass index values were calculated\(^\text{16}\) and used to classify respondents as normal weight (BMI less than 24.9), overweight (BMI 25-29.9), or obese (BMI 30+).

Census region was accounted for with a four category variable indicating whether the respondent lived in the northeast, northwest, south, or west during wave 1. The community setting that individuals reside within was captured with an indicators that distinguishes between living in an urban, rural, and suburban area. Finally, a binary indicator was added to distinguish between if a respondent lived in a retirement community based on the interviewer noting that the respondent “… [lived in] retirement housing or an adult only community [designed for older people].

\(^{14}\) Marital status and employment status are only considered at a single point in time (typically wave 1, unless the respondent turned 50 in the time after the wave 1) for this study because becoming a widow, divorcing, and unwanted job loss are counted as life events for the current study. Including changes in marital status and possibly employment status would risk double counting the events.

\(^{15}\) This measure includes “natural” children, adopted children, and stepchildren.

\(^{16}\) BMI was calculated as \(\text{BMI} = \frac{\text{weight (lbs)}}{\text{height (in)}^2} \times 703\)
Socioeconomic status was captured with a composite measure that accounts for an individual’s income, education, and accumulated wealth. First, individuals were classified into categories based on House and Colleagues’ composite SES measure:

"Socioeconomic status is defined in terms of education and income:
Upper SES defined as 16+ years of education and income > $20,000
Upper-middle SES defined as 12 to 15 years of education and income > $20,000
Lower-middle SES defined as either 0 to 11 years of education or income < $20,000, but not both and
Lower SES defined as both 0 to 11 years of education and income < $20,000 (House, Kessler, and Herzog 1990: 389)"

This resulted in an indicator that was strongly correlated with age, since older adults tend to have less income due to retirement. To account for this a modification was introduced to allow for the possibility that an individual is retired but living on saved wealth. Individuals were asked how much money they would have if they cashed in all checking, savings, stocks, bonds, and real estate other than their principle home. If respondents had over $10,000 saved but less than $99,000, their SES classification was increased one rank. If respondents had over $100,000 saved, their SES classification was increased two ranks. This yielded six classifications initially, but the top two were collapsed due to small cell sizes. This resulted in 5 group SES indicator with low, low middle, middle, upper middle, upper class categories. The final indicator is still correlated with age, but this correlation is weaker than if income and education were included in the model separately and in House and Colleagues’ (1990) measure.

Employment status, marital status, parental status, SES, and BMI were almost always derived from wave 1 measures unless the respondent was not 50 until wave 2. In
that case their measures were based on wave 2 data, since this is the first wave in which they contribute to the study’s developmental trajectories\(^\text{17}\).

3.2.6 Investigating Measurement Bias Due to Two-Wave Completion Requirement

It is possible, and even likely that failure to participate in the survey in wave 2 would be associated with indicators in the study. To investigate this, a logistic regression model predicting nonresponse (due to either mortality or other reasons) was estimated, using all independent variables as covariates\(^\text{18}\). It was found that each year of age decreased odds of participating significantly (OR=1.03). Having an increased number of cognitive impairments was also significantly associated with nonresponse (OR=1.21). Nonresponse risk was significantly decreased by being female (OR=.50), living in a rural area versus an urban area (OR=.47), living in a retirement community (OR=.36), higher activity scores (OR=.68), and volunteering 160+ hours versus not at all (OR=.27).

While this raises concern for measurement bias, using the survey weights specifically designed to adjust for bias associated with attrition between waves 1 and 2 alleviates this issue. For example, applying these weights makes distribution estimates for age, gender and community type almost identical to the larger wave 1 only sample. Cognitive impairment estimates are similarly unaffected, with a weighted mean of .9 in wave 1 and .87 in the wave 1 and wave 2 subsample. This bias reduction was present for all indicators, suggesting that the decision to require respondents to complete both waves 1 and 2 will not alter weighted inferences and associations in the current data.

\(^{17}\) Specifically, 5.9\% of cases- 97 of 1,643- have values from wave 2 instead of wave 1.

\(^{18}\) A multinomial model was also used to estimate attrition due to mortality versus attrition due to nonresponse. Substantive conclusions were comparable to those made here, and the ultimate conclusion remains the same regardless.
3.3 Indicators for Validation Study

3.3.1 Measures for Establishing Predictive Validity

The indicators described in the previous section were for the construction of successful aging and the testing of theoretical hypotheses. The measures summarized in tables 5 and 6 are for assessing the predictive validity of the successful aging continuum. These were measures that should be linked to successful aging but are not included in the final continuum. Often these items reflect expected outcomes that should be associated with successful aging, such as happiness, better health, and fewer depressive episodes. Most questions were asked directly to the respondent, but several were from a post-interview survey completed by the interviewer, which will reduce concerns about social desirability bias influencing successful aging scores. Only indicators from the first two waves are used, as most of these items did not trend across all waves of the ACL.
Table 5  Indicators for Predictive Validity Assessment at Wave 1 (n=1529)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Weighted %</th>
<th>Variable</th>
<th>Weighted %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Self-Reported Items</td>
<td></td>
<td></td>
<td>These are the best years of R’s life</td>
</tr>
<tr>
<td>Receives help in getting around community</td>
<td></td>
<td></td>
<td>Strongly Agree</td>
</tr>
<tr>
<td>Yes</td>
<td>10.0</td>
<td>Agree</td>
<td>37.2</td>
</tr>
<tr>
<td>No</td>
<td>90.0</td>
<td>Disagree</td>
<td>22.0</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>10.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>How limited is R in daily activities by health?</td>
<td></td>
<td></td>
<td>Looking back, R is satisfied with entire life</td>
</tr>
<tr>
<td>A great deal</td>
<td>6.0</td>
<td>Strongly Agree</td>
<td>49.8</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>7.6</td>
<td>Agree</td>
<td>41.0</td>
</tr>
<tr>
<td>Some</td>
<td>15.4</td>
<td>Disagree Or More</td>
<td>9.2</td>
</tr>
<tr>
<td>A little</td>
<td>13.1</td>
<td>Not at all</td>
<td>58.0</td>
</tr>
<tr>
<td>Not at all</td>
<td>58.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviewer Assessment Of R</td>
<td></td>
<td></td>
<td>Did R have difficulty remembering questions</td>
</tr>
<tr>
<td>R has stayed in hospital in past 6 months</td>
<td></td>
<td></td>
<td>No difficulty</td>
</tr>
<tr>
<td>Yes</td>
<td>92.6</td>
<td>A little</td>
<td>20.0</td>
</tr>
<tr>
<td>No</td>
<td>7.4</td>
<td>Some</td>
<td>8.7</td>
</tr>
<tr>
<td>Illness/injury kept R in bed in past 3 months</td>
<td></td>
<td></td>
<td>A lot</td>
</tr>
<tr>
<td>Yes</td>
<td>12.3</td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>No</td>
<td>87.7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Did R have difficulty walking</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R often feels fed up</td>
<td>Yes</td>
<td>22.4</td>
<td>No difficulty</td>
</tr>
<tr>
<td></td>
<td>Sometimes</td>
<td>13.9</td>
<td>A little</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>63.7</td>
<td>Some</td>
</tr>
<tr>
<td>R’s health</td>
<td>Excellent</td>
<td>24.3</td>
<td>A lot or couldn’t</td>
</tr>
<tr>
<td>Life could be happier</td>
<td></td>
<td></td>
<td>3.0</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>19.8</td>
<td>Good</td>
<td>52.4</td>
</tr>
<tr>
<td>Agree</td>
<td>52.5</td>
<td>Fair</td>
<td>17.9</td>
</tr>
<tr>
<td>Disagree</td>
<td>13.3</td>
<td>Poor or grave</td>
<td>5.4</td>
</tr>
<tr>
<td>Strongly</td>
<td>14.4</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>How depressed did R seem?</td>
<td></td>
<td></td>
<td>Quite or Very</td>
</tr>
<tr>
<td>R depressed for week or more in past year</td>
<td>Yes</td>
<td>9.5</td>
<td>3.1</td>
</tr>
<tr>
<td>No</td>
<td>90.5</td>
<td>Some</td>
<td>10.0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A little</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not</td>
<td>67.6</td>
</tr>
</tbody>
</table>
Table 6  Indicators for Predictive Validity Assessment at Wave 2 (n=1526)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Weighted %</th>
<th>Variable</th>
<th>Weighted %</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-Reported Items</strong></td>
<td></td>
<td><strong>Interviewer Assessment Of R</strong></td>
<td></td>
</tr>
<tr>
<td>How limited is R in daily activities by</td>
<td></td>
<td>Did R have difficulty remembering</td>
<td></td>
</tr>
<tr>
<td>health?</td>
<td></td>
<td>questions</td>
<td></td>
</tr>
<tr>
<td>A great deal</td>
<td>6.7</td>
<td>No difficulty</td>
<td>65.2</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>7.4</td>
<td>A little</td>
<td>23.2</td>
</tr>
<tr>
<td>Some</td>
<td>21.4</td>
<td>Some</td>
<td>8.4</td>
</tr>
<tr>
<td>A little</td>
<td>15.7</td>
<td>A lot</td>
<td>3.2</td>
</tr>
<tr>
<td>Not at all</td>
<td>48.8</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R has stayed in hospital in past 6 months</td>
<td></td>
<td>Did R have difficulty walking</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>9.7</td>
<td>No difficulty</td>
<td>79.7</td>
</tr>
<tr>
<td>No</td>
<td>90.2</td>
<td>A little</td>
<td>9.7</td>
</tr>
<tr>
<td>Illness/injury kept R in bed in past 3</td>
<td></td>
<td>Some</td>
<td>6.4</td>
</tr>
<tr>
<td>months</td>
<td></td>
<td>A lot or couldn’t</td>
<td>4.3</td>
</tr>
<tr>
<td>Yes</td>
<td>18.9</td>
<td>R’s health</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>81.1</td>
<td>Excellent</td>
<td>16.8</td>
</tr>
<tr>
<td>Good</td>
<td></td>
<td>Good</td>
<td>54.3</td>
</tr>
<tr>
<td>R had depressive episode in past 3 yrs</td>
<td></td>
<td>Fair</td>
<td>21.4</td>
</tr>
<tr>
<td>Yes</td>
<td>13.5</td>
<td>Poor or grave</td>
<td>7.5</td>
</tr>
<tr>
<td>No</td>
<td>86.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Overall, how happy is R?</td>
<td></td>
<td>How depressed did R seem?</td>
<td></td>
</tr>
<tr>
<td>Very Happy</td>
<td>32.4</td>
<td>Quite or Very</td>
<td>4.2</td>
</tr>
<tr>
<td>Pretty Happy</td>
<td>56.0</td>
<td>Some</td>
<td>10.2</td>
</tr>
<tr>
<td>Not Happy</td>
<td>11.5</td>
<td>A little</td>
<td>21.7</td>
</tr>
</tbody>
</table>

3.3.2 Construction of Alternative Operationalizations of Successful Aging

It was also important to establish the convergent validity of the successful aging continuum used in the current study. To do this, the successful aging continuum was compared against several other operationalizations of successful aging. Some of these operationalizations also depended on different conceptualizations of successful aging, although the details of these differences need not be evaluated here. For the current
analysis the primary goal is to check that the current study’s operationalization of successful aging is strongly correlated with a diverse set of measures of SA. If this is not established there is a risk that results are the product of this specific operationalization rather than something that would be found across multiple operationalizations.

To maximize the breadth of this comparison, three alternative operationalizations were constructed. The procedure for each variable’s construction is summarized in table 7 and descriptives can be found in table 8. First, a binary indicator of successful aging was created based on a commonly used procedure in the literature (Brandt, Deindl, and Hank 2012; Hank 2010; McLaughlin et al. 2009). This operationalization required the use of several indicators from waves 1 and 2 of the ACL which asked if the respondent had cared for children, helped with errands or housework, or assisted with “other things” for friends, neighbors or relatives in the past year19. A second continuum measure was constructed in all five waves using guidelines from Young and Colleagues (2009). The conceptualization they use is similar to the current study, but it also includes mastery as a part of its mental domain. The final scale ranges from 0 to 5, though the uppermost category was very sparse or empty in all waves20.

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19 Note that this is not a perfect reproduction of the procedure used in the cited studies, as the ACL lacks distinct measures of disability and physical limitation. Instead, they are combined together as part of a single Guttman scale used for this study. Because these two components are strongly correlated it is unlikely that this divergence will substantially alter results for the current study.

20 Ideally having low anxiety would also be considered alongside depression and mastery, but it is not available for the current study. The absence of this measure may alter results slightly, but depression and anxiety tend to be positively correlated with one another, reducing the likelihood of bias due to omitting one or the other.
Table 7  Summary of Construction of Alternative Successful Aging Indicators

**Binary Classification (Brandt et al. 2012; Hank 2010; McLaughlin et al. 2009):** Waves 1 and 2
Successfully aged (1) if: no functional limitations and no diseases or conditions and no cognitive impairments, and socially engaged, which entails:
1) At least one of the following
   a) Working a job
   b) Volunteering
   c) Providing care for a child
2) And at least one of the following
   a) Is living with partner
   b) Helping friends, neighbors or relatives with errands, housework, or “other things”
   c) Attending meetings OR religious gatherings at least once a month

**Factor Scores from Kahng’s (2008):** Factor loadings originally from Wave 3, applied to all waves.
Continuum of standardized indicators calculated using loadings for each dimension and indicator, resulting in the equation:
\[ 0.67\times(-0.42 \times \# \text{ of conditions}) + 0.87 \times \text{functional limitation score} + 0.61 \times \text{phys activity score} + \\
0.89\times(-0.71 \times \text{depression score}) + (-0.39 \times \text{cognitive impairment score}) + 0.64 \times \text{mastery score} + \\
0.67\times(0.54 \times \text{formal engagement scale}) + 0.69 \times \text{informal engagement scale} + 0.34 \times \text{support from friends and family} \]

**Continuum from Young and Colleagues (2009):** Constructed for all 5 waves
1) Start at 0.
2) Add 1 if no conditions/diseases
3) Add 1 if no functional limitations
4) Add 1 if 1 or fewer cognitive errors on cognitive impairment scale
5) Add 1 if in lowest two quintiles for depression score and “very satisfied” with life or more and in top 75th percentile for mastery
6) Add 1 score if average of informal and formal scales is greater than or equal to 8

A second continuum measure was constructed based on Kahng’s (2008) analysis of the ACL data. Factor scores were calculated using a weighted sum method and Kahng’s confirmatory factor analysis, which estimated successful aging. The weighted sum method incorporates information from Kahng’s confirmatory factor analysis results.
by first multiplying standardized indicators by their factor loadings and adding them together (DiStefano, Zhu, and Mindrila 2009). Then, each dimension was multiplied by its respective loading. Kahng’s analysis was on wave 3 of the ACL, but the factor loadings from the wave 3 model were applied to estimate continua for the other waves as well. Note that the support measure used by Kahng only considers support from friends and relatives, while the current study includes support from family members and children as well.

<table>
<thead>
<tr>
<th>Table 8</th>
<th>Summary Statistics for Alternative Successful Aging Indicators</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Wave 1</td>
</tr>
<tr>
<td>Binary (% SA)</td>
<td>12.2</td>
</tr>
<tr>
<td>Young (Mean)</td>
<td>2.7</td>
</tr>
<tr>
<td></td>
<td>SD=1.0</td>
</tr>
<tr>
<td>Kahng (Mean)</td>
<td>0.5</td>
</tr>
<tr>
<td></td>
<td>SD=1.4</td>
</tr>
</tbody>
</table>

### 3.4 Analytic Plan

This study’s analysis was conducted in three phases. The first two phases reflected a unique approach to estimating successful aging, as they combined an existing continuum measure for successful aging with a group based trajectory modeling approach. The first phase was to establish the successful aging continuum’s predictive validity and concordance with other operationalizations of successful aging. Then, a latent trajectory model is fit based on these continuum scores. This identifies common aging trajectories that are followed over time. The final phase will test the explanatory model presented earlier using a series of regression models, ultimately predicting
membership in the trajectories that were previously estimated. All analyses are performed in Stata 13 with the supplied sampling weights for respondents that completed both waves one and two.

3.4.1 Validating the Successful Aging Continuum

It is important that the validity of the successful aging continuum be established. Prior studies have done this by demonstrating the predictive validity of their successful aging indicator (Cosco, Stephan, and Brayne 2015; Young et al. 2009). That is, they have tested if their measure is associated with variables that reflect elements of successful aging in the present or the future. For the current study, predictive validity was assessed within waves 1 and 2 (e.g. wave 1 continuum predicting a wave 1 variable) and across waves (e.g. wave 1 predicting wave 2 variables). This was assessed using a series of weighted ordinary least squares regression models predicting changes in the successful aging scale, adding each expected correlate separately. All analyses use robust standard errors to accommodate for survey weights and heteroskedasticity. Estimates were adjusted for race, sex, SES, and age to minimize common sociodemographic confounding. Final results were presented as marginal predicted means- that is, the predicted mean score on the successful aging continuum adjusted for race, SES, sex, and age.

In addition to predictive validity, it is also possible to assess the convergent validity of the successful aging continuum. For this criterion to be met, the current successful aging continuum should be strongly correlated with other measures of successful aging. Cross tabulations and comparisons of means can both be used to detect significant associations between the binary measure and the successful aging continuum.
Pairwise correlations will be calculated between each wave’s scores on the successful aging continuum, Kahng scale, and Young scale. These relationships will also be graphed to investigate the possibility of nonlinear trends.

3.4.2 Estimating Multiple Aging Trajectories

3.4.2.1 Overview of Group Based Trajectory Modeling

A major issue with most prior approaches to the study of successful aging was that they depend on dichotomous methods that do not account for the presence of multiple aging groups that vary across the life course (Cosco, Stephan, and Brayne 2014; Cosco, Stephan, and Brayne 2015). I follow Hsu and Jones’s (2012) solution to this challenge by estimating aging trajectories over the life course using group based trajectory modeling (GBTM) (Nagin 2005). This is a form of a finite mixture model that uses maximum likelihood estimates to identify the characteristics of a pre-defined number of groups. These trajectory groups were estimated along a censored normal distribution. All missing data were handled using full information maximum likelihood estimation, meaning that all other missing cells are adjusted for and will not bias trajectory shapes or group membership probabilities.

3.4.2.2 The Analytic Process

The trajectory analysis had three main steps. First, the modeling software, in this case the TRAJ plugin for Stata 13 (Jones and Nagin 2013), estimated a model based on a researcher defined number of groups and their anticipated functional form. Each group could have a unique intercept and a linear, quadratic, or cubic functional form. Then, respondents were classified into a particular group based upon their posterior probabilities, which were estimates that reflect the individual’s conditional probability of
membership in a trajectory (Nagin 1999). Lastly, as will be described in the section about testing the explanatory model, time invariant covariates were used to predict membership in a particular group. For the remainder of this section I explain the process of fitting the trajectory model, determining its quality, and how I tested for cohort effects.

3.4.2.3 Identifying the Best Fitting Model

Determining the number of groups and their functional form is both an art and a science. Decisions must be simultaneously informed by theory, parsimony, and empirical criteria. Critics of trajectory models emphasize the possibility of researchers overfitting models, estimating a bevy of trajectories that look interesting but do not actually improve the model’s fit to the data. This can lead to misleading results and unwarranted theoretical conclusions (Bauer 2007; Sampson and Laub 2005). These concerns are certainly warranted, but appear to be overblown to some extent in light of simulation tests that demonstrate that several methods are useful for determining the appropriate number of trajectories to be used and their shape (Nylund, Asparouhov, and Muthén 2007). In this analysis I carefully employed several strategies to determine the best fitting model and avoid overfitting.

The appropriate number of trajectories was determined by estimating an increasing number of quadratic trajectories, up to as many as ten (Andruff et al. 2009). Following Nylund and colleagues’ (2007) recommendations, Bayesian Information Criteria (BIC), Akaike Information Criteria (AIC), and Log-Likelihood (LL) statistics were monitored for changes. Values closer to zero for these statistics indicated better model fit. While adding additional trajectories tended to reduce BIC values, eventually these returns diminished, suggesting that adding additional trajectory groups was not
improving model fit (Andruff et al. 2009). At that point the number of trajectories was locked in place and the functional form of each trajectory was determined. The same procedure was applied to determining the shape of each group’s trajectory- BICs, AICs, and LLs provided evidence for the best fitting model. In addition, trajectories that had non-significant parameter estimates such as an extremely small cubic slope were excluded, as this would suggest that a simpler model may be more appropriate (Nagin and Tremblay 2005).

It was also possible to assess how well individuals are classifying into individual trajectories by examining their posterior probabilities (Nagin 2005; Nagin and Odgers 2010). Posterior probabilities reflect the probability that an individual should be classified in one group rather than another. Average posterior probabilities for members of a particular group should be greater than .70, with higher values indicating a better probability that the model was properly classifying individuals (Nagin 2005). Odds of correct classification were also calculated using a simple formula that adjusts average posterior probabilities by estimated trajectory proportions. Utilizing AICs, BICs, LLs, posterior probabilities, and the odds of correct classification simultaneously helped to ensure that both the number of trajectories and their shape fit the data. The groups that were identified were then used to estimate the incidence of successful aging (as well as other aging groups) and the differences between those groups.

3.4.2.4 Testing for Cohort Differences

One important detail that was accounted for in this analysis was the effect of cohort membership on the shape of each trajectory. The accelerated cohort design of the ACL data allowed for multiple cohorts to be chained together to look at changes
specifically due to age, but doing so invoked a strong assumption that everyone follows the same trajectory shape regardless of when they were born (Miyazaki and Raudenbush 2000). Fortunately it was possible to model changes in trajectory intercepts by cohort. This was done by using a dummy variable for each cohort that is 1 for the ages to which the individual contributes and 0 for all other age groups. Doing this meant that cohort differences in trajectory shapes are much less of a concern, though it is not possible to estimate cohort differences in the functional form of each trajectory (Nagin 2005). Including these cohort differences in the estimation of the model also meant that age and birth cohort could not be included in the prediction of group membership, as controlling for cohort membership alters the covariance structure of the data in such a way that it can produce erroneous conclusions.

3.4.2.5 A Final Caveat

It must be emphasized that these groups are not “real” in the sense that they reflect a literal socially defined group. They are a statistical approximation, what Nagin and Tremblay (2005) refer to as a “convenient statistical fiction.” Individuals also do not necessarily follow trajectories lock-step; there is variation around the trajectory even though it is not directly modeled. While groups are necessarily reified as “real” when we refer to individuals as members of a particular trajectory (e.g. successfully aged), it is important to remember that we are really referring to an individual’s high probability of membership, they are not guaranteed members (Nagin and Tremblay 2005).

3.4.3 Testing the Predictive Model

Earlier in the manuscript a modified stress process model (the “successful aging explanatory model”, or SAEM) was presented which integrated social locators, early
childhood stressors, accumulated adult stressors, coping resources, and health behaviors. This theoretical framework was operationalized in the path diagram presented in Figure 7, though path analysis is not used in the current study. Each line from left to right reflects a relationship that must be tested. Dashed and solid lines note the method through which mediation will be tested, which is discussed later in this section.

Each path was tested by regressing the endogenous (e.g. predicted) variable on all exogenous variables (e.g. preceding measures in the diagram). So for instance, social support scores were treated as an outcome of sociodemographics, early life circumstances, number of life events, average stress scores, and controls. In contrast, number of life events was only predicted by sociodemographics, controls and early life circumstances. The type of regression model used depended on the dependent variable in question. All models used and diagnostic considerations are summarized in table 4, following analytic procedures suggested by popular texts on regression modeling (Hoffman 2003; Kohler and Kreuter 2012).

---

21 A path analysis model is not used for this analysis because of the large number of binary, nominal, and count variables. While Stata has Generalized Structural Equation Modeling (GSEM) functions that can allow for non-normal distributions to be used, no model fit statistics are available for this approach, leading to dubious conclusions. It is also not possible to standardize coefficients in GSEM, meaning that tests for mediation are not possible like in normal SEM. An alternative to GSEM is Asymptotic Distribution Free or Weighted Least Squares estimation, which relax normality assumptions (Kline 2010). This approach requires an extremely large sample to produce accurate estimates, and more importantly will not provide useful estimated probabilities of trajectory memberships since estimates are akin to standardized OLS estimates.
A multinomial logistic regression model was used to predict trajectory group membership. Group membership was estimated with all available covariates. Like all regression analyses, this estimation process also entailed a careful examination of the
bivariate descriptors of each trajectory’s membership (not shown). Weighted chi square tests and t-tests were used to assess the statistical significance of all bivariate differences. Also not shown is that variables were entered into the regression model into groups to see how associations were changed with the introduction of new controls.

3.4.3.1 Testing for Mediation

Figure 8 also specifies how mediating relationships were tested. Mediation is when a predictor is expected to exert its influence upon an outcome through its influence on another intervening variable. Assume we have X, a predictor, Y, an outcome, and M, a hypothesized mediator. In general, mediation tests are interested in directly assessing the magnitude and significance of the indirect effect of X on Y through M. If all indicators were continuous, then the mediation tests were calculated empirically using bootstrapped standard errors (Hayes 2009). Specifically, bias-corrected bootstrapped standard errors were used, as they have been shown to be more accurate than percentile cut-off standard errors (MacKinnon, Lockwood, and Williams 2004). All bootstrap tests used 5000 repetitions and were conducted on weighted data.

In many cases it was not possible for bootstrapped mediation tests to be used. For the current study, the challenge was that some of the mediators and outcomes of interest were categorical. These estimates could not be compared directly with OLS coefficients in a way that was meaningful, as OLS coefficients and multinomial models are scaled differently and handle error differently. For the current study Iacobucci’s (2012) recommendations were used to calculate a test statistic that can assess the significance of a mediating relationship with both continuous and non-continuous indicators in a mediation model. This approach used the product of indirect effects, similar to a
conventional Sobel mediation test. Though this form of test has less power in small sample contexts, both bootstrapped and product of coefficients approaches such as Iacobucci’s tend to yield consistent results with large samples (Fritz and MacKinnon 2007). The method Iacobucci (2012) prescribes was adapted for the current study in the following steps:

1) Estimate model for the relationship between X and Y using either OLS or multinomial model with all controls. If multinomial, one category is necessarily held constant. This yields one or more values and standard errors for $c$, the direct effect of X on Y.

2) Estimate a model for the relationship between X and M using either OLS or multinomial model with all controls. This yields one or more values and standard errors for $a$.

3) Estimate a multinomial or OLS model for the relationship between M and Y, controlling for X and all other mediators. This yields one or more values and standard errors for $b$.

4) Calculate standardized elements:
   a. $Z_a = \frac{a}{S_a}$
   b. $Z_b = \frac{b}{S_b}$

5) Calculate a test Z statistic for each pair of mediating paths using the following equation. If a multinomial model is used the significance of paths should be calculated one at a time:

$$Z_{Iacobucci} = \frac{a \times \frac{b}{S_b}}{\frac{S_a}{S_a} + \frac{S_b}{S_b} + 1}$$

6) Assess the statistical significance of the Z statistic using standard normal distribution cut offs (e.g. 1.96 for $p<.05$, etc).

One problem that cannot be handled empirically in the current study is that there were often two (or even three) mediators between X and Y. While there are options for handling this multiple mediator scenario when all dependent variables are continuous (see Hayes 2009), these could not be used in the current study due to the fact that
successful aging was measured with a categorical variable. As such, for the current study mediation analyses will be handled only one mediator at a time. That is, in a scenario where \(X \rightarrow M_1 \rightarrow M_2 \rightarrow Y\); the mediating effects of \(X \rightarrow M_1 \rightarrow M_2\) will be assessed followed by \(M_1 \rightarrow M_2 \rightarrow Y\).

### 3.4.3.2 Missing Data

The ACL has relatively strong item completion rates, with most questions being fully answered. In the trajectory models missing data are handled through estimation and modeling strategies (FIML estimation) described previously. Unfortunately, the socioeconomic status measure could not be constructed for 5.5% of respondents. Other items such as age and parental status also had a very small number of missing responses. These missing responses reflected an undesirable loss of power, though the amount of data missing was within the ignorable 5% missing threshold (Graham 2009). Multiple imputation analyses were pursued in preliminary analyses to restore this lost power, but could not be used for final analyses. This is because the bootstrapping used in this study’s mediation tests could not be combined with multiple imputation techniques. Therefore missing data were ignored for the current study. It is worth noting, however, that substantive conclusions from the preliminary analyses remained the same regardless of if imputed data were used or not.
Chapter 4

ASSESSING THE PREDICTIVE AND CONVERGENT VALIDITY OF THE SUCCESSFUL AGING CONTINUUM

One of the main goals of this dissertation was to establish that the successful aging continuum (SAC) adequately captures the underlying construct(s) of successful aging. The SAC, which was created by adapting Cosco and colleagues’ (2015) methods, is a measure of successful aging that captures all the distinct dimensions of successful aging in a single scale. The process used to construct this scale foregoes psychometric measures (e.g. Cronbach’s alpha, factor analysis) in favor of a closer fit to the conceptualization of successful aging. The downside to not using psychometric scale construction techniques is that the SAC may be incoherent due to low scale reliability. It is therefore important to establish that the SAC is a valid measure in every way possible.

Cosco and colleagues took steps towards establishing the criterion validity of their successful aging continuum by using it to predict future use of home health services. Their analysis was limited, however, because it did not assess if high successful aging scores also corresponded with increased life satisfaction and/or mental health in the future.

The analysis presented here used the same approach to establishing criterion validity as Cosco and colleagues’ analysis, which was to assess the predictive validity of the measure. This was done by using SAC scores to predict present and future results on
a number of indicators that reflect successful aging and/or should come alongside it. For example, successfully aged individuals should be less likely to have stayed in the hospital, not have had a depressive episode, and to report being happier. Only the first two waves of the ACL data were used for this analysis due to a lack of question availability in later waves of data.

The current study elaborates on Cosco and colleagues’ analysis in three ways. First, this study establishes if the SAC can predict indicators of mental health and life satisfaction instead of just physical functioning. These items were not available for Cosco and colleagues’ analysis, but they reflect an important part of successful aging as conceptualized for the current study. Another way that this study extends Cosco and colleagues’ analysis is that it establishes that high SAC scores also correspond to positive assessments of general physical and mental health by a third party. Social desirability may be a concern for self-reported items relating to mental and physical health, and it will be useful to establish that high SAC scores correspond with a less biased individual also perceiving the respondent as healthy, mobile, and not outwardly depressed. Both self-report and interviewer assessments contain useful and unique information for confirming that a person with high SAC scores is, in fact, successfully aged.

The final way that this study expands on Cosco and colleagues’ analysis is that this study also evaluates convergent validity of the SAC, which is a requirement for the establishment of construct validity. This analysis tests how the SAC correlates with other successful aging indicators. Doing so will help to assess how comparable the results of the current analysis are with other research, as well as possibly revealing limitations in the SAC or existing measures.
4.1 Assessing Within-Wave Predictive Validity

A variety of indicators were correlated with the SAC in two separate waves to assess the scale’s predictive validity. The analysis was conducted using a series of ordinary least squares regression models that predicted the SAC, each of which contained one validator and controls for age, race, sex, and SES. Each validator was entered into its own regression model to avoid biasing results due to multicollinearity across validators. Results of either wave’s cross-sectional analyses, which amounted to a total of 21 regression models, are presented in tables 10 and 11 respectively. In order to simplify presentation, these tables contain only predicted mean SAC scores (e.g. the sum of the adjusted slope and intercept) for each validator. The control variables are included in each model to account for potential confounding and increase the rigor of the validation model. They are omitted from these tables to keep the focus on the validating variables, much like in Cosco and colleagues’ analysis. The relationship between each of these controls and the final measure of successful aging will be discussed in detail in later analyses in this dissertation.

4.1.1 Wave 1

The first wave provided nine self-reported indicators that shed light on different dimensions of successful aging. These included questions on respondent’s satisfaction with life, use of health services, and reporting of depressive episodes. Adjusted mean SAC scores for each validator are presented in table 10. As noted, each of these predicted means was adjusted for race, age, sex, and SES in a regression model. In all cases it was found that respondents with undesirable outcomes were significantly less likely \( (p<.001) \) to have high scores on the SAC. In terms of physical health, respondents who needed
help getting around the community had successful aging scores that were 25.4 points lower, on average, than those that did not need help. Individuals who reported “a great deal” of limitations due to their health had an average score that was 66.2 points lower than those with none. With regards to mental health, respondents that had a depressive episode in the past year had successful aging scores that were 24.3 points lower, on average, than those that did not have a depressive episode. Several indicators demonstrated that the SAC also predicted general life satisfaction and happiness. As an example, respondents who strongly disagreed that “these are the best years of my life” had SAC scores that were on average 41.8 points lower compared to those who strongly agreed.

In addition, the interviewer provided a brief evaluation of the respondent after the interview. These items were of special interest because they provided a criterion for establishing predictive validity that was less dependent on the respondent’s self-evaluation. While ideally a trained medical practitioner would carry out such an assessment, having any external party reporting on the individual’s physical health, functioning, and mental state was preferable to validating solely based on self-report items. Having an additional source of information about the respondent, however limited, provided an opportunity for external validation that did not require trusting the respondent’s self-report. Respondents who were described as having “no difficulty” remembering questions had average successful aging scores that were 40.5 points higher than individuals with “a lot” of difficulty. This helped to validate the cognitive functioning elements of the SAC, as it illustrated the respondent’s ability to retain and
recall information. Respondents who the interviewer perceived as being highly depressed had continuum scores that were 38.0 points lower on average than respondents who were not depressed. It should be noted that this question was especially prone to bias on the part of the interviewer due to the subjective nature of what does or does not constitute “seeming depressed.” However, other studies have established that this external appraisal was largely consistent with the self-reported CES-D items in the ACL data, suggesting that it was a relatively accurate assessment (Tran and O'Hare 1996). Lastly, respondents who were described as having poor health had average scores that were 74.7 points lower than those with excellent health. These results supported the idea that the SAC has a degree of predictive validity, as it was able to predict a wide array of factors that theoretically should coincide and/or follow successful aging.  

22 It should be noted that other explanations for not remembering questions are certainly possible. Low intelligence, distractions, and language barriers could all produce difficulty with remembering or comprehending the survey questions. Unfortunately more precise assessments are not available, but it should be noted that difficulty remembering questions is significantly correlated with the cognitive impairment scale used in the SAC in both waves 1 (r=.34) and 2 (r=.48). This suggests that some degree of cognitive limitation does explain a substantial amount of the variation in this item.
Table 10  Assessing Predictive Validity of Successful Aging Continuum at Wave 1 (n=1526)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted Mean</th>
<th>Variable</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-Reported Items</strong></td>
<td></td>
<td><strong>These are the best years of R’s life</strong></td>
<td></td>
</tr>
<tr>
<td>Receives help in getting around community</td>
<td></td>
<td>Strongly Agree</td>
<td>212.3</td>
</tr>
<tr>
<td>Yes</td>
<td>176.3</td>
<td>Agree</td>
<td>200.0</td>
</tr>
<tr>
<td>No</td>
<td>201.7</td>
<td>Disagree</td>
<td>193.3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Strongly Disagree</td>
<td>170.5</td>
</tr>
<tr>
<td>How limited is R in daily activities by health?</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>211.9</td>
<td>Looking back, R is satisfied with entire life</td>
<td></td>
</tr>
<tr>
<td>A little</td>
<td>195.8</td>
<td>Strongly Agree</td>
<td>206.1</td>
</tr>
<tr>
<td>Some</td>
<td>191.7</td>
<td>Agree</td>
<td>196.4</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>164.1</td>
<td>Disagree Or More</td>
<td>177.3</td>
</tr>
<tr>
<td>A great deal</td>
<td>145.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R has stayed in hospital in past 6 months</td>
<td></td>
<td>Did R have difficulty remembering questions</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>181.95</td>
<td>No difficulty</td>
<td>204.1</td>
</tr>
<tr>
<td>No</td>
<td>200.6</td>
<td>A little</td>
<td>193.1</td>
</tr>
<tr>
<td>Illness/injury kept R in bed in past 3 months</td>
<td></td>
<td>Some</td>
<td>186.8</td>
</tr>
<tr>
<td>Yes</td>
<td>179.6</td>
<td>A lot</td>
<td>163.6</td>
</tr>
<tr>
<td>No</td>
<td>201.9</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R Often Feels Fed Up</td>
<td></td>
<td>Did R have difficulty walking</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>177.9</td>
<td>No difficulty</td>
<td>205.8</td>
</tr>
<tr>
<td>Sometimes</td>
<td>197.2</td>
<td>A little</td>
<td>180.5</td>
</tr>
<tr>
<td>No</td>
<td>207.5</td>
<td>Some</td>
<td>163.5</td>
</tr>
<tr>
<td>Life <em>Could</em> Be Happier</td>
<td></td>
<td>A lot or couldn’t</td>
<td>144.2</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>183.5</td>
<td>R’s health</td>
<td>219.0</td>
</tr>
<tr>
<td>Agree</td>
<td>198.6</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Disagree</td>
<td>206.8</td>
<td>Good</td>
<td>204.4</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>217.3</td>
<td>Fair</td>
<td>173.5</td>
</tr>
<tr>
<td>How depressed did R seem?</td>
<td></td>
<td>Poor or grave</td>
<td>144.3</td>
</tr>
<tr>
<td>R has had depressive episode in past year</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>177.6</td>
<td>Quite or Very</td>
<td>169.7</td>
</tr>
<tr>
<td>No</td>
<td>201.6</td>
<td>Some</td>
<td>172.7</td>
</tr>
<tr>
<td>All means are weighted and controlling for age, race, SES, and sex. All joint hypothesis tests significant at $p &lt; .001$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
4.1.2 Wave 2

Table 11 shows the predictive validity assessments for the wave 2 SAC. In wave 2 an item was added that asked how happy the respondent would rate themselves, revealing a 56.9 point difference in SAC scores between individuals who were “very happy” versus those who were “not happy.” One of the weakest associations was for having a depressive episode\textsuperscript{23} in the past three years, which had a difference of only 18.3 points between individuals who were or were not depressed. Similarly, the item for having been sick for at least a day in the past three months had a difference of only 16.8 points between individuals who had or had not been sick. Though still statistically significant, the other validators had a difference of at least thirty points, almost double the effect size for these two variables. This suggested that the SAC may be struggling to capture certain elements of physical and mental health, and further consideration should be given as to why this is the case.

\textsuperscript{23} Note that the phrasing for this item has changed since the first wave, which asked about only the past year. The time frame is now extended to the three years since the last survey wave.
Table 11  Assessing Predictive Validity of Successful Aging Continuum at Wave 2 (n=1526)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Adjusted Mean</th>
<th>Variable</th>
<th>Adjusted Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Self-Reported Items</strong></td>
<td></td>
<td><strong>Interviewer Assessment Of R</strong></td>
<td></td>
</tr>
<tr>
<td>How limited is R in daily activities by health?</td>
<td></td>
<td>Did R have difficulty remembering questions</td>
<td></td>
</tr>
<tr>
<td>Not at all</td>
<td>139.4</td>
<td>No difficulty</td>
<td>206.7</td>
</tr>
<tr>
<td>A little</td>
<td>162.4</td>
<td>A little</td>
<td>193.7</td>
</tr>
<tr>
<td>Some</td>
<td>190.6</td>
<td>Some</td>
<td>182.6</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>201.0</td>
<td>A lot</td>
<td>146.8</td>
</tr>
<tr>
<td>A great deal</td>
<td>217.1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>R has stayed in hospital in past 6 months</td>
<td></td>
<td>Did R have difficulty walking</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>172.5</td>
<td>No difficulty</td>
<td>208.7</td>
</tr>
<tr>
<td>No</td>
<td>202.7</td>
<td>A little</td>
<td>183.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Some</td>
<td>160.9</td>
</tr>
<tr>
<td></td>
<td></td>
<td>A lot or couldn’t</td>
<td>134.4</td>
</tr>
<tr>
<td>Illness/injury kept R in bed in past 3 months</td>
<td></td>
<td>R’s health</td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>186.8</td>
<td>Excellent</td>
<td>224.4</td>
</tr>
<tr>
<td>No</td>
<td>202.8</td>
<td>Good</td>
<td>210.2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fair</td>
<td>174.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor or grave</td>
<td>141.2</td>
</tr>
<tr>
<td>R has had depressive episode in past 3 yrs</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Yes</td>
<td>184.0</td>
<td>How depressed did R seem?</td>
<td></td>
</tr>
<tr>
<td>No</td>
<td>202.3</td>
<td>Quite or Very</td>
<td>159.1</td>
</tr>
<tr>
<td>Overall, how happy is R?</td>
<td></td>
<td>Very Happy</td>
<td>174.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pretty Happy</td>
<td>174.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Not Happy</td>
<td>211.4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All means are weighted and controlling for age, race, SES, and sex. All joint hypothesis tests significant at p &lt; .001</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Each of the four interviewer reported items, which asked the interviewer about their assessment of the respondent’s memory, physical health, and perceived mental health, were strongly associated with scores on the SAC. The weakest association still revealed a difference of 52.3 points between individuals who were perceived as being quite depressed versus those who were not depressed. Respondents who the interviewer viewed as having poor health had average SAC scores that were 83.1 points lower than those who were assessed as having excellent health. Respondents who were described as having “no difficulty” walking had average SAC scores that were 74.4 points higher than respondents who had a lot of difficulty walking. As conceptualized in this study, a person
that is successfully aged should retain high cognitive functioning, good physical health, and mental health. The fact that the SAC is strongly associated with the interviewer perceiving these traits in the respondent provides further evidence that the SAC is able to predict not only use of health services and self-rated health, but also positive external evaluations.

### 4.2 Assessing Longitudinal Predictive Validity

The previous analyses were limited because they are purely cross sectional. As a result, one could argue that the correlations between validators and SAC scale are unsurprising because they reflect the individual’s immediate state, rather than a future outcome. Ideally, predictive validity should also be established by examining if the scale is correlated with future outcomes that the measure should precede (Babbie 2013). One way to address this issue is to explore if scores on the SAC are significantly associated with *future* physical health, life satisfaction, and mental health. The SAC should also be able to predict decreased use of health services, higher happiness, and better physical functioning in the future as well. Therefore, the wave 1 successful aging continuum was used to predict the same wave 2 self-report and interviewer reported indicators that were used in the previous section. These results are presented in table 12
Table 12  Assessing Longitudinal Predictive Validity of Wave 1 Successful Aging Continuum (n=1526)

<table>
<thead>
<tr>
<th>Wave 2 Self-Reported Items</th>
<th>Wave 2 Interviewer Assessment Of R</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Variable</strong></td>
<td><strong>Adjusted Mean</strong></td>
</tr>
<tr>
<td>How limited is R in daily activities by health?</td>
<td>Did R have difficulty remembering questions</td>
</tr>
<tr>
<td>Not at all</td>
<td>161.0</td>
</tr>
<tr>
<td>A little</td>
<td>165.8</td>
</tr>
<tr>
<td>Some</td>
<td>192.4</td>
</tr>
<tr>
<td>Quite a bit</td>
<td>201.2</td>
</tr>
<tr>
<td>A great deal</td>
<td>211.7</td>
</tr>
<tr>
<td>R has stayed in hospital in past 6 months</td>
<td>Did R have difficulty walking</td>
</tr>
<tr>
<td>Yes</td>
<td>182.2</td>
</tr>
<tr>
<td>No</td>
<td>201.0</td>
</tr>
<tr>
<td>Some</td>
<td></td>
</tr>
<tr>
<td>Illness/injury kept R in bed in past 3 months</td>
<td>A lot or couldn’t</td>
</tr>
<tr>
<td>Yes</td>
<td>189.0</td>
</tr>
<tr>
<td>No</td>
<td>201.6</td>
</tr>
<tr>
<td>R has had depressive episode in past 3 yrs*</td>
<td>Good</td>
</tr>
<tr>
<td>Yes</td>
<td>191.9</td>
</tr>
<tr>
<td>No</td>
<td>200.4</td>
</tr>
<tr>
<td>Overall, how happy is R?</td>
<td>How depressed did R seem?</td>
</tr>
<tr>
<td>Very Happy</td>
<td>212.9</td>
</tr>
<tr>
<td>Pretty Happy</td>
<td>197.1</td>
</tr>
<tr>
<td>Not Happy</td>
<td>170.9</td>
</tr>
</tbody>
</table>

All means are weighted and controlling for age, race, wave 1 SES, and sex. *p<.05. All unmarked values had joint hypothesis tests that were significant at p<.001

In general, effect sizes were smaller than in the cross sectional models, but most were still substantively (e.g. greater than a difference of 15 points, 5% of the SAC’s range) and statistically significant. Respondents who were “very happy” in wave 2 had wave 1 SAC scores that were 42.0 points higher than those who were not happy in wave 2. Similarly, individuals who went to the hospital in wave 2 had wave 1 SAC scores that were 18.7 points lower than those in wave 2 who had not been to the hospital. The interviewer reported items had similarly strong associations, with the weakest association
(the depression indicator) still having a difference of 30.7 points between high and low categories. This establishes that high SAC scores predict fewer hospital visitations, higher self-rated happiness, and fewer functional limitations. This is important evidence of the criterion validity of the SAC because one would expect individuals who are aging successfully to carry these traits into the future.

Two effect sizes were weak relative to the other effects in the validation study. Individuals who had a depressive episode between 1986 and 1989 had wave 1 SAC scores that were only 8.5 points lower than those who did not have a depressive episode. This difference was only significant at the $p<.05$ level, whereas all other effects were significant at the $p<.001$ level. The second weaker association was for the question asking if the respondent had been sick in bed all day during the past three months. Though wave 1 SAC scores were significantly associated with not being sick in wave 2, the difference was by a margin of only 12.5 points. Compared to the next smallest effect size, 18.7 points, these two measures were substantially smaller. This suggests that the SAC may not be able to predict these outcomes into the future as accurately as would be hoped. As a result, the predictive validity of the SAC may be threatened.

4.3 Evaluating Convergent Validity

4.3.1 Comparing Against Other Continuous Measures

Convergent validity is the idea that “different measures of the same concept should be correlated … the results [of different measures] converge on the same meaning, namely, that conveyed by the underlying concept (Singleton Jr. and Straits 2010: 142).” This differs from the prior analyses because testing convergent validity is a method of establishing construct validity, while the prior analyses investigated predictive validity as
a way of assessing criterion validity. Convergent validity can be assessed by comparing the scale of interest with alternative measures of the same construct of interest. The first part of this analysis involved correlating SAC scores with both the Kahng (2008) and Young (2009) successful aging continua. A strong correlation between the scales would be evidence of convergent validity for the SAC. That is, it would illustrate that these disparate measures are all converging on a similar underlying construct of successful aging. To some extent correlations are to be expected, given that the SAC is made up of some of the same components as the Young and Kahng continua. At the same time, both of those continua use several indicators that are not in the SAC (e.g. self-efficacy and social support), as well as different scale construction methods. Specifically, Kahng’s scale is created using weighted factors scores from a structural equation model, while Young’s scale is a sum of several different binaries reflecting success (or not) on measures of physical, social, and mental functioning. The differences between these three scales in terms of both the items used and the scale construction methods reduces the possibility that results merely reflect a scale being correlated with itself.
Figure 9  Correlations Between SAC and Kahng Successful Aging Measure
Correlation coefficients and scatter plots between the SAC and either scale are presented in figures 9 and 10. As shown in these graphs, the SAC was strongly correlated with both alternative scales. Averaging five waves of pairwise correlations, Kahng’s study had a correlation of .69, while Young’s had an average correlation coefficient of .73. Interestingly, it was found that the correlation between the Kahng and Young scales was weaker than the either scales’ association with the SAC (wave 1 $r = .44$; wave 2 $r = .36$; wave 3 $r = .41$; wave 4 $r = .35$; wave 5 $r = .43$). The weaker correlation across both measures suggested that the SAC is preferable to the Young and Kahng scales. This is because the SAC sufficiently captured variability in both alternative scales, in spite of their measurement differences. In contrast, the Young scale less strongly captures
variation in the Kahng scale (and vice versa), suggesting that it was not as effectively measuring the underlying construct of successful aging that underpins all three scales that were used in this analysis.

### 4.3.2 Comparing the Successful Aging Continuum with a Binary Successful Aging Measure

A binary indicator that identified individuals as aging successfully was constructed using guidelines established in prior studies (Brandt, Deindl, and Hank 2012; Hank 2010; McLaughlin et al. 2009). This measure took into account several indicators of physical health, cognitive functioning, and social engagement simultaneously to produce a single dichotomy. Respondents that met specific cutoffs on all criteria were classified as successfully aged, while respondents that missed one or more criterion were classified as “not successful.” Independent samples T-tests were used to compare mean SAC scores for individuals who were classified as successfully aged versus “unsuccessful.” In addition, the SAC was broken into quintiles to minimize the possibility that outliers would skew results and to give a finer grained view of how the binary and continuum indicators correlate. These results are presented in Table 13.
Table 13  Comparison of Continuum Successful Aging Measures with Binary Operationalization (n=1526)

<table>
<thead>
<tr>
<th></th>
<th>Binary Wave 1</th>
<th></th>
<th>Binary Wave 2</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not Successful</td>
<td>Successful</td>
<td>Not Successful</td>
<td>Successful</td>
</tr>
<tr>
<td>SAC</td>
<td>193.9</td>
<td>235.5</td>
<td>194.0</td>
<td>234.9</td>
</tr>
<tr>
<td>Physical Dimension</td>
<td>67.7</td>
<td>94.1</td>
<td>63.8</td>
<td>92.0</td>
</tr>
<tr>
<td>Mental Dimension</td>
<td>74.2</td>
<td>85.9</td>
<td>77.8</td>
<td>86.4</td>
</tr>
<tr>
<td>Social Dimension</td>
<td>52.1 (n.s)</td>
<td>55.6 (n.s)</td>
<td>52.4*</td>
<td>56.5*</td>
</tr>
<tr>
<td>Kahng SA (mean)</td>
<td>0.1</td>
<td>1.0</td>
<td>-0.1</td>
<td>.77</td>
</tr>
<tr>
<td>Young SA (mean)</td>
<td>2.0</td>
<td>3.4</td>
<td>2.0</td>
<td>3.5</td>
</tr>
<tr>
<td>SAC quintiles (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>First (lowest)</td>
<td>18.7</td>
<td>0.0</td>
<td>18.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Second</td>
<td>20.7</td>
<td>0.9</td>
<td>21.8</td>
<td>3.7</td>
</tr>
<tr>
<td>Third</td>
<td>22.9</td>
<td>12.6</td>
<td>23.8</td>
<td>13.3</td>
</tr>
<tr>
<td>Fourth</td>
<td>21.7</td>
<td>30.5</td>
<td>20.2</td>
<td>23.1</td>
</tr>
<tr>
<td>Fifth (Highest)</td>
<td>16.1</td>
<td>55.9</td>
<td>16.01</td>
<td>58.7</td>
</tr>
</tbody>
</table>

All unmarked differences are significant at $p<.001$, *$p<.05$

The binary indicator was significantly associated with the SAC, which initially suggested a degree of convergent validity, since the two measures were in relative agreement about who should be described as successfully aged. This can be seen by the finding that individuals classified as aging successfully in the binary measure also had high SAC scores. However, the two measures did not consistently agree on who should be classified as “unsuccessfully” aged. This was shown by the high mean for the “unsuccessful” binary group, which had mean SAC scores that were very close to the overall mean for the SAC. Specifically, in wave 1 the SAC’s overall mean was 199.0 while the SAC for only “unsuccessful” individuals was 193.9. Ideally, this value would be much lower than it was, demonstrating a clear agreement that “low” scores correspond
to aging poorly. Instead, the binary approach’s “unsuccessful” category was still comprised of individuals with relatively high SAC scores. The disagreement between these two measures raised concerns that the SAC and binary classification may not be accurately measuring the same construct, calling the convergent validity of the measures into question.

A more detailed examination of where the binary and SAC measures disagree will help to explain why the measures have diverged and if one is likely to be more valid than the other. This was done by comparing a version of the SAC that was recoded into quintiles with the binary measure. This revealed that the binary measure classified individuals in the top three quartiles of the SAC as aging successfully, though the majority came from the top quartile. This again shows that the two scales largely agreed on who should be classified as successfully aged and reinforces the validity of that specific classification via either measure. The reason for the “unsuccessful” group’s high SAC mean is also clear, as individuals in the “unsuccessful” group came from all five quintiles of the SAC. In other words, the measure was classifying individuals with very high SAC scores into the same category as individuals with the lowest SAC scores. This is concerning for the convergent validity of the SAC, as it demonstrates a clear inconsistency in the decision of who is considered “not successfully” aged. If the two measurement strategies were consistent (e.g. if they had convergent validity) then individuals from the 4th and 5th quintiles of the SAC should not be classified as “unsuccessfully” aged, drawing a firm distinction between successful and “unsuccessful” aging. It is important to examine why individuals with such high scores on the SAC were
being classified as “unsuccessfully” aged in the binary measure in order to determine which measure was inaccurate: the SAC or the binary measure.

One way to determine specifically where the binary and SAC measures differed is to break the SAC into its three separate dimensions (physical, mental, social) to view their associations with the binary successful aging measure. This was shown in table 13. Since the binary measure considered social engagement, cognitive functioning, and physical functioning, it should be correlated with each discrete dimension of the SAC. If not, it would suggest that this measure was not capturing one of these components as effectively as the SAC. The binary measure was significantly associated with both the mental and physical components of the SAC, but it was only weakly associated with the social component. In the first wave the difference between successful and “unsuccessful” aging groups on the social dimension was only 3.5 points, not statistically significant. In the second wave the social component had a difference of 4.1 points between successful and “unsuccessful” individuals. This difference was significant at the .05 level, but the magnitude of the effect was very small. In other words, while the binary scale appeared to be adequately capturing the mental and physical components of successful aging, it seems to be less effective at capturing the social engagement components. This suggested that the binary measure had poor convergent validity, rather than the SAC.

The binary measure’s unintentional bias against social engagement appears to be because the social components did not have much influence on if a person is ultimately classified as successfully aged or not. In wave 1, only 31.1% of respondents did not meet the requirements for being “socially engaged” described by Brandt and Colleagues (2012). On the other hand, 60.8% of respondents did not meet their criteria for avoiding
chronic disease. The physical health items therefore had the ability to exert a much stronger influence on the determination of if a person was or was not successfully aged. This unequal influence can be demonstrated by looking at how many people are classified as “unsuccessfully” aged due to only having a physical condition or only not meeting the social engagement criteria. If the physical conditions criteria were excluded from the final successful aging binary, an additional 365 cases would be classified as aged successfully. By comparison, if the social engagement dimension was not used in constructing the successful aging binary, only 15 more individuals would be classified as aged successfully. This demonstrated that the social engagement components contribute very little variability to the final successful aging measure. Instead, the classification was primarily driven by physical health, resulting in a weaker correlation with the SAC’s social dimension in particular.

In sum, comparing the SAC with the binary operationalization suggests that while both measures produced relatively consistent decisions regarding who ages successfully, they disagreed on who should be classified as “unsuccessful.” This appears to be because social engagement had very little influence on the binary measure’s decision to classify a person as successfully aged or not. In contrast, the SAC’s calculation guaranteed that a third of the SAC’s possible variation comes specifically from social engagement. This means that moderately high scores on the SAC could occur in the absence of high physical health, allowing for a discrepancy between the two operationalizations to emerge. Given that social engagement is a major component of successful aging, these results raised concerns to the construct validity of the binary operationalization, rather than the SAC.
4.4 Discussion

The analyses presented in this chapter aimed to validate an a priori SAC that was constructed using a methodology based on Cosco and colleagues’ (2015) earlier analysis. The results of this study replicated and expanded on prior validation studies that have used a continuum based approach to operationalizing successful aging (Cosco, Stephan, and Brayne 2015; Young et al. 2009). Cosco and colleagues’ validation study focused on establishing predictive validity along lines of use of assistive services, while Young and colleagues’ analysis focused on hospital use. Their decision to focus on these factors was largely due to data availability. The current analysis extended the list of validators by capturing aspects of mental health and life satisfaction, some of which were provided by the interviewer. It was found that the SAC was able to predict staying at a hospital, being unhappy, and having physical limitations in both the present and the future. Given the consistency of these results it appears that the SAC was accurately capturing many of the components that comprise successful aging in the current study.

This continued validation of continuous measures of successful aging is important in light of arguments that emphasized that successful aging should be conceptualized as a continuum rather than a strict binary (Bowling 2007; Cosco, Stephan, and Brayne 2014; Cosco et al. 2014; Grundy and Bowling 1999; Young, Frick, and Phelan 2009). While this is easily thought of in conceptual terms, operationalizing a continuum model is very challenging in light of the presence of multiple dimensions and decisions that must be made about weighting individual elements. The approach used in the current study and Cosco and colleagues’ (2015) analysis provided steps towards a solution to this problem.
As well as having acceptable predictive validity, it was found that the SAC was strongly correlated with other continuum measures of successful aging that have been used in the past. This suggested convergent validity and consistency with the successful aging literature. However, I argue that the SAC had several advantages over these other approaches. Kahng’s (2008) structural equation modeling approach resulted in an indicator that weights some dimensions more strongly than others. While perhaps more psychometrically sound, the scale it created is unequally weighted in favor of mental health. Kahng’s scale also weighted cognitive impairment, social support, and chronic conditions very lightly on the final scale. For instance, social support scores were weighted by a factor of roughly .34, while CES-D scores were weighted by a factor of roughly .71. In the end, this results in a final measure where CES-D scores were allowed to have almost triple the influence on the final successful aging score compared to the social support items. As Cosco and colleagues (2015) have suggested, depending on psychometric methods such as those in Kahng’s study sacrifices the conceptual foundation of successful aging. In this case this is because some elements were ranked as more important than others. On the other hand, Young and colleagues’ (2009) ordinal approach achieved equal weighting at the cost of variability, resulting in only six possible categories. The SAC presented a more finely grained picture than Young’s scale, while also avoiding being biased towards certain conceptual components like Kahng’s scale. The greater construct validity of the SAC is further evidenced by the fact that it was strongly correlated with both the Young and Kahng scales, but the Young and Kahng scales were not as strongly correlated with one another. This suggests that the SAC was more effectively captures the underlying construct of successful aging that all three
measures are attempting to tap into. Future research should continue comparing these measurement strategies against one another to better understand their respective advantages.

The results of this study did raise concerns about the use of binary measures to operationalize successful aging. The binary measure used in the current study typically classified respondents as “not successful” because of their physical health, rather than social engagement or mental health. This may be an artifact of the dataset utilized in this study (ACL), as prior applications of this binary classification in other data found that a substantially smaller proportion of respondents were “actively engaged” than in the current study (67%): 56% for Brandt and colleagues (2012), 49.7% for Hank and colleagues (2010), and 47% for Mclaughlin and colleagues (2009). Despite this discrepancy, this analysis revealed how binary measures with multiple components can unintentionally reflect only one of these elements (in this case, physical health). The variable with the most stringent requirements for inclusion ended up producing much of the variation in the measure, while the other less stringent criteria actually add very little to the final measure. This suggested that future research should carefully examine how much unique variation is actually introduced by each component of their binary successful aging measure. Otherwise, claims that multiple dimensions are being accounted for in a meaningful way may be dubious and the construct validity of the measure may be threatened. One way to deal with this problem is to identify “easy” criteria and make them more exclusionary, but this may come at the cost of adherence to one’s conceptual model.
Another limitation of the binary approach in this study is that it appeared to lump together a very broad swath of individuals into the “not successful” category. This category contained anyone from the mortally ill to the individuals who may be very healthy but not particularly involved in their community. In the past it has been argued that depending on such a broad “not successful” category results in a less useful description of both how successfully agers are unique and how many people have truly aged poorly (Cosco et al. 2014). The results of this analysis illustrated this point empirically by highlighting how broad and nebulous the “unsuccessful” category was as a comparison group.

This oversimplification of heterogeneity has been pointed out by prior analyses, who suggested that it results in a less useful description of the predictors of successful aging (Cosco, Stephan, and Brayne 2014; Cosco et al. 2014). Future research should apply approaches that better capture heterogeneity in the aging process to allow for more precise comparisons to be made. The SAC did this by foregoing explicit distinctions between “diseased”, “usual”, and “successful” aging in favor of presenting a broad gradient. Other approaches that capture multiple aging groups, such as latent class models and ordinal scales, may also be viable for future research (Grundy and Bowling 1999; Hsu and Jones 2012; Tang 2014; Wickrama et al. 2013; Young et al. 2009). In some cases these alternatives may be preferable or complimentary with the SAC, as they retain a more strict distinction between aging groups. This can be useful in analyses that want to compare the successfully aged with individuals who have aged most poorly. Though the relative advantages of each of these non-binary approaches must be considered in light of research goals, they all have the advantage of dissuading all-or-nothing thinking about
aging outcomes. Avoiding this binary thinking is at the heart of Rowe and Kahn’s (1987) original proposition, which emphasized the importance of considering heterogeneity in the aging process while avoiding “sick” versus “normal” dichotomies.

The validation study revealed several potential limitations for the SAC that should be carefully considered. First, the SAC was not strongly associated with experiencing a depressive episode in the future, despite including the CES-D in the measure. Prior research has found that past depressive episodes are a major risk factor for future depression (Hammen 2005; Judd et al. 2000; Pizzagalli 2014). Furthermore, the presence of disease and disability has been linked to depression through both biological and social mechanisms (Clarke et al. 2011; Dantzer et al. 2008). It is therefore concerning that the relationship between past SAC scores and future depressive episodes, while significant, wasn’t stronger.

One reason for this difference was that the CES-D is a measure of depressive symptomology, rather than a diagnostic instrument. It was also only intended as a screening tool for current depression rather than future risk. Because it is a screening tool, it is prone to inaccuracies, even in studies with respondents who were depressed at the time of completing the instrument (Beekman et al. 1997; Dantzer et al. 2008; Irwin, Artin, and Oxman 1999; Townsend et al. 2012). It may therefore be more useful to think of the SAC as having captured current depressive symptoms, rather than lasting and clinically diagnosable depressive episodes. When this concession is made results are less concerning, as wave 1 CES-D scores were significantly correlated with wave 2 CES-D scores ($r = .55, p < .001$), as would be expected from the literature (Clark et al. 2002). This replicates studies that have found that depressive symptoms tend to recur. Wave 1 SAC
scores also significantly predicted depressive symptoms in wave 2 \( (r=-.44, p<.001) \).

While the SAC may not be as strongly correlated with depressive episodes as would be expected, it is clear that it captures and predicts mental distress in a way that is useful for the purposes of this study.

It should also be noted that the depressive episode measure used in this study was also imprecise, which may have produced results that are inconsistent with the depression literature. The wave 2 depressive episode specified two time frames— a three year window within which the individual could have experienced the episode and a requirement that the respondent felt “sad, blue or depressed” for at least a week. For the former, there is a great deal of room for misremembering experiences that had or had not occurred, leading to inaccuracy in reporting. The one week timeframe for symptoms may also have been too short for the classification of depression. Horowitz and Wakefield (2007) suggested that using such short timeframes in the diagnosis of depression can lead to the misclassification of bereavement and sadness as depression\(^{24}\). In other words, it is possible that week long periods of sadness due to life events were being group alongside long running episodes of depression for which there was no clear cause. As Horowitz and Wakefield (2007) argued, the latter sort of pathological sadness is recurring and long lasting (i.e. should be predicted by past episodes and symptoms) while the former is not. In the end, this item was no substitute for the formal psychiatric diagnoses that were used.

\(^{24}\) This explanation is further insinuated by looking at if the incidence of life events between waves 1 and 2 predict higher risk of a depressive episode between waves 1 and 2. A count of life events between waves 1 and 2 (death of either parent, spouse, child, or friend, divorce, relocation, major financial issues, involuntary job loss, being assaulted, being robbed, “something else that really upset [the respondent]”) was used. A logistic regression model controlling for age, race, sex, and SES was estimated, finding that each life event between waves 1 and 2 was strongly associated with higher risk of a depressive episode \((OR=1.79, p<.001)\). While these events could certainly be the catalyst to a major depressive episode, they may also easily trigger a one week period of sadness that is then reported as a depressive episode on the survey.
in ideal studies of the correlates of depression (Cui et al. 2008; Judd et al. 2000; Pizzagalli 2014). It would be useful for a future validation study to compare SAC scores on a small sample of formally diagnosed individuals and a control group. If SAC scores were still not strongly associated with this better measure then there would be reason for concern regarding the validity of the SAC with regards to capturing mental health. For now, it is best to be cautious and assume the SAC has only captured depressive symptomology rather than the incidence of depression itself.

The second area of concern is that the wave 1 SAC score was not strongly correlated with being sick in bed due to illness or injury in the future. Though statistically significant, one would expect this correlation to be stronger, given the breadth of research that has demonstrated the link between brief illness (e.g. the flu) with chronic illness, depression, and social engagement (Dantzer et al. 2008; Mertz et al. 2013; Thoits 2011). One explanation is that the phrasing of the question, which specifically excluded “days spent in the hospital or nursing home,” likely omitted more severe illnesses, which the less successfully aged appeared to be at higher risk of. This is evidenced by the finding that lower SAC scores in both waves were correlated with staying at the hospital. As a result, much of the variability in this item might better be understood as risk of minor infectious diseases and chronic illness. With this in mind, it is reasonable to expect that older individuals with different SAC scores might not have major differences in illness susceptibility, as older adults tend to have slower and less robust immune system responses, reducing the effectiveness of vaccinations increasing risk of infection (Weiskopf, Weinberger, and Grubeck-Loebenstein 2009). In effect, differences between
high and low scoring individuals would be narrowed due to shared biological changes that put both groups at greater risk.

Another reason for this weakened association has to do with how the “sick in bed” item correlates with the specific components of the SAC. Generally, a high score on the SAC’s wave 1 questions was associated with somewhat lower risk of being sick in bed in wave 2, as would be expected. The two exceptions were the items for informal engagement with friends and family via either visits or phone calls. In this case, individuals who were been sick in bed in wave 2 were somewhat more likely to have had very frequent (multiple times a day) communication with their friends and family, by a margin of about 8%. Further exploration of these data revealed that this was most likely to be because chronically ill respondents in wave 1 had very high contact with friends and family members at the time, and then continued to be chronically ill in wave 2, increasing risk of being sick in bed in the second wave. This heightened contact with family or friends among the chronically may have been due to caregiving obligations and/or increases in instrumental and emotional support from family members (Thoits 2011). This positive association was small, but it weakened the otherwise negative association between the SAC and the emergence of sickness. The positive relationship between high informal engagement and sickness points to the major limitation of the SAC, which was that it suffers from low scale reliability. This results in inconsistency across scale items. Importantly, however, the smaller net effect of the final SAC was still significant and in the expected direction, suggesting that this inconsistency did not fully invalidate the measure. Future research should experiment with methods of improving the
reliability of the SAC while still capturing all necessary components if possible. If this is not possible, it may be best to exclude certain items from the construction of the scale.

A final concern is that the SAC did not fully alleviate criticisms that measures of successful aging equate “success” with being young (Cosco, Stephan, and Brayne 2014). As many authors have argued, some changes and losses naturally occur with age, and ignoring those changes risks pathologizing the normal aging process (Bülow and Söderqvist 2014; Goodwin 1991; Katz and Calasanti 2015; Martinson and Berridge 2014; Minkler 1990; Young, Frick, and Phelan 2009). Empirically, this problem manifests itself in the form of a correlation between successful aging and young age, which is the most consistent predictor of successful aging according to Depp and Jeste’s (2006) review of the literature. The SAC used in this study was still significantly correlated with age, meaning that it still equates greater success with youth. Specifically, at wave 1 a 90 year old is expected to have a SAC score that is 31.8 points lower than a 50 year old, and in wave 2 the difference increases to 47.5. While controlling for age would help to alleviate this issue in predictive models, the correlation with age makes estimating the incidence of successful aging very difficult. Researchers are advised to avoid simply applying a single arbitrary cut off to the SAC to identify successful aging. For example, using an arbitrary cut off of a score of 225 resulted in 25.8% of individuals from 55-64 years old being classed as aging successfully, as compared to 17.9% of 75-84 year olds and 6.2% of persons 85 or older. This replicates a common problem that other researchers have observed, which is that “success” is all but inaccessible for even the old-old with strong social and mental functioning into old age (Cho, Martin, and Poon 2012; Cosco, Stephan, and Brayne 2014; Young, Frick, and Phelan 2009). As such, the criticism that successful
aging can reinforce a subtle ageism by tacitly excluding the old-old from the label of successful still applies to the SAC.

One possible solution to this problem is to use multiple cut-offs with age rather than just one. Successful aging as defined by Rowe and Kahn (1987) reflected within age-group heterogeneity, rather than holding all age groups to the same metric. The notion that the specific definition of success may be a moving target is partially captured by the SAC’s equal weighting of non-physical dimensions, but ultimately the same standards for a “high” score are applied to everyone. Applying age-specific cut offs instead of a universal standard would capture within age-group heterogeneity, moving past this problem. The problem for future research (and the next chapter of this dissertation) is to explore if it is possible to apply these age-varying cutoffs without depending on arbitrary decisions about where the line for “success should be drawn.

4.5 Conclusion

This analysis demonstrated the usefulness of the scale construction method proposed by Cosco and Colleagues (2015). Though the conceptual model used in the current study differed from Cosco and colleagues’, the operationalization created was found to be strongly associated with a number of external criteria that reflect successful aging. Similarly, the SAC appeared to be comparable to other existing continuous measures of successful aging, with the added benefit of having increased variability and equal weighting across dimensions. Though the scale constructed was not as strongly predictive of future minor illness or depression, it provided a broad reflection of successful aging as a whole. It will be important for further analyses to replicate this validation study in
different datasets, but these preliminary analyses suggested that it is a strong alternative to the binary measurement strategies that have been common in the field.

Subsequent analyses should be cautious about applying this scale without further manipulation, as high scores were still correlated with age. This is not ideal for the current study’s conceptualization of successful aging, which explicitly emphasized that successful aging reflects aging well relative to one’s peers as opposed to all older adults. Furthermore, the SAC does not define distinctions between different aging groups, which can be useful for theoretical tests and policy planning. This continuum, which I argue has been successfully validated through the analyses discussed in this Chapter, will therefore be used as the foundation for a group based trajectory model that can classify individuals into meaningful aging trajectory groups that also eliminate the correlation between age and group classification. Without this step, studies of successful aging using the SAC risk predicting being young, rather than being successfully aged relative to one’s peers.
Chapter 5

ESTIMATING AGING TRAJECTORIES

Having presented evidence that the successful aging continuum (SAC) has an acceptable level of validity and is correlated with other measures from the literature, the next step of the analytic process is to classify individuals into different aging groups. For this study, successful aging reflects aging well relative to one’s peers, returning to Rowe and Kahn’s (1987) emphasis on studying within age-group heterogeneity. In addition, successful aging is conceptualized as a trajectory that a person follows over time, rather than a discrete state that an individual has or loses at a given moment. This emphasis on long-term durable aging trends is rooted in Stowe and Cooney’s (2015) call for a more life course oriented conceptualization of successful aging. Treated as a linear variable, the SAC is capable of being used for longitudinal trajectory modeling that predicts changes along the entire continuum, such as in the case of a growth curve model. However, it is insufficient if an analysis needs to retain theoretically meaningful groupings such as the distinction between successfully aged and usually aged individuals. Such groupings are desirable because they help researchers and policy makers distinguish between groups.

Note that the conceptualization used in this study requires that the distinction between successfully aged individuals and usually aged individuals is relative to the dataset. In general, usually aged individuals have SAC scores that are near the mean over time. Successfully aged individuals would be defined in terms of having scores that are well above the mean over a long period of time. This differs somewhat from Rowe and Kahn’s (1997) conceptualization because it doesn’t necessarily require the presence of all components of successful aging to be deemed successfully aged. What matters in this case is that the individual possesses a much greater number of the things that make up successful aging than their peers, rather than having all of them.
with different priority levels for interventions. For instance, a group with poor aging outcomes may need more immediate assistance and have more to gain overall than a group that is usually aged.

In this study, the SAC’s strengths, specifically its incorporation of multiple dimensions and high variability, are combined with another approach in order to overcome some the SAC’s limitations, and, in turn, allow for the construction of meaningful aging groups. This grouping approach, called group based trajectory modeling (GBTM), has been used in various forms in previous research on successful aging (Hsu and Jones 2012; Tang 2014; Wickrama et al. 2013). However, despite its prior utilization, this technique has not been combined with a comprehensive scale like the SAC in the context of successful aging. It is advantageous to combine these methods because GBTM enables aging trajectory groups to be constructed without rigid assumptions about the number of groups, their size, or their shape over time. Put differently, it allows us to see the trends of decline and/or resiliency that individuals tend to cluster around as they age without the researcher needing to guess, for instance, how many people decline with age and how dramatic that decline is. Doing so overcomes limitations of methods that have attempted to classify individuals into aging groups using arbitrary cutoffs such as thirds or quartiles (Bowling and Iliffe 2006; Garfein and Herzog 1995; Grundy and Bowling 1999). As demonstrated in the prior chapter, depending on

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26 The term “trajectory group” refers to the combination of two pieces of information, both of which are determined through maximum likelihood estimation (Nagin 2005). The first piece of information is the trajectory itself, which is a trend that individuals tend to cluster around over time. The second piece of information is the individual’s probability of following that trajectory group as opposed to one of the other trajectory groups that was estimated. Individuals are assigned to the trajectory group to which they have the highest probability of being a member. In other words, a trajectory group membership refers to the common aging trend that a particular individual is most likely to belong to. For an intuitive visualization see the trajectory graph later in the manuscript.
percentile based cutoffs risks misclassification, as young individuals are more likely to be in the highest percentiles of the SAC. As a result, successful aging becomes synonymous with youth (Cho, Martin, and Poon 2012; Cosco, Stephan, and Brayne 2014). This is counter to the current study’s conceptualization of successful aging, which argue that successful aging exists in all age groups because the standards for success vary with age. GBTM allows for trajectory shapes\textsuperscript{27} to vary with age, simultaneously altering the cutoffs for success. Combining GBTM with the SAC results in a more parsimonious multidimensional model compared to multi-trajectory modeling, which is the most common GBTM method for modeling multidimensional constructs. For instance, Hsu and Jone’s (2012) multi-trajectory model requires 18 graphs to convey, while a trajectory model using the SAC will require only one.

The current chapter describes the process of fitting the trajectory model to identify different aging groups. First, evidence identifying the ideal number of trajectory groups is presented. This is followed by a presentation of statistics that help in determining the functional form that these trajectories follow over time. An assessment of model fit is also offered to determine if the final model adequately reflects underlying patterns in the data. Finally, the actual trajectory model is presented and several noteworthy points are discussed in the context of the literature.

\textsuperscript{27} The term trajectory shape refers to the functional form that individuals tend to cluster around over time. For instance, a linear functional form (e.g. \(a+bx\)) would create a trajectory shape that goes straight up or down while a quadratic functional form (\(a+bx+cx^2\)) would generate a trajectory shape that curves with age.
5.1 Fitting the Model

5.1.1 Determining the Number of Groups

The first step of the analysis is to determine how many aging groups exist in the data. This is done by first estimating a series of weighted trajectory models with an increasing number of quadratic trajectories (e.g. trajectories that follow the form $a+bx+cx^2$) (Andruff et al. 2009; Nagin 2005). Model fit statistics from each of these models are then compared against one another to determine which number of groups best fits the data. Ten trajectory models were estimated in total, at which point models failed to converge due to a number of empty trajectory groups emerging. Like Sautter (2010), I present the fit statistics for these ten models as a graph that illustrates the effect of increasing the number of trajectories on model fit. This graph is shown in figure 11.

The graph illustrates that Akaike Information Criteria (AICs), Bayesian Information Criteria (BICs) and -2 log likelihood statistics improved by a large margin until a four trajectory group was estimated, at which point model fit ceased to improve substantially. This point of diminishing returns suggested that increasing the number of trajectories would result in overfitting the model, creating unnecessary trajectories that did not improve the model’s reflection of the data (Andruff et al. 2009; Nagin and Tremblay 2005; Nagin and Odgers 2010). The fit statistics therefore suggested that a three or four trajectory model was the best fit to the data.
Results from this specific analysis showed that the fourth trajectory group contributed very little new information. In essence, this fourth group split two groups that were already estimated in half to create a new group that followed almost the exact same trend over time save for a slightly starting point. Nagin (2005: 75) cautions against blindly using model AICs, BICs, and -2LL values to make final decisions about the number of trajectories in cases where new trajectories are indistinct from previously estimated trajectories. In such cases Nagin advises that theory and parsimony should guide the decision to fit the final model.

Given this guidance, a three group model was favored for three reasons. First, prior analyses have also found a three group model to be ideal (Tang 2014; Wickrama et al. 2013). Secondly, a three group model is also more consistent with Rowe and Kahn’s (1987) theoretical distinctions between the successfully aged, usually aged, and (more implicitly) diseased. Third, the four trajectory group classified individuals into groups [Figure 11: Changes in Model Fit Statistics with Addition of New Quadratic Trajectories]
with less certainty and had a very small trajectory group which would have created power issues in subsequent analyses. This smaller group had very few individuals from each of the accelerated cohorts, calling estimates into question.

5.1.2 Determining Trajectory Shapes

Having settled on a three trajectory group model, the next problem considered was the shape of the trajectories that individuals clustered around as they aged. Previously only a model with quadratic trajectory shapes was estimated to keep the focus on how model fit changes with the introduction of new groups, but it is possible that not all of the three trajectories are quadratic. One group might follow a linear trend or be completely flat, while another might follow a cubic trend. A wide array of model configurations were estimated to investigate this, each of which reflected a different set of possible trajectory shapes (e.g. linear-quadratic-linear; linear-linear linear; etc.). The specific trajectory shapes and fit statistics for each of the models estimated are summarized in table 14. The BIC statistic for each model was used to identify changes in overall model fit that coincided with changes in trajectory shapes. In layman’s terms, these statistics help to assess which set of trend lines best describe the aging trends that different groups of individuals cluster around. BICs were compared against one another using an equation that estimates the probability that one model was the correct model relative to all others\(^{28}\). Using this metric, the best fitting three-group model had two quadratic trajectories and a third linear trajectory. According to calculations, this model has a 93% probability of being the correct model relative to all other models assessed.

\(^{28}\) The specific equation, from Nagin (2005: 70), was \(\frac{\text{BIC}_j - \text{BIC}_{\text{max}}}{\sum_j e^{\text{BIC}_j - \text{BIC}_{\text{max}}}}\) where \(j\) refers to one of several models and \(\text{BIC}_{\text{max}}\) refers to the largest (closest to zero) BIC value across all models.
The next best fitting model had linear, quadratic, and cubic trajectory groups, but this model was found to have only an 11.4% probability of being the correct model relative to all other alternatives. Furthermore, the effect size for the cubic slope was very small and nonsignificant, meaning it did not substantially change the shape of the aging trajectory relative to the simpler quadratic trajectory.

Table 14  Examples of Model Fit Statistics for Different Trajectory Shapes

<table>
<thead>
<tr>
<th>BIC (n=1526)</th>
<th>Model</th>
<th>P(Correct Model)</th>
</tr>
</thead>
<tbody>
<tr>
<td>-22102.28</td>
<td>1 1 1</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>-22081.89</td>
<td>1 2 1</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td><strong>-22065.84</strong></td>
<td><strong>2 2 2</strong></td>
<td><strong>0.929</strong></td>
</tr>
<tr>
<td>-22069.16</td>
<td>2 2 2</td>
<td>0.031</td>
</tr>
<tr>
<td>-22072.52</td>
<td>2 2 3</td>
<td>0.001</td>
</tr>
<tr>
<td>-22071.17</td>
<td>2 3 2</td>
<td>0.004</td>
</tr>
<tr>
<td>-22075.86</td>
<td>3 3 3</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>-22069.2</td>
<td>1 2 3</td>
<td>0.032</td>
</tr>
<tr>
<td>-22107.91</td>
<td>3 1 1</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>-22088.85</td>
<td>3 3 1</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>-22090.06</td>
<td>1 1 3</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>-22067.93</td>
<td>1 3 2</td>
<td>0.114</td>
</tr>
<tr>
<td>-22086.52</td>
<td>3 2 1</td>
<td>&lt;0.000</td>
</tr>
<tr>
<td>-22108.21</td>
<td>0 2 3</td>
<td>&lt;0.000</td>
</tr>
</tbody>
</table>

Final model is bolded.
0= intercept only; 1= linear trend; 2= quadratic trend; 3= cubic trend.

5.1.3 Assessing Model Fit To Data

The model with two quadratic trajectories and a linear trajectory (hereon referred to as the successful aging trajectory model (SATM)) was found to be the best fitting of all possible models. However, this does not guarantee that the SATM was actually a good fit to the data - it is possible that the model selected here is just the “best” of a group of bad models. This is because classification in a group is not absolute - individuals are assigned
a probability of being in one group versus others. This classification probability is more technically referred to as a posterior probability (Nagin 2005). If all individuals had low posterior probabilities it would suggest that the SATM still had poor fit to the data, though it is the best fitting model overall. It was therefore important to investigate these and other fit statistics to see if the model actually fits the data well.

The quality of the SATM’s fit was assessed in several ways, which are presented in table 15. First, it can be seen in the concordance between the model’s estimated group sizes versus the actual classification of individuals into groups. There is room for discrepancy because the classification process is a function of posterior probabilities, while the estimation of group sizes is not. In the case of the SATM, we can see that the estimated group sizes are within 2.9% of the sizes of the groups that were actually created using posterior probabilities. This similarity between estimated and actual classification indicated good model fit (Nagin 2005). A more precise way of observing the same thing is to look at the posterior probabilities directly, since the group with the highest posterior probability for a given individual is the group that the individual is ultimately assigned to. Nagin (2005) has suggested that average posterior probabilities for members of a particular group should be, at a minimum, .70. That is, a 70% probability that individuals are classified into that particular group over others. The SATM exceeds this standard by a large margin- the smallest average posterior probability is .87.

Further evidence with which to determine model adequacy is the odds of correct classification (OCC) statistic. This statistic combines group size estimates and posterior probabilities into a single measure. The OCC describes the odds that a respondent is being correctly assigned into a group based on their highest posterior probability. A value
of 1 means that the group classification method is essentially assigning individuals into
groups at random. Nagin (2005) suggested that a value of 5 or greater is indicative of
high assignment accuracy, though higher values preferable. The SATM’s lowest OCC
statistic was a 7.9 for the usually aged group, while the other two groups had statistics
that were at least triple the guideline. This provided further evidence that the SATM
being estimated was a good fit to the data and respondents are being assigned to different
groups with a high degree of certainty.

Table 15  Diagnostics of Assignment Accuracy for SATM (n=1526)

<table>
<thead>
<tr>
<th>Group</th>
<th>Estimated Trajectory Proportion</th>
<th>Proportion Classified to Group</th>
<th>Avg Posterior Probability</th>
<th>Odds Correctly Classified</th>
</tr>
</thead>
<tbody>
<tr>
<td>Successfully Aged</td>
<td>35.2%</td>
<td>32.6%</td>
<td>.91</td>
<td>15.99</td>
</tr>
<tr>
<td>Usually Aged</td>
<td>46.6%</td>
<td>48.3%</td>
<td>.87</td>
<td>7.94</td>
</tr>
<tr>
<td>Sub-Optimally Aged</td>
<td>16.2%</td>
<td>19.1%</td>
<td>.89</td>
<td>54.99</td>
</tr>
</tbody>
</table>
5.2 Finalized Successful Aging Trajectory Groups

Having determined the best fitting trajectory model (i.e. the SATM), we now turn to the specific substantive results implied by the model. Results from the SATM are presented in graphical and tabular forms in figure 12 and table 16 respectively. The uppermost trajectory reflects successful aging. A total of 32.6% of respondents were classified as successfully aged. The successful aging trajectory exhibited a very small increase in SAC scores up until roughly age 68, at which point SAC scores gradually decreased as age increases. Though the highest scoring group, the successful trajectory still described scores that were well below the maximum possible scores of the SAC, suggesting that not even the successfully aged should be held to a standard of perfect (or even near perfect) scores on the SAC. Similar results were found regarding the middle trajectory, which reflects usual aging, although the 48.3% of individuals in this group had lower SAC scores than the successful group and a sharper decline over time. A final sub-
optimally aged group began with relatively low scores that continually declines at a rate of 1.6 SAC points per year of age. Unlike the other two trajectory groups, there was no positive growth in the group’s lower than average SAC scores. The remaining 19.1% of respondents were classified in this trajectory group.

It is important to verify that membership in each trajectory was not driven by a single dimension of the SAC. For example, it is possible that the mental and social scores (e.g. volunteering and participating on groups, informal contact with friends, life satisfaction, CES-D scores, cognitive functioning) were very similar regardless of trajectory group, while physical scores (e.g. chronic conditions, self-rated health, and physical functioning) were very different. This would be problematic because it could mean only one dimension of the SAC was actually being captured by the trajectory groupings. If a single dimension was driving the group classification process, it would manifest itself empirically in the form of wide between-group differences in SAC scores for the influential dimension and little to no differences between groups for the uninfluential dimensions.
Table 16  Model Parameters for Successful Aging Trajectory Model (n=1526)

<table>
<thead>
<tr>
<th>Group</th>
<th>Slope Estimate</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Successfully Aged</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>227.8***</td>
<td>3.78</td>
</tr>
<tr>
<td>Linear slope</td>
<td>1.1***</td>
<td>0.28</td>
</tr>
<tr>
<td>Quadratic slope</td>
<td>-0.04***</td>
<td>0.01</td>
</tr>
<tr>
<td>Birth Cohort Dummy (Ref: 1910 or earlier)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1911-1920 cohort</td>
<td>-0.21</td>
<td>6.99</td>
</tr>
<tr>
<td>1921-1930 cohort</td>
<td>-4.75</td>
<td>7.03</td>
</tr>
<tr>
<td>1931-1940 cohort</td>
<td>-8.04</td>
<td>6.85</td>
</tr>
<tr>
<td><strong>Usually Aged</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept</td>
<td>196.0***</td>
<td>3.77</td>
</tr>
<tr>
<td>Linear slope</td>
<td>0.79*</td>
<td>0.32</td>
</tr>
<tr>
<td>Quadratic slope</td>
<td>-0.04***</td>
<td>0.01</td>
</tr>
<tr>
<td>Birth Cohort Dummy (Ref: 1910 or earlier)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1911-1920 cohort</td>
<td>4.58</td>
<td>14.77</td>
</tr>
<tr>
<td>1921-1930 cohort</td>
<td>2.39</td>
<td>17.79</td>
</tr>
<tr>
<td>1931-1940 cohort</td>
<td>-5.16</td>
<td>13.38</td>
</tr>
<tr>
<td><strong>Sub-Optimally Aged</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Intercept slope</td>
<td>158.54***</td>
<td>6.69</td>
</tr>
<tr>
<td>Linear slope</td>
<td>-1.26***</td>
<td>0.23</td>
</tr>
<tr>
<td>Birth Cohort Dummy (Ref: 1910 or earlier)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1911-1920 cohort</td>
<td>0.98</td>
<td>11.56</td>
</tr>
<tr>
<td>1921-1930 cohort</td>
<td>-12.91</td>
<td>13.54</td>
</tr>
<tr>
<td>1931-1940 cohort</td>
<td>-23.51</td>
<td>17.13</td>
</tr>
</tbody>
</table>

*p<.01; **p<.01; ***p<.001

Note that the time scale is centered at 50 years of age, so the intercept reflects SAC scores at 50 years of age.

Therefore, average aging trends for the SAC’s three dimensions were calculated to examine if group membership was influenced by only one dimension of the SAC.

These trends are presented in figure 13. Results from these analyses indicates that individuals who aged successfully had high scores on all dimensions, rather than just one. Overall, social engagement scores were lower for all dimensions compared to physical and mental dimension scores. Another important element that this decomposition revealed was that the downward trend in the combined trajectories was due to decreases
in physical health scores with age. The other two dimensions were relatively stable with age, exhibiting a small increase in the usual and successfully aged groups between ages 60 and 75. This suggested that the small increases in the usual and successful trajectories were primarily driven by positive changes in mental and social engagement scores. This decomposition helped to elaborate on the factors driving changes in the aging trajectory, but more importantly, it provided assurance that successful aging was associated with excelling on all dimensions rather than just one.

Figure 13  Mean Scores for Each Dimension of the SAC Broken Down by Trajectory Group and Age

The primary purpose for using group based trajectory modeling was to ensure that group classification was no longer correlated with age. Two approaches were used to assess this. The first approach was to use birth cohort as a time varying covariate in the
trajectory model, which helped to assess if age groups followed different trajectory lines. More precisely, these results tell how a given trajectory’s intercept shifted for members of a different cohort, as well as if the difference was statistically significant. These results were presented earlier in the manuscript alongside other model parameters in table 16. All of these effects were nonsignificant, suggesting that different cohorts do not have higher or lower mean scores in each trajectory group. The second approach used was to cross-tabulate birth cohort with group assignment to examine if members of different birth cohorts were more likely to be assigned to certain groups. This differs from the prior assessment because it examined classification, while the other analysis examined trajectory shape _after_ classification. The results of the cross tabulation are presented in table 17, which demonstrated that group assignment probabilities were not significantly different from one another. Both of these tests provided strong evidence that group classification was no longer correlated with age.

<table>
<thead>
<tr>
<th>Group</th>
<th>≤1910</th>
<th>1911-1920</th>
<th>1921-1930</th>
<th>1931-1940</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sub-Optimally Aged</td>
<td>18.5%</td>
<td>14.0%</td>
<td>16.1%</td>
<td>15.9%</td>
</tr>
<tr>
<td>Usually Aged</td>
<td>44.6%</td>
<td>45.8%</td>
<td>51.5%</td>
<td>54.9%</td>
</tr>
<tr>
<td>Successfully Aged</td>
<td>36.9%</td>
<td>40.3%</td>
<td>32.4%</td>
<td>29.1%</td>
</tr>
</tbody>
</table>

Note that this uses a version of the trajectory model that does not adjust for cohort effects. Nagin (2005) cautions against using time varying covariates in a model that will then be predicted by identical covariates. This can produce misleading correlations between classification and the time-invariant covariate simply due to adjustment for birth cohort during the model estimation process. All models in the manuscript use the version of the model which controls for cohort membership in the estimation process, omitting age.
5.3 Discussion

Latent trajectory modeling has been used in prior studies that examine successful aging (Hsu and Jones 2012; Tang 2014; Wickrama et al. 2013). This study elaborated on these prior applications by integrating latent trajectory models with the previously validated SAC which, I argue, resulted in a more parsimonious and interpretable model. The model fit statistics in the analysis were also very favorable, suggesting that the SATM was an accurate description of aging trends along the SAC. Furthermore, using this classification method appeared to alleviate the correlation between successful aging and age, providing a more accurate reflection of successful aging reflecting within age-group heterogeneity. Given these relative strengths, future research may benefit from also applying this approach.

The model estimated in this study points to the importance of embracing changes that occur with age when conceptualizing and measuring successful aging. Like other studies using latent trajectory models, it was found that all aging trajectory groups followed a general downward trend in even the successfully aged trajectory group (Hsu and Jones 2012; Tang 2014; Wickrama et al. 2013). As in Tang’s (2014) analysis, it was found that this decline was primarily due to changes in physical functioning. These findings substantiated a common criticism of some models of Rowe and Kahn’s (1987) model of successful aging, which has been accused of pathologizing normal changes that occur with age by implying that they rarely occur among the successfully aged (Calasanti 2015; Cho, Martin, and Poon 2012; Goodwin 1991; Katz and Calasanti 2015; Martinson and Berridge 2014; Minkler 1990; Young, Frick, and Phelan 2009). Ignoring normal changes with age insinuates that individuals who do experience some age related decline
are “failures” at aging. The approach used in this analysis helped to lessen this problem by capturing successful in a way that was more relative to one’s age group, which arguably reflects Kahn’s (2003) original intentions. Future studies should continue developing approaches that are flexible enough to accommodate for changes that appear to be typical with age.

Estimates for the incidence of successful aging were consistent with some studies and inconsistent with others. It was found that 32.6% of adults could be classified as aging successfully in the ACL data. Similarly, using the Taiwan Longitudinal Survey on Aging, Hsu and Jones (2012), calculated that 29.1% of their older adult sample aging successfully. However, other latent trajectory analyses found larger successful aging trajectory groups- 55.4% in Wickrama and colleagues’ (2013) analysis using the Health and Retirement Study (HRS), and 39.6% in Tang (2014), which also used the HRS data. It is important to note that this inconsistency is not specific to latent trajectory methods, as estimates of the proportion of adults that successfully age are very inconsistent regardless of the classification methods used (Depp and Jeste 2006). This is likely due to differences in conceptualization and methodological strategies, which makes it difficult to compare studies (Cosco, Stephan, and Brayne 2014). Overall, however, most studies tended to converge on an estimate similar to the current study’s value: Averaging estimates from 22 studies, Depp and Jeste calculated that roughly 27.2% of individuals are aging successfully. This lends some support to the current study’s findings, but the inconsistency of results throughout the literature suggests a need for more uniform approaches to studying successful aging.
The presence of multiple aging groups in the current analysis was important because it suggested that, as others have argued, depending on a binary operationalization of successful aging can result in a misleading description of aging outcomes in the sample (Cosco, Stephan, and Brayne 2014). Specifically, binary measures ignore the distinction between the usually aged and sub-optimally aged individuals which was detected in this study. If the current study had ignored this nuance it may have concluded that 67.4% of respondents “failed” to successfully age, versus the 19.1% of adults who could be said to be “failing” to age decently in the current study. By identifying this difference this study presented a far more realistic picture of how well the sample is aging as a whole, allowing for a more nuanced analysis of how successful agers differed from other aging groups. The results of this analysis therefore provided empirical evidence for suggestions that researchers avoid binary thinking in the context of successful aging (Bowling 2007; Cosco, Stephan, and Brayne 2014; Cosco et al. 2014; Cosco, Stephan, and Brayne 2015; Lowry, Vallejo, and Studenski 2012).

A final area of relative agreement is the number of aging trajectory groups that emerged. Similar to the findings presented here, Tang (2014) and Wickrama and colleagues (2013) found that a three trajectory solution was the best fit to the data. This gives a degree of support to Rowe and Kahn’s (1987) implication of the presence of roughly three aging classifications. A three-group classification has been used in a priori classification strategies in the past (Bowling and Iliffe 2006; Grundy and Bowling 1999), although four-group classification approaches have also been used (Garfein and Herzog 1995). The “advantage” that the current study had over earlier a priori approaches is that the best number of groups can be verified empirically rather than simply assumed.
The three trajectory solution did contradict findings by Hsu and Jones (2012), however, who settled on a four group latent trajectory model. This variation likely represents a meaningful empirical difference between Taiwanese and American data, but it is important to reiterate Nagin’s (2005) point that groups are not immutable or “real” in the sense that they truly exist in the population as a whole. In particular, the number and shape of trajectories identified is influenced by sample size and the number of waves used. Hsu and Jones (2012) may have found a larger number of cases simply because their sample (n=6,511) was four times larger than my data. This explanation is not wholly satisfying, however, given that Tang (2014) found a three trajectory solution with a similarly large dataset. If the differences in trajectory groups were a function of sample size we would expect Tang to also have had four or more groups as well. It is important for future research to continue to empirically establish the ideal number of groups to be used, but at the moment it appears that the existence of either three to four trajectories is highly plausible depending on the dataset.

5.4 Conclusion

The analysis presented here used a novel approach to classifying individuals as aging successfully, merging latent trajectory and continuum based approaches from the literature. A three group trajectory model was found to be the best fit in the existing data, with less than a quarter of respondents being classified as successfully aged. Each trajectory depicted a slow decline in scores with age, primarily due to changes in physical health with time. Capturing this downward change over time enabled the classification of individuals as successfully aged to be uncorrelated with age, overcoming a major limitation of other methods for classification. The end result of this analysis is a
potentially more realistic picture of successful aging than was previously available, as individuals are not immediately disqualified from being successfully aged due to changes that are simply due to normal aging.

It was found that 32.6% adults were classified as aging successfully. It is important to consider how individuals in the sub-optimal and successfully aged categories differ from one another, and what, if anything, can be done to further decrease the size of the suboptimal category and increase the number of successful agers. The chapter that follows aims to address this question, moving from description towards explanation.
Chapter 6

PREDICTING SUCCESSFUL AGING: DIRECT AND INDIRECT MECHANISMS

6.1 Introduction

Previous chapters have focused on proposed solutions to methodological issues in the study of successful aging. Three aging trajectory groups were identified using a group based trajectory modeling approach that identified the aging trends around which individuals tend to cluster. This final model, referred to as the successful aging trajectory model (SATM), classified 32.6% of respondents as aging successfully, 48.3% as usually aged, and 19.1% as sub-optimally aged. This chapter examines the substantive differences across the SATM groups in greater detail, aiming to identify why individuals successfully age to begin with.

In their recent discussion of directions for future research, Rowe and Kahn (2015) suggested that researchers give stronger consideration to the social and life course circumstances that give rise to successful aging. Some prior studies have already broken ground in this area by investigating if childhood SES and/or country GINI coefficients predicted successful aging (Brandt, Deindl, and Hank 2012; Britton et al. 2008; Pruchno et al. 2010; Schafer and Ferraro 2011; Wickrama et al. 2013). While these studies have highlighted the harmful effects of social inequality on successful aging, they did not fully resolve the issues Rowe and Kahn raise. In particular, little research has examined if
social inequality or life course experiences also operate indirectly through their influence on other predictors of successful aging, such as health behaviors. This would be consistent with prior research that found that some health behaviors and stress were unequally distributed along lines of race, SES, and gender (Cockerham 2007; Turner, Wheaton, and Lloyd 1995; Turner and Avison 2003). By leaving these indirect effects unassessed, prior studies may have underestimated the effect of both childhood and social conditions on successful aging. Therefore, an important step to meeting Rowe and Kahn’s request is the consideration of how social and life course variables shape exposure to other more proximate risk factors.

Giving deeper consideration to how social and life course factors influence successful aging is also important in light of critiques which have argued that Rowe and Kahn overstated the role of individual agency in producing successful aging (Calasanti 2015; Katz and Calasanti 2015; Minkler 1990; Schmeekle and Bengston 1999; Stowe and Cooney 2015). These critics have suggested that the importance of health behaviors is exaggerated and the social context surrounding the health behaviors is not sufficiently considered. They further claimed that by treating successful aging as the outcome of individual’s behavioral choices, theorists imply that individuals have the ability to “choose” to engage in the behaviors that allowed them to successfully age. The political implication of this agency-focused explanation was that “failing” to successfully age was solely the individual’s fault and therefore no political change was required to either assist older adults or to enable future adults to successfully age (Calasanti 2015; Dillaway and Byrnes 2009; Katz and Calasanti 2015; Minkler 1990). Once again, a way to expand on these critiques would be to empirically test their key assertion that social environments
strongly modify the health behaviors individuals choose to engage in. If this exposure to protective behaviors is unequal enough that it negatively influences a person’s odds of successfully aging, it would provide substantial empirical evidence for what is currently a theoretical argument in the successful aging literature.

6.2 Explanatory Model

Responding to this need for greater consideration on how upstream (e.g. social and life course determinants) and downstream (e.g. health behaviors, psychosocial risks) mechanisms interact, I proposed that the behavioral and psychosocial determinants of successful aging are, in part, mediators for the effect of social status and life course experiences. To create a testable representation of this idea, the successful aging explanatory model (SAEM) was constructed for this study. Described in detail in chapter 2 and reproduced in figure 14, the SAEM illustrates the hypothesized interrelationships between social statuses, life course experiences, and several other proximate mediators that directly and/or indirectly influence successful aging.

Figure 14 The Successful Aging Explanatory Model
The SAEM was devised using modern versions of the stress process model as a starting point (Aneshensel 2015; Pearlin et al. 1981; Pearlin et al. 2005; Wheaton 2010). The stress process model served as a foundation for this analysis for three reasons. First, it provided a useful framework for understanding the pathways through which social statuses and life course experiences go on to influence more proximate risk factors. Second, this emphasis on stress and social determinants was ideal for this study because it places emphasis on factors which individuals cannot control, which was critical in light of critiques that argue that individuals are often framed as being able to “choose” if they successfully age (Dillaway and Byrnes 2009; Minkler 1990). While Rowe and Kahn (1997) acknowledged that stress, support, and mastery are critical to producing successful aging, these less controllable factors are often downplayed in the successful aging literature in favor of health behaviors that are more amenable to direct intervention (Depp and Jeste 2006; Katz and Calasanti 2015). Lastly, the stress process model had a strong body of empirical work that substantiated its tenants (Longest and Thoits 2012; Pearlin 2009; Thoits 2010; Turner 2010; Wheaton 2010).

In its basic form, the stress process model presented the hypothesis that social statuses (race, SES, and sex), modify a person’s exposure to stressful life events and chronic stressors while also altering the resources that allow individuals to effectively cope with that stress (Pearlin et al. 1981). This heightened exposure to stress and diminished access to coping resources then produces detrimental effects on mental health (Aneshensel 2015; Pearlin et al. 1981), physical health (Kahn and Pearlin 2006; Turner 2010). Other studies have also demonstrated that stress is correlated with successful aging, suggesting that the stress process framework is also appropriate to apply in the
context of successful aging as well (Depp and Jeste 2006; Garfein and Herzog 1995; Grundy and Bowling 1999; Kahana, Kelley-Moore, and Kahana 2012; Moore et al. 2013; Moore et al. 2015; Rowe and Kahn 1997).

The basic stress process model was not sufficient for the current study, requiring expansion in several areas. To begin with, SAEM needed to account for evidence that suggested that successful aging is partly the product of childhood stress (Brandt, Deindl, and Hank 2012; Schafer and Ferraro 2011; Wickrama et al. 2013). Therefore, the basic stress process model was updated hypothesize that childhood stress operates directly and indirectly on successful aging via the process of stress proliferation (Pearlin et al. 2005; Pearlin 2009). The idea of stress proliferation applies to circumstances where “exposure to one stressor, regardless of whether it is an event or more chronic hardship, may lead over time to exposure to other, secondary, stressors (Pearlin 2009: 210).” These experiences can then go on to influence future access to coping resources as well (Pearlin et al. 2005; Pearlin 2009). The theoretical expansions made suggest that childhood stress will be associated with higher stress exposure, more life events, fewer coping resources, and lower odds of successfully aging. In addition, cumulative inequality theory has argued that childhood disadvantage can initiate a long running chain of blocked opportunities and harmful experiences which pile up on to one another, generating health disparities long into the future (Ferraro and Shippee 2008; Ferraro, Schafer, and Wilkinson 2016). Therefore, childhood stress was also expected to operate on successful aging through mechanisms that may not be accounted for, resulting in a direct negative effect on successful aging as well.
A second area where the stress process model needed to be expanded was to account for some of the health behaviors (smoking, drinking, exercise) that have been found to predict successful aging (Brandt, Deindl, and Hank 2012; Britton et al. 2008; Depp and Jeste 2006; Feng, Son, and Zeng 2015; Franklin and Tate 2009; Ng et al. 2009; Pruchno et al. 2010; Rowe and Kahn 1997). In addition, studies have demonstrated the presence of socioeconomic, racial and gendered disparities in smoking, drinking, and physical exercise (Cockerham 2007; Lantz et al. 2010; LaVeist 2005; McDonough and Walters 2001). For instance, low SES respondents have been shown to be more likely to smoke, drink heavily, and be inactive (Lantz et al. 2010). Other studies have also linked heightened risk of alcohol dependence and smoking issues back to stressful childhood experiences (Casement et al. 2015; Enoch 2011; Lloyd and Taylor 2006; Lloyd and Turner 2008). Based on these past studies, it is expected that these health behaviors with be associated with SES, gender, race, and childhood stress.

Furthermore, it has been argued that health behaviors can operate as mediators for the effect of stress on different health outcomes (Rutters et al. 2014; Umberson, Liu, and Reczek 2008). Physical activity has been found to be associated with decreased levels of stress, so this is hypothesized by the SAEM as well (Edenfield and Blumenthal 2011; Scully et al. 1998; Umberson, Liu, and Reczek 2008). Smoking has been linked to having higher stress, with stress levels predicting quantity smoked, difficulty with cessation, and risk of onset (Ayyagari and Sindelar 2010; Cheney et al. 2014; Kassel, Stroud, and Paronis 2003; Kendzor et al. 2010; Lloyd and Taylor 2006). Similarly, many studies have demonstrated that high levels of stress are correlated with more frequent and heavier drinking, as well as higher risk of dependence (Adams et al. 2015; Casement et al. 2015;
Enoch 2011; Fox et al. 2010; Grieger et al. 2003; Lloyd and Turner 2008; Moos et al. 2004; Mulia and Zemore 2012). Smoking and drinking were therefore treated like coping responses in the SAEM, much like mastery and social support, with the key difference being that smoking and drinking harm one’s odds of successfully aging.

Taken as a whole, the SAEM (and the test that follows) contributes to the successful aging literature by joining two narratives about the determinants of successful aging. On one hand, there has been an individual-focused explanation that argues that the health choices a person makes and their exposure to stress produce successful aging (Rowe and Kahn 1998). The counterargument to this was that race, SES, and gender appear to be the true underlying determinants of successful aging (Brandt, Deindl, and Hank 2012; Katz and Calasanti 2015; Wickrama et al. 2013). The SAEM highlights that these narratives are complimentary. By placing health behaviors and stress in social context the SAEM addresses critiques which suggest that social determinants of health are not being considered adequately (Katz and Calasanti 2015; Riley 1998; Schmeekle and Bengston 1999). This also lends itself to a more satisfying explanation of why sociodemographics and childhood stress are linked to successful aging by positing specific mechanisms instead of simply observing that they are correlated.

The SAEM’s core argument, which is that social statuses and childhood experiences function as underlying root causes of health disparities that operate through a wide array of proximate mediators, echoes a common position in the medical sociology literature (House 2002; Lantz et al. 2001; Lantz et al. 2010; Link and Phelan 1995; Phelan, Link, and Tehranifar 2010). This argument is well established within medical
sociology, but it is rarely incorporated into theoretical and/or empirical models in successful aging research. Katz and Calasanti recently noted this deficiency, arguing that:

“...aging research has to theorize lifestyle, choice, health, and successful aging beyond personal choice because lifestyles are configured by differential opportunities and relations to social inequality [citations omitted]. However, these critical perspectives on lifestyle are lost in the successful aging research because individual choice is reduced to decontextualized health-relevant choices such as smoking, diet, or exercise [citation omitted] (Katz and Calasanti 2015: 28-29).”

Therefore, though the SAEM retreads some soil within the medical sociology literature, both the proposal and an empirical test of the hypothesis asserted by the SAEM provide a useful contribution to the successful aging literature. In particular, it provides an empirical framework and a test for the idea that systems of social inequality ultimately shape aging outcomes, which would suggest the need for a more radical theory of the causes of successful aging than is currently available.

6.3 The Current Study

This chapter presents a test of the hypothesized relationships in the SAEM using the ACL data. This test was broken into three phases. First, I estimated a multinomial model that predicted classification into one of the three aging groups identified in the prior chapter. This tested all the paths from the SAEM that went directly to the successful aging outcome without first passing through a mediator (e.g. SES→Successful aging; Stress→Successful aging). This first step was equivalent to most analyses in the successful aging literature, which use a single regression model that treats all independent variables as if they were unrelated to one another (e.g. Brandt, Deindl, and Hank 2012; Britton et al. 2008; Feng, Son, and Zeng 2015; Garfein and Herzog 1995; McLaughlin et al. 2009; Ng et al. 2009; Schafer and Ferraro 2011). Second, I examined if the hypothesized risk factors, such as health behaviors and stress, were unequally distributed
by race, sex, SES, and childhood experiences. Six OLS and two multinomial models\textsuperscript{30} tested the many paths between social statuses, childhood stress, and the psychosocial risk factors and health behaviors. The analysis from the second step did not test if unequal exposure to risk factors was a pathway through which successful aging was impacted indirectly- it only tested the unequal distribution of a risk factor. The third step corrected this limitation by testing for mediating relationships using the results from all the regression models that were estimated up to this point. This last step rigorously tested the core theoretical assertion underlying the SAEM: that social statuses and childhood stressors operate indirectly through more proximate health lifestyles and psychosocial risk factors. After this, the implications of these analyses are considered in the context of both the successful aging and stress literature.

\textsuperscript{30} The models run in this analysis are analogous to estimating a path model that assumes all errors are uncorrelated. The reason a path model is not estimated is because of the categorical components of the SAEM, which are not supported in most software packages that estimate SEM models.
6.4 Analysis 1: Predicting Successful and Sub-Optimal Aging

The SAEM was ultimately designed to address the question of why individuals who age successfully differ from those who are usually or sub-optimally aged. In the SAEM all social statuses, childhood stress, health behaviors, and psychosocial factors are expected to have associations with successful aging. Verifying that this is the case is important because it will replicate past findings that demonstrated the effect of these variables on successful aging, which have found that both behaviors and social statuses have direct effects aging outcomes (Brandt, Deindl, and Hank 2012; Depp and Jeste 2006; Feng, Son, and Zeng 2015; Wickrama et al. 2013). To test if the SAEM accurately describes these relationships, a multinomial logistic regression model was estimated. These results of this model are presented in table 18.

Three technical details about this multinomial should be noted when interpreting these results. First, some study variables (noted in table 18) took variation across waves 1
and 2 into account to reflect the accumulation of risk exposure in accordance with cumulative inequality theory (Ferraro and Shippee 2008). For instance, a high score on the chronic stress measure reflected being highly stressed in both waves 1 and 2, rather than just one wave. A second consideration is that the measures for stress, support, mastery, and activity were standardized, meaning their interpretation is in standard deviation changes in each measure. Lastly, age was not controlled for in these models because birth cohort was already adjusted for as a time varying covariate in the group based trajectory model’s estimation. See chapter 5 for evidence that age was not associated with trajectory membership.
Table 18  Multinomial Logistic Regression Model Predicting Successful Aging
Outcome comparison: Usual Aging (n=738)  Sub-Optimal Aging (n=291)  Successful Aging (n=497)

Controls
Marital Status (Ref: Married)
- Separated/Divorced: 1.95  1.18
- Widowed: 0.76  1.61*
- Never Married: 0.37  0.19**

Employment Status (Ref: Employed)
- Retired: 1.29  0.84
- Not working for other rsns: 2.95***  0.58*

Urbanicity (Ref: Urban)
- Suburban: 1.93*  1.01
- Rural: 1.53  0.80

Region (Ref: Northeast)
- North Central: 1.07  1.01
- South: 1.78  0.94
- West: 1.68  0.65

BMI (Ref: Normal)
- Overweight: 1.15  0.49***
- Obese: 2.82***  0.61

Uninsured: 0.75  1.89
- Parent: 1.09  1.10
- In Retirement Community: 1.43  2.67*

Study Variables
- Female: 0.38**  1.13
- Black: 1.43  1.12
- SES: 0.66***  1.48***
- Childhood Stressors: 1.16  0.93
- Life Events Up to Wave 2: 1.14*  0.92
- 2 Wave Avg Chronic Stress (std): 1.42*  0.71*
- 2 Wave Avg Support (std): 0.84  1.41**
- 2 Wave Avg Mastery (std): 0.45***  1.74***
- 2 Wave Avg Activity Level (std): 0.37***  1.59***

Drinking (ref: Doesn’t drink)
- 1-59 drinks/week in wave 1 or 2: 0.63  1.02
- 60+ drinks/week in wave 1 or 2: 1.09  0.71

Smoking (ref: Never smoked)
- Former Smoker as of Wave 2: 1.51  0.81
- Still Smoking at Wave 2: 1.31  0.44**

*p<.05; **p<.01; ***p<.001
The “upstream” variables specified in the SAEM were race, gender, SES, and childhood stress. Women had 62% lower odds of being in the sub-optimal category as opposed to the usual category, while men and women were equally likely to be in the usual versus successful groups. Unexpectedly, being black was not a significant predictor of successful or sub-optimal aging. Similarly, exposure to stressful childhood circumstances was not associated with one’s aging outcomes. High SES, however, was significantly associated both aging outcomes. Specifically, a one unit increase on the 5-point SES variable was associated with a 44% decrease in one’s odds of sub-optimally aging and a 48% increase in one’s odds of successfully aging. In other words, the highest SES category was 240% more likely to successfully age than the lowest SES category.

In terms of psychosocial predictors, it was found that having a large number of stressful life events increased one’s risk of sub-optimally aging by a margin of 14% per event, though they did not decrease the respondent’s risk of successfully aging. Chronic stress was significantly associated with both outcomes, with a standard deviation increase in stress corresponding to being 42% more likely to sub-optimally age and 29% less likely to age successfully. Mastery had the strongest association of all the psychosocial factors. A one standard deviation increase in one’s mastery score being associated with a 74% increase of in one’s odds of successfully aging and a 55% decrease in one’s likelihood of sub-optimally aging. The other coping resource, social support, was only useful for differentiating between the successfully and usually aged.

Several health behaviors were expected to predict successful aging in the SAEM. Alcohol consumption was not associated with any aging outcome, but individuals who...
were still actively smoking at wave 2 had 56% higher odds than non-smokers of usually aging rather than successfully aging. Having smoked in the past was not a significant risk factor. Remaining physically active increased one’s odds of successfully aging by a large margin, with a one standard deviation increase in a respondent’s activity level corresponding to a 59% increase in one’s likelihood of successfully aging and a 63% decrease in one’s odds of sub-optimally aging.

Thus far, the results of this section supported Rowe and Kahn’s (1987; 1997; 1998) assertion that health behaviors and psychosocial factors are the key determinants of successful aging. Taken together, the proximate mechanisms had a much larger effect on successful aging than SES, race, gender, and childhood stress. One might be tempted to conclude that interventions should focus on getting people to exercise more, avoid stress, quit smoking, and maintain their social networks. It may also be possible to conclude that systemic interventions would be less effective than proximate ones, given the comparatively small effects of SES and gender. Such conclusions may be premature, however, as the SAEM also hypothesized that stress and health behaviors will be unequally distributed based on race, class, gender, and childhood stress. If this is found to be true it would problematize these preliminary conclusions by suggesting that social change may be required to mitigate increased risk experienced by specific groups.

6.5 Analysis 2: Predicting the Predictors of Successful Aging

The SAEM hypothesized that stress, health behaviors, and coping resources would be negatively correlated with low SES, being black, being female, and having a stressful childhood. To test this part of the SAEM (depicted in figure 16), each risk factor was used as the dependent variable in its own regression model. The results of these
analyses are presented in two tables, the first of which (table 19) summarizes four linear regression models that treated the psychosocial variables as outcomes. Table 20 accounts for the health behaviors, presenting four two multinomial logistic regression models for drinking and smoking and another OLS model for activity. Note that in some cases physical activity, life events, and physical activity were also used as independent variables, as specified in the SAEM.

Figure 16    SAEM Paths Tested in Analysis 2
Table 19  OLS Models Predicting Psychosocial Factors

<table>
<thead>
<tr>
<th>Variable Name</th>
<th>Life Events</th>
<th>Chronic Stress</th>
<th>Mastery</th>
<th>Support</th>
</tr>
</thead>
<tbody>
<tr>
<td>Female</td>
<td>-0.04</td>
<td>-0.01</td>
<td>0.01</td>
<td>0.22***</td>
</tr>
<tr>
<td>Black</td>
<td>0.17</td>
<td>0.24**</td>
<td>0.13*</td>
<td>0.15*</td>
</tr>
<tr>
<td>SES</td>
<td>-0.25***</td>
<td>-0.06**</td>
<td>0.08***</td>
<td>-0.02</td>
</tr>
<tr>
<td>Childhood Stressors</td>
<td>0.14*</td>
<td>0.01</td>
<td>0.02</td>
<td>-0.05*</td>
</tr>
<tr>
<td>2 Wave Activity Level (std)</td>
<td>-</td>
<td>-0.07*</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Life Events Up to Wave 2</td>
<td>-</td>
<td>0.09***</td>
<td>0.02</td>
<td>0.03*</td>
</tr>
<tr>
<td>2 Wave Avg Stress (std)</td>
<td>-</td>
<td>-</td>
<td>-0.45***</td>
<td>-0.49***</td>
</tr>
</tbody>
</table>

R-squared 0.13 0.23 0.24 0.26

All models control for age, urbanicity, region, BMI, insurance status, parental status, retirement community membership. All models except life events model\textsuperscript{31} also control for marital status, employment status.

*\(p<.05\), **\(p<.01\), ***\(p<.001\)

The first two columns present models predicting life events and chronic stress. In the case of life events, a one rank increase on the SES scale was associated with having an estimated .25 fewer life events, and each childhood stressor was associated with having .14 more events on average. Unexpectedly, race and sex were not associated with a higher number of life events. However, racial effects were found in the chronic stress model, with black respondents reporting average stress scores that are .24 standard deviations higher than whites. Similarly, a one point increase on the SES scale was associated with a .06 standard deviation decrease in stress scores. Childhood stress was not associated with having higher chronic stress levels in the present. Stressful life events after childhood, recent or otherwise, were associated with a .09 standard deviation increase in stress scores per event. Higher physical activity was also associated with a decrease in chronic stress levels.

\textsuperscript{31} The life events model omits marital status and employment status because changes in employment and marital status are classified as life effects. Including these variables would be the equivalent to correlating a measure of divorce with a count of divorce, guaranteeing a perfect correlation that would lead to biased estimates.
The psychosocial coping resources, mastery and social support, were both significantly associated with race, with black respondents reporting higher social support and mastery levels, opposite of the SAEM’s expectations. Also inconsistent with the SAEM is the finding that female respondents had social support scores that were .22 standard deviations higher on average. Stressful events in one’s childhood were associated with lower social support later in life. Another result that contradicts the SAEM’s expectations was that, recent life events were associated with a small increase in social support. Higher SES was associated with increased mastery, as was expected, but was not associated with any change in social support. As hypothesized, chronic stress had the strongest effect in both the mastery and support models, with a one standard deviation increase in stress scores corresponding to almost a half standard deviation decrease in support and mastery.

Table 20  OLS and Multinomial Logit Models Predicting Health Behaviors

<table>
<thead>
<tr>
<th>Outcome</th>
<th>Physical Activity</th>
<th>Drinking Behavior (ref: no drinks)</th>
<th>Smoking (ref: non-smoker)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Response Category</td>
<td></td>
<td>1-59 drinks a week</td>
<td>60+ drinks a week</td>
</tr>
<tr>
<td>Female</td>
<td>-0.17** 0.66*</td>
<td>0.08*** 0.25***</td>
<td>0.37***</td>
</tr>
<tr>
<td>Black</td>
<td>-0.23*** 0.92</td>
<td>1.46*** 1.30*</td>
<td>1.00 0.62*</td>
</tr>
<tr>
<td>SES</td>
<td>0.10*** 1.46***</td>
<td>1.30* 1.00</td>
<td>0.83* 0.59</td>
</tr>
<tr>
<td>Childhood Stressors</td>
<td>-0.01 0.90</td>
<td>0.86 0.95</td>
<td>0.85 0.59</td>
</tr>
<tr>
<td>Life Events Up to Wave 2</td>
<td>1.10* 1.24**</td>
<td>0.95 0.97</td>
<td>0.97 0.97</td>
</tr>
<tr>
<td>Total Chronic Stress</td>
<td>0.98 0.67*</td>
<td>0.88 1.19</td>
<td>1.19 1.19</td>
</tr>
<tr>
<td>R-squared</td>
<td>.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All models control for age, marital status, employment status, urbanicity, region, BMI, insurance status, parental status, retirement community membership.
*p<.05, **p<.01, ***p<.001
Looking at health behaviors specified in the SAEM, it was found that physical activity levels were associated with all sociodemographics. Males, whites, and high SES individuals had higher activity levels in this analysis. The strongest effect was for SES, with the model predicting that the highest SES individuals would have activity scores that are .5 standard deviations higher than the lowest SES group. Drinking and smoking behavior were both strongly gendered, with women being more likely to abstain. Increases in SES corresponded with a higher likelihood of drinking moderately or heavily, which was the opposite of what the SAEM hypothesized. Both moderate and heavy drinking in the past month were also associated with having a higher number of stressful life events. Conversely, chronic stress was correlated with a decreased risk of heavy drinking. Smoking was also associated with being black and low SES, albeit inconsistently. Blacks were significantly more likely to have stopped smoking than whites, and high SES individuals were less likely to be current smokers.

In sum, a number of predictors were associated with heightened exposure to both psychosocial and behavioral risk factors. The directions of relationships were often in the expected directions, but there were some exceptions such as black respondent’s higher levels of support and mastery; life events increasing support; and high stress being linked to less drinking. Though these results problematize the suggestion that everyone is equally able to “choose” to age successfully, the associations uncovered here may not be strong enough to indirectly influence a person’s probability of successful aging. It must be demonstrated empirically that, for instance, black’s higher master scores indirectly increased their probability of successfully aging. In other words, this section’s models allowed us to say that SES predicts the mediator, but we cannot say if SES changes one’s
odds of successfully aging *through* the mediating variable, which is what the SAEM implied. The next step of the analysis tied together all the models that were estimated thus far to formally test for mediating effects.

### 6.6 Analysis 3: Testing the Significance of Mediating Effects

The SAEM presents hypotheses that race, gender, SES, and childhood stressors would have significant indirect effects on successful aging through more proximate behavioral and psychosocial mechanisms. This mediating relationship was tested directly in this section. These paths are depicted in figure 17. The models in the prior two sections contain the information needed for testing each mediation, which can be written as $X \rightarrow M \rightarrow Y$ where $X$ was an independent variable that operated partially or fully through a mediator $M$ to influence a final outcome $Y$. The coefficients for $X \rightarrow M$ were all presented in section 2 of the manuscript. The values for $M \rightarrow Y$ were mostly obtained from the analyses predicting successful aging (analysis 1), though some of these paths were estimated in section 2’s models (e.g. $SES \rightarrow stress \rightarrow mastery$).
In basic terms, the mediation tests examined if the product of a given pair of $X \rightarrow M$ and $M \rightarrow Y$ coefficients (e.g. the indirect effect) was large enough to be statistically significant. If significant, this supported the idea that $X$ is operating on $Y$ in part due to its influence on the mediating variable. More specifically, two approaches were used to test for mediation, depending on if categorical variables were present. First, Iacobucci’s (2012) $Z$ statistic was calculated in circumstances with a categorical mediator or outcome (i.e. all paths drawn to successful aging, drinking, and smoking). Iacobucci’s test entailed standardizing the OLS and multinomial logit model coefficients and standard errors to calculate a test statistic.$^{32}$ Unfortunately it was difficult to determine a specific

$^{32}$ This test statistic produces similar results to other “product of terms” approaches for testing the mediation significance of mediation tests, such as Sobel mediation tests (MacKinnon, Lockwood, and Williams 2004). In circumstances where all mediators and outcomes were continuous, both Iacobucci’s and Sobel’s $Z$ tests were calculated. The $Z$ scores calculated were very similar in magnitude and they always yielded identical conclusions about the significance of a pathway.
effect size from this calculation and no precise estimation method has been developed to
determine how strong a mediation is when categorical variables are involved. The second
approach, referred to as a bootstrapped mediation test, was used when all variables are
continuous (e.g. SES → stress → mastery). In this case, 5000 estimates of the indirect effect
were created using bootstrap resampling, as described by Hayes (2009). The distribution
of these 5000 point estimates was then used to construct 95% confidence intervals for the
magnitude of the indirect effect 33. If the confidence intervals did not cross 0 then the
indirect effect was statistically significant. The strength of the indirect effect can be
interpreted in terms of changes in the dependent variable.

The results of all mediation tests are summarized in the path diagrams presented
in figures 18, 19, and 20. These diagrams bring together information from the earlier
regression models and the mediation tests to create a coherent picture of the indirect
pathways through which successful aging is influenced. Direct pathways between
exogenous 34 and/or endogenous predictors and successful aging are not shown if no
mediating effect was identified. The path diagrams only present significant mediations. It
should be noted that one association that is implied by the figure 19 does not exist-
women have significantly higher social support, but this only mediated their probability

33 In addition to the bootstrapping method, Sobel, Aroian, Goodman (as described in Hayes 2013), and
Iacobucci test statistics were calculated (2012). These did not conflict with the bootstrapped results except
in one situation where the indirect effect was very small and the bootstrapped confidence interval was more
conservative. Only the bootstrapped results are presented here to limit redundancy and because the
bootstrapped approach is preferable overall. In particular, it does not impose distributional assumptions
onto the indirect effects and it performs more consistently regardless of sample size (Hayes 2013; Hayes

34 Exogenous variables are those that are assumed to be independent of all other predictors in the model
(e.g. race, SES, various controls). Endogenous variables are variables wherein the assumed causes are
specified within the theoretical model. Somewhat confusingly, both exogenous and endogenous variables
can be treated as X in the mediation model X → M → Y. A simple heuristic for differentiating between the
two: If it’s at the end of an arrow in the theoretical model on page 2, it is endogenous. Otherwise, it is exogenous.
of successfully aging, not sub-optimally. This somewhat misleading conclusion needed to
be implied because chronic stress has mediating effects on both aging groups via social
support. No diagram was created for childhood stress, as the only possible indirect effect
found was a very small effect through one’s number of life events on chronic stress
levels.

Coefficients marked with † are Relative Risk Ratios. All other coefficients are standardized regression coefficients and
can be used to calculate indirect effects by hand. Only significant mediating pathways a coefficients are shown unless
noted.

Figure 18  Summary of Significant Mediating Relationships for the Effect of Being
Black on Aging Outcomes
Coefficients marked with † are Relative Risk Ratios. All other coefficients are standardized regression coefficients and can be used to calculate indirect effects by hand. Only significant mediating pathways a coefficients are shown unless noted.

**Figure 19**  Summary of Significant Mediating Relationships for the Effect of Being Female on Aging Outcomes

Coefficients marked with † are Relative Risk Ratios. Variables marked with a * are unstandardized count variables. All other coefficients are standardized regression coefficients and can be used to calculate indirect effects by hand. Only significant mediating pathways a coefficients are shown unless noted.

**Figure 20**  Summary of Significant Mediating Relationships for the Effect of SES on Aging Outcomes

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Many of the precise results for the mediation tests are presented in the tables 21 and 22. Table 21 presents Iaccobucci’s Z statistic for scenarios with continuous variables as mediators for the effect of race, gender, SES, and childhood stress on successful aging. Table 22 results tested the SAEM’s hypothesized interrelationships between the psychosocial, sociodemographic, life course, and health behavior measures, such as examining if SES had an indirect effect on mastery by increasing stress levels. To illustrate how these tables are read, each cell specifies a different combination of variables in the template: exogenous or endogenous independent variable (X) → mediator (M) → outcome (Y). For example, the Z statistic in the top left cell of table 21 (Z=−1.85) corresponds to a test of the mediating relationship between SES → chronic stress → suboptimal aging. Similarly, the values in the top left of table 22 reflect the indirect effect for the path SES → life events → chronic stress. In this case, as SES increased one unit we would expect a .02 standard deviation decrease in stress scores due to the fact that higher SES individuals also had fewer life events. The indirect effect of -.02 is in addition to the direct effect of SES on chronic stress shown in table 19 (B=−.06) (Hayes 2013). Because the upper and lower limits of the 95% confidence interval never cross 0 it is safe to conclude that the mediating effect was statistically significant.

The SAEM hypothesized that sociodemographics and childhood stress would affect successful aging indirectly through health behaviors and psychosocial variables. Table 21 describes tests of these hypotheses. It was found that the effects of SES were partially mediated through their positive influence on mastery and physical activity. In other words, it appears that high SES individuals were more likely to age successfully in part because they had higher mastery and are more active. The only mediating
relationship detected for female and black respondents was for physical activity, with both groups being less likely to exercise and therefore less likely to successfully age and at greater risk of sub-optimally aging. Childhood stress had no significant mediators, meaning it did not have direct or indirect effects on successful aging.
Table 21  Test Statistics For Mediating Relationships Between Study Variables and Successful Aging

<table>
<thead>
<tr>
<th>Mediator (M)</th>
<th>Chronic Stress</th>
<th>Life Events</th>
<th>Mastery</th>
<th>Support</th>
<th>Physical Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Sub-optimal</td>
<td>Successful</td>
<td>Sub-optimal</td>
<td>Successful</td>
<td>Sub-optimal</td>
</tr>
<tr>
<td>Outcome (Y)</td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
</tr>
<tr>
<td>SES</td>
<td>-1.85</td>
<td>1.86</td>
<td>-1.82</td>
<td>1.50</td>
<td>-3.13**</td>
</tr>
<tr>
<td>Female</td>
<td>-0.18</td>
<td>0.18</td>
<td>-1.13</td>
<td>1.01</td>
<td>0.09</td>
</tr>
<tr>
<td>Black</td>
<td>1.90</td>
<td>-1.92</td>
<td>0.73</td>
<td>-0.68</td>
<td>-1.88</td>
</tr>
<tr>
<td>Childhood</td>
<td>0.49</td>
<td>-0.49</td>
<td>1.50</td>
<td>-1.29</td>
<td>-1.16</td>
</tr>
<tr>
<td>Stress Activity</td>
<td>-1.59</td>
<td>1.60</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Chronic Stress</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>4.79***</td>
</tr>
<tr>
<td>Life Events</td>
<td>2.24*</td>
<td>-2.26*</td>
<td>-</td>
<td>-</td>
<td>-1.95</td>
</tr>
</tbody>
</table>

*p<.05; **p<.01; ***p<.001
Table 22  Indirect Effects and Bootstrapped Confidence Intervals for All Mediations With Continuous Mediators and Outcomes

<table>
<thead>
<tr>
<th>Mediator (M)</th>
<th>Life Events</th>
<th>Chronically Stress</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>SES</td>
<td>Chronic Stress</td>
<td>Mastery</td>
<td>Support</td>
</tr>
<tr>
<td><em>Female</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>-.02*</td>
<td>-.00</td>
<td>-.00*</td>
</tr>
<tr>
<td></td>
<td>LL=-.03 UL=-.01</td>
<td>LL=-.01 UL=.00</td>
<td>LL=-.01 UL=-.00</td>
</tr>
<tr>
<td><em>Female</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>.00</td>
<td>-.00</td>
<td>-.00</td>
</tr>
<tr>
<td></td>
<td>LL=.05 UL=0.00</td>
<td>LL=.02 UL=0.00</td>
<td>LL=.02 UL=0.00</td>
</tr>
<tr>
<td><em>Female</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>-.00</td>
<td>-.00</td>
<td>-.00</td>
</tr>
<tr>
<td></td>
<td>LL=.00 UL=0.00</td>
<td>LL=.01 UL=0.01</td>
<td>LL=.01 UL=0.01</td>
</tr>
<tr>
<td><em>Female</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>0.01*</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>LL=0.00 UL=0.02</td>
<td>LL=.00 UL=0.00</td>
<td>LL=.00 UL=0.00</td>
</tr>
<tr>
<td><em>Female</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>0.03*</td>
<td>0.02*</td>
<td>0.03*</td>
</tr>
<tr>
<td></td>
<td>LL=.00 UL=.06</td>
<td>LL=.00 UL=0.06</td>
<td>LL=.00 UL=.06</td>
</tr>
<tr>
<td><em>Female</em></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>0.05*</td>
<td>0.04*</td>
<td>0.05*</td>
</tr>
<tr>
<td></td>
<td>LL=.00 UL=.03</td>
<td>LL=.00 UL=0.03</td>
<td>LL=.00 UL=.03</td>
</tr>
</tbody>
</table>

 LL=Lower Limit of bias corrected bootstrapped 95% confidence interval; UL=Upper Limit of bias corrected bootstrapped 95% confidence interval
The SAEM also hypothesized that a number of endogenous variables (stress, life events, activity) would have indirect effects on successful aging through mediators. For instance, it was expected that stress would affect successful aging through its influence on mastery. This hypothesis was tested and supported in table 21, as chronic stress had a highly significant effect ($p<.001$) on successful aging via its influence on support and mastery. In other words, highly stressed individuals also had low mastery and social support, which decreased their likelihood of successfully aging and increases their risk of sub-optimal aging. Physical activity had no additional effects on successful aging through chronic stress levels. However, having a large number of life events did have an indirect effect on successful aging via its influence on chronic stress, suggesting that a large number of life events resulted in higher stress levels, which in turn lowered odds of successfully aging.

It was also hypothesized that there would be a number of mediating relationships between sociodemographics, childhood stress, physical activity, and psychosocial factors (e.g. SES $\rightarrow$ Stress $\rightarrow$ Mastery). Table 22 describes the bootstrapped mediation tests that were conducted to evaluate these hypotheses. These mediation tests found that SES has an indirect effect on both chronic stress and support through its effect on life events, though the indirect effect on support was very small (less than .00). It was also found that childhood stress operated through more recent life events such that each additional childhood stressor was associated with a .01 standard deviation increase in chronic stress scores owing to increases in life events. Race and gender also had small but significant indirect effects on chronic stress through their influence on activity. Specifically, female
and black respondents were expected to have slightly higher chronic stress levels (.01 and .02 SDs respectively) due to their lower activity levels.

The strongest and most consistent mediator in many of these bootstrapped analyses was chronic stress, as was hypothesized in the SAEM. For instance, black respondents were expected to have support and mastery scores that were .11 standard deviations lower due to their higher stress scores. A similar picture was painted for SES, though the effect size was even stronger given the higher range of the SES variable.

Stress also mediated the effects of both activity and life events on chronic stress in the hypothesized directions. These stress mediations lend themselves to a broader conclusion. As already discussed, the mediating relationship where chronic stress→mastery/support→successful aging was statistically significant. This earlier finding can be combined with the finding that many variables had effects on mastery/support through stress to argue the viability of the two-mediator hypotheses implied in the SAEM (e.g. X→chronic stress→support/mastery→successful aging). For example, it can be concluded that the path: SES→chronic stress→mastery→successful aging was supported given that both its corresponding “chunks” were significant.

Two additional tables of mediation tests are presented in Appendix C. One of these tables contains tests of the SAEM’s hypotheses that social statuses and childhood stress would have an indirect effect on drinking or smoking behavior via changes in stress or life events. The second omitted table contains tests of the hypotheses which suggest that several independent variables have indirect effects on successful aging via smoking and drinking. Both of these tables were omitted because almost all results were non-significant. The only exception is that it was found that the path for female→current
smoker → successful aging was statistically significant ($Z=2.37$, $p<.05$). In other words, women were less likely to smoke, which increased their likelihood to age successfully indirectly. In general, however, the analyses conducted strongly suggested that smoking and drinking were not avenues through which stress, life events, race, SES, and childhood experiences influenced successful aging.

To summarize, these mediation tests found evidence that sex, race, and SES operate indirectly through a number of mediators on successful aging, in addition to the direct effects that were observed in the initial model predicting successful aging. The most consistent of these mediators was physical activity, which indirectly increased the probability of men, white respondents, and high SES individuals successfully aging and avoiding sub-optimal aging. In addition, high chronic stress was a strong mediator for the effects of SES and race, and this effect was further mediated through social support and mastery to influence aging outcomes. Many of the hypothesized relationships were not found, as well. In particular, childhood stress did not have any significant indirect effects on successful aging. Drinking and smoking behavior were not mediators for the effect of stress and life events, contrary to expectations. Life events also did not act as mediators for the effect of race, sex, and SES on successful aging. The results of the analysis therefore lent support to the SAEM in some areas while casting doubt on some of its key assertions.

6.7 Discussion

6.7.1 Implications for the Study of Successful Aging

In sum, these analyses tested hypotheses that were proposed through the SAEM, a theoretical model which drew largely from the stress process literature (Aneshensel 2015;
Pearlin et al. 1981; Turner 2010; Wheaton 2010) to describe how social positioning, childhood conditions, and individual behavioral and psychosocial risk factors interact to ultimately influence successful aging. The first analysis in this chapter presented the predictors of successful aging when we assume that they are independent of one another. The results of this analysis aligned with an established body of research that has linked successful aging to not smoking (Brandt, Deindl, and Hank 2012; Feng, Son, and Zeng 2015; Pruchno, Wilson-Genderson, and Cartwright 2010) and physical activity (Brandt, Deindl, and Hank 2012; Britton et al. 2008; Depp and Jeste 2006). It was also confirmed that stress and its affiliated coping resources are strongly associated with successful aging, as has been shown in past research (Garfein and Herzog 1995; Grundy and Bowling 1999; Kahana, Kelley-Moore, and Kahana 2012; Moore et al. 2013; Moore et al. 2015). Also consistent with the literature was the finding that SES was a strong predictor of successful or suboptimal aging, while being black was not (Depp and Jeste 2006; Ng et al. 2009; Pruchno et al. 2010; Seeman et al. 2004). The gender associations observed in this study suggested that women were less likely to sub-optimally age than men, which is also consistent with arguments that have suggested that women’s increased longevity and larger social networks may increase their odds of being identified as successfully aging (Depp and Jeste 2006; Feng, Son, and Zeng 2015; McLaughlin et al. 2009; Ng et al. 2009; Pruchno et al. 2010; Tang 2014). Taken together, the net effect of the health behaviors and psychosocial risks was much larger than the combined social and life course variables, which suggested that proximate risk factors are more important to producing successful aging and should therefore be the target for interventions.
However, the second and third sets of analyses demonstrated that this conclusion is not as clear cut as the initial results suggested. Through these analyses it was shown that not only were some health behaviors and psychosocial risk factors unequally distributed based on race, sex, and SES, but the disparity in risk exposure was strong enough to suggest that these more immediate risk factors were ‘men in the middle’ through which social statuses operated on successful aging. This puts a very different interpretation to the initial results- for instance, in analysis 1 there appeared to be no race differences in successful aging. However, in analyses 2 and 3 it was revealed that the being black influenced successful aging indirectly through higher exposure to chronic stress and decreased activity scores. In other words, the results suggest that social statuses operate on successful aging through certain behavioral and psychosocial factors by altering exposure to a variety of different risks.

The case of sex differences in aging outcomes highlights how the interrelationships between risk factors and sociodemographics can enrich our understanding of successful aging. I designed the SAEM with the hypothesis that more men would successfully age in light of prior findings that had suggested this would be the case (Bowling 2007; Brandt, Deindl, and Hank 2012; Hank 2010; Jones and Nagin 2013; Wickrama et al. 2013). This led to the expectation that women would be exposed to more of the risk factors that make people less likely to age successfully. However, instead of women always being in an unfavorable position, as I hypothesized, a complex picture emerged where both men and women are at risk of not successfully aging under different circumstances. Specifically, it was found that men’s higher likelihood of smoking may partly explain their reduced odds of successfully aging, similar to findings that have
suggested that gendered smoking behavior increases men’s risk of mortality (Courtenay 2011; Ho and Fenelon 2015). However, it was also found that men were more likely to exercise, which was expected to help to increase their odds of successfully aging and also possibly lowering their stress levels. The nuance uncovered by these findings is that narrowing gender gaps in successful aging may require two distinct policy goals: reducing smoking specifically among men and increasing physical activity specifically among women.

Taken more broadly, the finding that race, gender, and/or SES influenced successful aging indirectly suggested that narratives surrounding the causes of successful aging have overstated the role of individual agency (Bülow and Söderqvist 2014; Calasanti 2015; Holstein and Minkler 2003; Katz and Calasanti 2015; Minkler 1990; Riley 1998; Stowe and Cooney 2015). Rowe and Kahn stated, “In short, successful aging is dependent upon individual choices and behaviors. It can be attained through individual choice and effort (1998: 37).” This individual focus is featured in numerous other successful aging studies, which have tended to emphasize health behaviors (rather than more meso-level social conditions) (Depp and Jeste 2006; Kahana, Kelley-Moore, and Kahana 2012; Katz and Calasanti 2015; Stowe and Cooney 2015). The results of this study raise questions about the extent to which individuals are able to “choose” to age successfully. Physical activity was distributed unequally by race, SES, and gender, suggesting differences in opportunity, socialization, and/or money. Exposure to stress and access to coping resources were also unequally distributed across racial and socioeconomic groups. These appear to imply that some individuals (e.g. wealthy, white) may have a much easier time “choosing” to successfully age compared to others (e.g.,
poor, black). While individual choices were clearly important to attaining successful aging, this study showed that the social context that surrounds individuals’ choices should also be addressed. Otherwise, we risk implying the ageist idea that the sub-optimally aged are solely in that position by their own decisions and are therefore less deserving of assistance.

The results of this dissertation demonstrated that there is substantial room for expanded theorizing on the determinants of successful aging that challenge the unequal distribution of opportunities, resources, and risk along lines of race, gender, and especially class. Katz and Calasanti (2015) argued that Rowe and Kahn’s 1997 model omits “the social forces that affect success … Both access to the means to success, however defined, and the very definition of success itself are matters of social inequality (31).” Rowe and Kahn (2015) have recently acknowledged this limitation, suggesting the importance of social change, race, class, and gender in producing successful aging, but they stopped short at explicitly challenging the existence of these inequalities. Instead they argue that we need to focus on reengineering core social institutions such as schools, hospitals, and workplaces to accommodate a graying population. Though certainly a laudable goal, this seems too limited in light of the findings of this chapter, which suggested that opportunities to age successfully were products of social stratification. Though newly reformed hospitals and neighborhoods may better serve our aging individuals with new technologies and design philosophies, access will likely be contingent on a person’s access to monetary, cultural, and social capital that allow them to utilize them. Therefore, a more radical framework that more fully stipulates the social changes that need to be made to alleviate disparities in successful aging is required.
The SAEM I have presented took steps towards this goal by advancing a framework that explicitly placed social inequality at the root of disparities in successful aging. This built on research that has demonstrated that low SES and being an ethnic minority are often associated with not successfully aging (Brandt, Deindl, and Hank 2012; Britton et al. 2008; Hank 2010; McLaughlin et al. 2009). The SAEM extended the point made by these prior studies by further acknowledging that individual choices which influence successful aging are also contingent on social positioning. The SAEM presented the argument that social stratification along lines of race, class, and sex (in a less straightforward manner), lie at the root of disparities in successful aging. Therefore, equalizing aging outcomes would require more than reforming social institutions in terms of hospitals and schools: the existence and subsequent effects of social hierarchies need to be targeted.

The test of the SAEM also provided empirical evidence for the indirect effects of social inequality on successful aging, though not all paths were supported. Therefore, the SAEM needs to be revised to bring it closer to the empirical results of this chapter. In light of the complexity of the associations uncovered, the single SAEM diagram is abandoned in favor of three models specific to race, sex, and SES. Figure 21 presents these updated versions of the SAEM, which summarize both the direct and indirect pathways through which SES, race, and sex were found to influence successful aging group membership. These revised versions of the SAEM should be used as a launching point for future empirical work that is focused on analyzing the determinants of successful aging in a way that specifically views social conditions as root causes of health disparities.
Figure 21  Updated Successful Aging Explanatory Models
This call for a greater focus on the social determinants of positive health, including successful aging echoes prominent theories in medical sociology and social epidemiology (House 2002; Link and Phelan 1995; Susser and Susser 1996). For example, Link and Phelan (1995) asserted that social conditions, in particular SES, are “fundamental causes” of health disparities that operated through a number of mediators to generate unequal health inequalities. They argued that targeting the mediators themselves would be ineffective and inefficient methods for eliminating health disparities, as new mediators would emerge to fill their place. In the context of the current study, a fundamental causes approach would suggest that interventions targeting stress, mastery, or physical activity directly are unlikely to close disparities in the incidence of successful aging because each was only one of many avenues through which status-based differences influence successful aging. Instead, the most effective and efficient way to narrow gaps in successful aging may be through societal-level reforms that address the effects of social inequality more directly. Doing so would simultaneously effect a wide array of mediators, instead of just one or two.

6.7.2 Policy Implications

Consistent with the theory of fundamental causes (Phelan, Link, and Tehranifar 2010), I argue that policies aimed towards promoting successful aging must address racial, socioeconomic, and gendered disparities more directly. One method of targeting both racial and socioeconomic disparities would be through community level interventions via collaboration between local public health departments and community members (Fairbanks and Wiese 1998). By working directly with members of the community, public health departments are better able to gauge the specific problems and
needs of the members of the community. The public health agency is able to then support
the residents in achieving those changes by providing resources, guidance, and advocacy.
The goal of this type of intervention is to empower communities to address their
problems and remove specific barriers, rather than to apply a “top down” approach where
solutions are unilaterally applied without consideration to the barriers facing a particular
community (Fairbanks and Wiese 1998). By identifying problems of access and
availability, and working with community members to tailor solutions, racial and
socioeconomic gradients may be targeted in a more direct manner (Fairbanks and Wiese
1998; Frieden 2009).

The Division of Community Health’s Communities Putting Prevention to Work
(CPPW) program, which distributed grants to 50 communities nationwide, was reflective
of such an initiative (Center for Disease Control 2013). A primary objective of the CPPW
initiative was to increase access to opportunities for exercise, quitting smoking, and for
healthy eating, rather than simply spreading information on these issues. In some regions
this meant negotiating with schools to provide residents access to their track for exercise,
while in other areas it meant paving walking trails or creating bike share stations. By
tailoring interventions to the needs of a specific community they were able to attain a
larger impact. Specifically, evaluations of CPPW interventions (see Center for Disease
Control 2013) estimates that 45.2 million Americans were given increased opportunities
for physical activity via free access to recreational facilities, churches, businesses,
schools, and community settings. In addition, an estimated 40.9 million Americans were
given access to healthy food or beverages via the development of farmers markets and
modification of food and beverage options in the workplace and schools. Simulation
studies suggest that the improvements implemented by CPPW would be associated with 14,000 fewer all-cause deaths between 2010 and 2020, resulting in $2.4 billion reduction in healthcare costs (Center for Disease Control 2013). This demonstrates the long-term cost effectiveness of programs such as CPPW, as the cost reduction was much higher than the initial $403 million investment. Though not specifically geared towards promoting successful aging, the results of this chapter suggested that these improvements, in particular the improvements in opportunities for physical activity, may spill over to also promote a greater degree of successful aging in the future as well.

Although perhaps more challenging politically, broader policy solutions are also an option for increasing the incidence of successful aging. The results of this analysis suggested that policies which mitigate the effects of poverty may be helpful for promoting successful aging because they operate directly on the results of income inequality. This assertion is consistent with findings that have suggested that the presence of a strong social safety net reduced health disparities by lowering the number of people in a state of absolute and/or relative poverty (Olafsdottir 2007). In the United States, the maintenance and/or expansion of two programs, social security and supplementary security income (SSI), may therefore be useful in promoting successful aging due to socioeconomic benefits. In the case of SSI, protection from poverty comes in the form of a stipend that can be given regardless of past economic involvement. In light of my results, this basic, albeit small, income would help to minimize the gap in successful aging by preventing low SES individuals from falling into a state of absolute poverty. The idea that SSI benefits can have health implications specifically for the poor has been demonstrated empirically in research that found that the receipt of SSI benefits was
associated with a lower incidence of physical limitations among low income adults (Herd, House, and Schoeni 2008). Given that physical health was a component of successful aging, these benefits are likely to also improve the incidence of successful aging, or at least reduce the incidence of sub-optimal aging.

Another program that may help to improve the incidence of successful aging is social security. The American Public Health Association (2013) argued that social security is directly linked to health outcomes because it prevents many of the poorest older adults from falling into a state of material deprivation (e.g. lack of shelter, food, basic hygiene). Specifically, they noted that without social security an estimated 45% of older adults would live below the poverty line, as opposed to the 10% of older adults currently in poverty (American Public Health Association 2013). Taken in conjunction with the results of this analysis, this would suggest that social security might already have a positive incidence of successful aging. Further expansion of social security benefits may have a positive effect on the incidence of successful aging via the reduction of poverty among the elderly, as it has been estimated that a $1,000 increase in social security benefits has been historically associated with a 2 to 3% reduction in elderly poverty (Engenhardt and Gruber 2006). Therefore, the results of the current analysis suggest that the future reduction or increase of social security benefits would be associated with a corresponding decrease or increase in the incidence of successful aging.

SES is not purely a matter of income, however, and policies effecting wealth and education disparities would also be crucial if successful aging is to be promoted. Policies that increase social mobility or the earning potential of future generations, such as continued investment in education or the minimization of college debts, are likely to help
increase the incidence of successful aging by narrowing hierarchies and improving individual’s sense of control around their lives (Marmot 2004; Pickett and Wilkinson 2015). Though these policies may not directly impact older adults in the present, they may help to improve future generation’s ability to age successfully. There is also the possibility of spillover benefits for current older adults, such as being able to avoid the stress and financial cost of having to support children that cannot afford to live independently.

Another avenue for directly influencing socioeconomic differences in successful aging would be the implementation of minimum wage laws or, more radically, progressive taxation that lessen the economic burden on lower income individuals (Braveman et al. 2005; Marmot 2004; Wilkinson and Pickett 2006). Increases in the minimum wage have been found to reduce the incidence of disease and mortality through a variety of mechanisms, even after accounting for potential increases in unemployment rates (American Public Health Association 2001; Bhatia and Katz 2001; Cole et al. 2005). Changes in the minimum wage may also help to reduce financial stress, which has been linked to socioeconomic inequality in both this study and other analyses (Kahn and Pearlin 2006; Turner and Lloyd 1999). On a broader level, this would narrow the scale of economic inequality in the United States, which has been found to be associated with decreased incidence of many diseases (Pickett and Wilkinson 2015; Wilkinson and Pickett 2006). Having additional income may also obviate the need for working multiple jobs or longer hours, allowing for more opportunities to exercise, volunteer, and/or participate in organized activities. In general, then, changes in the minimum wage may be
a strong option for directly affecting many of the pathways which were found to influence successful aging either directly or indirectly.

**6.7.3 Connections with the Stress Literature**

The results of this analysis also speak to the stress literature in a number of ways. Findings from this study were relatively consistent with previous research on stress, SES, and race that has demonstrated the presence and health impact of differences in exposure to stressors along both of these social statuses (Geronimus et al. 2005; Pearlin et al. 1981; Shippee, Wilkinson, and Ferraro 2012; Thoits 2010; Turner 2010; Turner and Avison 2003). This study’s results reproduced those findings, adding to an increasingly large body of research that suggests that racial and class inequality operate on health disparities through mechanisms other than access to food, shelter, and healthcare. In particular, differential exposure to chronic stress, life events, and having the mastery to cope with these stressors appeared to play a key role. As Marmot (2004) noted, the strong influence of these psychosocial mechanisms on health (i.e., successful aging), suggested that improvements in health behaviors will not be sufficient for eliminating gradients in health outcomes. Instead, certain sources of stress, such as relative deprivation, racial discrimination, exposure to violence, and lack of opportunity for social mobility, employment, and engagement needed to be treated as public health problems in their own right. For instance, racialized residential segregation would have to be addressed as a public health issue because it increases financial stress by reducing opportunities for wealth accumulation while also increasing risk of stressful life events such as being arrested or exposed to a violent crime (Williams and Collins 2001).
The lack of a relationship between gender and stress was unexpected. Other researchers have argued that women are prone to higher levels of stress due to occupying a higher number of social roles and having different expectations associated with those roles (Longest and Thoits 2012; McDonough and Walters 2001; Thoits 2010; Turner, Wheaton, and Lloyd 1995; Turner and Lloyd 1999). On one hand, this may be due to the study’s focus on older adults, who occupied a different set of roles and were exposed to different stressors than younger adults (Moen 2001). Some of the potential sources of gendered stress exposure, such as unequal parenting stress, appear to decrease as the child (and parents) grow older (Anderson 2008; Milkie et al. 2002; Umberson 1992). This explanation is not sufficient on its own, however, as analyses of the ACL suggested that another form of gendered stress, marital stress, increases with age (Umberson and Williams 2005).

Given the existence of known gendered stressors in the ACL, the chronic stress measure should have found significant gender differences in successful aging. It is possible that the null effect that was found was specifically due to aggregating several distinct stressors, as the ACL study from which the chronic stress measure was derived also found no gender differences (Umberson et al. 2005). Similarly, Turner and Avison’s (2003) results showed that some chronic stressors had a significant positive effect for men (e.g. witnessing violence) while others have a positive effect for women (e.g. deaths of friends and relatives), but when they are aggregated into an overall measure for chronic stress the stressors cancel each other, concealing the correlations between gender and stress. In this study’s case, the most likely culprit is job related stress, since men have been found to report higher levels of stress from the workplace relative to women.
This would cancel the potential gendered effect from marital stress, creating the appearance that gender did not have an indirect effect on successful aging. This renders it difficult to accept the result that chronic stress did not act as a mediator for the effects of gender on successful aging. It is more likely that certain chronic stressors are more common in one gender (McDonough and Walters 2001; Turner and Avison 2003; Williams 2002), and using disaggregated stress measures would reveal that stress mediates the effect of gender on successful aging for both men and women in specific circumstances. Future studies looking at stress as a mediator for the effect of gender on successful aging should therefore avoid an aggregated chronic stress measure, sacrificing the idea of stress accumulation for greater specificity. Until then the current results surrounding gender and stress should be viewed with a great deal of caution.

It was expected that blacks would have lower mastery and support in light of their higher chronic stress exposure, which tends to slowly break down both of these coping resources (Geronimus et al. 2005; Keyes 2009; Thoits 2010; Turner and Avison 2003). On the contrary, this study joins other research that has found that blacks have higher mastery and support than whites (Keyes 2009; Morin and Midlarsky 2016; Pearlin et al. 2007). The current results pointed to the possibility that black respondents may have substantially higher potential for resilience to stress than white respondents. Resilience describes “overcom[ing] adversity to achieve developmental outcomes (Masten and Coatsworth, 1998: 205),” where in this case, blacks are more prone to adversity in the form of perceived racism and institutionalized barriers to advancement (Geronimus et al.

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Examining this further, in wave 1 of my sample, women had average job stress scores that were .19 standard deviations lower on average than women (p=.06). On the other hand, in wave 1 women had marital stress scores that were .24 standard deviations higher (p<.05). Therefore, the idea that these two significant gendered effects have been canceled out by the aggregation of the scale is highly plausible.
2005; Utsey et al. 2007). Despite this adversity, it has been shown that blacks have high resiliency that can be attributed at least partly to greater family adaptability and cohesion, higher use of spiritual coping resources, and collective coping (e.g. depending on friends and family to avoid and respond to risk) (Utsey et al. 2007). These cultural differences provide an explanation for both the heightened social support and mastery that was uncovered in the current data.

However, high mastery and support is not in and of itself sufficient to constitute resilience, which requires the achievement of a favorable developmental outcomes. In this case, that outcome was successful aging, and it was found that those increases in mastery and support were not sufficient to indirectly increase black respondent’s odds of successfully aging. Furthermore, black respondents in this dataset had higher stress levels that were then associated with having lower mastery scores, negating some of the improvements that black respondents had. Therefore, while there is some evidence that the resources for heightened resilience are present, they are not sufficient to overcome what is an overall negative effect of race on successful aging.

One counter to this argument is that stress, mastery, and support would have had a less dramatic negative association when we look specifically at blacks instead of aggregating them alongside whites (Morin and Midlarsky 2016). This would have left room for the positive effects of mastery and support on successful aging to emerge. This seems unlikely, however, as a prior study of the ACL data demonstrated that the correlation between stress, mastery, and support is largely unchanged when only blacks are examined (Lincoln 2007). This would suggest that the stress→mastery→successful aging mediation that was uncovered is likely to hold specifically among blacks, negating
the benefits of their heightened mastery. In light of this, these results supported an established literature that suggests that, overall, blacks tend to be at a disadvantage with regards to health and, it appears, successful aging (Geronimus et al. 2005; LaVeist 2005; Williams and Sternthal 2010).

Another idea from the stress process literature that was incorporated into the SAEM was the concept of stress proliferation (Aneshensel 2015; Pearlin et al. 2005; Pearlin 2009; Wheaton 2010). Pearlin and colleagues (2005) described stress proliferation as a phenomenon where stressful life events result in the creation of additional stressors in both the immediate present and the future. Evidence supporting this theory was found in estimates that a person’s total life events, which included life events from both midlife and recent years, were strongly associated with chronic stress. The effect of life events on successful aging were mediated through their effect on chronic stress, suggesting that while life events appear to have had only a small direct effect on aging group membership, they also had an effect through increased exposure to chronic stress as well. Consistent with the boarder stress process framework, this proliferation was also strongly linked back to socioeconomic inequality in my results.

In light of the theories of stress proliferation and cumulative inequality (Ferraro and Shippee 2008; Ferraro, Schafer, and Wilkinson 2016; Schafer and Ferraro 2011), the SAEM also hypothesized that childhood stressful experiences would influence successful aging outcomes. Past studies examining successful aging have found that childhood living conditions had a significant and harmful effect on a person’s odds of aging successfully in the future (Brandt, Deindl, and Hank 2012; Schafer and Ferraro 2011; Wickrama et al. 2013). Contrary to expectations, childhood stress did not have any
significant direct or indirect effects on successful aging in my study. The most likely explanation for these null effects is that successful aging in this study was operationalized as a broader construct than prior studies, accounting for physical health, mental health, life satisfaction, cognitive functioning, and social engagement simultaneously. In contrast to this multidimensional measure, Schafer and Ferraro (2011) looked at only successful aging along lines of physical health, and Wickrama and Colleagues’ (2013) successful aging measure only looks at physical and mental health. It seems likely that when a more comprehensive measure of successful aging was used the effect of childhood conditions was diminished. In other words, while an array of research has demonstrated the harmful effect of childhood stress in the realm of physical and mental health, this effect does not appear to translate to affect overall successful aging (Berkman 2009; Ferraro and Shippee 2008; Ferraro, Schafer, and Wilkinson 2016; Schafer and Ferraro 2011). The null association found in this study suggested that childhood stress may not be as useful for explaining successful aging as initially hoped. On the other hand, these results presented a less fatalistic picture of the causes of successful aging than the idea that one’s odds of successful aging are partly determined by childhood (Schafer and Ferraro 2011; Wickrama et al. 2013), suggesting the possibility that individuals can overcome difficult childhood experiences to successfully age in the future.

Another area of disagreement between the current study and previous stress research was that this study did not find that smoking and drinking mediated the effects of stress on successful aging. The idea underlying this set of hypotheses was that drinking and smoking reflected unhealthy coping mechanisms to stress (Grieger et al. 2003; Kendzor et al. 2010; Lloyd and Taylor 2006; Lloyd and Turner 2008; Mulia et al. 2008;
Mulia and Zemore 2012; Peirce et al. 1994). It was unexpectedly found that high stress was associated with a decrease in alcohol consumption, contrary to prior research (Casement et al. 2015; Lloyd and Turner 2008; Mulia et al. 2008; Mulia and Zemore 2012; Peirce et al. 1994). This same pattern was observed by Umberson and Colleagues (2008), who presented results from another analysis of the ACL that demonstrates that stress at young ages is associated with increases in drinking, but by age 55, stress is associated with decreases in alcohol consumption, much like the current findings. Because my analysis looks at only individuals who are 50+, only the inverse relationship between stress and drinking was found.

Applying a life course perspective, Umberson and colleagues (2008) theorized that the age-specific change in the direction of the relationship between stress and alcohol use was due to changes in social roles and biological processes that occur with age. They argued that as the individual age, drinking becomes a less desirable way to spend one’s time recreationally and to deal with stress, as peer networks stop using drinking for recreation and the probability of adverse side effects increases with age. This possibility is further evidenced by population trends that indicate that adults tend towards abstinence with age (Shaw et al. 2010). In lieu of drinking, it has been argued that older adults transition towards dependence on entrenched social networks to cope with stress, relying on friends and family to cope with chronic stress (Umberson, Liu, and Reczek 2008; Umberson, Crosnoe, and Reczek 2010). The correlation between life events and drinking was consistent with this explanation since the life events measured mostly represented major changes in one’s support network (e.g. relocating, death of family members and friends, divorce). The elimination of these social networks may have increased risk of
social isolation, which has been associated with increases in problematic (e.g. non-social) heavy drinking later in life (Shaw et al. 2010). Therefore, these results, while unexpected, make sense within the context of a life course theory of stress and alcohol use. However, it should be emphasized that modifying alcohol use among the old does not appear to be a good method for promoting successful aging, given both the null results of the current study and other study’s results that demonstrate that alcohol use tends to decrease with age on its own (Shaw et al. 2010).

The aforementioned link between stress and smoking was not found in the current data. The apparent lack of a connection between the two may be due to complexities in how stress relates to smoking initiation, continued addiction, recovery, and relapse. The current study examined continued use, while many prior studies linking stress to smoking examined risk of onset (Lloyd and Taylor 2006), difficulty quitting (Kendzor et al. 2010), and number of cigarettes smoked (Ayyagari and Sindelar 2010). The current results supported Kessel and colleagues’ (2003) observation that while stress coincides with smoking initiation it may not be associated with habitual day to day smoking. It is likely that the hypothesized mediating effect would have been observed with a more nuanced smoking measure that assessed the rate of cigarette consumption, like in Ayyagari and Sindelar’s study (2010), rather than a yes/no binary. In the end, however, not smoking was a significant predictor of successful aging (though not sub-optimal aging), and results optimistically suggest that former smokers were just as likely to age successfully. Efforts to prevent smoking initiation and aid cessation may therefore be useful in promoting successful aging, especially among men, who were found to be more likely to smoke than women and were therefore less likely to successfully age.
The SAEM tested one final modification to the basic stress process model by accounting for physical activity, which was consistently found to predict successful aging directly and to mediate the effects of SES, race, and sex on stress and successful aging. This is consistent with research that has established a protective link between physical activity with stress levels (Edenfield and Blumenthal 2011; Scully et al. 1998; Umberson, Liu, and Reczek 2008). Taken cautiously, my results suggested that it is possible that subsequent stress process models would benefit from the consideration of exercise as a buffer that reduces stress levels, joining several authors who have made similar arguments (Rutters et al. 2014; Umberson, Liu, and Reczek 2008). While modern stress process models carefully incorporate many macro and micro-factors such as neighborhood conditions, social capital, and self-worth, the link between stress and exercise is generally absent (Aneshensel 2015; Wheaton 2010; see Umberson, Liu, and Reczek 2008 for an exception). Considering this relationship between stress and health behaviors such as exercise may be a fruitful area for future development. Future studies should examine the specific forms of exercise that are engaged in and their intensity to see if only certain forms of exercise are effective for reducing the effects of stress in the context of the stress process framework.

6.7.4 An Important Limitation

Ideally, mediation tests should have temporal ordering between measures (Hayes 2013). The current analysis did not have temporal ordering across some relationships in the SAEM, meaning it was impossible to determine if, for instance, high stress preceded low mastery or if the reverse is true. It also means that the possibility of reciprocal causality could not be tested. However, the causal ordering implied in the current study is
consistent with both the empirical literature that does establish temporal ordering (House, Lantz, and Herd 2005) and the general stress process literature (Aneshensel 2015; Kahn and Pearlin 2006; Pearlin et al. 1981; Turner 2010; Turner and Avison 2003; Wheaton 2010).

Causal ordering is clearer in two cases. First, sociodemographics and childhood stress variables are ascribed or attained far before the data were collected, meaning it is safe to say that these preceded their respective outcomes. Second, the successful aging measure incorporated information from a span of as long as 24 years, not just the first and second waves like the other predictors. Therefore, at least some of the variation in the successful aging measure follows the behavioral and stress measures. This supports the use of the current implied causal ordering rather than the inverse.

A future analysis should examine models oriented towards establishing causal effects, perhaps using the SAC and multiple waves of the ACL data. Instrumental variable modeling (Bollen 2012) is one potential option for establishing these causal effects, and some of the mediators identified in the current analysis may be useful as instrumental variables. Such an analysis would help to differentiate between correlates of successful aging (arguably what is observed here) and true “causes” of successful aging.

6.8 Conclusion

The purpose of this chapter was to take the operationalization of successful aging that was developed in the prior two chapters and to apply it to a substantive problem in the successful aging literature. Specifically, this chapter presented an investigation of if social and life course explanations of successful aging could be integrated with the more common behavioral and psychosocial explanations. This was done using the SAEM, a
modified stress process model that describes how social determinants operate through proximate factors to influence successful aging. This model was modified to account for childhood stress in light of prior research that suggested that childhood experiences are associated with future health and stress (Ferraro and Shippee 2008; Ferraro, Schafer, and Wilkinson 2016; Pearlin et al. 2005; Pearlin 2009). A second change was added to account for prior findings surrounding the link between health behaviors, successful aging, and stress, treating harmful health behaviors as negative coping resources that can be linked back to stress (Rutters et al. 2014; Umberson, Liu, and Reczek 2008).

The initial analyses reproduced a common finding in the successful aging literature: social determinants appeared to be much less influential on successful aging than behavioral and psychosocial variables. However, I then problematized this conclusion by conducting several subsequent analyses that demonstrated that not only were race, SES, and sex strongly associated with those behavioral and psychosocial factors, but their effect was mediated through them in certain circumstances. For example, physical activity mediated the effects of sex, race, and SES on successful aging, and chronic stress mediated the effects for race and SES. In other words, even when sociodemographics were not strongly associated with successful aging directly, they modified individuals’ exposure to risk and protective factors, modifying their chances of successfully aging indirectly. Many hypothesized mediations were not found, including almost all hypothesized paths for childhood stress, smoking, and drinking.

This analysis attempts to address Rowe and Kahn’s (2015) call for a more in-depth examination of social and life course determinants of health. Moreover, the findings presented in this chapter suggest that future discussions of and research on
successful aging carefully consider the social context surrounding more proximate sources of successful aging. The SAEM provides a starting point for future studies to theorize these interrelationships. Adopting a model that accounts for these determinants, such as the SAEM, is important for four reasons: important for three reasons. First, it yields a more satisfying explanation of the determinants of successful aging by describing why social conditions may influence successful aging besides just noting a correlation between SES and successful aging. This is lacking in models which ignore the relationship between individual choice and social positioning (Rowe and Kahn 1987; Rowe and Kahn 1997). Second, a better appreciation of social context’s role in producing successful aging may help to eliminate the oft criticized implication that individuals are able to freely choose to successfully age (Calasanti 2015). Ignoring these social determinants results in the implication that individuals are wholly responsible for if they do not age successfully, risking blaming the victim of a problem that is partly a function of their social positioning. Third, the SAEM provides a more radical theoretical framework of the determinants of successful aging by placing social inequality at the root of the problem. This challenges the unequal distribution of scarce resources and power in our society, suggesting that broad social change (as opposed to individual behavior change) may be required to alleviate disparities in successful aging. In a similar vein, use of the SAEM (or a similar model) shifts the discussion of improving aging outcomes interventions towards social policies. Until the social determinants of successful aging are addressed it is likely that many efforts to promote successful aging will be less effective than they could be.
Chapter 7

CONCLUSION

7.1 Summary

When Rowe and Kahn proposed the idea of successful aging in 1987, they challenged researchers to examine the possibility that old age could be a time of flourishing and resilience. By noting that some older adults aged exceptionally well along lines of physical health, cognitive functioning, and social engagement, they challenged narratives that viewed old age as a time of inevitable loss of both health and independence. This sparked a new wave of research into what made successful agers unique, but in the process several critiques have emerged, identifying problems with the very notion of aging successfully and raising the possibility that the concept should be abandoned entirely (Bülow and Söderqvist 2014; Calasanti 2015). In light of these criticisms, there have been calls for continued developments around what it means to successfully age, why some people do/don’t attain that goal, and the creation of new methods for identifying successful agers empirically (Cosco et al. 2014; Rowe and Kahn 2015). This dissertation was, in part, a response to those calls, synthesizing conceptual, methodological, and predictive approaches while also driving the discussion forward in those areas. This project attempted to provide a more empirically grounded and holistic approach to measuring and explaining the determinants of successful aging than was previously available. In the section that follows I summarize key points from each of the
previous chapters, and then discuss the significance of this dissertation’s results for the successful aging literature, including recommendations for future research. This is followed by an explanation of the project’s limitations and concluding remarks.

The first two chapters distilled research from the successful aging literature, highlighting several areas for development. First, scholars criticized Rowe and Kahn’s model of successful aging both for omitting important facets of successful aging (e.g. mental health, self-appraisal of how well you’ve aged) and being biased against older adults by holding them to the same standards as young individuals (Cho, Martin, and Poon 2012; Martinson and Berridge 2014; Minkler 1990; Pruchno, Wilson-Genderson, and Cartwright 2010). Second, most classification approaches depended on binary “successful vs unsuccessful” thinking about aging outcomes (Cosco et al. 2014). This, ignored the theoretical distinction between “usual” aging (i.e. middle of the road aging without disease but with some losses or risk) and sickness (e.g. disabled, diseased) (Rowe and Kahn 1987), instead lumping the very sick and the near-successful into the same “unsuccessful” category. It has also been argued that these binary measures are biased against older adults because they hold them to unreasonable standards of physical health, ignoring normal changes that occur with age in favor of using a universal cut-off for success (Cho, Martin, and Poon 2012; Cosco, Stephan, and Brayne 2014). Third, critics have argued that explanations for why individuals successfully age are often individualistic, overstating a person’s control and/or responsibility in producing successfully aging (Calasanti 2015; Minkler 1990). For example, health behaviors such as smoking and exercise have been emphasized in the successful aging literature, whilst the social circumstances that encourage those same behaviors have been relatively
downplayed (Katz and Calasanti 2015; Riley 1998). Similarly, the life course perspective has been relatively underutilized in successful aging research, which has neglected the importance of childhood and midlife experiences in producing successful aging (Rowe and Kahn 2015; Stowe and Cooney 2015). In short, emphasizing the individual has obscured, or even negated, systemic and structural inequality as well as the life experiences that make it easier for some groups to “choose” to successfully age (Calasanti 2015; Holstein and Minkler 2003; Katz and Calasanti 2015; Martinson and Berridge 2014; Minkler 1990; Schmeekle and Bengston 1999; Stowe and Cooney 2015).

This dissertation addressed the conceptual, methodological, and explanatory critiques that were described in the prior paragraph. Regarding conceptual limitations, I proposed a conceptual model that defined successful aging as aging well relative to one’s peers along lines of physical health, mental functioning and outlook, and social engagement. This conceptualization differed from Rowe and Kahn’s model because it emphasizes the importance of mental health and life satisfaction. It also focused on the possibility that the requirements for identification as successfully aged may need to vary as individuals grow older. A final distinction is that this dissertation incorporated a life course perspective, asserting that successful aging is not just being healthier than your peers at one point in time, but rather a consistent pattern as the person ages.

To operationalize this model and address the aforementioned binary measurement concerns, I presented a measurement strategy that borrowed strengths from two earlier approaches to measuring successful aging. This is described in chapter 2 and executed in chapter 3. First, I created a successful aging continuum (SAC) (see table 2, page 57) so the full distribution of aging outcomes could be observed. Then, that continuum was split
into several distinct groups using group-based trajectory modeling, a technique which identifies the aging trends which individuals tend to cluster around. This technique allowed for the operationalization of successful aging as a longitudinal trajectory while also making it so membership into the successful aging group was uncorrelated with age. As a result, it was less biased against older adults because it allowed for normal age related declines to occur without immediately eliminating a person from the successfully aged group, unlike binary approaches that depend on a hard cut off for all ages. Two research goals came from this two stage classification process: 1) To establish the validity of the successful aging continuum by assessing its convergence with past measures and predictive validity? 2) To determine the number of aging groups that best fit the data, the shape of their trends over time, and that membership in each group was uncorrelated with age.

In chapter 2 I also addressed criticisms regarding the general understanding of why individuals age successfully, I proposed a modified stress process model that specified the complex relationships between social, life course, psychosocial, and behavioral correlates of successful aging (presented in figure 6, page 46). This model (the successful aging explanatory model (SAEM)) accounted for the importance of individual health behaviors and psychosocial risk factors in producing successful aging, while also suggesting that these proximate risk factors were mediators for the effect of race, SES, sex, and childhood stress. In doing so, it placed a stronger emphasis on the social and life course determinants which have been argued to be at the root of successful aging.

Chapter 3 described how these research goals would be achieved. The analyses were conducted using as many as five waves of data from the Americans’ Changing
Lives study, which was collected from 1986 to 2010. I focused specifically on a sample of 1526 respondents 50 or older who had completed both waves 1 and 2, since certain questions were only asked in wave 2. Part of this chapter described the operationalization of the conceptual model from chapter 2, while the rest was dedicated to describing measures and laying out a plan for testing the SAEM. Testing the SAEM entailed estimating a series of multinomial logistic regression models and OLS models to identify both the predictors of successful aging and the correlates of different health behaviors and psychosocial risk factors. Specifically, this study looked at smoking, drinking, and physical activity levels for health behaviors. In addition to this, measures of chronic stress, stressful life events, mastery, and social support were used to operationalize psychosocial stressors and coping resources. After these models were estimated, a series of mediation tests were conducted with their results to test for significant indirect effects.

Chapter 4 addressed the first research goal of establishing the predictive and convergent validity of the successful aging continuum (SAC). This entailed ensuring that the SAC predicted present and future outcomes that it should be associated with (e.g. being happy, not using the hospital), and examining if this measure was correlated with other operationalizations of successful aging (i.e. they converge on the same underlying construct). Support was found for the SAC’s predictive validity in the form of strong correlations between SAC scores and respondents being happier, having fewer hospital visits, and appearing to be healthier and less depressed to the interviewer in both the past and present. The exception to this was that, though significantly associated, the SAC had a relatively weak relationship with future depressive episodes and minor sickness.

Evidence in support of convergent validity of the SAC came in the form of its strong
correlation with two other continuum measures from the successful aging literature. However, the SAC was found to be only moderately associated with a binary measure of successful aging from prior research (Brandt, Deindl, and Hank 2012; Hank 2010; McLaughlin et al. 2009), raising concerns about the SAC’s convergent validity. It was argued that the binary measure lacks validity, rather than the SAC, as the binary measure was found to not capture social engagement adequately and was primarily influenced by the presence or absence of physical health instead of overall successful aging. The results of this chapter’s analyses generally suggested that the concept of successful aging is being adequately captured by the SAC measure, given the evidence of both criterion and convergent validity that was found.

Chapter 5 tracked how SAC scores changed as individuals aged, using group-based trajectory modeling to identify the aging trends that individuals tended to cluster around most often. It was found that the best fitting model had three aging trajectory
groups, reproduced in figure 22. 32.6% of respondents were classified as aged successfully, 48.3% as usually aged, and 19.1% as sub-optimally aged. Each group had a gradual decline in SAC scores as age increased, though this decline was sharpest in the sub-optimal group, demonstrating that some degree of decline is unavoidable among even the successfully aged. The downward trend with age was found to be a product of the onset of physical conditions through the aging process, rather than changes in the mental functioning and outlook or social engagement dimensions of successful aging. Further analyses of bivariate and time varying associations revealed that birth cohort was unassociated with the shape a trajectory took over time (i.e. all age groups follow a similar trend regardless of when they are born), and that group membership was uncorrelated with age (i.e. the young-old and old-old were not disproportionately represented in any of the three groups). That the classification into a particular aging trajectory group was not associated with age, indicating that the young-old or old-old were not overrepresented in any trajectory group. It was hypothesized that there would be roughly three aging trajectories based on Rowe and Kahn’s framework (1987), with each demonstrating a downward trend due to seemingly unavoidable losses in physical health that occur with age (Cho, Martin, and Poon 2012; Cosco, Stephan, and Brayne 2014; Young, Frick, and Phelan 2009). The results of this chapter supported this hypothesis, given that three trajectories were found and each demonstrated a downward trend that was specifically attributed to decreases in physical health (as shown in figure 13, page 128).

Chapter 6 presented a test of the proposed SAEM, which summarized my hypotheses surrounding the ways through which social statuses, childhood stress,
psychosocial risk factors, and health behaviors interrelate to influence group membership. It was found that socioeconomic status, stress levels, mastery scores, and physical activity were strong predictors of membership in both the usual and successful aging groups. Smoking, sex, life events, and social support were also correlated with group membership, albeit less consistently. In addition to this, it was found that many of the same variables that predicted successful aging were also mediators for the effects of sex, race, and SES suggesting that these sociodemographics exerted a strong indirect effect on successful aging through their influence on several more proximate mediators. Physical activity was the most consistent mediator, with significant indirect effects for SES, being female, and being black indicating that, for instance, being black decreased one’s level of exercise and thereby increased risk of not successfully aging. In addition, the effects of SES and race were mediated through chronic stress, mastery, and social support which meant that psychosocial risk factors are strong mechanisms through which social conditions indirectly influence a person’s changes of successfully aging. The specifics of the SAEC were not supported in many cases, but its general assertion that sociodemographics has strong indirect effects on successful aging through more proximate risk factors was supported implying that future research should avoid theorizing these risk factors out of their social contexts. Some findings did not support some of the hypotheses that I put forward in the SAEM. In particular, childhood stress was not associated with successful aging in any way, and smoking and drinking did not mediate the effects of stress, SES, and race on successful aging. Therefore, these smoking and drinking behaviors do not appear to be harmful coping mechanisms for stress that are unequally distributed throughout society, as was hypothesized.
7.2 Key Implications

The methodological and empirical insights developed in this dissertation have a number of implications for the successful aging literature. To begin with, the results of this dissertation add to discussions about how we should or should not define successful aging. As others have noted, it is not possible to converge on a single universal conceptualization of successful aging because the idea of “success” requires a normative judgement about what aging outcomes are desirable or important (Aldwin and Gilmer 2013; Cosco et al. 2013; Havighurst 1961; Phelan et al. 2004). This dissertation cannot resolve this issue, yet this specific study does lend insight to certain aspects of the debate on the conceptualization of successful aging that may assist with future research in this area.

First, this study shows that definitions of successful aging should be sensitive to within age-group variability. It was found that all aging groups, including the successfully aged, saw some decline over time. The downward trend was mostly due to loss of physical functioning and/or the acquisition of chronic illnesses, as shown in chapter 5. The presence of what appears to be unavoidable losses in physical functioning substantiates a concern that others have raised: Using a universal set of criteria for successful aging (i.e. absence of disease and disability, cognitive functioning, and social engagement) that ignores normal age related changes may result in pathologizing that aging (Cho, Martin, and Poon 2012; Cosco, Stephan, and Brayne 2014; Young, Frick, and Phelan 2009). Conceptualizations of successful aging should therefore emphasize aging well relative to one’s age group, as Rowe and Kahn (1987) originally argued, as opposed to old age mirroring young age. Though unintentional, many discussions of
Rowe and Kahn’s model have depended on the latter instead of the former, either conceptually or operationally (Calasanti 2015; Goodwin 1991; Katz and Calasanti 2015; Martinson and Berridge 2014; Minkler 1990). In line with Rowe and Kahn’s (1987; 1998) original thinking, the conceptual model in this study allows for successful aging to be relative to one’s age group. While this study also offers useful expansions to Rowe and Kahn’s original model by incorporating other dimensions and considering the life course more explicitly, my results suggest that future studies would benefit from pursuing a more relative approach to understanding successful aging even if they used Rowe and Kahn’s (1997) original three dimensional model.

Secondly, findings from this study suggest that conceptual models of successful aging would be improved by acknowledging a wide array of aging outcomes (e.g. they should be explicitly non-binary). Kahn (2002) noted that his and Rowe’s original conceptualization of successful aging had unintentionally encouraged binary thinking about aging outcomes in the form of a success vs failure dichotomy, even though the purpose of their original manuscript was to criticize binary thinking (i.e., comparing the sick versus the “normal”). In the current study, it was found that a binary trajectory model was insufficient for describing aging trajectories. In fact, no other latent trajectory analysis studying successful aging has found a simple binary model to be sufficient for describing aging trends (Hsu and Jones 2012; Tang 2014; Wickrama et al. 2013). The presence of multiple distinct aging groups demonstrates the need for future theories of successful aging to return to Rowe and Kahn’s (1987) emphasis on heterogeneity by simultaneously considering the theoretical and/or empirical differences between individuals with excellent, average, and poor aging outcomes.
Scholars have suggested ways to move past the binary conceptualizations. Bowling (2007) and Cosco and Colleagues (2013) argue for a continuum of successful aging rather than a comparison of distinct groups. A second approach, as used in the current study, is to theorize the presence of multiple meaningful and empirically distinct aging groups. Rowe and Kahn (1987) suggested this when they acknowledged the distinction between successful, usual, and (less explicitly) the diseased. This conceptualization is especially useful for when one would like to assess predictors that result in overall changes in aging outcomes. The current study draws lines between aging groups using statistical techniques, while Rowe and Kahn differentiate between them in terms of the presence of risk factors and/or disease, disability, and social disengagement. Conceptualizations that draw lines between distinct groups are best suited to research goals assessing how successful agers differ from individuals with average or very poor aging outcomes. Each of these non-binary conceptualizations promises a more nuanced understanding of successful aging than is currently afforded by models that only focus on only the elite group of successful agers.

Moving past binary thinking when *defining* successful aging is important, but it is also advised that future *measures* of successful aging be non-binary in light of a number of limitations in binary measures that were highlighted in the validation study. While conceptualizations such as Rowe and Kahn’s (1987) account for multiple aging groups, it is generally operationalized as an all-or-nothing successful vs unsuccessful binary because identifying multiple aging groups has required arbitrary decisions on the lines between successful, usual, and sub-optimal aging (Cosco et al. 2014). A binary all-or-nothing approach was at least consistent in defining success as meeting all of a list of
criteria, a multi-group model would need to decide what sets of criteria and what cut-offs to use in identifying people in each aging group. Despite having the advantage of simplicity, prior discussions have argued that the binary measurement approach is not sufficient for capturing the heterogeneity at the core of both Rowe and Kahn’s model and continuum conceptualizations (Cosco et al. 2014; Cosco, Stephan, and Brayne 2015). The results of the validation study further demonstrate that the binary measure oversimplify very diverse group, since the “unsuccessful” category contained individuals with extremely high and extremely low SAC scores. This ambiguous unsuccessful category ignores the distinction between usual and sub-optimal aging, making it harder to tell who is furthest or closest to successfully aging. In addition, my findings supported arguments that binary measures are biased against the old-old, holding them to an unreasonable standard (Cho, Martin, and Poon 2012; Cosco, Stephan, and Brayne 2014). A conventional binary measure would use a single cut-off to differentiate between successful and non-successful aging. Using a universal cut-off would ignore the downward aging trend that was found in SAC scores, classifying the older individuals who were still aging very well compared to their peers as having aged unsuccessfully. In essence, this holds the old-old and the young-old to the same standards of success. Doing so appears to result in the underestimation of the incidence of successful aging, as the binary measure determined that 13.8% aged successfully, as compared to the estimate of 32.6% after accounting for normal age related declines. This underestimation of the incidence of successful aging raises concerns about the validity of analyses that go on to identify how the successfully aged differ from others, as those analyses may only predict successful aging among the young.
Another, less discussed, problem with the binary measurement of successful aging was also uncovered in this analysis. Specifically, it was found that binary measures of successful aging that attempt to capture multiple dimensions at once (e.g. using perfect health, high engagement, and cognitive functioning as a standard for success) may not be capturing variation in all those dimensions adequately. In my study, I required three components to be classified as successfully aged—physical health, cognitive functioning, and high social engagement on physical health (Brandt, Deindl, and Hank 2012; Hank 2010; McLaughlin et al. 2009). Missing one or more meant you would be classified as unsuccessful. However, it was found that very few people “failed” to meet the standards because of poor cognitive functioning and low social engagement. As a result, very few people were classified as “unsuccessful” based on these standards. On the other hand, lots of people didn’t meet the criteria for physical health, meaning that there were many “unsuccessful” people who were excluded based on this criteria. The implication is that my binary measure was primarily distinguishing between people with good and bad physical health—the other dimensions were, in essence, just for show because they did very little to produce variation in the final measure. Why does this matter? It suggested that binary measures which purport to capture multiple dimensions often do not, as certain dimensions (especially physical health, it seems) produce most of the variation between successful/unsuccessful. As a result, when we try to predict the differences between successful and usual aging, we ultimately are just predicting the difference between people with excellent physical health relative to everyone else, as opposed to the overall successful aging that the measure was intended to capture. Taken as a whole,
these limitations suggests that binary measures are not ideal for capturing overall successful aging, and future research should instead consider alternatives.

This dissertation offers alternatives to these limited binary measures. The first alternative developed in this study is the SAC, which was constructed based on guidelines proposed by Cosco and colleagues (2015). Substantial evidence was found in this study to suggest that the SAC had predictive and convergent validity, while also capturing a larger spectrum of variability than the binary measure could. I argue that the SAC is preferable over prior successful aging continua, as the SAC captures a greater array of variability in aging outcomes than Young’s (2009) scale while also weighting each dimension of successful aging evenly, unlike Kahng’s model (2008). Another appealing trait of the SAC is that high scores on the scale can be attained by individuals who are struggling on one dimension as long as they have high scores on the others. This more permissive standard addresses concerns raised by some scholars that models of successful aging tend to make it impossible for the chronically ill to age successfully, because they treat the presence of even minor age-related chronic illness as immediate grounds for no longer successfully aging (e.g. Martinson and Berridge 2014; Minkler 1990; Young, Frick, and Phelan 2009). The SAC sidesteps this issue by letting respondents compensate by maximizing outcomes in realms other than physical health.

The SAC would be useful for future scholars that are interested in operationalizing models of successful aging that conceptualize success as one end of a continuum ranging from completely successful to completely unsuccessful, rather than a specifically defined category (e.g. Bowling 2007; Cosco et al. 2013; Cosco, Stephan, and Brayne 2015; Young et al. 2009). The SAC is especially well suited for research
questions that focus on predicting increases and decreases on that continuum, especially if estimates about the incidence of successful aging in the population are not required. The SAC’s wide range of continuous variability lends itself to precise estimates of effects that covariates have on aging outcomes overall, instead of focusing only on determining the differences between individuals who do or do not age successfully. These more general findings would lend themselves to identifying public health and policy interventions that may have the largest impact for the greatest number. While increasing someone’s aging outcome from one end of the continuum to another may be unrealistic, the SAC may suggest areas where more realistic interventions that yield smaller improvements can be made.

However, researchers that implement the SAC should also try to improve on the scale’s limitations. The SAC used in this study only captured depressive symptomology, and the SAC was only weakly associated with future acute depressive episodes. Subsequent research should improve upon this limitation in several ways. For instance, a measure of the incidence of major depression could be included in future versions of the SAC. The presence of other mental health problems such as anxiety disorders, impulse control disorders, and psychotic episodes could also be measured in the SAC to better reflect the conceptual model’s assertion that successful aging reflects having good mental health. Future studies should also assess the effects of excluding informal social engagement in the SAC on its predictive validity, as it was found that the inclusion of

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36 This was not done for the current study because the depressive episode item has very inconsistent measures across all five waves. In wave 1 it refers to a one week period in the past 12 months, in wave 2 it refers to the past 3 years, in wave 3 it refers to the past 5 years. In waves 4 and 5 the time frame of the question shifts to be in reference to a two week long episode in the past year. This inconsistency would have raised concerns about the comparability of SAC scores across waves.
informal engagement hurt the scale’s reliability and its ability to predict the occurrence of minor disease in the future. Other validation methods to establishing the validity of the scale should also be pursued. In particular, the SAC’s validity would be strongly supported by a comparison of samples that are known to meet (and not meet) parts of the successful aging conceptualization in advance. For instance, SAC scores could be calculated for individuals with a formal depression diagnosis or a chronic illness compared to a control group. If valid, the SAC should show much higher scores for the control group. Pursuing these areas for improvement will result in a more comprehensive and interpretable SAC measure that can be used with confidence.

A second method for measuring successful aging was also presented, demonstrating that the SAC can be broken into distinct aging groups using group-based trajectory modeling (GBTM, Nagin 2005). Incorporating this technique with the SAC has several advantages over just using the SAC. First, it allows for a coherent estimation of the incidence of successful aging. Second, GBTM can identify multiple aging trajectory groups simultaneously, meaning that it can accommodate non-binary operationalizations of successful aging. Third, the researcher does not need to make arbitrary assumptions about the number of people who age successfully (e.g. the top 20%) or a given cutoff (e.g. a SAC score of 230). Fourth, the use of GBTM enables the researcher to capture within age group heterogeneity in aging trends. In other words, it allows the standards for success to be relative to one’s age group, rather than holding all adults to the same standard. Both the size of the group and the shape of the aging trends (i.e. the standards for group membership) are determined empirically, with a wide array of rigorous tests being available to determine if the model is an adequate fit to the data. When these
advantages are considered alongside the disadvantages of the binary classification approach that were already discussed, it is clear that the GBTM method is a stronger approach for identifying the distinctions between successful agers and other aging groups. GBTM is especially well suited to research questions where the researcher is curious about how many people age successfully or what can be done to help the individuals in a particular aging group (e.g. the sub-optimally aged) to age better. Future research should implement both the SAC and GBTM measurement approaches, as they yield a more precise and comprehensive measure of who ages successfully, which in turn will lead to more accurate conclusions about why some individuals do or do not age successfully.

An important issue to address in future research is the comparability between the substantive conclusions drawn from the SAC, GBTM, and binary approaches. Cosco and Colleagues (2014) note that a key issue that the successful aging literature will need to overcome is that inconsistency in measures and conceptualizations has made it difficult for researchers to come to a consensus on most topics. Therefore, it is important to determine if, assuming the same conceptualization of successful aging, these different methodologies produce similar substantive conclusions about the individuals who do and do not age successfully. If all these measures yield consistent results, despite the limitations of binary measures outlined previously, it will assure researchers that our conclusions about why people successfully age are not being influenced by our methods. On the other hand, if the different measurement strategies provide inconsistent theoretical conclusions, it will signal a further need for scholars to adopt more robust non-binary methods for measuring successful aging such as those outlined in this dissertation or
other studies (Bowling 2007; Cosco, Stephan, and Brayne 2015; Hsu and Jones 2012; Vaillant and Mukamal 2001; Young et al. 2009).

To summarize, the current study has a number of methodological advantages relative to other studies. First, estimates of successful aging presented here depend on a more comprehensive conceptualization that includes mental health and life satisfaction, avoiding criticisms about the omission of these important elements (Jeste, Depp, and Vahia 2010; Pruchno, Wilson-Genderson, and Cartwright 2010). Second, a classification as successfully aged also reflects aging well relative to your peers, meaning it is not biased against older adults like binary measures can be (Cosco, Stephan, and Brayne 2014). A final advantage for this analysis is that the measure of successful aging also empirically identifies multiple aging groups, catching important detail in aging outcomes without having to assume the specific cut offs or sizes of those groups. Capturing this heterogeneity avoids the binary thinking and measurement that other researchers have criticized (Bowling 2007; Cosco et al. 2014; Cosco, Stephan, and Brayne 2014). By addressing these methodological and conceptual criticisms, the analyses that follow are likely to present a more accurate picture of both the incidence and determinants of successful aging.

The first substantive (i.e. non-methodological) contribution of this study is estimates for the incidence of successful, usual, and sub-optimal aging. It was found that 32.6% of respondents aged successfully, which is consistent with some studies (Brandt, Deindl, and Hank 2012; Depp and Jeste 2006; Hsu and Jones 2012; Ng et al. 2009; Tang 2014) though it diverges with others that report much lower proportions (Hank 2010; McLaughlin et al. 2009; Strawbridge, Wallhagen, and Cohen 2002). The implication of
this finding is that, after accounting for normal age related changes and capturing all dimensions of successful aging adequately, a relatively large minority of the sample were already successfully aged. At the same time, the majority of people (48.3%) who did not age successfully were classified as “usually” aged, with only a small proportion of respondents struggling to age well (e.g. the 19.1% who sub-optimally aged). The large size of the usual aging group suggests that almost half of older adults might have had successful aging within their grasp if the appropriate preventative measures, and opportunities for social engagement were available throughout their lives.

This study also provides insight into the factors that give rise to successful aging, which also points to the improvements that could enable more people to age successfully in the future. Rowe and Kahn’s (1987; 1997; 1998) discussions on this topic have, until recently, focused on biological and psychosocial factors- smoking, drinking, exercise, stress, and social support were all crucial to promoting successful aging. The results of this dissertation suggest that emphasizing only the individual’s choices and immediate psychosocial state might be overly simplistic, as social statuses (e.g. race, sex, SES) were found to shape exposure to several risk factors of successful aging. This is an unsurprising insight given the wide array of theorizing and research in medical sociology (and sociology in general) that has demonstrated the powerful relationship between social status and health (Aneshensel 2009; Cockerham 2007; House, Lantz, and Herd 2005; Phelan, Link, and Tehranifar 2010; Turner, Wheaton, and Lloyd 1995). However, as several commentators have noted, these social conditions are often downplayed or ignored in the successful aging literature (Bülow and Söderqvist 2014; Katz and Calasanti 2015; Minkler 1990; Riley 1998; Rowe and Kahn 2015; Schmeekle and
Bengston 1999; Stowe and Cooney 2015). Therefore, this study’s findings echo the findings of numerous previous studies that empirically spotlight the need for a more serious consideration of the social determinants of successful aging (Brandt, Deindl, and Hank 2012; Britton et al. 2008; Hank 2010).

This study further adds to the discussion on social determinants of successful aging by creating and testing the SAEM to theorize the interrelationships between social conditions and proximate risk factors of successful aging. It was found that race, gender, and SES all had indirect effects on successful aging, operating most commonly through physical activity and chronic stress exposure. Not all paths that I hypothesized were supported, with a large number of null relationships emerging. In particular, childhood stress, smoking, and drinking were not associated with successful aging and stress like was initially hypothesized. In light of these and other results, three revised versions of the SAEM were created (figure 21, page 169) to provide future research with a launching point for examining the relationship between health behaviors, psychosocial risks, and social statuses.

These updated theoretical models present a more critical narrative of the causes of successful aging than what has been presented by Rowe and Kahn (1997; 2015), as they strongly emphasize the social context which surrounds individual health behaviors, stress, mastery, and social support. Focusing on this context and the mediators through which they operate yields a more satisfying narrative for how both sociodemographics and health behaviors operate on successful aging. Though individual choices are critical to successful aging, each explanatory model also suggests that choices are not made in a vacuum, and many of the things that influence successful aging are not chosen at all. The
revised explanatory models account for this, incorporating evidence that these stressful experiences are also conspicuously likely to be experienced by black and low SES respondent. As a result, social inequality, in particular as relates to race and class, is explicitly specified as the root “problem” which drives unequal successful aging outcomes.

Even after the revisions presented in chapter 6, the SAEM still needs further assessment and expansion. Neighborhood conditions were omitted from the SAEM because hypotheses surrounding their effect on successful aging could not be tested with the ACL, although there is substantial evidence that they influence future physical and mental health outcomes and would therefore be linked to successful aging (Aneshensel 2009; Hicken et al. 2014; Williams and Collins 2001). Future research should integrate census data with individual level survey data to test if a person’s community has a direct and/or indirect effect on a person’s probability of successful aging. The SAEM also did not consider dietary choices as a determinant of successful aging due to lack of measures, despite it being found to predict successful aging in other studies (Bowling 2007; Depp and Jeste 2006). A follow up study that examines if SES, race, or sex influence successful aging indirectly through dietary choices would therefore be a useful expansion to the SAEM. The Health and Retirement Study or the Panel Study of Income Dynamics may lend themselves well to such an analysis because they contain measures that were not in the ACL data. Two other ways to expand on this study would be to test for reciprocal effects and empirically establishing temporal ordering. For instance, does stress lead to worse odds of successfully aging, or does not successfully aging lead to stress? Or, is the pattern closer to a loop where stress harms health which begets more stress? These issues
are difficult to disentangle with cross sectional surveys but longitudinal datasets that are better suited to identifying temporal ordering are becoming increasingly common (House, Lantz, and Herd 2005). Testing these proposed extensions of the SAEM will result in a more comprehensive and empirically sound model that can be used to invigorate discussions on the determinants of successful aging.

Another area for future research will be to replicate and expand on this study’s findings relating to childhood stress and successful aging. The null results in this study point to the optimistic possibility that individual’s chances of successful aging are less tied to the past than was previously expected, but these results counter past research (Brandt, Deindl, and Hank 2012; Ferraro and Shippee 2009; Schafer and Ferraro 2011; Wickrama et al. 2013). As well as replicating current results, a subsequent study should explore alternate approaches to measuring childhood stress and disadvantage, as it is possible that abuse as a child or poverty are sufficient to influence health outcomes on their own (Ferraro, Schafer, and Wilkinson 2016). These discrete effects would have been concealed by the count measure used in the current study, which focuses on the accumulation of multiple insults. Until these null results are reproduced we should not discard the role of childhood in promoting successful aging.

Furthermore, even if childhood experiences are found not to be linked to successful aging, future research should utilize a life-course lens to explore the causes of successful aging. The experience of a larger number of life events was associated with sub-optimally aging, suggesting that other studies should continue examining how different experiences over one’s life influence successful aging. What, for instance, are the effects of having a child at a young age, single parenthood and/or incarceration on an
individual’s odds of successfully aging? Exploring topics such as these may increase our understanding of how different life-transitions can ultimately set an individual on a trajectory towards or away from successful aging.

The updated versions of the SAEM imply that the most favorable/fruitful approach for promoting successful aging in a population is to target these “fundamental causes” (i.e., class, race, and gender hierarchies) of successful aging directly through social policy (Link and Phelan 1995). This focus on policy interventions contrasts against Rowe and Kahn’s emphasis on modifying individual choices and behaviors. These policy based solutions are preferable to direct health interventions (e.g. promoting diet and exercise) because there is no requirement for individuals to opt-in to reap the benefits (Phelan, Link, and Tehranifar 2010). Ultimately, eliminating racial and socioeconomic disparities in successful aging may require addressing the root causes of these disparities through many years of political activism on local, state, and federal levels. A major task for future research will be to identify policies that may have a positive or negative influence on successful aging, even if this is not their express purpose.

There are many policy implications that can be derived from the updated SAEM and this study’s results. This dissertation’s analyses suggest that alleviating the effects of socioeconomic inequality has the potential to effect the largest number of people, since it was more strongly correlated with successful aging than sex and race and it operated through a wider array of mediators. Alleviating the effects of socioeconomic inequality via wealth redistribution and the establishment of social safety nets is a promising avenue for promising successful aging, as past research has already demonstrated that such policies can have strong health impacts (Bhatia and Katz 2001; Herd, House, and Schoeni
2008; Marmot 2004; Neumayer and Plümper 2016). One policy suggestion is adjusting the minimum wage. A number of studies have demonstrated that even a one to two dollar increase in the minimum wage can have strong health implications, potentially improving the incidence of successful aging in the future (American Public Health Association 2001; Bhatia and Katz 2001; Cole et al. 2005). Another policy recommendation that would more immediately benefit older adults would be to avoiding decreasing social security benefits and potentially expanding eligibility criteria to minimize the number of older adults in poverty (American Public Health Association 2013). In addition, expanding or at least not reducing Supplemental Security Income (SSI) benefits would have a similar effect, and some evidence has suggested that receiving SSI benefits has positive health benefits especially for the poorest older adults, potentially helping to narrow gradients in successful aging outcomes (Herd, House, and Schoeni 2008). Based on this dissertation’s results, these economic improvements would help to improve the incidence of successful aging directly and indirectly by increasing one’s probability of exercising and mastery levels while also, decreasing stress. Though far from the only option, these policy interventions reflect a handful of options that may help to mitigate disparities in successful aging, or at least prevent them from growing even larger.

7.3 Limitations

This study has a number of limitations. First, there are several conceptual limitations which spill over to influence the operationalization of successful aging. In particular, the current study cannot measure (and does not define successful aging as requiring) the positive gains in self-understanding, self-confidence, and wisdom that can come with old age (Tornstam 1989). The conceptualization of successful aging may
therefore be overly interested in the loss of traits (e.g. being disease free) that affect midlife rather than the positive attributes that come with getting older. This negative focus is offset in the current study to some extent by including mental health, self-rated health, and life-satisfaction, which allows respondents to contribute their own evaluation of their life and health. However, future studies might benefit from using this study’s continuum and/or group-based trajectory modeling approaches to focus on new gains that were made in the face of the losses and declines that this study found. A second successful aging continuum that focused on the positives of aging may contribute an important inverse to the current study, which found that aging often corresponded with losses.

Another conceptual issue of this study is that I assume that successful aging is comprised of three dimensions: physical health, mental functioning and outlook, and social engagement. These three dimensions were chosen based on a conceptually valid model that views successful aging as a function of physical, mental, and social health (Young, Frick, and Phelan 2009; Young et al. 2009). However, future research should explore the possibility of breaking the SAC into five dimensions (physical health, mental health, cognitive functioning, life satisfaction, social engagement) to examine if this produces a more reliable or valid measure.

A second issue is the reliability of the SAC, as it had alpha values in roughly the .5 range. The fourth chapter was dedicated to ensuring that this low reliability did not prevent the SAC from having a degree of validity. Though it did not strongly predict certain outcomes (depression and minor illness in the future), the SAC generally predicted future health and happiness, as it should. Similarly, it was strongly correlated
with other continuum measures of successful aging, suggesting that they are all tapping into a similar construct. Despite its low reliability, the SAC is appears to still be meaningful, which is an important criteria of validity in and of itself (Ebel 1961). In the future, however, efforts should be made to improve the reliability of the scale or to continue to assess its validity, as the scale may be incoherent in some datasets due to poor reliability.

A third set of limitations pertain to the group-based trajectory modeling approach used to identify individuals into different aging trajectories. Because of this approach, I am unable to directly model how changes over time alter a person’s probability of classifying into different aging trajectories. Changes over time are accounted for, to a degree, by averaging some of the measures across two waves. But it is still not possible to track if, for instance, a change in employment status late in life affects the shape of an individual’s aging trajectory. Future analyses using the SAC could overcome this limitation by foregoing the process of classifying individuals into groups and instead using a technique such as growth curve modeling, which is specifically designed to look at time varying measures. Of course, this has the trade-off of assuming everyone clusters around a single general trajectory in a normal distributed, which may not be the case given the results of the group-based trajectory models. It also requires giving up being able to estimate the proportion of the population who age successfully. The current study had the goal of making these estimates, and so this sacrifice was unacceptable.

The trajectory models use information from all respondents, but no single respondent contributes to all of the age groups that were used. This partial data may
produce right truncation\textsuperscript{37} (i.e. missing data for older years) due to attrition and lack of data and left truncation (i.e. missing data for younger years) due to data collection starting after the 50 year mark. The main problem this introduces is how it influences the characteristics of the people who survive or respond to subsequent waves. There is a strong possibility that later age groups reflect a “survivor elite” wherein individuals who age successfully are more prone to live longer and therefore be more likely to participate in the survey (Li and Ferraro 2005; Nosraty et al. 2015). There is little that can be done about this bias, unfortunately. The most likely implication of these results is that the decline captured by the aging trajectory model is understated, since the individuals who aged most poorly passed away before data could be collected from them. Another bias caused by this survivor elite is that some healthy behaviors, such as not smoking, are overrepresented among older adults who have not yet died from their risky behaviors. Since few older smokers were present in the data, it is possible that the correlation between smoking and sub-optimal aging is weaker than it might have been if more old smokers were alive to be classified into an aging trajectory.

\textsuperscript{37} Truncation refers to the process where data is observed for only a small portion of the full observation period as part of the study design (Hoffman 2003). In my case, the observation period is their aging between 50-89 years. I have left hand truncation because some people started the study older than 50 (i.e. there is data missing data to the left of the age timeline). I have right truncation because some people did not turn 89 over the course of the study, and others dropped out died before their information at that age could be collected. This produces data that is missing to the right hand due to survey design.

\textsuperscript{38} One potential solution that was explored in preliminary options was to estimate an extended version of a group based trajectory model called a dropout model. These models account for nonresponse due to random and nonrandom mechanisms (Haviland, Jones, and Nagin 2011). Unfortunately this type of model ended up not being suited for this analysis. As implemented in software, the dropout model requires a single variable marking a person as non-randomly missing or randomly missing. This is too simple - a person could have died in wave 5, but simply not responded in waves 3 and 4. A simple binary dropout marker would not adequately identify individuals in either scenario, unfortunately. Therefore, like Sautter’s (2010) similar analysis of the ACL data, I depend on maximum likelihood estimation to deal with missingness, conceding that nonrandom attrition likely introduces bias.

A fourth set of limitations pertain to the operationalization and test of the SAEM. The baseline variables are not reflective of a person’s status at a given age (e.g. all respondents at 50), instead they are reflective of all respondents at a given time (e.g. all respondents at 1986). Ideally these measures would all be in reference to the same age but this is not possible in the current analysis. For instance, the socioeconomic status measure depends in an assumption that 16 years of education qualifies as “highly” educated. However, a respondent who is 80 years old may have been highly educated relative to their peers with only 12 years of schooling. This is because in 1930 (when the 80 year old was 24) the median level years of school completed for 25-29 year olds was only 10.3 years and college degrees were still uncommon (Snyder 1993). This cohort effect might reduce the effect SES on successful aging, as individuals who had high education in the past, with all the privileges associated, might be grouped into the low SES category instead of the high SES group. Future analyses could rectify this limitation to a degree by analyzing only a single cohort. Doing so was not possible for the current study due to limitations in sample size.

Some measures were either unavailable for testing the SAEM, or were otherwise limited. For example, certain health behaviors such as diet and a precise assessment of exercise were not available. The indicator for alcohol may also be truncated too low to capture problem drinking. Other analyses of the ACL have used a cut off of at 80 or 90 drinks per month to denote heavy drinking, and have found very small but significant socioeconomic gradients in heavy drinking category (Lantz PM, House JS, Lepkowski JM, Williams DR, Mero RP, Chen J. 1998; Lantz et al. 2010). These gradients may be concealed by the current coding scheme, as too few cases exist to truncate at a higher
level of consumption. Also, life satisfaction would ideally be measured with a more robust index, but only a single item is available in the ACL, limiting its precision greatly. Lastly, some stressors and life events were not measured, such as exposure to racial or gender based discrimination, witnessing violence, and being imprisoned. Researchers have argued that less comprehensive measures of life events, such as the one in this study, may understate the effect of life events and their correlation with race, gender, and SES (Turner, Wheaton, and Lloyd 1995). This study likely suffers from this understated effect, and future analyses would benefit from more comprehensive measures when possible.

As noted in chapter 6, the test of the SAEM also does not attempt to empirically establish temporality or causality. In other words, this study cannot tell us which variables in the SAEM should come first- it only tells us they go hand in hand. While it is possible to force temporal ordering in some analyses by using wave one scores for stress and life events to predict wave two mastery, health behaviors, and social support, doing so would require giving up the cumulative element of the stress variables that is critical to the proposed explanatory framework. It would also risk incoherence when predicting successful aging, since the groups for successful aging contain information from waves one through five. Some of the independent and dependent variables may have reciprocating effects over time, but analyses in the ACL have indicated that predictors such as poverty precede health declines but the inverse is not true (House, Lantz, and Herd 2005). Disentangling the problems of causal ordering and reciprocal causality for the variables in this study is important for future analyses and the literature, but it is beyond the scope of the current analysis.
Lastly, the SAEM is also limited in terms of its scope. In this study, exposure to various social conditions is operationalized solely on the individual level in the form of race, class, and gender. This omits a broad literature that identifies the importance of neighborhood and other regional effects on health outcomes as a whole. Unfortunately, the current data does not permit the examination of neighborhood effects. Controlling for the difference between urban, rural, and suburban living may capture some of this variability, but ultimately will not capture the specific context within which the individual spends most of their time. Some studies have begun addressing the issue of cross country differences in successful aging (Brandt, Deindl, and Hank 2012; Hank 2010), but these do not address immediate neighborhood conditions. The conventional stress process model has already been adapted to account for neighborhood effects (Aneshensel 2015), and, as already suggested, future applications of the SAEM would benefit from empirically accounting for neighborhood conditions as an additional “upstream” predictor of success.

7.4 Concluding Statement

Recently, debates regarding “successful aging” have been reignited. In fact, an entire 2015 issue of The Gerontologist was dedicated to showcasing critiques about the conceptualization and prediction of successful aging (e.g. Katz and Calasanti 2015; Martinson and Berridge 2014; Stowe and Cooney 2015). Similarly, contemporary aging scholars have proposed new approaches to measuring successful aging after demonstrating that previous popular measures strained to detect successful aging among the old-old (Cho, Martin, and Poon 2012; Cosco et al. 2014; Cosco et al. 2014; Cosco, Stephan, and Brayne 2015). Responding to these criticisms, Rowe and Kahn (2015)
recently restated their theoretical framework, calling for new ideas, syntheses of old ideas, and expanded perspectives of why people age successfully. These debates reflect uncertainty about fundamental conceptual and methodological issues in the study of successful aging.

In light of this ongoing dialogue in the realm of successful aging, through this dissertation I proposed solutions to what I perceived as critical issues. I developed a more holistic and flexible model of successful aging that emphasizes success in aging as being relative to one’s age group. To operationalize this model, I presented a continuum-based measure of successful aging and a method for identifying multiple aging groups that accounts for normal age related changes. This approach overcomes the binary thinking of past research, which grouped the very sick and the near-successful into the same somewhat vague “unsuccessful” category. By identifying these more nuanced distinctions, I was able to precisely identify the unique risk factors of sub-optimal and usual aging, as well as successful aging. My approach to predicting successful aging is also unique because I utilized an explanatory model that placed individual health behaviors and psychosocial factors into social context, thereby emphasizing that individual choices (a persistent motif in the successful aging literature) are actually shaped by a person’s position in social hierarchies. Results from testing this model suggested that social inequality may be the ultimate determinant of successful aging, rather than the individual health choices. Based on these results, I argued that social policy that targets class, race, and gender disparities may be the best tool for promoting successful aging among future generations. Taken as a whole, the results of this dissertation highlight the need for scholars of successful aging to not only adopt more
holistic measures and definitions of successful aging but also to focus more intently on
the role of social structure on the aging process.
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## Appendix A

**ILLUSTRATION OF AGE STRUCTURED DATA**

<table>
<thead>
<tr>
<th>Age at Birth Year</th>
<th>Age Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>50-52</td>
<td>W1</td>
</tr>
<tr>
<td>53-55</td>
<td>W2</td>
</tr>
<tr>
<td>56-58</td>
<td>W3</td>
</tr>
<tr>
<td>59-61</td>
<td>W4</td>
</tr>
<tr>
<td>62-64</td>
<td>W5</td>
</tr>
<tr>
<td>65-67</td>
<td>W6</td>
</tr>
<tr>
<td>68-70</td>
<td>W7</td>
</tr>
<tr>
<td>71-73</td>
<td>W8</td>
</tr>
<tr>
<td>74-76</td>
<td>W9</td>
</tr>
<tr>
<td>77-79</td>
<td>W10</td>
</tr>
<tr>
<td>80-82</td>
<td>W11</td>
</tr>
<tr>
<td>83-85</td>
<td>W12</td>
</tr>
<tr>
<td>86-88</td>
<td>W13</td>
</tr>
<tr>
<td>89+</td>
<td>W14</td>
</tr>
</tbody>
</table>

*W* = wave at which respondent contributes to age group
Appendix B

SENSITIVITY ANALYSIS FOR SUCCESSFUL AGING CONTINUUM WEIGHTING

One of the challenges of creating the successful aging continuum (SAC) is the decision of how to code (and thereby weight) individual components. In some cases it may be ideal to recode a variable for theoretical or methodological convenience. To list a few examples, rather than use the CESD’s raw values one might use a cut off score of 16, as recommended by Beekman’s and colleagues’ sensitivity tests (1997). In addition, the ACL’s social engagement items could be treated as having either five discrete questions that comprise one dimension (e.g. Thomas 2012) or two distinct dimensions (e.g. Kahng 2008). Lastly, it is possible that the expectations of a “perfect” score on the social dimension are unreasonable, since they require respondents to be spending most of their time at religious meetings, volunteer events, and other meetings. It may be preferable to truncate these items to allow a larger proportion of respondents to age successfully along this dimension. A sensitivity analysis was conducted to assess if alternate coding that address some of these issues yield comparable conclusions.

The sensitivity analysis involved creating different versions of each component of the SAC, which are described in table 23. In total, there were two versions of the physical functioning dimension, six versions of the mental functioning and outlook dimension, and four versions of the social engagement scale. 48 distinct versions of the SAC
could be constructed from these disparate parts. Regression models with all independent variables were estimated using each of these permutations. Standardized coefficients are shown in ladder plots in figures 23 and 24 which will highlight any coding schemes that may be influencing the successful aging measure. The points in these figures reflect a regression coefficients for a particular model, while bars reflect 95% confidence intervals.

The coding of the social engagement items usually have only a small effect on substantive conclusions about each of the predictors. One exception to this is for the childhood stress item, which becomes nonsignificant when the truncated two dimensional item (version 3 in the table) is used. This can be seen towards the bottom of table 23 where confidence intervals drop below 0. These results suggest that this coding scheme should not be used in the current study, as it was only done to keep both scales on the same interval.

Other than this, the two dimensional operationalization (version 4) is preferred for two reasons. Grouping all five items together has much lower reliability scores than first combining discrete scales separately. In addition, ignoring the separate dimensions results in a measure that is biased towards formal engagement, which has an additional item compared to the informal engagement dimension.
Table 23  Summary of Coding Variations

<table>
<thead>
<tr>
<th>Variable</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Number of conditions</strong></td>
<td></td>
</tr>
<tr>
<td>Version 1</td>
<td>Truncated at 99\textsuperscript{th} percentile</td>
</tr>
<tr>
<td>Version 2</td>
<td>Untruncated</td>
</tr>
<tr>
<td><strong>CES-D Scores</strong></td>
<td></td>
</tr>
<tr>
<td>Version 1</td>
<td>Truncated at 99\textsuperscript{th} percentile to reduce effect of excess outliers.</td>
</tr>
<tr>
<td>Version 2</td>
<td>Broken into quintiles to better having a high score on CES-D within this dataset.</td>
</tr>
<tr>
<td>Version 3</td>
<td>Three groups-scores of 0 to 7, 8 to 15, and 16+ based on Beekman and colleagues’ cut off criteria.</td>
</tr>
<tr>
<td><strong>Cognitive Functioning</strong></td>
<td></td>
</tr>
<tr>
<td>Version 1</td>
<td>Truncated at 99\textsuperscript{th} percentile</td>
</tr>
<tr>
<td>Version 2</td>
<td>Untruncated</td>
</tr>
<tr>
<td><strong>Social Engagement</strong></td>
<td></td>
</tr>
<tr>
<td>Version 1</td>
<td>Average of all social engagement items without creating two separate dimensions first</td>
</tr>
<tr>
<td>Version 2</td>
<td>Three formal engagement items are truncated at “once a week,” collapsing the “several times a week” category. Volunteering cut off at 80+ hours instead of 160+ hours. These are treated as a single dimension</td>
</tr>
<tr>
<td>Version 3</td>
<td>Two social engagement scales are used. The formal social engagement items are truncated at 10 to ensure both dimensions are equally weighted.</td>
</tr>
<tr>
<td>Version 4</td>
<td>Two social engagement scales are created and then averaged. The formal engagement scale is not truncated.</td>
</tr>
</tbody>
</table>
The coding of the CES-D produced a number of concerning patterns. The cumulative stress measure has a very distinct repeated diagonal pattern in its results. A similar pattern can be seen in the mastery measure, where a number of models have much larger effect sizes. Finally, the childhood stress item loses statistical significance in several models. All of these patterns are due to changes in the coding of the CES-D. While collapsing the CES-D’s values may increase its ability to capture “real” depression cases (Beekman et al. 1997), it appears that it substantially inflates regression coefficients.

39 The pattern repeats itself several times due to the algorithm used to construct the scale variations. In essence, six versions of the mental domain are first manipulated under one version of the social engagement scale. Then, the social engagement scale is changed and all six mental domains are changed again. This is repeated several times, producing the repetitive diagonal effect.
in this analysis. Therefore, this analysis uses the depression index which has only been truncated at the 99\textsuperscript{th} percentile, which minimizes biases produced by outliers.

In most cases coding for number of conditions and cognitive functioning has little discernable effect on the strength of most regression coefficients. The main exception for this is that the cumulative stress measure has noticeably larger coefficients for the untruncated version of conditions count. This can be seen by how the first half of coefficients for the cumulative stress measure are lower than the second half. Closer inspection reveals that this is due to outliers in the number of reported conditions, which biases the weighting of the measure. If truncating is not used, only one person with 8 conditions would score a “0” on the physical functioning measure across all five waves. Truncating at the 99\% percentile results in using a cut off of 4, resulting in a larger penalty for having any chronic illness. This measure is preferred because it is more conservative and consistent with Rowe and Kahn’s (1997) emphasis on avoiding disease and disability.
Figure 24  Comparison of Regression Coefficients for Mastery, Support, and Activity Across Different Coding Schemes
Appendix C

MEDIATION TESTS FOR DRINKING AND SMOKING

The results or mediation tests for the following implied paths were omitted from chapter 6 for sake of simplicity:

Figure 25  Summary of Paths Tested in Appendix C

The first table presents all mediation tests that treat smoking and drinking behavior as endogenous variables. These can be visualized by covering the successful aging trajectory group part of the path model. The second table treats drinking and smoking as mediators instead of outcomes. Like the tables in chapter 6, the results of the mediation models are pointed out in the format of exogenous or endogenous independent variable
mediator→outcome (i.e. drinking/smoking). For example, the top left corner cell (Z=0.22) of table 23 reflects the path SES→chronic stress→1-59 drinks/week.
Table 24  Mediation Tests Treating Drinking and Smoking as Outcomes

<table>
<thead>
<tr>
<th>Mediator</th>
<th>Chronic Stress</th>
<th></th>
<th>Life Events</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Drinking</td>
<td>Smoking</td>
<td>Drinking</td>
<td>Smoking</td>
</tr>
<tr>
<td></td>
<td>1-59 Drinks</td>
<td>60+ Drinks</td>
<td>Former Smoker</td>
<td>Current Smoker</td>
</tr>
<tr>
<td></td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
<td>Z</td>
</tr>
<tr>
<td>SES</td>
<td>0.22</td>
<td>1.65</td>
<td>1.26</td>
<td>-0.76</td>
</tr>
<tr>
<td>Female</td>
<td>0.05</td>
<td>0.21</td>
<td>0.40</td>
<td>-0.30</td>
</tr>
<tr>
<td>Black</td>
<td>-0.22</td>
<td>-1.74</td>
<td>1.31</td>
<td>0.78</td>
</tr>
<tr>
<td>Childhood Stress</td>
<td>-0.12</td>
<td>-0.54</td>
<td>-0.42</td>
<td>0.32</td>
</tr>
<tr>
<td>Stress</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Activity</td>
<td>0.06</td>
<td>1.53</td>
<td>1.24</td>
<td>-0.48</td>
</tr>
<tr>
<td>Life Events</td>
<td>-0.23</td>
<td>-2.06</td>
<td>-1.48</td>
<td>-0.84</td>
</tr>
</tbody>
</table>

*p<.05
Table 25  Summarizing Mediation Tests Using Drinking and Smoking as Mediators of the Effect of Exogenous Variables on Aging Outcomes

<table>
<thead>
<tr>
<th>Mediator</th>
<th>Drinking</th>
<th>Smoking</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1-59 Drinks</td>
<td>60+ Drinks</td>
</tr>
<tr>
<td></td>
<td>Sub-optimal Successful</td>
<td>Sub-optimal Successful</td>
</tr>
<tr>
<td>Outcome</td>
<td>Z Z Z Z Z</td>
<td>Z Z Z Z Z</td>
</tr>
<tr>
<td>Independent Variable</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SES</td>
<td>-1.79 0.01 -0.24 -1.25</td>
<td>-0.16 0.13 -0.35 1.67</td>
</tr>
<tr>
<td>Female</td>
<td>1.44 -0.01 0.27 0.02</td>
<td>-1.22 0.80 -0.38 2.37*</td>
</tr>
<tr>
<td>Black</td>
<td>0.30 -0.00 -0.20 -0.88</td>
<td>-0.99 0.69 -0.33 1.41</td>
</tr>
<tr>
<td>Childhood Stress</td>
<td>1.17 -0.01 0.22 1.06</td>
<td>-0.59 0.45 -0.34 1.43</td>
</tr>
<tr>
<td>Chronic Stress</td>
<td>0.30 -0.00 0.25 1.36</td>
<td>-0.91 0.65 0.23 -0.73</td>
</tr>
<tr>
<td>Life Events</td>
<td>-1.40 0.01 -0.26 -1.53</td>
<td>-0.64 0.48 -0.14 -0.37</td>
</tr>
</tbody>
</table>

*p<.05