ABSTRACT

Title of Dissertation:	DO POSITIVE AND NEGATIVE EMOTIONS PREDICT OLDER ADULT WELL-BEING? PROSPECTIVE RELATIONSHIPS WITH CARDIOVASCULAR HEALTH, SOCIAL FUNCTIONING AND PSYCHOLOGICAL SKILLS IN A NATIONALLY REPRESENTATIVE SAMPLE
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Cardiovascular disease is the number one cause of death in older American adults. To improve both individual and population cardiovascular health (CVH), the American Heart Association (2016) has emphasized the concept of *ideal cardiovascular health,* which involves achieving ideal levels on several health factors (e.g., blood pressure) and health behaviors (e.g., exercise engagement). Using nationally representative data from the Midlife in the United States (MIDUS) survey, the present study explored whether positive affect (PA) relates to ideal CVH in 1266 adults followed over a 20-year period, above and beyond the effects of negative affect (NA). At present, the relative contributions of PA and NA on CVH remain unclear. The broaden-and-build theory of positive emotion posits that PA supports health by 1) *broadening* one's

repertoire of adaptive behaviors and 2) *building* personal resources, which could be psychological, physical, or social. From this perspective, CVH was explored as a physical resource that may build in conjunction with and following PA. Analyses also explored the extent to which PA predicts a broadening of behaviors relevant to CVH and healthy aging (i.e., volunteerism) and a building of psychological resources tied with CVH and healthy aging (i.e., positive reappraisal, or the tendency to locate positive meaning during times of loss and difficulty). Linear growth models were used to examine initial levels and change trajectories in outcomes, and post-hoc analyses were conducted using multiple linear regression modeling. Collectively, results suggest that PA is irrelevant for CVH and provide support for the well-established detrimental effects of NA on CVH. PA did not associate with volunteerism, and NA predicted lower volunteer engagement on average at the 20-year follow-up. PA, and not NA, supported positive reappraisal use. Results also provide evidence of the well-documented detrimental effects of socioeconomic and racial disadvantage on CVH. Implications for further research are discussed.

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by

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Chapter 1: Introduction to the Problem

The number of individuals in the United States entering middle to late adulthood is on the rise (Antonucci & Akiyama, 1993; Ortman, Velkoff, & Hogan, 2014). Cardiovascular disease (CVD) poses a major public health problem among aging adults. Although deaths due to CVD have declined in the United States over the past three decades due to healthcare advances, CVD remains the number one cause of death in American men and women (American Heart Association et al., 2016). CVD generally represents a class of diseases that share similar physiological mechanisms and includes both coronary heart disease (CHD) and cerebrovascular disease (i.e., stroke) (Boehm & Kubzansky, 2012). There are varied health factors and behaviors that contribute to the risk of experiencing a cardiovascular disease event. As reported by the American Heart Association (2016), untreated hypertension (an indicator of poor cardiovascular functioning), high cholesterol and overweight status (indicators of poor metabolic functioning), diabetes, cigarette smoking, unhealthy diet and physical inactivity are modifiable factors that show some of the most robust associations with CVD events and should constitute primary intervention targets. Further, individuals should try and achieve ideal levels as defined by the AHA (2016), a goal termed ideal CVH, in order to best prevent CVD events (American Heart Association et al., 2016; Boehm & Kubzansky, 2012; see Appendix A).

There are also various risk factors for CVD events that are non-modifiable, including male sex, family history, and age (American Heart Association et al., 2016). During the fifth decade of life, the relationship between age and CVD risk takes on a linear slope, such that each year of advancing age confers greater amounts of risk

(American Heart Association et al., 2016). However, there is strong evidence for individual variability in CVH during later life development (Lakatta, 2002), encouraging research into identifying factors that can slow the rate of CVH decline in aging adults.

Although non-modifiable risk factors (e.g., family genetics) play a role, empirical data show that CVD incidence and progression can be appreciably influenced by psychological, social and behavioral factors (American Heart Association et al., 2016). For example, personality traits (e.g., hostility) (Markovitz, 1998), social support/isolation (Berkman et al., 2003) lifestyle choices (e.g., diet, exercise, substance misuse) and stress have been shown to influence CVD risk and progression (American Heart Association et al., 2016; Stampfer, Hu, Manson, Rimm, & Willett, 2000). Increasingly, health psychology researchers have explored the role of protective factors (e.g., positive affect, meaning in life, optimism) on CVD progression, in addition to characterizing CVD risk factors (e.g., depression, neuroticism) (Boehm & Kubzansky, 2012; Sin, 2016). This conceptual perspective is similar to the American Heart Association's emphasis on both reducing risk and also promoting ideal cardiovascular health (e.g., through smoking cessation and engaging in regular exercise) (American Heart Association et al., 2016). The present study explored the specific role of positive affect (PA), defined as the experience of pleasurable emotions such as joy, happiness, excitement, enthusiasm, and contentment (Pressman & Cohen, 2005) on CVH. Five of the 7 ideal health factors were used to reflect CVH in a nationally representative, large sample of aging adults. Given inconsistency in the literature as to whether PA affords any protective benefit above and beyond the detrimental effects of negative affect (NA), or the tendency to experience unpleasant emotions like sadness in daily life (Pressman & Cohen, 2005), PA and NA were explored jointly. The predictive influences of PA and NA on two protective factors important for CVH and healthy aging were also explored: altruistic behavior (i.e., volunteerism) and positive reappraisal, or the tendency to locate positive meaning during times of loss and difficulty (Affleck, Tennen, Croog, & Levine, 1987; Folkman, 1997; Nowlan, Wuthrich, & Rapee, 2015b; Pavani, Le Vigouroux, Kop, Congard, & Dauvier, 2016).

Chapter 2. Review of the Literature

In this section, I first discuss information on CVH in the United States population. Next, I discuss literature describing the relationships between positive affect and cardiovascular health and disease. The review of literature on the associations between PA and CVD focuses on findings obtained from prospective longitudinal data to summarize what is known about temporal associations. The majority of studies reviewed used the term cardiovascular disease risk rather than CVH in discussing health outcomes. In many cases, the outcome variable is risk of experiencing a CVD event during the study timeframe. Other studies conceptualize a single health marker (e.g., blood pressure) as an indicator of risk. The five health factors and behaviors included in the present study are conceptualized by the AHA as reflecting both ideal CVH as well as CVD risk. Thus I discuss these constructs somewhat interchangeably in the literature review, and use the term CVH to describe the present analyses.

Next, I discuss a theoretical framework that provides some explanation as to why positive affect may relate to CVH. Specifically, the *broaden and build* theory of positive emotion (Fredrickson & Joiner, 2002; Fredrickson & Cohn, 2008; Fredrickson, 2004) posits that experiencing positive emotions (e.g., joy, contentment) leads people to think and act in ways that are broad, flexible, and approach-oriented. This kind of broad responding is distinct from the narrowed, automatic thought and behavior patterns that occur with many negative feelings (e.g., fear, anger), whose evolutionary purpose was to trigger the fight-or-flight response (Fredrickson & Cohn, 2008). Consistent with this conceptual framework, cardiovascular health researchers have proposed that one primary way that positive affect may benefit physical health is by motivating engagement in healthy behaviors (Boehm & Kubzansky, 2012; Pressman & Cohen, 2005). The *broaden and build* theory further proposes that the broader ways of thinking and behaving caused by positive affect are associated with an accrual of *personal resources* in one or more life domains (e.g., psychological, social, physical) (Fredrickson et al., 2004) . Positive affect can also have a direct influence on a building of personal resources (Fredrickson, Cohn, Coffey, Pek, & Finkel, 2008). Unlike the transient nature of positive feelings, personal resources are durable in nature, and could be physical (e.g., reduced illness symptoms), psychological (e.g., acquisition of cognitive skills), or social (e.g., improved relationship quality). Importantly, positive affect is specifically hypothesized to *produce* gains in well-being and is thus thought to temporally precede broadened behaviors and resource development. Once positive affect has led to increased personal resources, an "upward spiral" is set in motion whereby personal resources support the experience of future positive affect and continued growth in personal resources (Fredrickson, 2004).

The present study examined CVH as a *physical resource* that may be related to positive affect. Specifically, I explored whether PA predicts better CVH in a sample of older adults, as well as slower rates of CVH decline over time. I conceptualized and operationalized CVH by examining 5 of the 7 health factors and behaviors identified by the American Heart Association (2016) as particularly robust predictors of the risk of experiencing a first-time or recurrent CVD event (e.g., myocardial infarction, stroke). These include body mass index, hypertensive status, smoking status, diabetes status, and exercise behavior. Consistent with prior research, I examine the unique contribution of PA on CVH in conjunction with negative affect. The role of negative affectivity (as assessed by varied constructs and diagnoses; for instance, neuroticism, depression, anxiety) (Davidson, Mostofsky, & Whang, 2010; Frasure-Smith & Lespérance, 2003; Moser et al., 2010) cardiovascular health has been of empirical interest since the early 1900s, and its detrimental effects are well known. With more recent research recognizing the nature of negative and positive affect as related but also distinct processes (Keyes, 2005; Ryff et al., 2006) the manner in which they uniquely influence CVH has gained empirical attention (Agewall, Wikstrand, & Fagerberg, 1998; Boehm, Chen, Williams, Ryff, & Kubzansky, 2016; Davidson et al., 2010; Freak-Poli et al., 2015), but remains unclear. For instance, is positive or negative affect more important for CVH? Is there an optimal balance of positive and negative affect that is most supportive of CVH? Does the protective benefit of positive affect depend on one's level of negative affectivity? For example, does positive affect only matter for those with low to moderate levels of negative affectivity? I explore these questions using longitudinal data provided by older adults (aged 50 and above) who answered questions about their positive and negative affect levels, as well as about their CVH at three separate measurement occasions spaced 10 years apart. These data were drawn from the Midlife in the United States (MIDUS) survey, which was an interdisciplinary effort to understand the psychosocial contributors to healthy aging (Brim, Ryff, & Kessler, 2004).

In addition to exploring CVH as a physical resource tied with positive emotion, from the *broaden and build* perspective this study explored whether positive emotion leads to broadened action repertoires tied with better health, and a building of psychological resources tied with better health. First, I examined the extent to which positive affect contributes to altruistic behavior in aging adults. Behaving altruistically through volunteerism has been robustly associated with better mental and physical health

(Piliavin & Siegl, 2007), particularly among aging adults (Van Willigen, 2000), and has been associated with cardiovascular disease risk specifically (Sneed & Cohen, 2013; Whillans, Dunn, Sandstrom, Dickerson, & Madden, 2016). The notion that people accrue health benefits through helping others has been conceptualized as a novel approach to enhancing physical functioning that simultaneously promotes civic engagement (Schreier, Schonert-Reichl & Chen, 2013). From the *broaden and build* perspective, aging adults experiencing higher levels of positive affect may be more likely to engage in volunteerism (e.g., a broadened behavior), and consequently gain resources that support health (e.g., increased social ties). The limited literature on the relationship between positive affect and volunteerism suggests that positive affect may be both a cause and consequence of volunteering (Greenfield & Marks, 2004; Son & Wilson, 2012). The present study explored whether positive affect may motivate (i.e., precede) engagement in volunteerism, a behavior known to benefit health, among aging adults.

Finally, the present study explored whether positive affect leads people to *build* psychological resources known to impact health. Specifically, I explored the role of *positive reappraisal*, defined as an active self-regulation strategy whereby distressing events are reconstructed as benign, meaningful, or positive (Affleck, Tennen, Croog, & Levine, 1987; Folkman, 1997; Nowlan, Wuthrich, & Rapee, 2015b; Pavani, Le Vigouroux, Kop, Congard, & Dauvier, 2016). Conceptually related to *benefit finding* (locating positive meaning in traumatic events) (Bower, Kemeny, Taylor, & Fahey, 1998), positive reappraisal has been prospectively associated with better health outcomes in several domains (Bower et al., 1998; Dunigan, Carr, & Steel, 2007; Ickovics et al., 2006), including cardiovascular disease (Affleck et al., 1987). Given that the aging process confers mounting constraints on development (e.g., physical limitations) that are largely beyond personal control (Antonucci & Akiyama, 1993), it has been argued that aging adults may benefit from using self-regulation strategies that involve changing their *response* to life events, rather than trying to change external events themselves (Nowlan et al., 2015b). In support of this position, empirical data have suggested that the association between positive reappraisal use and physical functioning (Wrosch, Heckhausen, & Lachman, 2000), as well as that between positive reappraisal use and depressive symptoms (Garnefski & Kraaij, 2006) is stronger in older adults relative to younger adults. The present study explored whether positive reappraisal emerges as a psychological resource following the experience of positive affect, as would be predicted by the *broaden* and *build* theory of positive emotion.

Defining Ideal Cardiovascular Health

The American Heart Association (AHA) has defined criteria for what constitutes poor, intermediate and ideal cardiovascular heath for each of seven health factors, which include smoking status, blood pressure, body mass index, physical activity levels, diet, total cholesterol, and fasting plasma glucose, which reflects diabetes risk and status. Conceptually, to meet ideal CVH levels, individuals should be nonsmokers, normotensive, eat a healthy diet, show normal untreated blood cholesterol levels (untreated), engage in regular physical activity and show a healthy body mass index (AHA, 2016). Some of these factors represent health behaviors robustly tied with CVD event incidence (e.g., smoking, which accounts for nearly one third of deaths by CVD) (American Heart Association, 2016) whereas others represent health factors that reflect cardiovascular functioning (e.g., hypertension) or metabolic functioning (e.g., body mass index). Ideal health behaviors (e.g., regular exercise) and ideal health factors (e.g., non-hypertensive status) are related and are also independently associated with risk of incident CVD. For instance, at any level of exercise engagement (e.g., low, moderate, high), hypertension remains predictive of cardiovascular disease risk and vice versa (American Heart Association et al., 2016). The number of ideal health factors people have is related to their risk of death due to CVD. For example, one study reported that the hazard ratios for people with 6-7 health factors in the ideal ranges versus those with no ideal factors in the ideal ranges were 0.24 (95% CI, 0.13–0.47) for cardiovascular disease death (Yang et al., 2012). Thus, those with zero health factors in the ideal range were 76% more likely to die from cardiovascular disease relative to those individuals who had almost or all health factors in the ideal range. Notably, some of the correlations among the risk factors are modest. For example, the association between body mass index and HbA1c (an indicator of average blood sugar levels within a specified time period) is in the moderate range, whereas that between HbA1c and physical activity has been reported as low (American Heart Association, 2016). Thus, although the AHA conceptualizes these seven risk factors as representing a total risk score, due to the substantial independent variation among risk factors there is also reason to address the metrics separately in research and clinical practice (American Heart Association, 2016).

Cardiovascular Disease Risk in American Adults

Very few American adults meet criteria for ideal cardiovascular health as defined by the AHA (2016). Just 18% of American adults have five or more health factors in the ideal range. In the past decade, the number of adults achieving nonsmoker status has increased, which is projected to favorably impact population-level CVD incidence;

however, these gains are expected to be offset to some degree by an increase in the number of Americans with obesity and high blood glucose levels (American Heart Association, 2016).

CVD risk factors are related to age, gender and race. The relationship between age and heart disease incidence exhibits a curvilinear pattern between the ages of 35 and 84, with a relatively flatter slope in samples of individuals younger than 55 relative to samples of individuals 55 and older. In samples 55 and older, age and risk of heart disease incidence takes on a steeper, approximately linear slope (see American Heart Association et al., 2016). With the exception of healthy diet, the proportions of older adults (>60) meeting cutoffs for ideal cardiovascular health metrics (i.e., physical activity, nonsmoking, total cholesterol, blood pressure, blood glucose and BMI) are lower relative to younger adults as described by data obtained in the National Health and Nutrition Examination Survey administered from 2011-2012 (see American Heart Association, 2016; p. e54). Regardless of age, women meet more ideal metrics of cardiovascular health than men. Men are more likely to die from cardiovascular disease than women, and they demonstrate higher levels of risk over the lifespan (American Heart Association et al., 2016). Individuals categorized as black or Hispanic tend to show a lower number of ideal metrics relative to individuals categorized as white. Specifically, 60% of white adults and 70% of black or Hispanic adults have low numbers (<3) of metrics at ideal levels (American Heart Association et al., 2016).

Negative Affect and Cardiovascular Health

The increased cardiovascular disease risk imposed by negative affect is well established. In an extensive narrative review of prospective studies conducted between

1966 and 2005 exploring the role of negative affect in a) incident CVD and b) CVD progression, Suls and Bunde (2005) reported that depressive symptoms, anxiety, and anger-hostility positively predicted cardiac event incidence and progression in the majority of studies reviewed. In other studies, researchers have reported associations between the presence or absence of a clinical diagnosis (e.g., depression, anxiety) with CVD outcomes (Penninx et al., 1998), and others have associated negative affect-prone personalities (e.g., neuroticism) with CVD (Hagger-Johnson et al., 2012). In general, this research tradition supports the position that negative affect is significantly related to CVD incidence and progression, although some null findings have been reported (Suls & Bunde, 2005). Null findings may be related to a lack of statistical power due to small initial sample sizes and/or participant attrition. It may also be that covariates linked with CVD included in multivariate models examining CVD (e.g., indices of socioeconomic status) are also related to negative affect, thus attenuating the statistical relationship between negative affect and CVD outcomes. Finally, it is also possible that negative affect is unrelated to CVD, although the high number of studies documenting significant relationships over the past several decades suggests that negative affect is an important predictor of CVD.

A challenge in the affect-CVD literature is the inconsistency around the conceptualization and measurement of affect. In their narrative review, Suls and Bunde (2005) argued that the extensive conceptual and measurement overlap between scales assessing single negative affects, as described by factor analytic work (Raynor, Pogue-Geile, Kamarck, McCaffery, & Manuck, 2002) suggest that in general a negative affective tendency may be more reflective of CVD risk than any single negative affect.

Negative affectivity has been described as a general tendency to experience negative emotions like sadness, guilt, anger, irritability, and others (Watson, Clark, & Tellegen, 1988). In this regard, some studies have used scales meant to capture general negative affectivity that ask individuals to report the frequency with which they experience a set of negative emotions, although as reported by a recent review this approach is less common than studies examining the role of a single negative affect (Suls & Bunde, 2005). For example, one prospective study (Todaro, Shen, Niaura, Spiro, & Ward, 2003) assessing the relations between negative affect and CVD risk used the MMPI Welsh A Scale to assess negative affectivity, which asks participants to rate the frequency with which they experience feelings like anxiety and dysphoria. A one standard deviation increase in negative affect was associated with a 51% greater risk of experiencing a cardiovascular disease event during the 3-year follow-up period, even after controlling for age, education, health behaviors, dietary intake, and physiological risk factors. This study provided compelling evidence that negative affect contributes to cardiovascular disease event risk. Another prospective study (Frasure-Smith & Lespérance, 2003) examined general negative affectivity and CVD, and used a variety of psychometric scales and visual analogue scales to assess anxiety, depression, and anger. Through factor analysis the authors observed that a general negative affectivity construct explained common variance among these scales. Thus, the authors examined the relationship between factor scores on negative affectivity and mortality in a large sample of cardiovascular disease patients. They reported that a 1-point increase in negative affectivity was associated with a 38% greater risk of death within a 5-year follow-up period (Frasure-Smith & Lespérance, 2003). These results provide support for general negative affectivity as an important predictor of CVD outcomes.

The aforementioned studies examining general affectivity and CVD (Frasure-Smith & Lespérance, 2003; Todaro et al., 2003) failed to include measures of positive affect in their models, which is consistent with the history of the health psychology tradition of emphasizing risk factors over protective factors. To date, just a handful of studies have examined negative affect in conjunction with positive affect in longitudinal studies of CVD risk, incidence and progression. The question of whether positive affect confers a protective benefit above and beyond the risk conferred by negative affect is therefore an interesting question. Positive affect is defined as the experience of pleasurable emotions such as joy, happiness, excitement, enthusiasm, and contentment (Pressman & Cohen, 2005). Positive feelings can be momentary and state-like, and also, the tendency to experience high or low positive affect has been characterized as a trait-like quality (Watson, 2002). Positive affect has been characterized in many studies as largely independent from negative affect (Keyes, 2005; Ryff et al., 2006), and not merely its opposite (Tellegen et al., 1999).

Positive affect has been prospectively associated with better cardiovascular disease outcomes in aging individuals in a handful of studies that also take into account negative affect (Boehm & Kubzansky, 2012). These studies have generally recorded baseline positive affect and then evaluated CVH markers and/or the risk of experiencing a CVD event at a later point in time. Specifically, researchers have associated positive emotions with disease-related endpoints, including incident CVD in healthy adults and CVD progression in clinical samples. Furthermore, positive emotions have been linked with CV risk and health by examining markers of biological functions that confer risk, including blood pressure, heart rate, hyperlipidemia, body mass index, inflammatory markers, and others in that higher levels of positive emotions are negatively associated with these negative markers (Boehm & Kubzansky, 2012; Steptoe, Wardle, & Marmot, 2005).

Positive Affect and Incident CVD

A small number of prospective longitudinal studies have suggested a relationship between trait positive affect and cardiovascular events in healthy adults. In a large study of aging North Americans (aged 65 and older at the baseline assessment), trait positive affect was associated with a 26% reduced risk of stroke 6 years later, an effect that remained after controlling for relevant disease risk factors and negative affect (Ostir, Markides, Peek, & Goodwin, 2001). Positive and negative affect were assessed with the Center for Epidemiologic Studies Depression Scale (CES-D), which includes four positive affect items: "I felt that I was just as good as other people," "I felt hopeful about the future," "I was happy," and "I enjoyed life." Strengths of this study included its large sample size, prospective longitudinal design, use of a well-validated measure to assess positive affect, and control of relevant disease risk factors and negative affect. A recent study (Yanek et al., 2013), used the General Well Being Schedule (GWBS) to assess positive and negative affect in a) a healthy sample deemed at risk for heart disease based on family history, and b) a national probability sample of adults living in the United States. Specifically, siblings of individuals who experienced early onset cardiovascular disease (i.e., at age 60 or below) were included the high risk sample, and individuals partaking in the First National Health and Nutrition Examination Survey (NHANES I) and NHANES I Epidemiologic Follow-up Study (NHEFS) were included in the national probability sample. The GWBS includes items representing six psychological domains: relaxed versus tense (anxiety), cheerful versus depressed mood (depression), freedom from health concern (somaticism), energy level (vitality), life satisfaction, and emotional-behavioral control. Results showed that positive psychological well-being as reflected by GWBS total scores was associated with significantly reduced risk of incident CVD during follow-up in both samples, controlling for other variables linked with CVD (i.e., smoking status, male sex, African American race, hypertensive status and cholesterol levels). The magnitude of the effect was slightly greater in the at-risk sample as well as the general population sample, suggesting that positive psychological well-being may be more protective for at-risk groups relative to groups with typical risk levels. However, the authors did not examine the sub scales representing positive and negative affect on the GWBS, so this study does not provide specific evidence on the role of affect in CVD but rather affect in conjunction with other positive well-being variables.

In a 12-year follow-up study involving nearly 55,000 aging Japanese adults, low life enjoyment (as measured by a single item, "Are you enjoying your life?) was associated with increased risk of cardiovascular disease incidence in male participants only, after adjusting for perceived stress and hostility (Shirai et al., 2009). Strengths of this study included its prospective longitudinal design and large sample size. It is possible that the protective influence of positive affect on cardiovascular disease incidence is more pronounced in male individuals (whose gender confers greater CVD risk) than in female individuals, although further research into gender effects is warranted because many studies also report no effect modification by gender (Davidson et al., 2010; Yanek et al., 2013).

Rather than use self-reports of positive affect, one 10-year follow-up study of North American adults used external raters to assess trait positive affect. Positive affect was assessed using a structured interview format whereby participants were asked to verbally describe how they typically respond to a series of stress-inducing situations. Positive affect levels were judged by rating the positivity of words, behaviors and tone shown by participants. Negative affectivity was controlled by self-reported measures of depression and anxiety. Results from adjusted models showed that each single point increase in positivity at the baseline assessment was associated with a 22% relative risk reduction reduction for experiencing a cardiovascular disease event at follow-up, holding constant depressive symptoms, anxiety and hostility (Davidson et al., 2010). Strengths of this study include its large sample size and removal of self-report bias on positive affect scores via the use of external raters. Notably, one recent study reported no relationship between positive affect and incident CVD in healthy samples. Specifically, in a 12-year prospective cohort study involving over 10,000 British adults, positive affect was unrelated to the risk of experiencing coronary heart disease during the follow-up period (Nabi et al., 2008), although participants with very high levels of negative affect (i.e., scoring in the highest third in the sample) were at slightly higher risk than the other participants. This study used a well-validated measure of positive and negative affect (i.e., the Affect Balance Scale), which contains 5 items assessing positive affect and 5 items assessing negative affect. Scores for negative affect, positive affect, and the balance between negative and positive affect were computed from these items and examined in separate Cox regression models. Scores ranged from 0 to 15 for positive affect and 0 to 15 for negative affect. Affect balance was calculated by subtracting the negative affect score from the positive affect score, and then adding a constant of 15 to remove negative values. Affect balance scores ranged from 0 to 30, with 30 reflecting the highest balance of negative and positive affect. Because no clinical cutoffs exist for the Affect Balance Scale scores, the authors divided the participants into thirds, reflecting low, moderate, and high scores on each of the affect metrics. They then used these categories as the predictor variable in regression models, controlling for covariates related to incident CVD risk. Like positive affect, the balance between negative and positive affect was unrelated to risk of incident coronary heart disease. A recent study (Freak-Poli et al., 2015) also reported a null relationship between positive affect and CVD incidence in a large, prospective study of older, healthy adults living in the Netherlands. Positive affect was assessed by drawing items from the CES-D and the Hospital Anxiety and Depression Scale. In a sample of 6359 adults aged 55 and older, neither positive nor negative affect was associated with incident CVD during an average follow-up period of 11.9 years. Incident CVD was defined as experiencing one or more of the following conditions during follow-up: heart failure, coronary heart disease, or stroke. The authors assessed positive affect using an identical measure to the Ostir (2001) study, which reported significant associations between positive affect and stroke incidence during a 6-year follow-up period among healthy older adults living in the United States. These differences in findings may have been related to differences in the outcome used (a single cardiovascular disease versus having one or more of three cardiovascular diseases) or differences in the study populations. Although the samples were similar in that they involved community dwelling older adults, Ostir and colleagues (2011) followed individuals living in the United States, whereas Freak-Poli and colleagues (2015) followed individuals living in the Netherlands. There were some differences in covariates included in the models as well. For instance, Freak-Poli and colleagues (2015) controlled for cholesterol levels, whereas Ostir and colleagues (2011) did not. There appears to be some inconsistency across studies regarding the conceptualization and statistical treatment of other variables previously linked with outcome variables, which may relate to inconsistencies in the results reported.

Positive Affect and Disease Progression

In clinical samples of individuals with prior CVD events, positive affect has been shown to protect against future disease events in a small number of prospective studies, although results are mixed. In one study of over 800 patients with significant, previous coronary artery disease (Brummett et al., 2005), the authors examined the predictive influence of positive and negative affect on all-cause mortality. Items assessing positive and negative affect were drawn from the extraversion (positive emotions facet) and neuroticism (depression facet) subscales of the NEO 5-factor personality inventory. In multivariate models, the relationship between trait positive affect and mortality was reduced to non-significance with the inclusion of trait negative affect in the model, although the effect size was only slightly reduced for positive affect. This pattern of findings suggests that negative affect was a stronger predictor of mortality than positive affect, but also that positive affect may still be a relevant predictor of mortality. Regarding the specific nature of the relationship between negative affect and mortality, results showed that a 1-point increase in depression scores was associated with a 28% greater risk of death (Brummett et al., 2005).

Two other studies identified a link between positive affect and future CVD events. In a 2-year period following stent implementation, one study of nearly 1,000 patients showed that lower levels of positive affect as assessed by the Hospital Anxiety and Depression Scale were associated with future cardiac events (Denollet et al., 2008). Another study involving 1,250 patients with significant heart disease examined the predictive role of well-being and depressive symptoms on survival (Barefoot et al., 2000). Researchers used a depressive symptoms checklist (SDS) (Zung, 1965) that included a group of items assessing positive affect (e.g., I am hopeful about the future; I still enjoy the things that I used to"). Participants were given questionnaires during hospitalization for diagnostic coronary angiography and completed annual follow-up surveys for up to 19 years following the baseline assessment. In separate models, well-being and depressive symptoms each predicted risk of death; when combined into the same model, however, the association between well-being and survival was reduced to non-significance, suggesting that perhaps the presence of negative affect was a more important predictor of survival than the presence of positive affect. Of note, one prospective study that followed 300 angioplasty patients over a median period of 10 years showed no relationship between positive affect and mortality after accounting for other disease risk factors (van Domburg, Pedersen, van den Brand, & Erdman, 2001). The authors used a scale specifically validated in cardiac patients, which included positive affect items (e.g., I feel happy). In another study using the same measure of positive affect that followed 500 survivors of acute myocardial infarction over a median of 8 years (van der Vlugt et al., 2005), null associations between well-being and all-cause mortality were likewise reported. It may be that the smaller sample size in these two studies precluded detection of associations between positive affect and mortality, and it also may be that positive affect had no true association with survival in survivors of cardiac events. Finally, in a sample of 400 men being treated for hypertension, lower feelings of contentment were associated with significantly elevated stroke risk as assessed during a 6.6 median year follow-up period (Agewall et al., 1998).

Positive Affect and Biological Function

A small number of prospective studies have described the relationships between positive affect and biological markers known to confer CVD risk; for example, cardiovascular function (e.g., hypertension, heart rate), metabolic function (e.g., BMI, hyperlipidemia), and neuroendocrine function (e.g., cortisol). High blood pressure has been identified as one of the most relevant risk factors for CVD (Chobanian et al., 2003). Also important are metabolic functions, which refer to chemical processes that enable people to function in their environment (Boehm & Kubzansky, 2012); markers of metabolic function that have been robustly linked with CVD outcomes are lipids (Sarwar et al., 2007) (i.e., cholesterol levels) and body mass index (BMI) (Manson et al., 1990), which is computed from an individual's height and weight and commonly used as a proxy for body fat (Boehm & Kubzansky, 2012). In an experience sampling study (Steptoe et al., 2005), European middle-aged men and women reported their happiness levels over the course of a single day. A single, Likert-type item was used to assess happiness. Happiness ratings were used to predict heart rate, blood pressure, and cortisol levels over the course of the same day. Self-reported happiness positively predicted lower ambulatory heart rate and lower cortisol levels and was unassociated with blood pressure. These relationships remained significant after controlling for psychological distress and demographic characteristics, supporting the position that positive affect uniquely relates to CVD risk factors above and beyond negative affect.

Two experimental studies have suggested that positive affect positively influences cardiovascular functioning. In the laboratory, college student participants undergoing a positive mood induction demonstrated faster return to baseline levels of heart rate and blood pressure following acute stress relative to control condition participants (Fredrickson & Levenson, 1998; Fredrickson, Mancuso, Branigan, & Tugade, 2000). A handful of studies have described relationships between positive affect and markers of poor metabolic function (e.g., hyperlipidemia, obesity), although most are limited by cross-sectional designs. In one longitudinal study, prospective relationships between positive affect and weight gain were reported (Korkeila, Kaprio, Rissanen, Koskenvuo, & Sörensen, 1998). In this study, 5867 twin pairs were asked to rate their level of interest, happiness, easiness and loneliness in life. In women only, low life satisfaction predicted weight gain over the follow-up period. In a cross-sectional study of 126 women, positive affect was negatively associated with higher HDL cholesterol (Ryff et al., 2006).

In general, there is a lack of longitudinal data documenting the relationship between positive affect and markers of metabolic function (see Boehm and colleagues, 2012), although metabolic functions are robust indicators of CVD risk (Manson et al., 1990; Sarwar et al., 2007). However, one study (Boehm et al., 2016) used MIDUS I data (collected in 1995) and data obtained from the MIDUS Biomarker project, which was a subsample of participants who completed in-person laboratory assessments ten years later (between 2004 and 2005). The purpose of the study was to explore the prospective associations between positive affect and life satisfaction with a) incident cardiometabolic disease, and b) biomarkers of cardiometabolic disease risk. Life satisfaction was measured with a single item asking participants to rate satisfactoriness of their life overall, and positive affect was measured by the positive affect scale developed for the MIDUS study, which asked participants to rate the frequency with which they experienced six positive emotions in the past 30 days. The authors included only those participants who were free of incident cardiometabolic disease at baseline, which they argued was for the purpose of characterizing temporal associations between baseline positive affect and life satisfaction with incident CVD. Incident cardiometabolic disease was operationalized through participant self-reports of the presence or absence of heart problems (including heart attack or heart failure), hypertension, diabetes, stroke, high cholesterol, or medication use for one of the conditions. If participants reported at least one condition, they were classified as having cardiometabolic disease. Further, if medication use was reported for a condition, the participant was classified as having a cardiometabolic condition. Cardiometabolic disease risk was computed by standardizing and summing scores on eight biomarkers of cardiometabolic disease risk: systolic blood pressure, diastolic blood pressure, triglycerides, HDL cholesterol, low-density lipoprotein (LDL) cholesterol, glycosylated hemoglobin, waist circumference, and C-reactive protein. In Poisson regression models adjusting for age only, a one standard deviation increase in positive affect was associated with a 7% reduction in cardiometabolic disease risk. A 7% decrease in cardiometabolic disease risk was also associated with a one standard deviation increase in life satisfaction. When additional sociodemographic covariates were included in the models, including gender, race, marital status, education level, household income, and family heart attack history, positive affect and life satisfaction remained as significant predictors of incident disease. When depressive symptoms were included in the two models, positive affect was no longer a significant predictor of disease incidence, whereas life satisfaction remained significant. When health behaviors linked with incident cardiometabolic disease were included in the two models, including smoking status, alcohol consumption levels, and physical activity levels, neither positive affect nor life satisfaction was predictive of incident disease. In final, fully adjusted models, the significant predictors of incident cardiometabolic disease included age, engagement in vigorous physical activity, and family history of heart attacks. In a similar fashion, life satisfaction was associated with cardiometabolic risk scores in adjusted linear regression models that included sociodemographic characteristics, but was reduced to non-significance when health behaviors were included as covariates. Of note, depression scores were entered prior to entering health behaviors, and when added as a covariate, the effect of life satisfaction on risk scores was unchanged. These results suggest that the absence of depression is not equivalent to the presence of life satisfaction. These results also suggest that health behaviors may be more strongly associated with cardiometabolic risk and incidence than life satisfaction or positive affect. Positive affect was not associated with cardiometabolic risk score in any of the models tested. Thus, these findings also suggest that life satisfaction may be a more important predictor of cardiometabolic risk and incidence than positive affect.

Summary of Findings on the Relationship between Positive Affect and CVD

Among healthy adults, there are several studies suggesting that positive affect is prospectively associated with reduced risk of cardiovascular disease (Agewall et al., 1998; Davidson et al., 2010; Davidson et al., 2010; Ostir et al., 2001; Shirai et al., 2009;

Yanek et al., 2013) and others suggesting no association (Brummett et al., 2005; Freak-Poli et al., 2015; Nabi et al., 2008; van der Vlugt et al., 2005; van Domburg et al., 2001). Studies examining biological markers reflecting CVD risk suggest a protective influence of positive affect. As discussed, happiness levels have been shown to prospectively predict ambulatory heart rate and cortisol levels (Steptoe et al., 2005), and feelings of contentment have been prospectively associated with stroke incidence in males (Agewall et al., 1998). Experimental data suggest that evoking positive affect in research participants can promote faster cardiovascular recovery from stress, as evidenced by faster restoration of baseline heart rate and blood pressure (Fredrickson & Levenson, 1998; Fredrickson et al., 2000). Regarding metabolic functions, some data suggest that positive affect is positively related to maintaining healthy cholesterol levels (Ryff et al., 2006), as well as negatively related to weight gain over time (Korkeila et al., 1998). Results provided by Boehm (2016) and colleagues suggest that positive affect is linked with cardiometabolic disease, but that life satisfaction may be a stronger predictor of disease than positive affect per se.

Limitations and Implications for Further Research

There are numerous gaps in the literature that encourage further research into the relationships between positive affect, negative affect, and cardiovascular disease risk. First, studies to date show both significant and null relationships between affect (positive and/or negative) and cardiovascular disease risk. Next, positive affect and negative affect have been conceptualized and measured inconsistently across studies. For instance, studies examining positive affect have used measures ranging from single item scales assessing constructs like life enjoyment (Shirai et al., 2009) to using multidimensional well-being scales that include positive affect subscales (Yanek et al., 2013) to multi-item measures of positive and negative affect like the Positive and Negative Affect Schedule (Ostir et al., 2001). These inconsistencies likely contribute to inconsistencies across study conclusions. Furthermore, some studies have examined negative and positive affect in the same statistical model (Barefoot et al., 2000; Boehm et al., 2016; Brummett et al., 2005) while others have examined positive affect without accounting for negative affect (Yanek et al., 2013), and many have examined negative affect without accounting for positive affect (Frasure-Smith & Lespérance, 2003; Todaro et al., 2003). Another contribution to mixed results regarding the relationship between affect and cardiovascular disease risk pertains to the conceptualization and statistical treatment of other variables related to CVD risk. For example, each study uses a unique set of covariates, which typically include sociodemographic variables like age, gender, race, and some combination of markers of socioeconomic status. The selection of control variables beyond these sociodemographic factors has been varied, with some authors electing to control for variables like Type A personality and perceived stress (Shirai et al., 2009), family history of heart disease (Boehm et al., 2016), and/or health behaviors (Yanek et al., 2013). Yet, according to the AHA (2016), some health behaviors (e.g., smoking status, regular exercise, healthy diet) should be considered outcome variables reflective of overall CVH. Further, some studies have accounted for health behaviors linked with risk of incident CVD in statistical models but failed to conceptualize them as control variables or as mediating variables (Boehm et al., 2016). The Boehm (2016) study is similar in many ways to the present study in that it uses MIDUS data, examines prospective associations, and uses some of the same disease indicators in analyses (e.g., blood pressure) although with greater measurement specificity (i.e., laboratory measures rather than self-reports). However, it does not conceptualize CVH in accordance with the AHA (2016) framework, which suggests treating health behaviors (i.e., healthy diet and exercise behavior) as outcome indicators of CVH rather than as covariates or predictor variables. Thus, findings from Boehm (2016) provide some basis for hypothesizing that positive affect will predict CVH, but there are also significant differences in the analytic approaches that make it difficult to compare the two.

Another limitation of the literature is that prospective studies have been limited to two measurement occasions relating affect and CVH. Two repeated observations allow one to describe the amount of change in an outcome, but do not allow for estimation of the rate of change in individuals or the shape of change (Duncan & Duncan, 2004). For these reasons, it has been strongly suggested that developmental studies include more than two assessment points (Duncan & Duncan, 2004)**.** The literature describing the relationship between positive affect and incident CVD could benefit from studies that assess variables on multiple occasions over time. Such designs could allow researchers to explore the extent to which positive affect explains individual differences in the rates of change in cardiovascular disease risk accrual across development. From a theoretical perspective, researchers have posited that positive affect is important for healthy functioning because it leads to an accrual, or a building, of resources over time (Fredricson, 2004). These resources could be physical, psychological, and/or social. In the context of cardiovascular disease, it may be that positive affect influences the accrual, or growth in, cardiovascular disease risk (i.e., a physical resource). However, the prospective longitudinal data available to date have been limited to two assessment occasions and have thus been unable to test this hypothesis.

Broaden and Build Theory of Positive Emotion

The *broaden and build* theory of positive emotion (Fredrickson, 2004) provides a conceptual framework to guide investigation of the relationships between positive affect and CVD in older adults. According to theory, positive emotions lead to the accrual of personal resources, which could lie in psychological, physical, and/or social domains. These resources are thought to accrue through engagement in broad and flexible *thought-action repertoires*. For example, experiencing a positive emotion like curiosity leads people to explore their environment, and through this exploration, they develop intellectual resources like expert knowledge and intellectual complexity. Experiencing love causes people to engage in social bonding behaviors, which leads to the accumulation of social resources like expanded social networks and enhanced relationship quality. Unlike the transient nature of positive emotions, the resources accrued through positive emotion are enduring in nature and support sustained well-being (Fredrickson, 2004).

Experimental data have supported the position that positive emotions promote expanded thinking and behavior (i.e., the *broaden* component of the theory). For instance, inducing positive emotion in adults under laboratory conditions has been shown to promote increased creativity (Phillips, Bull, Adams, & Fraser, 2002) integrative and inclusive thinking (Bolte, Goschke, & Kuhl, 2003) and openness to new information (Estrada, Isen, & Young, 1997). Positive emotion has been shown to prospectively predict college students' sense of interpersonal connection with others and intellectual complexity in social contexts (Waugh & Fredrickson, 2006) and community adults' trust of other people (Dunn & Schweitzer, 2005).

In field settings, empirical data have supported the position that positive affect promotes resource accrual (i.e., the *build* component of the theory). In a compelling study (Fredrickson et al., 2008), participants were randomly assigned to participate in a 7-week intervention where they were taught to self-generate positive emotions, or to a wait-list control condition. Pre-test and post-test assessments were administered along with daily momentary assessments of emotion. Participants in the intervention group experienced elevations in positive emotions relative to baseline levels, and concurrent with these elevations, they accrued resources in several domains. These included psychological resources (i.e., mindfulness and purpose in life) and social resources (i.e., social support). Although the authors tested whether positive emotions preceded increased physical resources (i.e., reduced illness symptoms), positive emotions did not associate with illness symptoms. In laboratory settings, induced positive emotions (via film clips) have been shown to associate with acute changes in physical processes relevant to physical health and implicated in the etiology of cardiovascular disease. In two studies, Fredrickson and colleagues (1998, 2000) induced positive emotion in the laboratory through film clips, and observed that those participants who viewed positively valenced clips showed a faster return to baseline levels of heart rate and blood pressure following a laboratory challenge relative to participants who viewed neutral or negatively valenced clips (Fredrickson & Levenson, 1998; Fredrickson et al., 2000). Although these studies do not provide support for the enduring nature of physical resources purported to emerge in the wake of positive affect, they do show that positive affect may acutely impact psychophysiological processes that support healthy physical function.

Limitations of the Broaden and Build Theory of Positive Emotion

The broaden and build theory is complex and proposes that positive affect can exert both direct effects on a building of personal resources (Fredrickson et al., 2008) and indirect effects through broadened behavior (Fredrickson, 2004, 2008). The theory further proposes that personal resources are enduring in nature, and predictive of further experiences of positive affect. Thus positive affect is thought to initiate an *adaptive spiral* towards enhanced well-being (Fredrickson, 2004, 2008). This last component is more difficult to test and currently lacks direct empirical support. Given the complex nature of the broaden and build theory, it is difficult to test all relationships simultaneously in a single study, and to my knowledge no study has been able to definitively show that within individuals over multiple occasions, positive affect causes engagement in broadened behaviors, which then causes resource accrual, which then facilitates future experiences of positive affect. Further, no study has shown that the resources accrued through positive affect are *enduring* in nature; for example, no study has conducted multiple long-term follow-ups to determine the enduring or non-enduring nature of personal resources that emerge in the wake of positive affect.

Perhaps related to its complex nature, research using the theory has generally tested a specific component of the theory rather than all components of the "upward spiral." Empirical studies have provided support for the broaden component of the theory (Bolte et al., 2003, Dunn & Schweitzer, 2005, Estrada et al., 1997, Phillips et al., 2002, Waugh & Fredrickson, 2006), as well as the build component (Fredrickson, 2008). For example, a recent intervention study directly tested the build component of the theory by examining whether positive affect, induced by a meditation intervention, preceded gains in physical resources (i.e., reduced illness symptoms), psychological resources (e.g., mindfulness skills) and social resources (i.e., relationship quality) (Fredrickson, Cohn, Coffee, Pek & Finkel, 2008). Thus, the *broaden and build* theory has empirical support, but is still open to conjecture and should continue to be tested using longitudinal data. The present study tests the *broaden* and *build* hypotheses of the theory by examining whether positive affect promotes broadened behaviors known to support health in aging adults (i.e., volunteerism) (see Appendix A), and whether it leads to a building of physical resources (i.e., cardiovascular health) and psychological resources (i.e., positive reappraisal). Volunteerism and positive reappraisal are explored in the present study because of empirical evidence that these support health and cardiovascular health in particular in aging adults, and more generally, because of how they have been widely discussed in the literature as resources supportive of successful aging.

A primary strength of this study it its longitudinal design and use of data collected over a 20-year span, allowing for observation of growth in personal resources hypothesized by *broaden and build* to unfold over the course of time. Further, this study examines the *broaden and build* theory in a sample of older adults that was selected to accurately represent the demographics of the US general population. To date, the *broaden and build* model has generally been tested in college students (e.g., Fredrickson, 1998, Fredrickson et al., 2008).

<u>Using the Broaden and Build Theory to Understand Cardiovascular Health</u>

Cardiovascular Health

Perspectives towards the role of positive affect on CVH as described by cardiovascular health researchers are well-aligned with the broaden-and-build perspective towards positive affect. Specifically, common explanations for why positive affect favorably impacts CVH is that it motivates people to engage in a broader repertoire of healthy behaviors (Boehm & Kubzansky, 2012; Sin, 2016), and that it may directly improve physical functioning through physiological pathways (Sin, 2016). In this sense, cardiovascular disease researchers cite broadened actions (e.g., physical activity) and a building of physical resources (e.g., healthy blood pressure) as benefits that result from experiencing positive affect. This perspective in conjunction with the broaden-and-build theory suggests that levels of positive affect relate to declines in CVH in late life development. However, as reviewed, empirical results on whether positive affect favorably impacts CVH risk are mixed, and no study has described rates of decline in CVH as related to the experience of positive affect. Furthermore, the relative contributions of positive and negative affect and their potential interaction are poorly understood.

Volunteerism

As discussed, the *broaden* component of the theory suggests that positive affect motivates engagement in expanded, adaptive behaviors like social bonding and intellectual exploration (Fredrickson & Cohn, 1998).Volunteerism is an altruistic behavior that has been linked with better physical and mental health (Piliavin & Siegl, 2007), particularly among aging adults (Van Willigen, 2000) and has been positively associated with better cardiovascular health (Sneed & Cohen, 2013; Whillans et al., 2016).Volunteerism is broadly defined as unpaid work designed to benefit others (Van Til, 1988), which is unassociated with a sense of obligation (e.g., as may occur in a family caregiving context) (Van Til, 1988).

Recent statistics on volunteerism in the United States show that volunteerism peaks in mid-life (Bureau of Labor Statistics, 2015). Time spent volunteering is positively associated with being female and married and is also linked with income, education, and race (Bureau of Labor Statistics, 2015). Varied explanations have been put forth to explain why volunteerism benefits health. In the domain of social functioning, volunteerism provides an opportunity to expand social networks and receive expressions of gratitude from others, which may boost mood (Son & Wilson, 2012). Further, it affords the opportunity to acquire new social roles in the wake of age-related losses in social role functioning (e.g., retirement) (Baker, Cahalin, Gerst, & Burr, 2005). From an existential perspective, volunteerism may be a resource through which people construct personal meaning, for example, by developing a sense that they have contributed meaningfully to the public good (Sherman, Michel, Rybak, Randall, & Davidson, 2011). Moreover, volunteering may reduce reliance on maladaptive self-regulation strategies like self-focused rumination, by directing attention away from the suffering of the self and towards efforts to alleviate the suffering of others. Numerous other benefits have been discussed in the literature, including positive impact on personal mastery and autonomy (Kahana, Midlarsky, & Kahana, 1987), skill development (Son & Wilson, 2012) and physical activity levels (Tan, Xue, Li, Carlson, & Fried, 2006).

Regarding the relationship between positive affect and volunteerism, two studies have investigated their relationship using MIDUS data, which taken together suggest that volunteerism may be both a cause and consequence of positive affect. In a study using two waves of MIDUS data examining the temporal associations between positive affect and volunteerism (Son & Wilson, 2012), positive affect positively predicted volunteer status, as well as the number of hours spent volunteering. In a model examining reverse associations, volunteerism did not predict positive affect. Therefore, this study provided support for positive affectivity as a characteristic that motivates people to engage in volunteerism, consistent with the broaden-and build perspective on positive emotion.

A cross-sectional study using one wave of MIDUS data reported that volunteer status was positively associated with positive affect, but due to its cross-sectional design the temporal associations between variables could not be determined (Greenfield & Marks, 2004). No study has used all three waves of MIDUS survey data to examine the relationship between positive affect and growth rates in volunteerism. Given that mid-life adults volunteer more frequently than older adults (Bureau of Labor Statistics, 2015), suggesting a decline in volunteerism with age, it is possible that positive affect predicts a slower decline in volunteerism among aging individuals. The present study explores this possibility using three waves of MIDUS data in aging adults, and specifically addresses whether positive affect is a factor that promotes sustained engagement in volunteerism during the aging years.

Positive Reappraisal

One prediction of the broaden and build theory is that individuals experiencing positive emotions accrue psychological resources by broadening the way in which they think and behave. Within the psychological domain, positive-reappraisal is a self-regulation strategy that has been conceptualized as a broad-minded (Pavani, Le Vigouroux, Kop, Congard, & Dauvier, 2016; Burns et al., 2008; Fredrickson & Joiner, 2002), been theorized as being particularly relevant for aging adults (Worsch et al., 2000) and associated with healthy functioning in patients struggling with a variety of health conditions (Bower, Kemeny, Taylor, & Fahey, 1998; Dunigan, Carr, & Steel, 2007; Ickovics et al., 2006). Positive reappraisal is defined as active and meaning-focused (Folkman, 1997), and involves reconstructing stressful events as benign, positive, or meaningful (Garland, Gaylord, & Fredrickson, 2011; Nowlan, Wuthrich, & Rapee, 2015a; Nowlan et al., 2015b). An example of positive reappraisal would be reframing a cardiovascular disease diagnosis as an opportunity to make lifestyle changes rather than as a sign of impending decline (Garland et al., 2011). Theorists have argued that the capacity to appraise situations positively is particularly relevant for aging adults due to how the mounting constraints on development that occur with age are largely beyond personal control (e.g., increasing physical limitations, loss of loved ones). Thus, aging adults may benefit from changing how they interpret situations, rather than attempting to change the situations themselves (Nowlan, 2015a,b). Consistent with these perspectives, cross-sectional data have suggested that positive reappraisal is associated with better health (Bower, Kemeny, Taylor, & Fahey, 1998; Dunigan, Carr, & Steel, 2007; Ickovics et al., 2006), and that the strength of the relationship between positive reappraisal use and health may be stronger in older adults than younger adults (Wrosch, Heckhausen & Lachman, 2000). In one study using MIDUS data, (Wrosch et al., 2000) older adults were shown to use positive reappraisal at higher frequencies than younger adults. Further, the use of positive reappraisal had a higher adaptive value (i.e., stronger relationship with subjective well-being) in older adults relative to younger adults.

In MIDUS, four items were used to assess positive reappraisal that were part of a series of measures examining primary and secondary control strategies, which refer to the strategies people employ to manage environmental challenges (e.g., failure and loss) (Heckhausen & Schulz, 1995). These types of control strategies have been identified as important predictors of well-being and health (Wrosch, 2000). Primary control strategies are focused on changing the external circumstances so that they meet personal needs; examples include persistence in goal striving or increasing effort in the face of obstacles. Secondary control strategies conversely address inner experiences and involve adjusting inner emotions, cognitions, or motivations (Heckhausen & Schulz, 1995). Examples of secondary control strategies include positive reappraisal, downward comparison, and goal disengagement (Heckhausen & Schulz, 1995). In MIDUS the four items used to represent the positive reappraisal construct are as follows: 1) "I find I usually learn something meaningful from a difficult situation," 2) "When I am faced with a bad situation, it helps to find a different way of looking at things," 3) "Even when everything seems to be going wrong, I can usually find a bright side to the situation," and 4) "I can find something positive, even in the worst situations." Therefore, these items reflect the self-reported tendency to locate positive aspects of challenging situations. As discussed, this construct overlaps with the construct termed *benefit finding,* although benefit finding tends to refer to finding benefits in a specific traumatic event, rather than the tendency to reappraise situations positively in general (Helgeson, Reynolds and Tomich, 2006). Other researchers using MIDUS data (Wrosch et al., 2000) have provided some support for the convergent validity of the positive reappraisals subscale by reporting significant correlations with related constructs (e.g., mastery beliefs).

There are sparse data on whether or not positive affect promotes the use of positive reappraisal specifically, although some data suggest that this may be the case. A recent study using ecological momentary assessment explored the relationships between positive affect and "broad-minded" affect regulation, a construct that included a measure of positive reappraisal (Pavani, Le Vigouroux, Kop, Congard, & Dauvier, 2016). Over the course of a few hours, experiencing positive emotion at the beginning of the time interval predicted increases in the use of positive reappraisal throughout the remainder of the time interval. Furthermore, increasing the use of positive reappraisal, along with other broad-minded strategies like problem-solving, predicted higher levels of positive affect at the end of the time interval (Pavani et al., 2016). Few studies to date have explored positive reappraisal in the context of cardiovascular disease, although in one study of survivors of myocardial infarction, positive reappraisal of the heart attack event was shown to negatively predict heart attack recurrence within an 8-year follow-up period (Affleck et al., 1987). In this study, a slight majority of participants perceived benefits associated with the heart attack event, and the most frequently reported perceived benefits included 1) an increased perceived benefit of healthy behaviors (e.g., exercise), 2) the belief the event would lead them to make behavior changes that would increase life enjoyment and longevity (e.g., implementing stress reduction techniques), and 3) experiencing changes in values, religious views, and meaning in life. Based upon the broaden and build perspective that positive affect promotes psychological resource accrual and limited empirical data, there is reason to believe that positive affect may promote the use of positive re-appraisal strategies in aging adults. The present study explored the degree to which positive affect predicts growth in positive reappraisal use among older adults over a 20-year period.

Chapter 3. Statement of the Problem

Although positive affect has been associated with cardiovascular health outcomes, no study has quantified the degree to which positive affect relates to both the initial level and the rate of change in CVH across later life development. Furthermore, the potentially unique contribution of positive affect on CVH above and beyond the role of negative affect remains unclear. The present study used the *broaden and build* theory as a conceptual framework from which to examine the predictive influence of positive and negative affect on the rate of change in physical resources (i.e., CVH). Further, I examined whether, as predicted by the *broaden and build* theory, positive affect precedes engagement in broadened behaviors known to support health (i.e., volunteerism), and a building of psychological resources linked with better physical health (i.e., use of positive reappraisal strategies). Given that cardiovascular disease remains a widespread public health concern, it is necessary to better understand protective factors that may mitigate CVH decline in aging adults. For a visual representation of the components of the broaden and build theory tested in the present study, see Appendix A.

The present study used data obtained from the Midlife in the United States (MIDUS) survey series; specifically, data collected in the following three waves: MIDUS 1 (collected from 1995–1996; T1), MIDUS 2 (collected from 2004– 2005; T2, and MIDUS 3 (collected from 2013-2014; T3). MIDUS was a multidisciplinary effort to understand the predictors and correlates of healthy aging. At the initial assessment, participants were aged between 25 and 74 years. At each time point, variables describing trait positive affect, cardiovascular health and positive reappraisal use are available. Age and cardiovascular disease show a curvilinear relationship during adulthood, which becomes linear in the fifth decade of life as reported by others (American Heart Association, 2016). Given the increased risk of CVD and linear relationship between age and risk in later life, the present study included adults aged 50 and older.

The present analyses controlled for sociodemographic variables previously linked with CVH, including age, gender, household income, education level, and race (American Heart Association, 2016). Conceptualization of these variables as control variables is typical in the literature on affect and CVH (Boehm & Kubzansky, 2012; Todaro et al., 2003; Yanek et al., 2013). Beyond these sociodemographic variables, there is inconsistency in the literature regarding how health factors identified by the AHA (2016), including smoking status, hypertensive status, hyperlipidemia, exercise behavior, diabetes status, diet and body mass index are conceptualized and treated in statistical models. For example, some studies have conceptualized blood pressure, hyperlipidemia, body mass index, and exercise behavior as outcomes that reflect CV risk or health, whereas others have used these as control variables in an attempt to isolate the effect of affect on a specific CVD-related outcome (e.g., cardiac death). Consistent with the AHA's conceptualization of health factors and behaviors, I used the following five variables as outcome variables reflecting CVH: hypertension, smoking status, diabetes status, body mass index, and physical exercise. Each of these variables was assessed at each of the three MIDUS survey waves. A composite score was computed for each participant by summing the number of CV health metrics falling into the ideal range, consistent with prior studies (Fang, Yang, Hong and Loustalot, 2012; Wu et al., 2012; Yang et al., 2012).

When examining relationships between affect and volunteerism, analyses adjusted for demographic characteristics previously associated with volunteerism, including age, gender, income, education level, and race (Bureau of Labor Statistics, 2015). The relationships between demographic characteristics and positive reappraisal use are less clear. Studies using MIDUS data to examine control strategies, including positive reappraisal, have included age, gender, race, and education level as covariates, and have reported that older individuals use positive reappraisal more frequently than younger individuals, and that African Americans tend to endorse higher levels of positive reappraisal use than Whites (Wrosch, 2000). Another study examining health status and control strategies (Chipperfield et al., 2007) reported that women tend to use positive reappraisal more frequently than men, but that income, race, and education levels are only weakly associated with control strategies (r's$<.15$). Due to these low correlations, the authors elected not to include education level, income, gender and race in statistical models. I included age, gender, race, education level, and income as covariates in the latent growth models exploring the relations between affect and positive reappraisal. Specific hypotheses and exploratory questions tested in the present study and their justification are listed below:

1. At the group level, CVH will decline from T1 to T3 (a 20-year period).

   Justification: Empirical data show that at the group level, CVH declines with age.

2. Positive affect will explain individual variation in the initial levels of CVH (T1) and rates of change in CVH over a 20-year span (T1-T3), above and beyond the effect of negative affect and sociodemographic covariates. Specifically:

a. Individuals higher in positive affect at T1 will exhibit better CVH at T1 relative to those lower in positive affect, holding constant negative affect and sociodemographic risk factors.

Justification: The *build* component of the *broaden and build* theory holds that positive affect leads to increases in physical resources. Likely at the initial assessment when participants have reached late life (age range 50-74 at T1), those higher in positive affect will already have accrued some amount of physical resources (i.e., better CVH).

b. Individuals higher in positive affect at T1 will show slower rates of decline in CVH from T1 to T3, holding constant negative affect and sociodemographic risk factors.

Justification: The *build* component of the *broaden and build* theory states that positive affect leads to increases in physical resources over time. Thus, positive affect should explain individual variation in the rate at which people decline in CVH from T1 to T3.

3. In an exploratory fashion, I examined the interaction between positive and negative affect on CVH.

   Justification: It is currently unknown how negative and positive affect relate to predict CVD risk. It may be that the protective role of positive affect depends upon levels of negative affect in some fashion. Therefore, no a prior hypothesis were made for this analysis.

4. Positive affect will explain individual variation in the initial levels of volunteerism (T1) and rates of change in volunteerism over a 20-year span (T1-T3), above and beyond the effect of negative affect and sociodemographic covariates. Specifically:

a. Individuals higher in positive affect at T1 will exhibit higher levels of volunteerism at T1 relative to those lower in positive affect, holding constant negative affect and sociodemographic covariates.

b. Individuals higher in positive affect at T1 will show slower rates of decline in volunteerism from T1 to T3, holding constant negative affect and sociodemographic factors. Statistically, the path coefficient between T1 positive affect and the volunteerism slope will be positive and significant.

Justification: The *broaden* component of the *broaden and build* theory holds that positive affect leads to an expansion in action repertoires that support well-being. Therefore, individuals higher in positive affect may feel more motivated to engage in volunteerism, an altruistic behavior previously linked with better health.

5. Positive affect will explain variation in initial levels (T1) and rates of change in positive reappraisal use over a 20-year period (T1-T3), holding constant negative affect and sociodemographic covariates.

    a. Individuals higher in positive affect at T1 will exhibit higher levels of positive reappraisal use at T1 relative to those lower in positive affect, holding constant negative affect and sociodemographic covariates.

Justification: The *build* component of the *broaden and build* theory holds that positive affect leads to increases in psychological resources. Likely at the initial assessment when participants are aged somewhere between 50 and 74, those higher in trait positive affect will already have accrued some level of psychological resources (i.e., use of positive reappraisal).

b. Individuals higher in positive affect at T1 will increase their use of positive appraisal over a 20-year span (T1 to T3) to a greater extent than those lower in T1 positive affect, holding constant negative affect and sociodemographic covariates.

Justification: The broaden and build theory states that positive affect leads to increases in psychological resources. Thus, positive affect should explain individual variation in the rate at which people make gains in their use of positive appraisal.

Chapter 4: Method

Design Statement

A linear growth modeling approach (LGM) was used to examine initial levels and trajectories of change in variables (Duncan & Duncan, 2004). This approach has the capacity to describe individual differences in growth trajectories over time and the degree to which predictor variables explain these differences. At the same time, group level trends can also be described. The LGM approach provided a means to explore the degree to which positive affect predicts initial levels of outcome variables as well as individual differences in their change over time.

The *broaden and build* theory posits that positive emotions lead people to broaden their thoughts and behaviors and to build personal resources. In the proposed study, three LGM models were used to examine the relationships between 1) positive affect and CVD risk (a physical resource), 2) positive affect and volunteerism (a broadened behavior) and 3) positive affect and positive reappraisal (a psychological resource) (see Figure 2).

Independent variables, dependent variables, and covariates are listed below:

Independent variables: Initial levels of positive affect, initial levels of negative affect, and the interaction between initial levels of positive and negative affect.

Dependent variables: Initial levels (intercepts) and growth (slopes) in CVH (Model 1), volunteerism (Model 2), and positive reappraisal (Model 3)

Fixed covariates: These were consistent across all three models and included the following: Age at T1, gender, education level, household income, and race/ethnicity.

Figure 2 below is a visual representation of the three models:

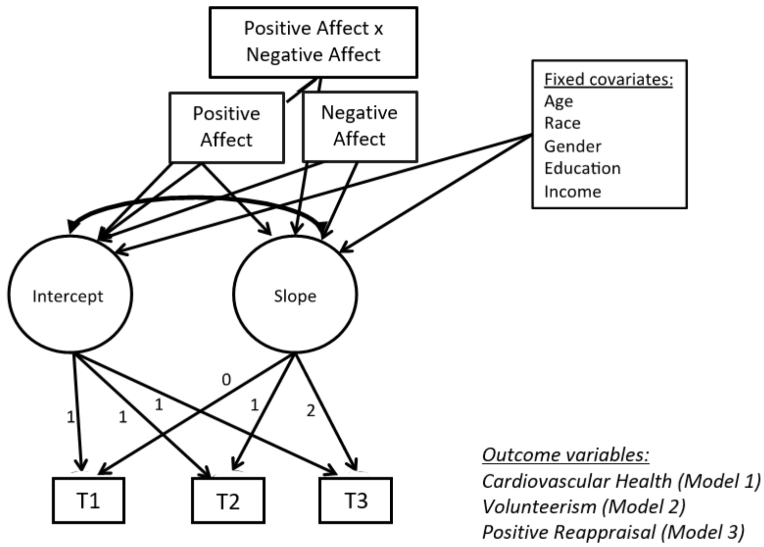


Figure 2: Visual representation of linear growth models.

Participants and Procedures

Data were drawn from three waves of the Midlife in the United States (MIDUS) survey, including MIDUS 1 (collected from 1995–1996), MIDUS 2 (collected from 2004–2005, and MIDUS 3 (collected from 2013-2014). The MIDUS project is a multidisciplinary study of factors contributing to healthy adult development in the areas of physical health, psychological well-being, and social functioning. MIDUS 1 included a probability sample of 7108 non-institutionalized, English speaking adults living in the United States aged 25-74 (Radler & Ryff, 2010). The sample was not stratified. Assessments included a 30-minute phone interview followed by two Self-Administered Questionnaires (SAQs), which were mailed to participants after they completed the phone interview. The analytic sample included 1266 participants who were aged 50 and above who also had a value for the main weight (see Weights).

Weights

A main weight (titled NFNWT in the MIDUS datafile) was constructed by MIDUS researchers that corrects for differences in selection probability (e.g., as related to the neighborhood characteristics of a respondent's household) and differential non-response following successful contact with the respondent (e.g., as related to individual sociodemographic characteristics) (Brim et al., 1995-1996). This weight was used in analyses. Standard errors were adjusted using jackknife repeated replication (JRR) methods for unstratified samples (see Stapleton, 2008, p.191) based on recommendations from MIDUS researchers and in accordance with recommended procedures for MPlus users (https://www.statmodel.com/download/Resampling_Methods5.pdf). Because the MIDUS sampling design was not simple random sampling (SRS), as is the case with most national datasets, the assumption of independence of observations does not hold and standard errors must be adjusted (see Stapleton, 2008). MIDUS researchers recommend jackknife repeated replication as a preferred method to adjust standard errors. In general, jackknife repeated replication involves systematically recomputing estimates by leaving out one or more observations at a time. MIDUS researchers created 100 random subsamples for this purpose, and analysts must create the JRR weights using these subsamples. To construct the replicate weights, the main weight (NFNWT) must be used in conjunction with a variable titled JRR, which ranges from 1 to 100 and denotes subsample membership. Both of these variables can be found in the datafile titled "DS2 Main Sample: Weights for Respondents Completing Both the Telephone Survey and Mail Questionnaire" held with the Inter-university Consortium for Political and Social Research (ICSPR) and accessed directly via the following link: https://www.icpsr.umich.edu/icpsrweb/ICPSR/studies/2760/datadocumentation# (Brim, Baltes, Lachman, Markus, Shweder, Marmot,…Kessler, 1995-1996).

To build the JRR weights, one hundred columns of data must be created such that each respondent's main weight is populated across all 100 columns, except for the column corresponding to their JRR value, in which a 0 is assigned. There are various ways of accomplishing this. In a hypothetical example to illustrate the procedure used in the present study, the 100 newly created columns were named JRR1-JRR100. These columns were populated with 1's and 0's in accordance with JRR (e.g., if JRR=1, JRR1=0, if else, JRR1=1). Following the population of 1's and 0's to JRR1-JRR100 in correspondence with JRR, JRR1-JRR100 were multiplied by the main weight (NFNWT). JRR1-JRR100 were then specified as the jackknife replicate weights in MPlus. To view instructions associated with JRR weights published by MIDUS researchers, please consult the document titled “Midlife In the United States (MIDUS 1),1995-1996, Technical Report on Methodology” available on the ICSPR website.

Measures

Demographics

Demographic variables included age in years (ranging from 50 to 74 at T1), gender (0=*male*, 1=*female*), college graduate (1 = *yes, 0 =no)* household income (dollars per year) and race/ethnicity (1 = White [n=1117], 2 = Black and/or African American [n=74], 3 = Native American or Aleutian Islander/Eskimo [n=8], 4 = Asian or Pacific Islander [n=6], 5 = Other [n=16], 6 = Multiracial [n=9] (see Appendix B). Prior studies examining affect and CVD using MIDUS data (Carr, Friedman, & Jaffe, 2007) have categorized the race and ethnicity variable dichotomously as 1 = Black/African American, and 0 = all others, due to the low representation of other groups besides those categorized as White or Black/African American. Other studies have dichotomized race as 1 = White and 0 = all others (Keyes, 2005). Descriptive data in the analytic sample (i.e., means and standard deviations) on cardiovascular health for each category of race/ethnicity were reviewed. Participants categorized as African American or Native American or Aleutian Islander/Eskimo had on average the lowest number of CVH metrics in the ideal range (unweighted *M* at T1 = 2.67, *SD*=1.01; n=82). This is consistent with literature identifying these groups as vulnerable populations in terms of cardiovascular health (e.g., Lloyd-Jones et al., 2009, Zhang et al., 2008). Whites and Asian Americans had the highest number in the ideal range (unweighted *M* at T1 =3.16, *SD* = 1.10, n=1123), and those classified as Multiracial or Other averaged 3.06 (*SD*=1.12) metrics in the ideal range. Although it is difficult to understand who is represented specifically within the Other and Multiracial categories as defined by MIDUS, these cases were retained in the analysis to maximize the number of older adults included in the study, and three race/ethnicity categories constructed and used in analyses: 1) White/Asian American (the reference group), 2) African American/Native American, and 3) Multiracial/Other. In additional post-hoc MLR analyses, dummy codes were computed to examine CVH in each group in comparison with a reference group and in other combinations in comparison with a reference group. The reference group was defined as White respondents in some analyses and African American respondents in others (see Data Analysis). Household income and education level were selected as variables to represent socioeconomic status consistent with prior research using MIDUS (Boehm, Chen, Williams, Ryff, & Kubzansky, 2015; Boylan & Robert, 2017).

Positive and Negative Affect

The MIDUS study assessed positive affect via self-administered surveys, where participants reported on the degree to which they experienced six positive emotions (e.g., cheerful, in good spirits) over the previous 30 days on a 5-point frequency rating scale (1=*none of the time*, 2=a *little of the time*, 3=*some of the time*, 4=*most of the time*, and 5=*and all the time*) (Appendix C). The 6-item positive affect scale included items drawn from several measures of positive emotions, including the Affect Balance Scale (Bradburn, 1969) and General Well-Being Schedule (Fazio, 1977). Positive affect scores were computed by MIDUS researchers by calculating the mean for the 6 items; higher scores indicate higher levels of positive affect. Reliability estimates for the positive affect scale are high (MIDUS 1 = .90, MIDUS 2 = .92; MIDUS 3 = .91). Negative emotions were similarly measured with 6 items asking participants to report the frequency with which they experienced a series of negative emotions (e.g., sadness) on a 5-point frequency rating scale (1=*none of the time*, 2=a *little of the time*, 3=*some of the time*, 4=*most of the time*, and 5=*and all the time*) (Appendix E). Negative affect scores were computed by calculating the mean for the 6 items; higher scores indicate higher levels of negative affect. Reliability estimates of the 6-item negative affect scale are high (MIDUS 1 = MIDUS 2 = .85, MIDUS 3 = .85). In analyses, positive and negative affect were mean centered to reduce multicollinearity. Centered positive and negative affect scores were multiplied to construct the positive by negative affect interaction term.

Volunteerism

On mailed surveys, participants answered the following question: On average, about how many hours per month do you spend doing formal volunteer work of any of the following types: a) hospital, nursing home, or other healthcare-oriented volunteer work, b) school or other youth-related volunteer work, c) volunteer work for political organizations or causes, d) volunteer work for any other organization, cause, or charity?" Hours reported for each of these categories were summed to create a volunteerism score, consistent with prior research using MIDUS (Son & Wilson, 2012) (Appendix D).

Positive Reappraisal

Positive appraisal was assessed in MIDUS using the Positive Reappraisals scale of the Primary and Secondary Control questionnaire. Four items comprised the scale, 1) "I find I usually learn something meaningful from a difficult situation," 2) "When I am faced with a bad situation, it helps to find a different way of looking at things," 3) "Even when everything seems to be going wrong, I can usually find a bright side to the situation," and 4) "I can find something positive, even in the worst situations." Respondents answered on 4-point rating scales (1=*A lot*; 2=*Some*; 3=*A little*; 4= *Not at all*) (Appendix E). Scale scores were created by calculating the mean for the four items. Higher scores indicate higher tendency to positively reappraise distressing situations. Cronbach's alpha coefficients in MIDUS have been reported as follows: .78 (MIDUS 1), .78 (MIDUS 2), and .77 (MIDUS 3).

Cardiovascular ealth

CVH was measured using 5 of the 7 American Heart Association (2016) metrics available in MIDUS I, II and III: 1) hypertensive status (dichotomous), 2) diabetes status (dichotomous), 3) exercise behavior (continuous), 4) smoking status (dichotomous) and 5) body mass index (continuous) (Appendix F). According to the American Heart Association (2016), these are five of seven variables considered to be the most robust indicators of cardiovascular health. The two remaining variables identified by the AHA are healthy diet and cholesterol status, which were not included because they are not included in MIDUS I, II and III. Consistent with prior research (Wu et al., 2012; Yang et al., 2012), each health metric was first evaluated as to whether it met the ideal level; next, and the number of ideal health metrics were then summed to create a total score ranging from 0 to 5 (0 = no health metrics in the ideal range, 5 = all available health metrics in the ideal range).

The self-report nature of data collection in MIDUS I, II and III precluded direct measurement of blood pressure and blood sugar levels; thus, self-reported hypertensive diagnosis and diabetes diagnosis were used as proxy variables for non-ideal status on these variables, consistent with prior population survey studies using self-report data to examine the AHA (2016) health metrics in the US population (Fang, Yang, Hong and Loustalot, 2012). Other approximations of AHA-defined health metrics have been made; for instance, using sodium intake as a proxy for healthy diet score (Wu et al., 2012), and physical activity levels have been summarized through various methods to approximate the criteria outlined by the AHA; for instance, Wu and his colleagues (2012) classified participants as "very active (>80 minutes/week)," moderately active (0-80 minutes/week)," or "inactive"(no activity) based on responses to questions about type and frequency of physical activity during work and leisure time (no further details about the questions were published), and defined ideal physical activity as the "very active" category, whereas other authors (Yang et al., 2012) assigned intensity values to participants' self-reported physical activities using metabolic equivalent tasks (METs), and classified participants as physically active (ideal category) if they engaged in any physical activity with 3-5.9 METs 5 or more times per week, or any physical activity with 6 or more METs 3 or more times per week. This latter approach reflects a conceptualization of a physically active individual as one who engages in moderate activity on a frequent basis and/or one who engages in vigorous activity on a somewhat less frequent basis. I defined ideal physical activity as engaging in year-long physical activity multiple times per week at either moderate or vigorous intensity levels. MIDUS I versus MIDUS II and III in the way that physical activity questions were posed. In MIDUS I, participants were asked to report the frequency with which they engaged in moderate and vigorous exercise in the winter and summer months. Thus, to meet ideal levels at MIDUS I, participants needed to have reported engaging in moderate or vigorous exercise multiple times per week in both summer and winter months. In MIDUS

II and III, participants were asked to report the frequently with which they engaged in moderate and vigorous activities in job related, household related, and leisure related activities in the summer and winter months. Data from leisure, job-related and household-related activity items were examined in order to determine levels representing ideal levels of physical activity. At T2, job-related moderate and vigorous activities on average ranged from 1.5-1.8, reflecting a frequency of less than once per week. Job-related activities were thus excluded from analyses, perhaps related to irrelevance of these activities for the aging adult sample (e.g., retirement). Leisure and chore-related activities were examined further as indicators of physical activity levels. In accordance with AHA (2016) guidelines, those participants who reported engaging in consistent yearlong (i.e., in both summer and winter months) physical activity at either moderate or vigorous intensity levels multiple times per week were defined as meeting ideal levels of physical activity. For MIDUS II and III waves, the moderate or vigorous physical activity could be through leisure or chore-related activities.

To compute the CVH composite, I modified the approach used by cardiovascular health researchers published in the *Journal of the American Medical Association* (Yang et al., 2012) documenting associations between the 7 health metrics with all-cause CVD mortality in US adults. The authors used a representative sample of nearly 50,000 adults from the National Health and Nutrition Examination Survey (NHANES). Similar approaches have been used by other researchers using the AHA health metrics (Fang et al., 2012; Wu et al., 20120;). Specifically, a CVH score (number of health metrics falling into the ideal range) was computed by recoding the 5 metrics as dichotomous variables using 1 point to represent the ideal category and 0 points reflecting other categories:

nonsmoking (never and former) [1 point] vs current [0 points], + ideal physical activity [1 point] versus others [0 points] + body mass index [BMI, computed as weight in kg/height(m^2)]<25 (1 point) versus others (0 points) + nondiabetic [1 point] versus diabetic [0 points] + normotensive [1 point] + hypertensive [0 points]. Participants were classified as meeting 0, 1, 2, 3, 4, or 5 of the CVD health metrics at each time point. In Yang (2012), participants were excluded from analyses if they were missing data on 1 or more of the health metrics. I took a similar approach when analyzing CVH and excluded participants if they were missing data on one or more health metrics.

Chapter 5: Data Analysis

The present study used a latent growth modeling (LGM) approach. Three separate LGM models were used examine the components of the broaden-and-build theory of positive emotion. Specifically, three models were used to examine the relationships between 1) positive affect and CVH (a physical resource), 2) positive affect and volunteerism (a broadened behavior) and 3) positive affect and positive reappraisal (a psychological resource). These models correspond with the *broaden* (model 2) and *build* (models 1 and 3) components of the broaden and build theory of positive emotion (Fredrickson, 2004). In all three models, T1 positive affect, T1 negative affect, the interaction between T1 negative and T1 positive affect, as well as fixed sociodemographic covariates were used to predict the intercept and slope of dependent variables.

LGM analyses were conducted in MPlus (Muthén & Muthén, 2012). Data were inspected for normality and outliers (see Results). Growth models were specified using maximum likelihood estimation with robust standard errors, which yields parameter estimates and standard errors that are robust to non-normality with complex sample designs (Muthén & Muthén, 2012). Baseline models without any predictors were first examined to evaluate model fit. If acceptable fit was evident, predictors of intercept and slope variance were added and evaluated. Recommended fit indices and cutoff scores (Hu & Bentler, 1999) were used to evaluate model fit, including the model chi squared statistic and the SRMR (absolute fit indices comparing observed and model-implied variance/covariance matrices), the RMSEA (a fit index adjusting for model complexity), and the CFI (an incremental fit index comparing the target model with a baseline model specifying no relationships between variables). Cutoff scores for fit indices were as follows: SRMR $\leq$.08, RMSEA $\leq$.06, CFI $\geq$.95. Fixed covariates included the following: age in years at T1, gender (male versus female), household income at T1 (rescaled by 1,000), education level (college graduate versus other), and race/ethnicity (grouped as African American/Native American, White/Asian-American and Multiracial/Other). Cardiovascular health was computed by summing the number of cardiovascular health metrics defined by the AHA that fell into the AHA's defined criteria of what constitutes ideal levels: body mass index (a continuous variable), hypertensive status (dichotomous), smoking status (dichotomous), diabetes status (dichotomous), and frequency of exercise (continuous).

Conceptual and statistical hypotheses are listed below:

1. At the group level, CVH will decline from T1 to T3 (a 20-year period). Statistically, the group level growth trajectory (mean associated with the slope factor) will be negative and significant.

Justification: Empirical data show that at the group level, CVH declines with age.

2. Positive affect will explain individual variation in the initial levels of CVH (T1) and rates of change in CVH over a 20-year span (T1-T3), above and beyond the effect of negative affect and sociodemographic covariates. Specifically:
    a. Individuals higher in positive affect at T1 will exhibit better CVH at T1 relative to those lower in positive affect, holding constant negative affect and sociodemographic risk factors. Statistically, the path coefficient between positive affect and the CVH intercept will be positive and significant.

Justification: The *build* component of the *broaden and build* theory holds that positive affect leads to increases in physical resources. Likely at the initial assessment when participants have reached late life (age range 50-74 at T1), those higher in positive affect will already have accrued some amount of physical resources (i.e., better CVH).

b. Individuals higher in positive affect at T1 will show slower rates of decline in CVH from T1 to T3, holding constant negative affect and sociodemographic risk factors. Statistically, the path coefficient between positive affect and the slope of CVH will be positive and significant.

Justification: The *build* component of the *broaden and build* theory states that positive affect leads to increases in physical resources over time. Thus, positive affect should explain individual variation in the rate at which people decline in CVH from T1 to T3.

3. In an exploratory fashion, I examined the interaction between positive and negative affect on CVH.

   Justification: It is currently unknown how negative and positive affect relate to predict CVD risk. It may be that the protective role of positive affect depends upon levels of negative affect in some fashion. Therefore, no a prior hypothesis were made for this analysis.

4. Positive affect will explain individual variation in the initial levels of volunteerism (T1) and rates of change in volunteerism over a 20-year span (T1-T3), above and beyond the effect of negative affect and sociodemographic covariates. Specifically:

   a. Individuals higher in positive affect at T1 will exhibit higher levels of volunteerism at T1 relative to those lower in positive affect, holding constant negative affect and sociodemographic covariates. Statistically, the structural path between T1 positive affect and the volunteerism intercept will be positive and significant.

5. Individuals higher in positive affect at T1 will show slower rates of decline in volunteerism from T1 to T3, holding constant negative affect and sociodemographic factors. Statistically, the path coefficient between T1 positive affect and the volunteerism slope will be positive and significant.

Justification: The *broaden* component of the *broaden and build* theory holds that positive affect leads to an expansion in action repertoires that support well-being. Therefore, individuals higher in positive affect may feel more motivated to engage in volunteerism, an altruistic behavior previously linked with better health.

6. Positive affect will explain variation in initial levels (T1) and rates of change in positive reappraisal use over a 20-year period (T1-T3), holding constant negative affect and sociodemographic covariates.

   a. Individuals higher in positive affect at T1 will exhibit higher levels of positive reappraisal use at T1 relative to those lower in positive affect, holding constant negative affect and sociodemographic covariates. Statistically, the path coefficient between T1 positive affect and the positive reappraisal intercept will be positive and significant.

Justification: The *build* component of the *broaden and build* theory holds that positive affect leads to increases in psychological resources. Likely at the initial assessment when participants are aged somewhere between 50 and 74, those higher in trait positive affect will already have accrued some level of psychological resources (i.e., use of positive reappraisal).

b. Individuals higher in positive affect at T1 will increase their use of positive appraisal over a 20-year span (T1 to T3) to a greater extent than those lower in T1 positive affect, holding constant negative affect and sociodemographic covariates. Statistically, the path coefficient between positive affect and the positive reappraisal slope with be positive and significant.

Justification: The broaden and build theory states that positive affect leads to increases in psychological resources. Thus, positive affect should explain individual variation in the rate at which people make gains in their use of positive appraisal.

Chapter 6: Results

Sample Characteristics

Participants ranged in age from 50 to 93 years across the two decades of data collection. Age composition at each time point is shown in Figure 3.

There were 1266 participants aged 50 and older who completed the T1 assessment and who also had a value for the main weight variable; of these, 883 and 514 participants provided some amount of data at T2 and T3, respectively. Weighted means and standard deviations for all variables are shown in Table 1. Differences between weighted and unweighted means show consistencies with weighted versus unweighted data published by MIDUS researchers (Brim, 1995; see Midlife In the United States [MIDUS 1],1995-1996, Technical Report on Methodology, p.20).

Outcome variables were inspected for normality and outliers. Skewness and kur tosis values ranged from -1.02 to .05 for CVH and PR. Values for volunteerism at each ti me point indicated non-normal distributions with substantial positive skew (4.85 at T1, 3. 51 at T2, an7.77 at T3) and high kurtosis (107.1 at T1, 17.4 at T2, and 34.5 at T3). Non-n ormality appeared related to the high proportions of respondents at each time point report ing that they never volunteered (64% [n=737] at T1, 57%[n=348] at T2, and 64% at T3[n =232]). Maximum likelihood estimation with robust standard errors (the MLR estimator i n Mplus) was used in statistical models, which yields parameter estimates with standard e rrors and a chi-square test statistic that are robust to non-normality (Muthén & Muthén, 2 012).

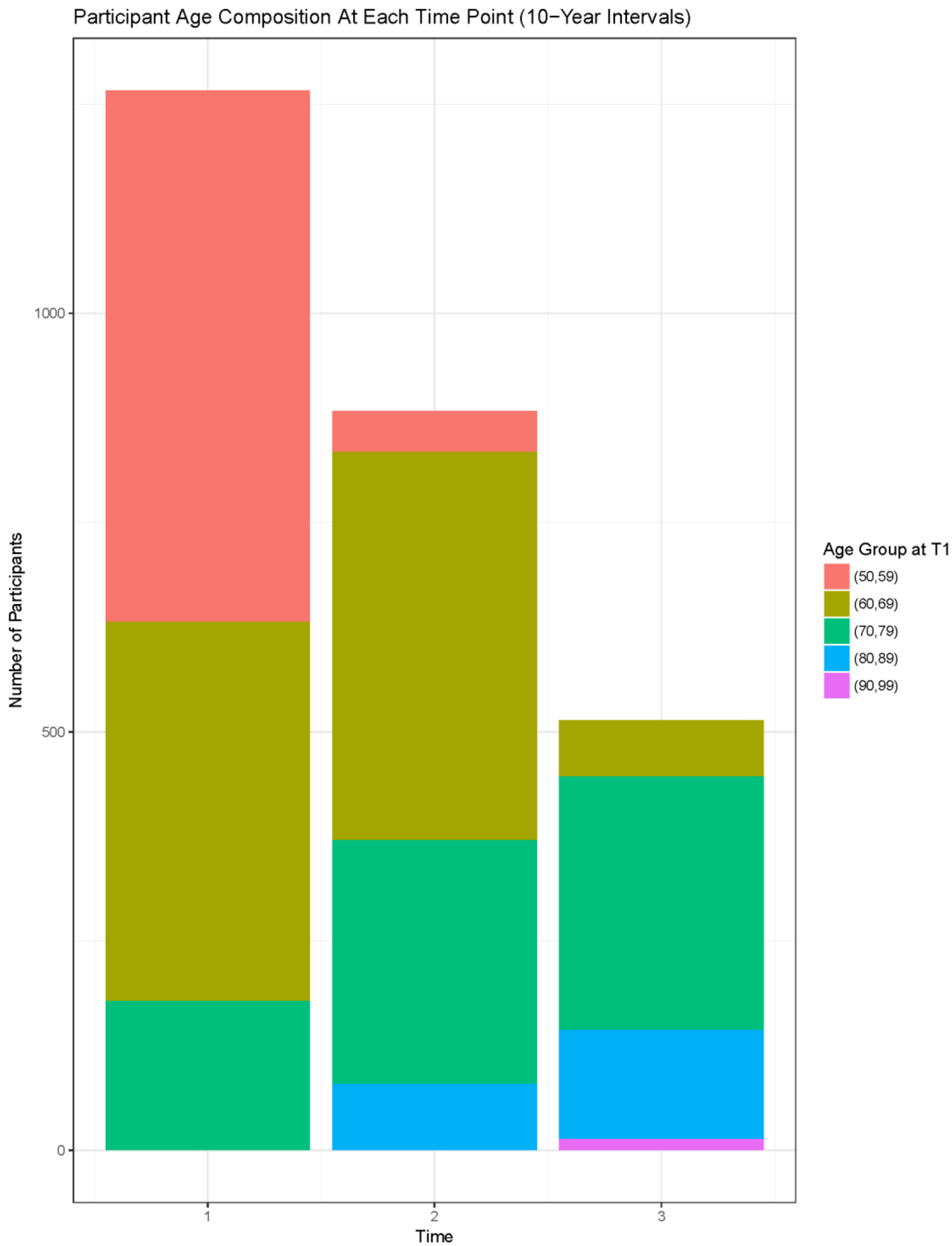


Figure 3: Age composition of participants. There were 1266 participants at T1, 883 at T2, and 514 at T3.

Table 1

Unweighted and Weighted Means and Proportions

	Unweighted			Weighted		
	Time 1	Time 2	Time 3	Time 1	Time 2	Time 3
	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)	Mean (SE)
Age	60.14	68.75	76.03	57.39(0.63)	66.53(0.53)	75.64 (0.62)
Family Income	61.54	-	-	68.49 (5.04)	-	-
Cardiovascular Health*	3.11 (0.04)	2.77 (0.06)	2.86 (0.07)	3.29 (0.12)	2.80 (0.13)	2.67 (0.11)
Volunteerism	5.03 (0.38)	7.68 (0.60)	6.42 (0.78)	3.74 (1.04)	6.67 (1.72)	4.27 (1.03)
Positive Reappraisal	3.19 (0.07)	3.05 (0.02)	3.01 (0.02)	3.13 (0.06)	3.03 (0.07)	2.95 (0.07)
Positive Affect	3.45 (0.02)	3.55 (0.02)	3.52 (0.03)	3.43 (0.07)	3.52 (0.08)	3.41 (0.08)
Negative Affect	1.5 (0.02)	1.5 (0.02)	1.44 (0.03)	1.52 (0.06)	1.47 (0.06)	1.46 (0.05)
Body Mass Index	27.44 (0.15)	27.87 (0.19)	27.36 (0.24)	26.78 (0.38)	27.87 (0.45)	27.65 (0.48)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Female	678 (54)	-	-	643 (59)	652(60)	656 (61)
White/Asian American	1123 (91)	-	-	950 (88)	-	-
African American/Native American	82 (6)	-	-	117 (10)	-	-
Multiracial/Other	25 (2)	-	-	16 (2)	-	-
College graduate	689 (55)	-	-	411 (38)	-	-
Nonsmoker	514 (69)	394 (48)	239 (86)	734 (68)	860 (79)	941 (87)
Normotensive	870 (69)	428 (55)	237 (51)	727 (67)	582 (54)	536 (50)
Nondiabetic	1142 (91)	639 (82)	355 (80)	968 (89)	890 (82)	816 (75)
Physically Active	578 (46)	213 (29)	157 (35)	475 (44)	291 (26)	355 (33)
Ideal BMI	406 (34)	208 (29)	143 (32)	362 (33)	314 (29)	331 (31)

Table 1: Means, standard errors and proportions for all variables. *Cardiovascular health refers to number of cardiovascular health metrics meeting ideal levels (0-5). The baseline assessment of demographic covariates was used in models and T1 data for these values are shown.

Weighted descriptive data shown in Table 1 show that older adults averaged just over 3 cardiovascular metrics out of 5 in the ideal range at Time 1, which declined slightly over the subsequent 20 years. Examining the specific health metrics used to compute the composite cardiovascular health score, consistencies with other national reports (AHA, 2016) on Americans' cardiovascular health are apparent, including a reduction in the proportion of smokers over the past three decades, and low proportions of adults meeting recommendations for physical activity and ideal body mass index. Table 2 shows the average number of health metrics falling into the ideal range by demographic groups at each time point.

Regarding psychological variables, older adults reported generally high and stable levels of positive affect over time and comparably low and consistent levels of negative affect. Volunteer behavior averaged between 3.74 and 6.67 hours per month, with highest average volunteerism occurring at T2. Weighted means for volunteering by sociodemographic groups are shown in Table 2. Female participants as a group showed an apex shape in volunteer behavior, whereas male participants showed stability in volunteerism.

Table 2

Average Number of Cardiovascular Health Metrics in the Ideal Range by Demographic Group

Demographic Characteristics			Time 1	Time 2	Time 3
Age at Enrollment (T1)	50-60	M	3.33	2.83	2.75
		SE	0.13	0.12	0.11
	60-70	M	3.26	2.70	2.73
		SE	0.18	0.19	0.17
	70-80	M	3.61	3.17	3.25
		SE	0.32	0.37	0.43
Gender	Female	M	3.42	3.09	2.91
		SE	0.18	0.15	0.15
	Male	M	3.23	2.55	2.63
		SE	0.12	0.12	0.10
Race	White/Asian American	M	3.30	2.83	2.80
		SE	0.11	0.11	0.10
	African American/Native American	M	3.50	2.53	2.17
		SE	0.34	0.32	0.26
	Multiracial/Other	M	4.09	2.70	2.70
		SE	2.27	0.76	0.76
College Graduate	Yes	M	3.64	3.07	2.95
		SE	0.12	0.14	0.13
	No	M	3.06	2.59	2.61
		SE	0.15	0.14	0.12

Table 2: Average number of CVH metrics falling into the ideal range (0-5) by demographic groups at each time point. Higher numbers mean having more health metrics in the ideal range. Means and SE's computed using weighted data prior to imputation (see Treatment of Missing Data).

Table 3

Average Volunteerism by Demographic Groups

Demographic Characteristics			Time 1	Time 2	Time 3
Age at Enrollment (T1)	50-60	M	3.99	8.74	4.53
		SE	0.83	1.56	0.80
	60-70	M	5.12	5.41	5.44
		SE	1.61	1.73	2.07
	70-80	M	6.12	15.54	2.30
		SE	5.69	10.88	2.37
Gender	Female	M	4.61	10.37	5.00
		SE	1.10	2.06	1.20
	Male	M	4.14	4.26	4.48
		SE	1.15	0.73	0.97
Race/Ethnicity	White/Asian American	M	4.51	8.05	4.97
		SE	0.79	1.22	0.88
	African American/Native American	M	4.37	6.34	3.33
		SE	4.67	6.67	2.26
	Other/Multiracial	M	0.50	4.11	2.43
		SE	0.62	3.37	2.33
College Graduate	Yes	M	5.40	8.31	5.16
		SE	1.11	1.90	1.24
	No	M	3.70	7.45	4.50
		SE	1.03	1.29	0.91

Table 3: Self-reported engagement in volunteerism (hours/month) by demographic groups over time. Means and SE’s computed using weighted data prior to imputation (see Treatment of Missing Data).

Weighted correlations and standard errors between independent and dependent variables are shown in Table 4. PA was positively correlated with CVH at T1 and NA was negatively correlated with CVH at all three time points. CVH scores at each time point were positively correlated with one another. PA and NA were unassociated with volunteerism, and T2 volunteerism was positively correlated with T3 volunteerism. PA was positively correlated with PR at each time point and NA was negatively correlated at each time point. PA and NA were inversely related.

Table 4

Correlations among Independent and Dependent Variables

		CV Health			Volunteerism			Positive Reappraisal			Positive Affect	Negative Affect
	Time	1	2	3	1	2	3	1	2	3	1	1
CV Health	1	1										
	2	.61(.04)***	1									
	3	.57(.06)***	.73(.04)***	1								
Volunteerism	1	.04(.07)	.06(.08)	.12(.08)	1							
	2	.02(.12)	.09(.08)	.08(.10)	.43(.08)***	1						
	3	.00(.10)	.07(.08)	.09(.07)	.13(.07)	.20(.10)*	1					
Positive Reappraisal	1	.07(.05)	.01(.06)	.06(.06)	.08(.03)*	-.01(.06)	.00(.06)	1				
	2	.03(.05)	.03(.05)	.01(.06)	.08(.03)**	.07(.06)	.04(.07)	.54(.03)***	1			
	3	.10(.06)	.09(.06)	.09(.07)	.06(.04)	.00(.08)	-.02(.06)	.56(.04)***	.61(.04)***	1		
Positive Affect	1	.16(.04)***	.08(.05)	.13(.07)	-.05(.03)	.05(.03)	.01(.07)	.33(.04)***	.33(.03)***	.27(.06)***	1	
Negative Affect	1	-.23(.04)***	-.18(.06)**	-.23(.08)**	.06(.04)	-.02(.04)	.13(.07)	-.28(.04)***	-.28(.04)***	-.20(.07)**	-.58(.04)***	1

Table 4: Correlations and standard errors among independent and dependent variables on data prior to imputation (see Treatment of Missing Data). The magnitude of correlations and significance values on the imputed data were consistent with the unimputed data.

*p<.05, **p<.01, ***p<.001

Table 5 shows correlations with demographic covariates.

Table 5

Correlations with Demographic Covariates

		Age	Gender	African American/Native American	Multiracial/Other	Income	Education
	Time	1	1	1	1	1	1
CV Health	1	-.01(.05)	.03(.04)	-.31(.05)**	.04(.03)	.09(.05)*	.11(.04)**
	2	.07(.06)	.13(.06)*	-.13(.05)*	-.01(.02)	.10(.06)	.06(.06)
	3	.07(.07)	.04(.06)	-.11(.05)*	-.03(.04)	.08(.07)	.07(.06)
Volunteerism (V)	1	.02(.04)	.02(.03)	-.003(.003)	-.002(.00)	.09(.04)*	.12(.03)***
	2	-.04(.05)	.11(.05)*	-.004(.004)	-.002(.00)	.10(.04)**	.11(.05)*
	3	.03(.07)	.04(.04)	-.001(.003)	.00(.00)	.07(.07)	.11(.07)
Positive Reappraisal (PR)	1	-.00(.03)	-.00(.03)	.12(.07)	-.003(.01)	.02(.03)	-.04(.03)
	2	-.07(.04)	-.06(.04)	.16(.10)	.08(.03)*	-.01(.03)	-.02(.03)
	3	-.10(.06)	.04(.05)	.16(.12)	.02(.01)	.07(.04)	.02(.05)
Positive Affect (PA)	1	.12(.03)***	-.08(.04)*	.07(.12)	.002(.01)	.05(.03)	-.05(.03)
Negative Affect (NA)	1	.09(.03)*	.12(.03)***	-.01(.07)	.03(.05)	-.12(.04)***	-.10(.03)***
Age	1	1					
Gender	1	.00(.04)	1				
African American/Native American	1	-.01(.01)	.01(.07)	1			
Multiracial/Other	1	-.003(.004)	-.01(.01)	.	1		
Income	1	-.12(.04)***	-.23(.03)***	-.002(.001)***	.00(.00)	1	
Education	1	.14(.03)***	.07(.03)*	-.14(.06)*	.01(.01)	.32(.03)***	1

Table 5. Correlations and standard errors for independent and dependent variables with sociodemographic covariates on data prior to imputation. The magnitude of correlations and significance values on the imputed data were consistent with the unimputed data, with the exception of gender, which was positively correlated with PR use at T2 and at T3 in the imputed data (p's $< .01$). *$p<.05$, **$p<.01$, ***$p<.001$

At T2, male gender was associated with worse CVH, and African American or Native American race/ethnicity was associated with worse CVH at all three time points. At T1, having a higher household income and having a college degree were each associated with better CVH. Surprisingly, age was unassociated with CVH.

Women also volunteered more than men on average at T2. Having a higher household income was associated with more volunteering at T2 and at T3, and having a college degree was also associated with more volunteering at T2 and at T3.

PA was correlated with age and gender, such that older individuals reported higher PA relative to younger individuals and men reported higher PA than women. NA was also correlated with age, such that older individuals reported less NA relative to younger individuals. Being female, having lower household income and having less than a college degree were each associated with higher levels of NA.

Correlations among sociodemographic variables are consistent with well-known patterns of societal disadvantage tied with age, gender and race, as older individuals, individuals classified as African American or Native American and women reported lower household income levels. Classification as African American or Native American was also associated with having less education. Consistent with national trends (US Department of Education, 2018), having a college degree was associated with being female and with higher household income. Younger age at enrollment (1994-1995) was also associated with having a college degree, which likely reflects national trends over the past 50 years where more Americans are obtaining college degrees (US Department of Education, 2018)

Treatment of Missing Data

Substantial participant attrition was evident, which is common in longitudinal health studies among the elderly (Chatfield, Brayne, & Matthews, 2005). Numbers of cases with complete data on CVD health metrics from T1-T3 were as follows: hypertension (n=435), diabetes (n=437), body mass index (n=391), smoking status (n=265), and exercise behavior (n=405). Just 185 cases had complete data for all health metrics across all three time points (i.e., complete data on cardiovascular health status from T1-T3). Substantial missing data was evident for volunteerism and positive reappraisal as well. There were 433 adults with complete data on positive reappraisal use and 283 with complete data on volunteerism. Item-level missing data patterns are shown in Appendix G. In a systematic review on attrition patterns in health studies among older adults, Chatfield and colleagues (2005) reported that attrition is more common among those with worse physical health, more advanced in age and with higher levels of cognitive decline.

Due the high likelihood that missing data patterns were tied with cardiovascular disease and/or health more generally, methods for reducing inaccuracy in models introduced by missing data patterns were explored. Missing data were imputed using predictive mean matching (PMM) with the MICE (Multivariate Imputation by Chained Equations) package in R (Buuren & Groothuis-Oudshoorn, 2010). PMM has been described as a type of hot deck imputation method whereby missing values within a record are replaced with values based on observed data within that same record (Vink, Frank, Pannekoek & Buuren, 2014). PMM has been shown to preserve underlying distributions and yield acceptable estimates for continuous, categorical, dichotomous (Vink. Lazendic & Van Buuren, 2015) and semicontinuous data (Vink et al., 2014).

Data were imputed in MICE according to recommended procedures (Buuren & Groothuis-Oudshoorn, 2010), including inspection of missing data patterns, selecting predictor variables to be used to impute missing values, generating imputations via PMM (the default method for numerical data in MICE) and inspection of multiply imputed datasets for plausibility (e.g., examination of distributions of imputed versus raw data with jitter plots, histograms). MICE in R imputes five datasets by default. For each outcome variable, distributions of the five imputed datasets were inspected by comparing histograms visually and examining the means, standard deviations, skewness/kurtosis and standard errors. Values for each of these were similar in the five imputed datasets for each outcome variable. In particular, standard errors of the means of each outcome variable were identical across the five imputations for positive reappraisal, identical for CVH except for one that differed from the others by .01, and identical for nearly all volunteerism distributions with the maximum difference between any two values equaling .03. Given these similarities, a single imputation used and the first of the five imputed datasets for each outcome variable was brought to Mplus and R for statistical analyses. Regarding predictor variables, the recommendation is to include as many relevant variables as possible (Buuren & Groothuis-Oudshoorn, 2010; Collins et al. 2001). To impute CVH, demographic variables, including age, sex, income, and race/ethnicity along with CVD health metrics at each time point were selected to impute missing values. For volunteerism, demographic variables were used along with values for volunteerism on the individual volunteerism items (volunteer hours in schools, hospitals, political causes and other charities) were used to impute volunteerism totals. Demographic data, including age, education level, race/ethnicity and income were used to impute values for PR. Demographic variables were not imputed because they were assessed at T1 and did not have substantial missing data.

Unweighted values for imputed versus non-imputed data for cardiovascular health, volunteerism and positive reappraisal are shown in Appendix H. The imputed values for CVH at later time points (i.e., T2 and T3) were such that the imputed values characterized the sample as “less healthy”, with the distributions of participants meeting 0-5 CVH metrics showing a slightly reduced negative skew. For instance, at T3, the imputed data indicated that 56% of participants had 3 or more metrics in the ideal range versus 62% at T2, and 24% with 4 or more meeting ideal levels versus 28%. At T2, the distribution of unimputed data suggested 59% of adults as having 3 or more metrics in the ideal range and 27% with 4 or more, whereas the imputed data suggested 56% with 3 or more and 24% with 4 or more. Comparison of these values suggests that the imputation provided a directionally appropriate correction for inaccuracy in the data introduced by participant attrition (i.e., less healthy participants drop out of research studies at higher rates). The distributions of the number of CVH metrics falling into the ideal range in the unimputed and imputed data at T1 were comparable.

Cardiovascular Health

Change in the number of health metrics falling into the ideal range was examined visually for participants with data on at least two time points (Figure 3A) for adults with complete data (n = 185; Figure 3B), and on the imputed data (Figure 3C). These patterns were similar to one another and did not demonstrate a linear decline in CVH over time as was expected.

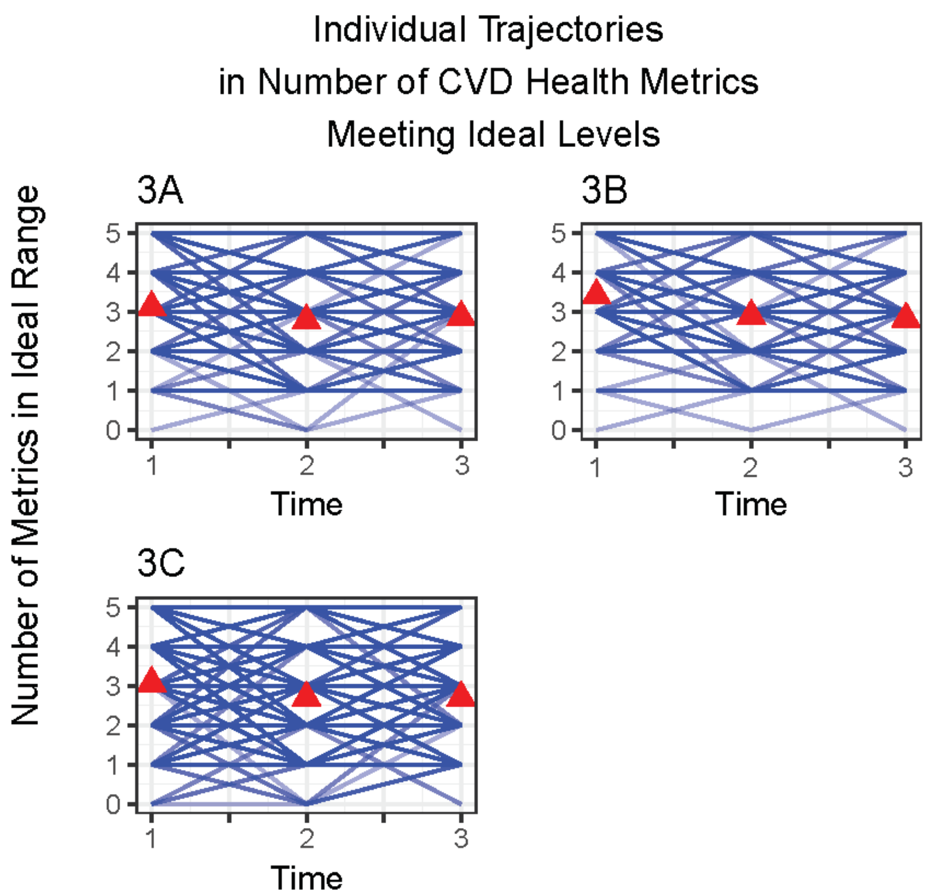


Figure 3: Individual growth trajectories in cardiovascular health (number of CVH metrics meeting ideal levels as defined by the AHA), using data from participants with data on at least two time points (3A), with complete data (3B), and with data imputed via PMM (3C). Group level change is shown in red. As shown, individual change trajectories were ill-characterized by a growth model with each type of data.

A baseline linear growth model without predictors did not fit the unimputed data (Chi-Square = 17.52, df = 1, $p<.0001$, RMSEA = 0.15, CFI = .94, SRMR = .05). Next, a baseline model was specified on imputed cardiovascular health outcomes, which showed unacceptable fit (Chi square = 39.62, df = 1, $p < .0001$, RMSEA = .18, CFI = .95, SRMR = .04). There were no theoretically plausible modification indices to consider. Due to the poor fit of the model and lack of steady decline in CVH over time, intercept and growth parameters, although statistically significant, were not valid and predictors of initial CVH levels and growth trajectories were not examined further. Visual examination of the growth trajectories along with poor fit of the models suggests that the data were not well-characterized by a linear growth model.

In a post-hoc analysis, positive and negative affect were explored as predictors of group level averages on CVH at T2 and at T3, controlling for T1 CVH scores. These analyses were conducted using the survey package in R. This approach is consistent with the prospective association studies in the literature examining the role of positive affect and negative affect on CVD risk (e.g., examining positive and negative affect scores recorded at one point in time and the degree to which they predict cardiovascular disease events at a later point in time) (e.g., Davidson et al., 2010; Denollet et al., 2008; Ostir et al., 2001; Shirai et al., 2009). Consistent with the approach taken with LGM models, imputed data were used, and sociodemographic covariates were entered first, followed by NA, then PA, and then the PAxNA interaction term. Results indicated that T2 CVH was positively associated with T1 CVH ($b = .47$, $t(1258) = 17.57$, $p <.001$) and with household income ($b = .001$, $t(1259) = 2.03$, $p <.05$). When added to the model, neither PA nor NA was associated with T2 CVH. Income was also positively predictive of CVH at T3 ($b = .001$, $t(1259) = 2.50$, $p<.01$, along with T1 CVH ($b = .42$, $t(1258) = 16.96$, $p <.0001$). T3 CVH was also associated with race/ethnicity, such that African American and Native American participants had worse T3 health relative to the comparison group ($b=-.16$, $t(1258) = -2.01$, $p<.05$) consisting of Whites and Asian Americans. Participants categorized as Other or Multiracial also had worse T3 CV health relative to Whites and Asian Americans ($b=-.25$, $t(1258)=-2.60$, $p<.05$). Higher NA scores predicted worse T3 CVH ($b=-.14$, $t(1258) = -2.38$, $p <.05$). PA was unassociated with CVH and did not interact with NA to predict CVH.

The race/ethnicity variable was further examined in additional post-hoc analyses. Another model that included dummy codes to compare each race/ethnicity category (i.e., African Americans, Native Americans, Asian Americans, Multiracial individuals, and Other) with White respondents indicated that African Americans demonstrated worse CVH at T3 relative to Whites ($b=-.16$, $t(1253)=-2.01$, $p<.05$). This value indicates that African Americans reported on average .16 fewer health metrics in the ideal range 20 years after enrollment relative to Whites. Comparing individuals categorized as Other with Whites, those selecting Other had worse T3 CVH relative to Whites ($b=-3.10$, $t(1253)=-2.31$, $p<.05$). It is difficult to interpret this last finding due to 1) how it is impossible to know what “Other” race really means, and 2) there is a small number of Other respondents. The interpretable finding emerging from these analyses is that African Americans demonstrated worse CVH relative to Whites, which is consistent with the literature (e.g., Lloyd-Jones et al., 2009). The dataset does not have a sufficient number of respondents to make clear conclusions about the other racial/ethnic groups specifically.

Volunteerism

Visual inspection of time trends suggested an apex shape whereby participants showed an increase in volunteerism from T1 to T2, and then a decline from T2 to T3. This trend was evident when examining data from participants with data on at least two time points (Figure 4A), data from participants with complete data (n=283; Figure 4B), and the imputed data (Figure 4C).

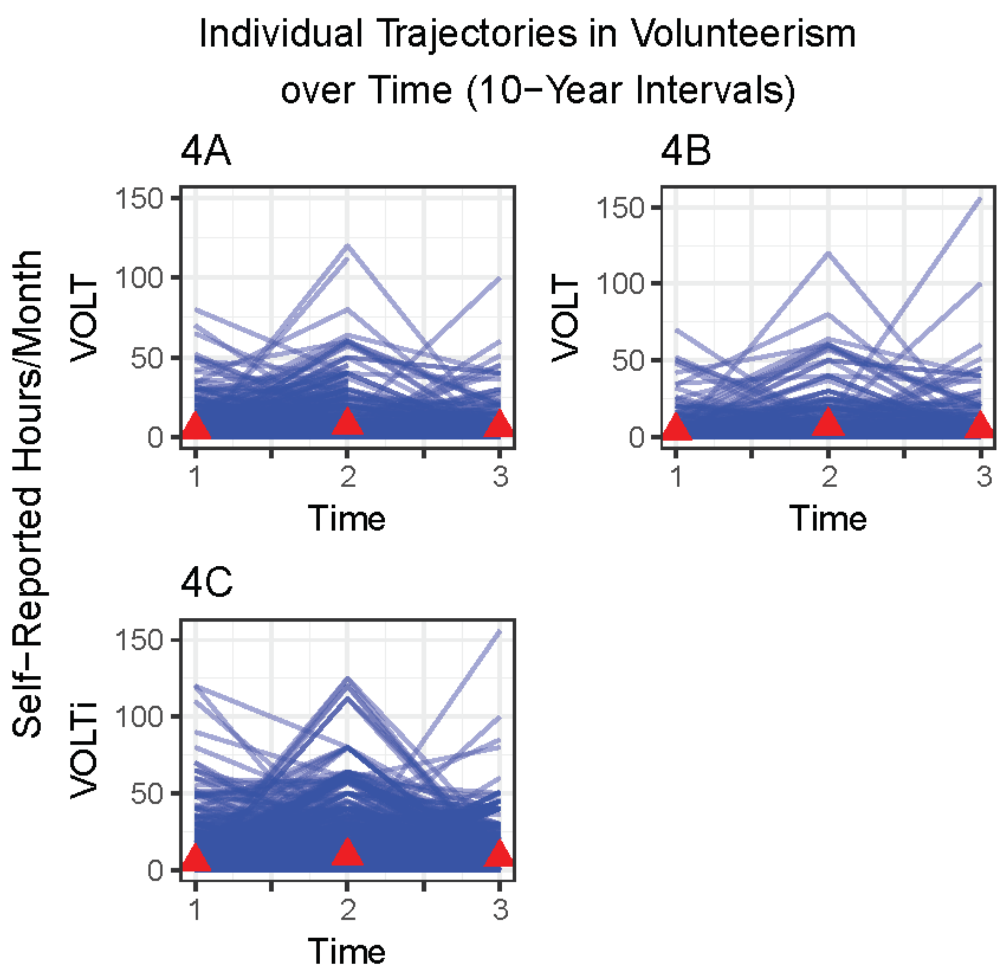
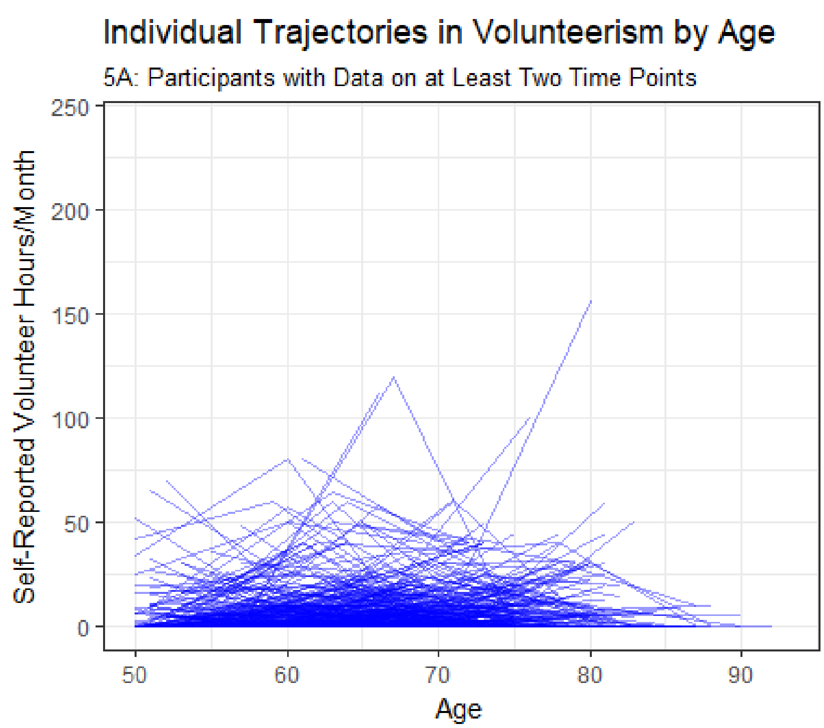
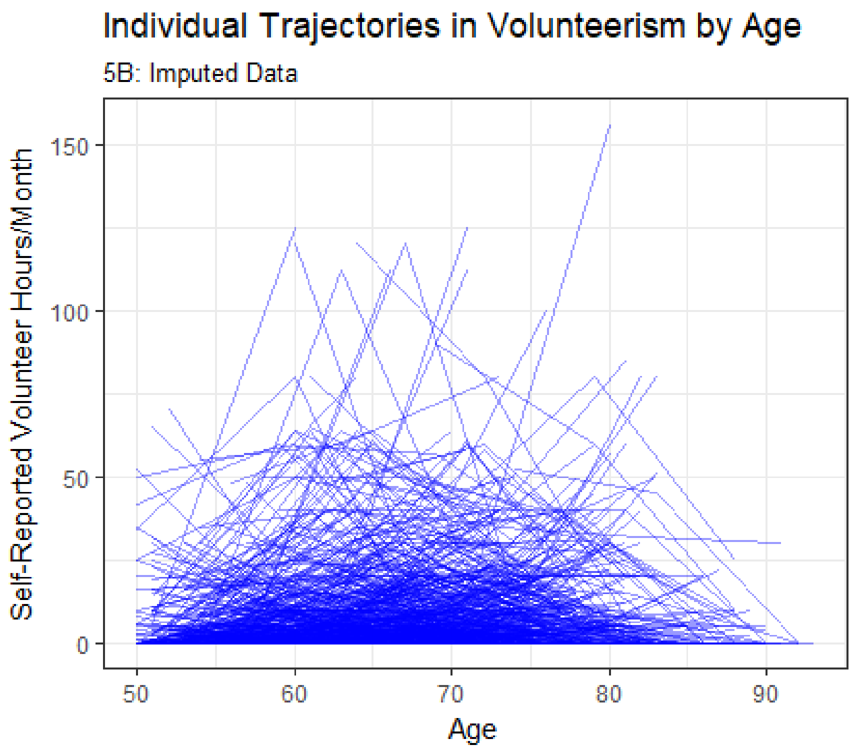


Figure 4: Individual trends in volunteerism for respondents with data on at least two time points (4A), with complete data (4B, n = 283), and with imputed data (4C). Group means shown in red.

The baseline model fit was inadequate (Chi square = 7.28, df = 1, p = .007; RMSEA = .07, CFI = .78, SRMR = .05), as was baseline model fit using imputed data (Chi square = 23.50, df = 1, = < .0001, RMSEA = .13, CFI = .78, SRMR = .04). Thus, statistical significance of initial levels and growth trajectories in volunteer behavior was not further evaluated. Thus, according to these data older adults do not show a steady decline in volunteer behavior in older age, but rather show an increase followed by a decrease. This pattern may be related to age-related role changes (e.g., retirement). Data were visually inspected further to determine whether there was a meaningful age at which older adults seemed experience elevations or declines in volunteer behavior. When examining individual trends on the unimputed data (Figure 4A) and the imputed data (Figure 4B), it appeared that older adults tended to



volunteer most between ages 60-70; and examining Figure 2 showing the age breakdown of participants at each time point, it appears that the majority of participants were aged 60-70 at Time 2. This may be related to changes in time constraints associated with retirement and the relatively good health of this age group relative to adults aged 70 and above. As opposed to a steady decline in volunteerism from T1 to T3 as originally hypothesized, the decline occurred in the data from T2 to T3. In a post-hoc analysis, from the broaden and build perspective I explored predictors of the variance in T3 volunteerism with multiple linear regression analyses using the R survey package examining whether positive and negative affect predicted in T3 volunteerism, holding constant T2 volunteerism. T2 volunteerism was entered first, followed by demographics, then PA, NA, and finally, the PAxNA interaction term. In the final model, T2 volunteerism positively predicted T3 volunteerism, (b = .12, SE = 0.03, $t(1256) = 4.49$, $p < .0001$), and NA negatively predicted T3 volunteerism (b = -2.24, SE = 1.04, $t(1256) = -2.15$, $p < .01$). No other predictors were significant (p's > .05).



Positive Reappraisal

The baseline model using imputed PR outcome data fit well (Chi square = 6.04, df = 1, p < .05; RMSEA = .06, CFI = .99, SRMR = .02). On average, participants averaged 3.2 scale points (SE = .02) in PR use (p < .0001) and on average declined .10 scale point every 10 years (p <.0001). The 10 scale point decrease corresponded to a decrease of .84 in standard units. Individuals varied in their initial levels of PR use (Variance = .16, SE = .02, p<.001), and did not vary in their growth trajectories (Variance = .005, SE = .008, p = .54) (see Figure 6). Slopes and intercepts were uncorrelated.

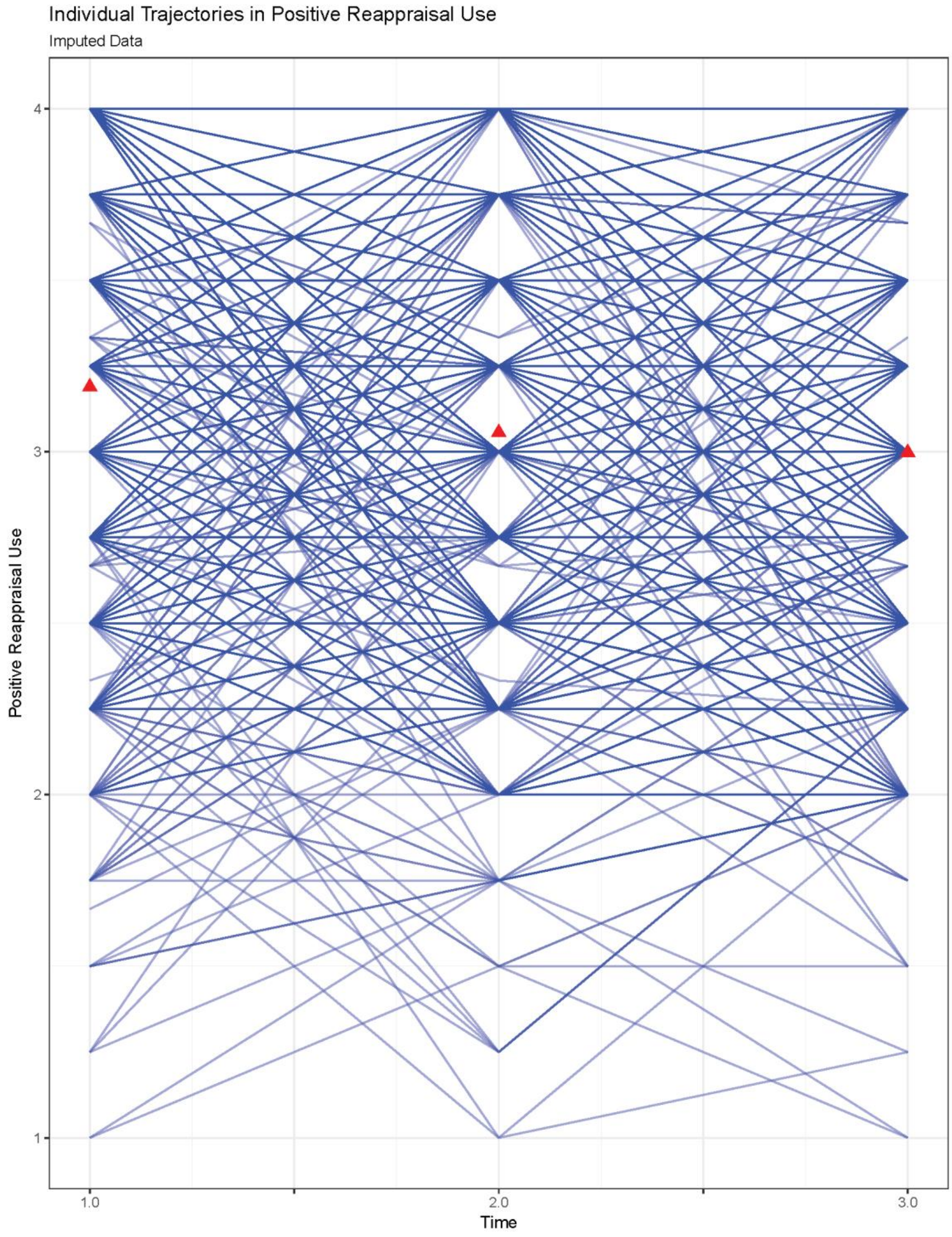


Figure 6: Individual trajectories in positive reappraisal use (group means shown in red).

Demographics were then regressed on the intercept. This model demonstrated acceptable fit (Chi square=31.78, df=14, p<.01; RMSEA=.03; CFI=.98; SRMR= .02) and suggested higher PR use among African Americans and Native Americans relative to Whites and Asian Americans (b = .12, SE = .05, p <.01). Participants in Multiracial and Other categories were undifferentiated from Whites and Asian Americans. Female participants also showed higher PR use (b = 0.08, SE = .03, p = .01). Income, education level and age were unassociated with PR use. NA was then added to the model. Those higher in NA showed less use of PR (b = -0.28, SE = .03, p <.0001). After accounting for NA, PA predicted increased PR use (b=.32, SE = .05, p<.0001). When PA was added to the model, NA became nonsignificant, while race/ethnicity and gender remained significant. Fit of the final model was acceptable (Chi square = 67.44, df=18, p<.001; RMSEA=.05; CFI=.95, SRMR=.03). PA did not interact with NA to predict PR use. A model including all race/ethnicity categories as intercept predictors using dummy codes failed to converge.

In a second analysis I grouped race/ethnicity differently (African Americans vs Whites, and African Americans vs all others [Asian Americans, Native Americans, Multiracial respondents, and Other respondents]). This model also fit the data well (Chi square = 70.28, df=18, p<.001; RMSEA=.05, CFI=.94, SRMR = .03) and suggested that white respondents showed reduced PR use relative to African Americans (b=-.10, SE = .04, p<.02). African Americans and the “all others” group were undifferentiated. Women showed higher PR use in this model as well (b=.10, SE=.03, p<.01). Positive affect predicted PR use (b=.19, SE = .03, p<.001) and negative affect did not.

A model using the unimputed data fit the data well (Chi square = 4.23, df = 1, $p = .03$, RMSEA = .05, CFI = .99, SRMR = .02), and suggested that participants averaged 3.2 scale points on PR at baseline (SE = 0.02) and on average declined .11 scale points every 10 years ($p < .0001$). Participants likewise varied in baseline levels of PR (Variance = .19, SE = .03, $p < .001$), and not growth. In a model including demographic predictors of the intercept (Chi square=23.66, df=14, $p < .05$; RMSEA=.02, CFI=.97, SRMR=.03), African American/Native American race/ethnicity was associated with PR (b=.15, SE=.07, $p < .05$) and in a similar fashion NA predicted PR prior to the addition of PA and then became nonsignificant after its addition, and PA remained significant (b = .23, SE = .04, $p < .0001$). Race/ethnicity was reduced to non-significance in this model and thus PA was the only significant predictor of the PR intercept. Model fit indices for the model including PA and NA were acceptable (Chi square=32.82, df=18, $p < .05$; RMSEA=.03, CFI=.97, SRMR=.03). No PAxNA interaction was evident.

Chapter 7: Discussion

Cardiovascular Health

In the present study, it was expected that cardiovascular health would decline in a linear fashion over a 20-year span, and that positive affect would predict slower declines in cardiovascular health based upon the *broaden-and-build* perspective on positive emotion. As discussed, the *broaden-and-build* theory asserts that positive affect benefits well-being through a broadening of thought-action repertoires and a building of personal resources (e.g., social, physical, cognitive) that are enduring in nature and support further experiences of positive emotion (Fredrickson, 2004, 2008). This consequently facilitates further experiences of positive affect and thus a perpetuation of the broaden and build cycle (termed an *adaptive spiral*). Although it is difficult to test all components of this theory in a single study given its complexity, CVH was conceptualized as a physical resource that would emerge as a consequence of positive affect. From the broaden and build perspective, a growth modeling approach was selected to characterize individual-level gains and losses in resources (i.e., CVH, positive reappraisal use) and level of engagement in broadened, adaptive behaviors (i.e., volunteerism) over time.

Linear declines in CVH trajectories were expected based on health surveillance data documenting linear increases in CV risk beginning in the fifth decade of life (AHA, 2016). However, CVH was not characterized by steady declines over time. Missing data was explored as an explanatory mechanism for this pattern; however, the consistent patterns in individual growth trajectories observed between participants with some data, complete data, and the imputed data, it appears that findings cannot be completely accounted for by missingness. The assessment of CVH at 10-year intervals may have contributed to the poor fit of the linear growth model, as the time points may have been too few to capture a process unfolding over time. CVH was unrelated to age in bivariate correlations and in post-hoc MLR models, which is surprising and may be related to several factors. First, the nature of the CVH metric may have lacked sufficient sensitivity to detect age-related declines in CVH. Self-report proxy variables were used for the AHA (2016) health metrics blood glucose and blood pressure (i.e., hypertensive status and diabetes diagnosis), which can be problematic because people lack awareness and overestimate their health, introducing error in measurement. This limitation has been noted by other authors using health surveillance data to document nationwide estimates of cardiovascular health in the US using self-report variables to represent AHA CVH metrics (Fang et al., 2012). Furthermore, the CVH composite did not include two of the 7 health metrics identified by the AHA as reflective of ideal CVH (i.e., healthy diet and normal cholesterol), due to their unavailability in these MIDUS datasets, which also likely reduced the sensitivity of the measure to detect change. Second, the overall MIDUS sample may have been relatively high functioning and thus showing little decline in CVH. The MIDUS sample is more highly educated than the general US population (Brim et al., 1995) and was sampled and weighted to be nationally representative. It thus constitutes mostly white individuals, who enjoy the best CVH among sociodemographic groups in the United States (AHA, 2016) as a result of privileged access to resources (e.g., healthcare). Difficulties in accurately modeling change in CVH over time were also introduced by participant attrition. The data did not contain information on reasons for dropout (e.g., CV-related processes, death), but it is well-known that healthier participants are retained for longer periods of time in longitudinal health research studies (e.g., Chatfield, Brayne, & Matthews, 2005).

Imputation procedures were used to try and correct for bias in the data introduced by attrition; however, this strategy cannot ultimately overcome the fact that a large proportion of participants were lost to follow-up and many trajectories in CVH over the 20-year span were unobserved.

Despite the limitations in terms of the growth model, several interesting findings emerged from this study. Post-hoc regression analyses examining the relationship between positive affect and negative affect and CVH in the aggregate 10 and 20 years later contribute to the literature exploring whether positive affect constitutes a protective factor in the maintenance of cardiovascular health, above and beyond the detrimental effects of negative affect. Results suggest that adjusting for sociodemographic variables tied with CVH, negative affect is predictive of having fewer cardiovascular health metrics in the ideal range, and that positive affect does not provide a protective benefit. These results are consistent with prospective association studies documenting that negative affect is an important predictor of cardiovascular health, and that positive affect is not (Barefoot et al., 2000; Brummett et al., 2005; Freak-Poli et al., 2015; Nabi et al., 2008; van Domburg, 2001; van der Vlugt et al., 2005). These results are in contrast with a smaller number of prospective association studies suggesting that positive affect does in fact provide a protective benefit with regard to cardiovascular health, above and beyond negative affect

(Davidson et al., 2010; Denollet et al., 2008; Korkeila et al., 1998; Ostir et al, 2001; Ryff et al., 2006; Shirai et al., 2009). Some of these have used risk of having a CVH-related event within a follow-up period as the outcome variable (Davidson et al., 2010; Denollet et al., 2008; Ostir et al, 2001; Shirai et al., 2009), whereas others have used single CVH markers. Specifically, one experience sampling study (Steptoe et al., 2005) reported that PA favorably impacts ambulatory heart rate and cortisol levels, but not blood pressure. In a cross-sectional study, PA was associated with healthier cholesterol levels (Ryff et al., 2006), and in a prospective association study, PA at baseline predicted future weight gain (Korkeila et al., 1998). One possibility is that PA differentially relates to the CVH metrics (AHA, 2016), associating with some and not others. Future analyses could examine the CVH metrics as individual outcomes rather than as a composite. Singular examination of each metric has emphasized by the AHA as an appropriate research strategy (AHA, 2016).

Finally, these results fail to provide support for the *broaden-and-build* position that positive affect is a factor that precedes the development of physical resources, in this case, cardiovascular health. The only support for the importance of positive affect on CVH was by a significant bivariate correlation between PA and CVH at the initial assessment. NA was associated with CVH at all three time points in bivariate correlations, providing further support for the greater importance of NA relative to PA.

As discussed previously, inconsistency in the literature regarding the respective contributions of positive and negative affect on cardiovascular health and risk levels may be tied with several factors pertaining to how studies are conducted, including differences between samples (e.g., size, demographic composition), differing measures of affect (e.g., validated scales versus single items), inconsistencies in the selection of covariates, and heterogeneity in the measurement of cardiovascular disease health and risk (e.g., risk of experiencing a CVD event within the study period, risk of dying of CVD within the study timeframe, a grouping of biomarkers or single biomarker of CVD risk, self-report data on single indicators of CVD risk, etcetera). Amidst this heterogeneity, the present study used the AHA's framework of ideal cardiovascular health to measure CVH and conceptualize covariates (e.g., exercise engagement was treated as part of the outcome variable as opposed to a covariate). Scores on the CVH metric reflect clinically meaningful information (e.g., a score of 0 means the individual has 0 metrics in the ideal range). As discussed, in this context ideal CVH includes both health factors (e.g., ideal blood pressure) and health behaviors (e.g., nonsmoking). Use of this framework in future research may be facilitative of cross-study comparisons of psychological predictors of CVH. This is the first study to examine positive affect in conjunction with the CVH metrics defined by the American Heart Association (2016) so these findings cannot be compared directly with other studies using the AHA's (2016) guidelines defining ideal cardiovascular health. In a recent theoretical paper, Labarthe and his colleagues (2016) posit that the AHA's (2016) conceptualization of ideal cardiovascular health fits well with the positive psychology field, and that future studies examining positive psychological well-being, which they term *positive cardiovascular health* in the context of CVD, should utilize the AHA's 7 health factors as outcome measures in conjunction with positive psychological well-being predictor variables liable to support the achievement of ideal cardiovascular health (e.g., optimism, positive affect, life satisfaction) (Labarthe et al., 2016).

Relationships with Demographic Characteristics

Relationships between several demographic characteristics and CVH emerged that are consistent with national health surveillance data (AHA, 2016). Women had more health metrics in the ideal range at the 10-year (T2) follow-up relative to men, which accords with national data documenting better CVH among women relative to men in general (AHA, 2016). Consistent with national trends documented elsewhere (AHA, 2016; Lloyd-Jones et al., 2009), African American race was associated with worse CVH. In MLR analyses adjusting for income, gender, education, income and baseline CVH, African American race was predictive of having fewer health metrics in the ideal range 20 years later. There are numerous reasons why African Americans in the United States are at a disproportionately high risk of cardiovascular disease, which are tied with structures of oppression dating back to slavery and present-day efforts to segregate African Americans from American society (Artinian & Franklin, 2010). Implications of this situation for cardiovascular health include, for instance, reduced physical activity involvement because of failing infrastructure, high crime rates and inadequate recreational facilities in neighborhoods predominated by marginalized racial groups (Lopez, 2006). Safety factors contribute to various other CVH-relevant lifestyle factors, for instance using television, an inexpensive and safe activity, as a source of family recreation (Kumanyika et al., 2007). African Americans have reduced access to fresh, organic food options in their neighborhood grocery stores relative to grocery stores in neighborhoods predominated by whites (Galvez, Morland & Raines, 2008). Within the healthcare system, African Americans have been mistreated by healthcare professionals over the course of generations, having led to what one author calls a "chronic mistrust" of the healthcare system (Murray, 2015, p.286), and continue to experience inequitable access to treatment. For example, African Americans receive treatment for depression, a known CVD risk factor, at reduced rates relative to whites (Miranda & Cooper, 2004). The present study did not explore ways of reducing this health disparity or specific reasons for poor cardiovascular health among African Americans, or protective factors that may specifically benefit African American older adults. MIDUS researchers collected data more recently from a large sample of African Americans. Future studies should explore within this sample which protective factors are most meaningful for African American adults. The present study sought to study growth, and this type of approach was not possible using these data. However, a future direction could be to examine specific protective factors within the African American sample and among older African Americans specifically, and whether positive and negative affect have any connections with cardiovascular health.

Positive and Negative Affect

These data also provide a nationally representative characterization of older adults on positive and negative affect over a 20-year period. Consistent empirical data documenting higher negative affectivity (Fujita, Diener, & Sandvik, 1991) and rates of depression (Ford & Erlinger, 2004) and among women relative to men, women in the present study tended to report lower positive and higher negative affect than men. As with all studies examining this phenomenon, these associations likely reflect a combination of true effects as well as error (for instance, men may tend to underreport negative emotions and depressive symptoms; see Hunt, Auriemma, & Cashaw, 2003). NA was unassociated with race/ethnicity, and respondents without college degrees and with lower income levels tended to report higher NA. PA and NA were associated with age, such that older adults tended to report higher PA and as well as higher NA, although the strength of the association between PA and age was higher (.12) than that between NA and age (.09). The nature of change or stability in affect as people move through older adulthood should be explored further empirically, as results are inconclusive and have been commonly based on cross sectional studies comparing an older adult cohort with a younger adult cohort (e.g., Lucas & Gohm, 2000; Mroczek & Kolarz, 1998). One longitudinal study using a sample of over 2,000 respondents suggested that older adults show small decreases in both positive and negative affect over time, and that the rate of decline in negative affect is attenuated in older adults as compared with younger adults (Charles, Reynolds & Gatz, 2001). Two longitudinal studies that followed oldest old adults reported declines in PA over time (Ferring & Fillip, 1995; Smith & Baltes, 1993). In the present study, respondents showed generally high and stable levels of positive affect generally low and stable levels of negative affect as suggested by visual examination of group means. Future analyses could test the stability of these means using a latent means model framework.

Volunteerism

The present study addressed whether positive affect is a factor that promotes sustained engagement in volunteerism during the aging years. Behaving altruistically through volunteerism has been robustly associated with better physical health (Piliavin & Siegl, 2007), particularly among aging adults (Sneed & Cohen, 2013), and has been associated with cardiovascular disease risk specifically (Whillans et al., 2016). The notion that people accrue health benefits through helping others has been conceptualized as a novel approach to enhancing physical functioning that simultaneously promotes civic engagement (Schreier, Schonert-Reichl, and Chen, 2013). From the *broaden and build* perspective, aging adults experiencing higher levels of positive affect may be more likely to engage in volunteerism (e.g., a broadened behavior), and consequently gain resources that support health (e.g., increased social belonging). The limited literature on the relationship between positive affect and volunteerism suggests that positive affect may be both a cause and consequence of volunteering (Greenfield & Marks, 2004; Son & Wilson, 2012). The present study explored whether positive affect may motivate (i.e., precede) engagement in volunteerism, a behavior known to benefit health, among aging adults.

Examining individual level trajectories in volunteerism over the three MIDUS waves along with the age breakdown of participants at each time point suggested that volunteerism in older adults shows an apex shape; in particular, an age-related increase followed by a decrease, with volunteerism appearing to peak between ages 60-70. This increase may have been tied with age-related role changes (e.g., retirement allowing more time for volunteering). The apex trajectory in volunteerism was not aligned with a priori hypotheses predicting a steady decline in volunteerism over time, and thus, positive and negative affect and sociodemographic characteristics were not examined as predictors of individual change in volunteerism in a linear growth modeling framework. The apex-shaped trajectory evident in individual-level trajectories was also apparent in group-level means, which were higher at T2 relative to T1 and T3. Due to the decline observed at T3 relative to T2 in group level averages as well as in individual trajectories, from *a broaden and build* perspective positive affect was examined as a predictor of volunteerism at T3. Negative affect, but not positive affect, was associated with lower levels of volunteerism ten years later. No other demographic characteristics predicted volunteerism, except for T2 volunteerism, with those volunteering more at T2 tending to volunteer more at T3. Thus, no support for positive affect as a motivating factor in volunteerism (i.e., a broadened behavior) emerged from the present analyses as was hypothesized from the broaden-and-build theory. It does provide a kind of "reverse" support for the theory in the sense that negative affect predicts a reduction in expanded behaviors. The fact that those higher in negative affect showed reduced volunteer behavior 10 years later is consistent with some findings documenting the detrimental effects of negative affect on social and community participation (Berry & Hansen, 1996; Graney, 1975). Many studies examining negative affect and volunteerism in aging adults specifically have focused on affect as an outcome of volunteering rather than a predictor (Kahana, Bhatta, Lovegreen, Kahana, Midlarsky, 2013; Windsor, Anstey & Rodgers, 2008). These findings suggest that negative affect may also be an important predictor of the extent to which older adults engage in volunteerism.

The increased level of volunteer engagement at T2 relative to T1 and subsequent decline at T3 is likely related to health-related variables; in particular, it may be that adults aged 60-70 still have the physical resources to engage in volunteerism, and at older ages, failing physical health imposes too much of a demand to continue volunteering. Consistent with this interpretation, gerontologists classify aging adults into young-old (also called the *third age*; those aged 60 to 80 in developed countries) and oldest-old (the *fourth age*; those aged 80 to 85 and above in developed countries) (Baltes & Smith, 2003), and note that the level of physical pathology among the oldest-old is markedly higher than among the young-old, making it much more difficult for oldest-old adults to maintain levels of vitality and functionality (i.e., markers of "successful," "robust," or "productive" aging, broadly defined as maintenance of physical, social and psychological functioning into the aging years; Garfein & Herzog, 1995) (Bales & Smith, 2003). They note that it is important to differentiate older adults into these groups so as not to generalize findings about young-old cohorts to the oldest old as well.

The trajectories observed in the individual level and group level data may also be related to age-related role changes that aging adults experience; for instance, changes in employment status (e.g., retirement), changing family structure (e.g., gain and loss of caregiving responsibilities for children and spouses; loss of loved ones) (Greenfield & Marks, 2004). Some authors (Greenfield & Marks, 2004) have described the loss of valued roles associated with advancing age as "role identity absences" and have provided data suggesting that volunteering can buffer the detrimental effects of role identity losses on well-being. Using the first wave of MIDUS data collected in 1995, Greenfield and Marks (2004) showed that volunteerism mediated the relationship between the number of role identity absences (i.e., spousal, parental, and employment-related) that older adults experienced and their sense of purpose in life, such that volunteering helped older adults maintain a sense of purpose the face of major role losses. Role losses like employment and spousal loss were not assessed in the present study; however, the literature suggests that these variables are associated with volunteering and it is possible that they relate to the apex-like trajectory observed over the three MIUDS waves. For instance, employment status has been associated with volunteerism, although there is not a clear inverse relationship between paid employment hours and volunteer hours. Using the 1993 Asset and Health Dynamics Among the Oldest Old (AHEAD) survey, Choi (2003) showed that adults aged 70 and above who were employed part-time were more likely to volunteer than those employed full-time and also relative to those who were not working at all. Further, formal paid employment hours also show differing patterns of associations with formal volunteering by gender in some research. One study (Taniguichi, 2006) reported that women who worked part-time were more likely to volunteer than women who worked full time, but that men employed part time were no more likely to volunteer than men who were employed full time. Unemployed men volunteered less than employed men, whereas unemployed women were just as likely to volunteer as employed women (Taniguichi, 2006). As a group, in the present study women showed an increase in volunteerism followed by a decrease, whereas men showed stable levels of volunteerism. Perhaps changes in employment status or changes in other important roles differentially impacted male-identifying and female-identifying participants regarding volunteer engagement. In the present study, gender was associated with volunteerism at T2, with women showing higher levels of volunteerism than men. These data are consistent with national survey data document higher rates of volunteer engagement among women relative to men in the United States (Independent Sector, 2001; US Bureau of Labor Statistics, 2015), which may be tied with social norms encouraging women to take on caregiving roles (Einolf, 2010), higher religiosity, a factor promoting formal volunteerism, among women (Cnaan, Kasternakis, & Wineburg, 1993; Musick & Wilson, 2008), and career-related variables tied with gender; for example, women's tendency to have fewer paid employment hours per week relative to men (Sayer, 2005), or greater involvement in unpaid work (e.g., housework) relative to men (Dempsey, 2000), possibly contributing to a greater willingness to seek unpaid work.

Volunteerism was associated with several sociodemographic variables that are consistent with data describing national trends in volunteerism (US Bureau of Labor Statistics, 2015). Women, individuals with higher levels of education and higher household income volunteer at higher frequencies relative to men, those with less education and those in lower income brackets (US Bureau of Labor, 2015). Consistent with these data, descriptive data on the analytic sample show that individuals who were female, with higher household income levels, and with college degrees volunteered to a greater extent at T2 and at T3 relative to male individuals, those without college degrees, and those with lower household income levels. Examining group-level trends by sociodemographic groups, male participants showed stable levels of volunteer engagement across the three time points, whereas female participants showed a more pronounced increase at T2 followed by a decrease at T3.

Career related variables and informal caregiving variables were not assessed in this study; future analyses could incorporate these variables to better understand the explanatory factors contributing to gender differences and the apex trajectory in volunteerism observed in these data. Having more detailed information on reasons for attrition and cause of death would also contribute to understanding changes in volunteer behavior as people move from young-old to oldest-old. Role losses (e.g., loss of partner) may also be important variables to consider in future analyses. No study has used all three waves of MIDUS survey data to examine the relationship between positive affect and growth rates in volunteerism. This is the first study to use the MIDUS III data to describe volunteerism in older adults.

Positive Reappraisal

Examining individual growth trajectories, older adults varied in their initial levels of positive reappraisal use, and not in their rates of growth. Initial levels of positive reappraisal use were related to positive affect, gender and race. Specifically, positive affect predicted increased positive reappraisal use after adjusting for negative affect, which is consistent with findings from other studies documenting positive associations between positive affect and positive reappraisal (Pavani et al., 2016). Therefore, there was some support for the broaden-and-build perspective on positive emotions emerging from this analysis (i.e., positive affect supported higher initial levels of positive reappraisal use). Given that individual growth trajectories in positive reappraisal did not vary, the hypothesis as to whether positive affect predicts a building of psychological resources (Fredrickson, 2004) (e.g., making gains in positive reappraisal use) was not tested.

The finding that female participants showed higher initial positive reappraisal use than males accords with empirical literature documenting higher positive reappraisal use among women relative to men (Chipperfield et al., 2007; Nolen-Hoeksema & Aldao, 2011). Women have been shown to use several secondary control strategies more frequently than men (Nolen-Hoeksema & Aldao, 2011), reflecting a greater tendency to self-regulate by altering their internal responses to events. Although speculative, the higher tendency among women to self-regulate in this way may be linked with their greater tendency as reported in some literature to attend to internal feelings and thoughts, in contrast with men who may be more apt to use distraction or suppression strategies to self-regulate (Fivish & Buckner, 2000). African Americans also showed higher PR use relative to Whites. There are very sparse data on racial differences in positive reappraisal use. In one study using MIDUS I data, African American respondents reported higher PR use relative to white respondents (Worsch, 2000). In a very specific health context (coping with breast cancer) in a small sample that included white and African American women, there were no differences in positive reappraisal use by race category (Pikler & Winterowd, 2003). Thus, this is one of few studies to document differences in positive reappraisal use between African Americans and Whites. Thinking about African Americans and women together as marginalized populations who face structural barriers that limit their ability to exercise control over their environment to the same degree as white men, they may turn towards secondary control strategies (i.e., altering their internal responses to external events that are beyond their control), to cope. Minority groups have been shown to perceive less personal control relative to majority groups (Shaw & Krause, 2001). Theories of primary and secondary control (Heckhausen & Shulz, 1995) assert that when personal control over external circumstances cannot be excised, secondary control strategies become relatively more adaptive. Primary control strategies are focused on changing the external circumstances so that they meet personal needs; examples include persistence in goal striving or increasing effort in the face of obstacles. Secondary control strategies like positive reappraisal involve adjusting the internal response to events rather than trying to change external circumstances (Heckhausen & Schulz, 1995); other types of secondary control include downward comparison and adjusting goals/expectations. This possibility could be explored more deeply by comparing both primary and secondary control strategies in African Americans versus Whites and women versus men in the MIDUS series, and exploring their relative adaptive value (e.g., relationship with health, subjective well-being, etcetera).

Growth model results also indicated that on average positive reappraisal use declined slightly over the 20-year span of the study (one tenth of a scale point every 10 years). Thus, these data suggest that within older adults, there is a slight decline in positive reappraisal use during the aging years. Although these findings appear to contrast with findings that older adults use positive reappraisal more frequently than younger adults (Lohani & Isaacowitz, 2015; Wrosch et al., 2000), they accord with and bolster findings from studies comparing positive reappraisal use in young-old versus oldest-old adults. In a cross-sectional cohort study comparing five age groups, although the older age cohorts showed higher positive reappraisal use than adolescents, the oldest age group (mean age 77) showed lower positive reappraisal use relative to mid-life adults (mean age 41) (Garnefski & Kraaij, 2006). Findings from another cross-sectional cohort study indicated that an older adult group aged 65-

75 years was lower in comparison with adults aged 45-55 years as well as young adults (25 to 35 years) (Nolen-Hoeksema & Aldao, 2011). However, one longitudinal study in older adults with serious illnesses reported that positive reappraisal was higher among the oldest-old relative to the young-old, and also had a higher adaptive value (i.e., more highly correlated with well-being) (Hall et al., 2010). Because the present data are from the same individuals over time, they contribute to clarifying the inconsistency in the literature regarding changes in positive reappraisal use in older adults and suggest that they decline on average. The present analyses cannot speak to why these declines occur, although because reappraisal strategies rely on executive functions that decline with age (Opitz, Rauch, Terry & Urry, 2012), positive reappraisal use might decline because of more general cognitive decline. Alternatively, it may be that the environmental and health-related difficulties that oldest-old adults encounter are so numerous that it becomes difficult and/or inappropriate to regulate one's emotions by looking for the positive aspects of situations. This explanation relates to the assertion that self-regulation strategies categorized as adaptive are context dependent and may not be appropriate or possible in every situation (Aldao et al., 2010). Future research could compare the decline in positive reappraisal use observed in these data with changes in other primary and secondary control strategies (e.g., downward comparison, problem solving) to contribute to the literature on understanding age-related changes in primary and secondary control strategies and which may be most adaptive as one moves from young-old to oldest-old. At present, positive reappraisal has been identified as an adaptive strategy for coping with the aging process and both acute and chronic health

conditions in aging adults, including cardiovascular disease (Hall, Chipperfield, Heckhausen & Perry, 2010), functional mobility issues (Wrosch, Heckhausen, & Lachman, 2000) and depression (Kraaij, Pruymboom, & Garnefski, 2002), as well as better health outcomes in individuals facing reduced functional capacity due to chronic illness (Bower et al., 1998; Dunigan, Carr, & Steel, 2007; Ickovics et al., 2006)..

Chapter 8: Limitations and Future Directions

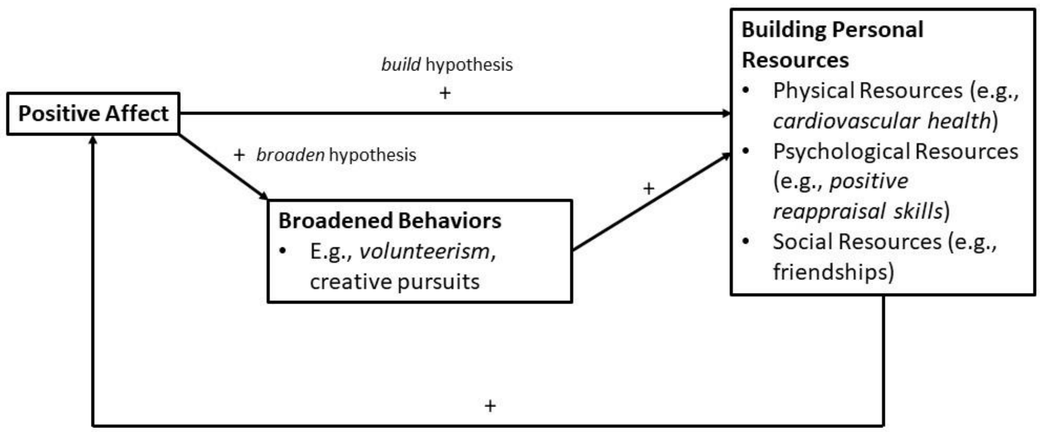
The present study had several limitations. Although common in large population survey studies, error was introduced participant attrition, reasons for which were unknown, and self-report bias. Items assessing exercise behavior were not the same at each wave and may have introduced error as well. MIDUS researchers did not sample sufficient numbers of individuals from diverse racial and ethnic groups to conduct meaningful research about CVH among diverse groups living in the US. Data from the nationally representative MIDUS sample generalizes to a majority white population, and although the present findings contribute to affect and CVH they do not provide insights into CVH in some of the most vulnerable groups in the US regarding CVH (e.g., Native Americans, African American women and men). There were enough African-American respondents in this study to document some associations between African-American race and having fewer CVH metrics in the ideal range, although these analyses are limited as there were fewer than 100 African American respondents in the dataset. Limitations were also introduced by how measurement occasions were spaced 10 years apart, which may have reduced the ability of this study to detect change in variables. These research questions could be better answered with a series that follows participants on a yearly basis obtains data on all 7 health metrics. This could be possible with the National Health and Nutrition Examination Survey (NHANES), which has been used to explore a variety of CVH-related issues (e.g., Nguyen et al., 2011).

Contributions to the Literature

Despite these limitations, findings from this study make several contributions to the literature. First, they suggest that older American adults (age 50 to 74) higher in negative affectivity tend to have, on average, fewer cardiovascular health metrics in the ideal range 20 years later. Thus, negative affect emerged as a risk factor for poorer CVH outcomes in aging adults. Positive affect does not appear to provide any protective benefit for cardiovascular health as assessed in the present study. Holding constant negative affect and initial cardiovascular health scores, African Americans had on average fewer cardiovascular health metrics in the ideal range relative to Whites 20 years after enrollment, echoing the widely documented cardiovascular health disparity between African Americans and Whites in the United States. This is a public health crisis and future research should explore within African Americans which protective factors (e.g., positive and negative affect) are most important within African American individuals and ways of dismantling structures of oppression that uphold this health disparity. Volunteering, an important protective factor for cardiovascular and general health in older adults, appears to peak between ages 60-70, presumably after retirement and before the onset of declines tied with very old age. In the succeeding decade, adults higher in negative affect tend to volunteer less on average than those lower in negative affect. Positive affect did not relate to volunteering. Consistent with national trends documented elsewhere, women tend to contribute more to volunteer activities than men, along with those who have college degrees and higher income levels. These findings are likely related to the time and resources afforded by education and adequate financial resources, as well as prescribed sociocultural norms for women in the United States to help others. Positive affect did emerge as important for older adults' use of psychological coping skills; specifically, the tendency to reappraise situations positively. Within individual respondents, their positive affect levels positively predicted their positive reappraisal use at the time of enrollment, and their negative affect levels had no relationship with their positive reappraisal use. As a group, however, older adults showed a reduction in positive reappraisal use over each decade (1/10 scale point, which was nearly a 1 standard deviation decrease of .84). This suggests an age-related decline in positive reappraisal use. The present study cannot ascertain why this decline occurs, and research into the coping strategies best suited to support older adults as they move through the young-old to oldest-old ages is an important area for future research. Positive reappraisal use was higher among women and African Americans, the reasons for which were unexplored in this study. One speculation is that this tendency is tied with their reduced ability to exert primary control over their environment because of their marginalized status, and reliance on strategies that involve adjusting their inner experiences rather than trying to change external circumstances.

These findings provide limited support for the validity of the broaden and build theory of positive emotion (Fredrickson, 2004). Positive affect emerged as relevant for individuals' initial levels of psychological resources (in this case, positive reappraisal). Positive affect did not appear to build physical resources (i.e., cardiovascular health), although it was associated with cardiovascular health in a bivariate correlation at enrollment. Finally, it did not predict broadened behavior (in this case, volunteerism). Negative affect was tied with worse outcomes in cardiovascular health and volunteerism, which suggests that negative affect may interfere with the development of physical resources and engagement in broadened behavior. As noted previously, there were limitations in the dataset that precluded exploration of individual growth trajectories and thus the extent to which people gain or lose personal resources because of positive affect. The validity of the broaden and build theory should continue to be evaluated by research using longitudinal data with multiple assessment occasions. There are also measures of various well-being constructs in the MIDUS series that could be examined to explore the role of positive psychological constructs on cardiovascular health in addition to positive affect, including optimism, life satisfaction, and eudaimonic well-being. The relative contributions of these constructs versus positive affect on CVH and protective factors could also be informative.

Appendix A: Visual Representation of Broaden and Build Theory and Components Tested in the Present Study



Appendix B: Sociodemographic Items

1. **Race**

What race do you consider yourself to be?

a. White
b. Black and/or African American
c. Native American or Aleutian Islander/Eskimo
d. Asian or Pacific Islander
e. Other
f. Multiracial

2. **Age**

What is the month and year of your birth?

3. **Gender**

What is your gender?

a. Male
b. Female

4. **Household Income**

Household income is a calculated variable in MIDUS that includes income (in US dollars) from all household members as reported by the participant, including government assistance, social security, personal income (i.e., wages and stipends from employment), and other household income sources identified by respondents (i.e., pensions, investments, and other non-wage income).

Scores range from 0 to $300,000. Values from any respondent that were greater than $300,000 were coded as $300,000 to preserve confidentiality. I treated household income as a continuous variable ($0 to $300,000).

5. **Education Level**

What is the highest grade of school or year of college you completed?

1. Less than high school
2. High school diploma
3. Some college
4. College degree or more

Appendix C: Positive and Negative Affect

During the past 30 days, how much of the time did you feel...

1. "cheerful?"
2. "in good spirits?"
3. "extremely happy?"
4. "calm and peaceful?"
5. "satisfied?"
6. "full of life?"

During the past 30 days, how much of the time did you feel...

1. "so sad nothing could cheer you up?"
2. "nervous?"
3. "restless or fidgety?"
4. "hopeless?"
5. "that everything was an effort?"
6. "worthless?"

Appendix D: Volunteerism

On average, about how many hours per month do you spend doing formal volunteer work of any of the following types:

a. hospital, nursing home, or other healthcare-oriented volunteer work;
b. school or other youth-related volunteer work;
c. volunteer work for political organizations or causes;
d. volunteer work for any other organization, cause, or charity?”

Hours reported for each of these categories were summed to create a volunteerism score, consistent with prior research using MIDUS (Son & Wilson, 2012).

Appendix E: Positive Reappraisal

To what extent to the following statements describe you?

1. I find I usually learn something meaningful from a difficult situation.
2. When I am faced with a bad situation, it helps to find a different way of looking at things.
3. Even when everything seems to be going wrong, I can usually find a bright side to the situation.
4. I can find something positive, even in the worst situations.

Response choices:

1=A lot

2=Some

3=A little

4=Not at all.

Note: Scale scores in MIDUS were formed by reverse coding the items and calculating the mean (so higher scores reflect higher levels of positive reappraisal)

Appendix F: Cardiovascular Disease Risk Indicators

1.Body mass index

How much do you currently weigh?

How tall are you in inches?

BMI was calculated in MIDUS by dividing weight (kg) by height squared (cm).

2. Hypertension

In the past twelve months, have you experienced or been treated for any of the following - HIGH BLOOD PRESSURE OR HYPERTENSION?

a. Yes

b. No

3. Diabetes

In the past twelve months, have you experienced or been treated for any of the following: DIABETES OR HIGH BLOOD SUGAR?

a. Yes

b. No

4. Smoking status as current smoker, former smoker or never smoker

Do you smoke cigarettes regularly NOW?

a. Yes

b. No

Have you ever smoked cigarettes regularly - that is, at least a few cigarettes every day?

a. Yes
b. No

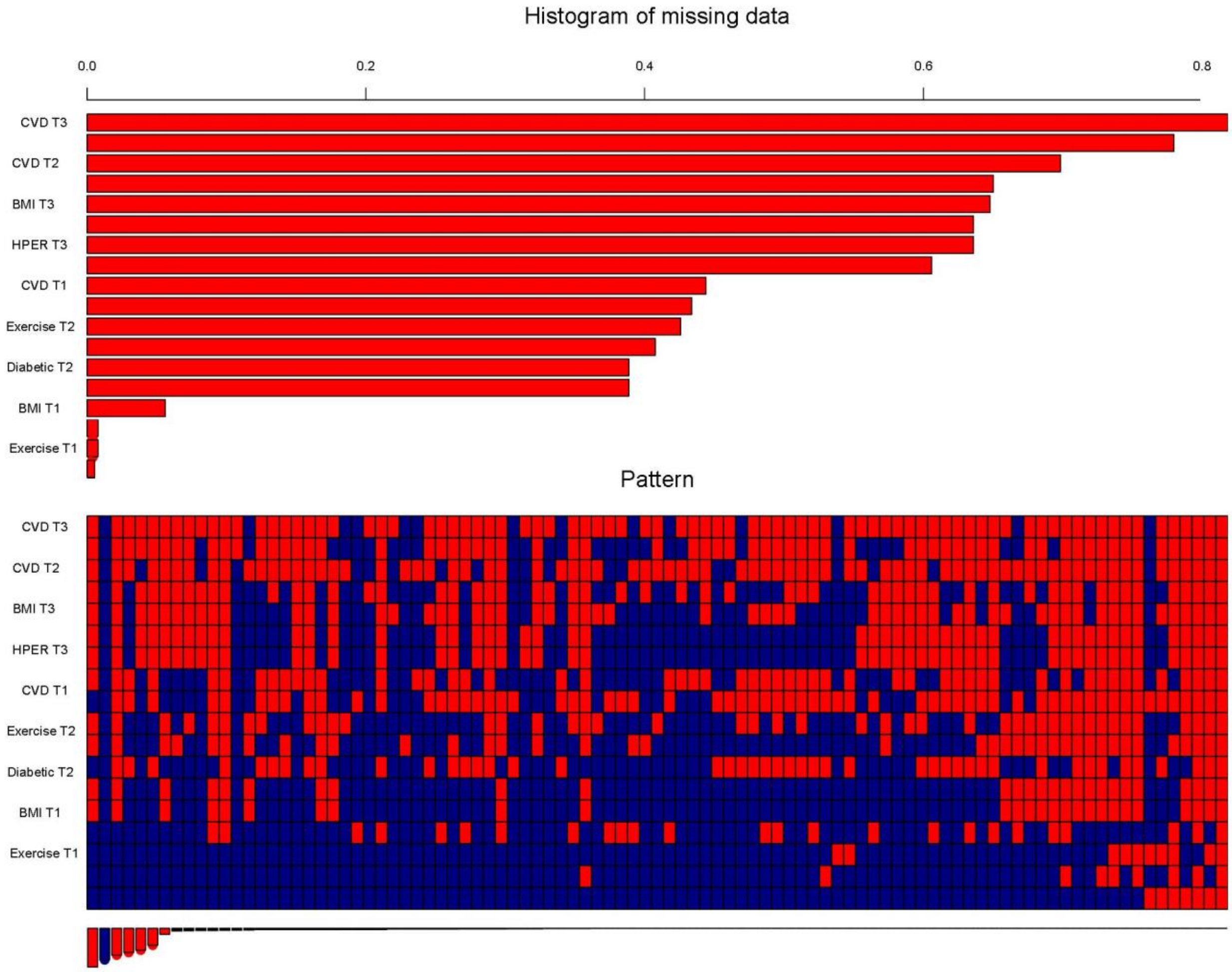
5. Physical exercise

Participants answered the following questions:

a. During the summer, how often do you engage in VIGOROUS physical activity (for example, running or lifting heavy objects) long enough to work up a sweat?
b. During the summer, how often do you engage in MODERATE physical activity (for example, bowling or using a vacuum cleaner)?
c. What about during the winter -- how often do you engage in MODERATE physical activity?
d. What about during the winter -- how often do you engage in VIGOROUS physical activity long enough to work up a sweat?

Response choices: 1) Several times a week or more, 2) about once a week, 3) several times a month, 4) about once a month, 5) less than once a month, 6) never

Appendix G: Item-level Missing Data Patterns



Some items assessed at T2 or T3 had between 60 and 80 percent missing data.

Appendix H: Imputed versus Unimputed Data

Unimputed (Unweighted)									
	N	Mean	SD	Min	Max	Range	Skew	Kurtosis	SE
Cardiovascular Health T1	704	3.11	1.10	0.00	5.00	5.00	-0.18	-0.37	0.04
Cardiovascular Health T2	382	2.77	1.12	0.00	5.00	5.00	-0.02	-0.60	0.06
Cardiovascular Health T3	230	2.86	1.11	0.00	5.00	5.00	0.05	-0.59	0.07
Positive Reappraisal T1	1252	3.19	0.58	1.00	4.00	3.00	-0.42	-0.20	0.02
Positive Reappraisal T2	761	3.05	0.59	1.00	4.00	3.00	-0.20	-0.40	0.02
Positive Reappraisal T3	460	3.01	0.58	1.00	4.00	3.00	-0.09	-0.48	0.03
Volunteerism T1	1151	5.03	12.93	0.00	240.00	240.00	7.77	107.17	0.38
Volunteerism T2	615	7.37	14.88	0.00	125.00	125.00	3.51	17.35	0.60
Volunteerism T3	366	6.42	14.92	0.00	156.00	156.00	4.85	34.46	0.78
Imputed Data (Unweighted)									
	N	Mean	SD	Min	Max	Range	Skew	Kurtosis	SE
Cardiovascular Health T1	1266	3.07	1.06	0.00	5.00	5.00	-0.12	-0.40	0.03
Cardiovascular Health T2	1266	2.70	1.05	0.00	5.00	5.00	0.04	-0.61	0.03
Cardiovascular Health T3	1266	2.70	0.95	0.00	5.00	5.00	0.18	-0.31	0.03
Positive Reappraisal T1	1266	3.19	0.58	1.00	4.00	3.00	-0.41	-0.20	0.02
Positive Reappraisal T2	1266	3.06	0.58	1.00	4.00	3.00	-0.21	-0.33	0.02
Positive Reappraisal T3	1266	3.00	0.57	1.00	4.00	3.00	-0.01	-0.54	0.02
Volunteerism T1	1266	5.56	12.07	0.00	120.00	120.00	4.09	24.15	0.34
Volunteerism T2	1266	9.39	17.29	0.00	125.00	125.00	2.89	10.48	0.49
Volunteerism T3	1266	8.13	12.78	0.00	156.00	156.00	2.99	18.42	0.36

	Weighted			
	Imputed		Unimputed	
	Mean	SE	Mean	SE
Cardiovascular Health T1	3.00	0.04	3.33	0.13
Cardiovascular Health T2	2.65	0.04	2.81	0.13
Cardiovascular Health T3	2.65	0.03	2.70	0.11
Positive Reappraisal T1	3.21	0.02	3.13	0.06
Positive Reappraisal T2	3.07	0.02	3.03	0.06
Positive Reappraisal T3	3.01	0.02	2.97	0.07
Volunteerism T1	5.21	0.39	3.73	1.04
Volunteerism T2	8.56	0.51	6.61	1.69
Volunteerism T3	8.15	0.40	4.24	1.01

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