Resilience and longevity: expert survivorship of centenarians

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Resilience and longevity: expert survivorship of centenarians

Peter Martin, Maurice MacDonald, Jennifer Margrett, and Leonard W. Poon

Abstract

Centenarians are survivors, and many among them exemplify sustained competence into very old age. This paper highlights three important resilience domains among centenarians: personal resilience (e.g., personality), cognitive resilience (e.g., intellectual functioning), and social and economic resilience (e.g., social support and economic resources). These psychosocial resources of resilience are linked to overall functioning and survivorship among centenarians. Our findings suggest that a “robust” personality, cognitive reserves, and social and economic resources are salient resilience factors necessary for survival and optimal functioning and well-being. To illustrate, personality traits (e.g., competence) and perceived economic status served as mediators between negative life stress and negative affect. With regard to cognition, some centenarians function very well despite low education or poor physical functioning. Finally, perceived economic status mediates the relation between physical functioning and negative affect. Taken together, we conclude that psychosocial resources and resilience are important components of quality of life in late life.

Introduction

Resilience is a descriptor placed on individuals or groups of individuals who survived in the face of adversities. Resilience has been used to describe survivors of the September 11, 2001 attack at the New York World Trade Center as well as the 2005 Katrina hurricane survivors in New Orleans. Masten (2001) defined resilience as “a class of phenomena characterized as good outcome in spite of serious threats to adaptation or development” (p. 227). The construct of resilience must involve the inclusion of risks or threats toward development such as compelling socioeconomic circumstances, trauma, life events, health, and other adverse conditions which happened in serial, parallel, or concurrent fashion over time. Therefore, to be resilient implies that it is necessary
to survive or to meet the condition of a satisfactory or "good" outcome in dealing with the risks and threats. In a review of resilience research Masten (2001) noted a surprising conclusion, which is the ordinariness of the phenomenon. Resilience is a common occurrence within the context of human development. That is, most people encounter adversities over time, and yet many people tend to adapt adequately or successfully in their development.

In this chapter, we outline and discuss a model of successful adaptation in the study of centenarians (Poon et al., 1992a, 2007). Centenarians have met the two major requirements of being resilient. The first requirement concerns the presence of risks or threats. These individuals have accumulated a century of life events, including surviving the deaths of family members and birth cohorts, economic depression, world wars, and health morbidity and co-morbidity. The second concerns successful adaptation in that centenarians have adapted and survived in spite of the cumulative negative as well as positive events. In this respect, longevity, resilience, and successful adaptation are intimately related, and it is likely that they share many of the common mechanisms and characteristics. Long-lived individuals experience risks and adversities over time and the presence of adversity and successful adaptation are the two necessary ingredients present in resilience. Hence, in discussing resilience among centenarians, it is essential to include concepts of longevity and successful adaptation in the face of cumulative risks and threats.

From this perspective, it can be said that centenarians' resilience may be one of the factors in doubling their lifespan. By definition, an American centenarian born in 1900 lived to 2000 and beyond, while their birth cohort survived to an average of 46.3 years for men and 48.3 for women (National Center for Health Statistics, 2007). Not many people are fortunate to achieve centenarian status; however, the proportion of centenarians is increasing at a dramatic rate among industrialized countries around the world. According to the US Census Bureau, there were 37,306 centenarians in 1990, 50,454 in 2000 (Hetzel and Smith, 2001), and it is projected that the number could increase to 324,000 in 2030, 447,000 in 2040, and 834,000 in 2050 (Krach and Velkoff, 1999). It is noted that the accuracy of the American census of centenarians is controversial as it is based on self-reports which are not validated. The number of centenarians in most industrialized countries is about 1 in 10,000, and the trend is toward 1 in 5,000 (Poon and Perls, 2007b).

The pertinent question for this chapter is what individual characteristics potentially contribute to resilience among centenarians. We do not know whether long-lived individuals inherently exhibit the resilience characteristics, acquire these characteristics along the way and hence
become long lived, or how resilient people become long-lived individuals. Further, we do not know what heritable and environmental influences combine to inculcate resilience among the oldest-old. While longevity researchers around the world are seeking answers to contributors to longevity, which may have close and important correlates to resilience, there is general consensus on the following conclusions relating to longevity. One, there are large individual differences among centenarians (Gondo and Poon, 2007; Hagberg et al., 2001; Martin, 2007; Poon and Perls, 2007a) along the dimensions of physical, mental, cognitive, and functional health as well as variations in family longevity, support systems, coping, personality, and lifestyles. These findings lead to the second consensus that there are multiple factors that contribute to longevity, and there is no one "secret" to longevity (for reviews see Poon and Perls, 2007b). Similarly, many factors are postulated to contribute to resilience with as many controversies and criticisms as the extant longevity research (Luthar, Cicchetti and Becker, 2000; Masten 1999, 2001; Masten and Coatsworth, 1998). Finally, women, compared with men, are the champion survivors in all the adult age ranges (Poon and Perls, 2007a). Eighty-five percent of centenarians are women, and the ten oldest persons in the world are women. Are long-lived women more resilient as well? We do not know. We do know that some factors contribute to female longevity superiority, while others do not. Further research in both longevity and resilience among the oldest-old is needed.

In this chapter, we begin by introducing a model of adaptation employed by the Georgia Centenarian Study (Poon et al., 1992a). Within this model, we discuss resilience associated with three types of psychosocial contributors that could act as risks or threats toward successful adaptation on the one hand and positive or protective mediators on the other hand. These are personality/coping styles, cognition, and social and economic resources.

**Theoretical and conceptual background**

The outcome of successful adaptation is one contributor to resilience (Masten, 2001). Figure 8.1 outlines a conceptual model of Phase 1 (1988–1992) of the Georgia Centenarian Study (Poon et al., 1992a), which examined successful adaptation of cognitively-intact and community-dwelling centenarians, octogenarians, and sexagenarians. The predictors in this model measure the direct and indirect impact of family longevity, environmental support, individual characteristics, coping abilities and styles, and nutrition on physical health, mental health, and life satisfaction.
Taken together, this model meets all the expectations of a study of resilience (Masten, 2001) in which the impacts of risks and adversities are examined against “good” outcomes or successful adaptation. Phase 2 (1992–1998) of the study examined longitudinal changes of the model components. The basic question of Phase 2 was whether centenarians could exceed all expectations of survival and continue to extend their individual lifespan. For these unusual centenarians, we were wondering whether there were any resilience factors contributing to continued survival. Phase 3 (2001–2009) is a population-based study examining both biomedical (genetics, neuropathology, blood chemistry, nutrition, health) and psychosocial (neuropsychology, adaptation, resources) contributors to longevity (Poon et al., 2007). Our current study also addresses resilience, as we are comparing those centenarians who adapt well with those who may not adapt well in very late life.

This chapter is designed to focus on three aspects of the Georgia Centenarian Study that could potentially contribute to our understanding of resilience among the oldest-old: personality and coping styles (i.e., individual and adaptational characteristics), cognition (i.e., behavioral skills and functional status), and economic and supportive resources (i.e., environmental support). As noted by Masten (2001), resilience occurs in the context of ordinary everyday lives and, among adversities,
good outcomes may occur. In the study of lives and patterns of centenarians, paradoxes present themselves as a matter of course. For example, centenarians may have poor resources in that their income and assets are frequently below the poverty level. Centenarians may also lack in family and support systems as they frequently outlive their families, and yet they may have good everyday problem abilities and coping skills that help them survive with good mental health and excellent perceived quality of life. On the other hand, some centenarians may have a sufficient support system to be cared for in a private nursing home or at home; however, they may have severe dementia that compromises their quality of life at the end stage. Owing to the prevalence of dementia in late life, our study attempts to triangulate self- and proxy reports, actual performances, as well as an interviewer’s assessment to ascertain different points of view of the same situation. From this perspective, we have expected complex interactions in both direct and indirect assessment in the study of adaptation among the oldest-old. Our study represents an attempt to take a first few steps to better understand longevity and successful aging in the midst of challenges among the oldest-old.

**Personality and coping resilience**

The first resilience domain we discuss is concerned with personality and coping behaviors. It is easily noticeable that many centenarians experience a number of limitations. Notwithstanding those limitations, many centenarians continue to astonish family members, nursing staff, and community service providers. What makes centenarians so fascinating? We have noted that, among other things, centenarians have a robust or resilient personality (Martin, 2007). In addition, centenarians have found effective ways to cope with their own limitations (Martin et al., 2008). Personality and coping are considered personal or individual resources that help to adapt during times of change.

Consistent with the definition of resilience provided by Masten (2001), suggesting that resilience refers to beneficial outcomes even if individuals experience threats to their adaptation, personality traits and coping behaviors are resources available during challenging times. For example, centenarians as survivors have lost many family members and friends, yet their unique personality may help them overcome these loss events. Likewise, centenarians may employ unique coping behaviors that help them to adjust to age-associated changes. Resilience is therefore dependent on personal resources available in times of crises.

If these personal resources are characteristic of centenarians, then they should show up in the overall personality profile of centenarians.
In previous publications, we have pointed to a number of important traits and states that are consistently noticeable in the profile or configuration of centenarians. In Phase 1 of the Georgia Centenarian Study, we reported that centenarians had higher scores in dominance, suspiciousness, and shrewdness, whereas they were lower in imagination and tension when compared with two younger groups (Martin, 2002). Our longitudinal Phase 2 data showed that when retesting centenarians after approximately 20 months, centenarians had decreased scores in sensitivity, but demonstrated higher scores in “openness to change” (Martin, Long, and Poon, 2002). We argued that a relaxed but upfront personality describes the “robust personality” among these highly selected centenarians and that this distinct personality pattern was not only an indication of survivorship but also an important resource helping centenarians to adapt well in later life (Martin, 2002, 2007).

In Phase 3 of the Georgia Centenarian Study, we have used the Big 5 framework and reported that centenarians overall had low levels of neuroticism, but relatively high levels of extraversion, competence (a facet of conscientiousness), and trust (a facet of agreeableness; Martin et al., 2006).

Caspi (1998) suggested three personality patterns can be directly related to the Big 5: the “well adapted” or resilient personality (i.e., persons who score moderately high on extraversion, openness, conscientiousness, and agreeableness but low on neuroticism); the “overcontrolled” personality (i.e., persons particularly low on extraversion and emotional stability); and the “undercontrolled” personality (i.e., persons who score high on extraversion, but low on agreeableness, and conscientiousness). Based on this definition of a resilient personality, our results confirmed a tendency toward this special combination of traits among centenarians (i.e., low levels of neuroticism, high conscientiousness, and moderately high extraversion; Martin et al., 2006).

Other centenarian studies have reported similar results. For example, centenarians in a Swedish centenarian study were described as dependable, reliable, mature, and conscientious (Samuelsson et al., 1997). Furthermore, centenarians on average were responsible, easygoing, capable, relaxed, efficient, and not prone to anxiety. A Japanese centenarian study indicated that centenarians scored higher in openness when compared with younger controls (Masui et al., 2006). In addition, relatively high scores for conscientiousness and extraversion were found among female centenarians when compared with elderly individuals aged from 60 to 84 years. These studies suggest a common pattern of resilience: low scores in neuroticism and relatively high scores in conscientiousness and extraversion.
Resilience and longevity

Table 8.1. Cross-tabulation of stressful life events and mental health outcome

<table>
<thead>
<tr>
<th>Negative life events</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>43 (A)</td>
<td>23 (B)</td>
</tr>
<tr>
<td></td>
<td>33.9%</td>
<td>18.1%</td>
</tr>
<tr>
<td>High</td>
<td>25 (C)</td>
<td>36 (D)</td>
</tr>
<tr>
<td></td>
<td>19.7%</td>
<td>28.3%</td>
</tr>
</tbody>
</table>

*Note:* A median split was used to distinguish low and high negative life events and negative affect.

Resilience may also directly relate to effective coping. Centenarians are faced with many adverse changes, and how they deal with these late-in-life changes may be informative as to their ability to survive under unusual circumstances. In our previous research we noted two different aspects of coping: first, whereas centenarians are less likely to use behavioral coping styles (e.g., “made a plan of action”), continued high levels of cognitive coping (e.g., “went over the situation in my mind”) are noticeable in these expert survivors (Martin et al., 1992, 2008). Second, when individual coping items were evaluated, we noticed that centenarians were more likely to accept adverse situations, use religious coping, and to take one day at a time. Furthermore, centenarians were less likely to worry about stressful situations (Martin et al., 2001). Taken together, the coping literature on centenarians suggests resilient behaviors rooted primarily in cognitive coping, acceptance, and religious coping.

In the next section, we will provide illustrative examples of how centenarians might use their individual resilience characteristics (i.e., personality and coping behaviors) in challenging situations. We will relate these characteristics to mental health and, with reference to Masten (2001), we will first take a person-focused and then a variable-focused approach to resilience among centenarians.

**Illustrative examples: life events, personality, and mental health**

Person-focused approaches to resilience, as outlined by Masten (2001), “attempt to capture the configural patterns of adaptation, that naturally occur” (p. 232). A simple example would include a cross-tabulation of risk variables and outcomes. Table 8.1 summarizes an illustrative example.
with our centenarian data. In this example, cumulative or lifetime negative events were conceptualized as a risk factor and the outcome is mental health (i.e., degree of negative affect).

We used a life event checklist and summarized all events that reportedly occurred at any time of the centenarians’ lives and that were rated as negative experiences. The negative affect subscale of Bradburn’s Affect Balance Scale (Bradburn, 1969) was used as a mental health measure. We would expect that centenarians who reported many negative events throughout their lives would show higher levels of negative affect.

Group A includes centenarians who do not report many negative life events and who show low levels of negative affect. Perhaps these could be termed our “fortunate” centenarians, and it includes the highest percentage of centenarians. Group B includes centenarians who did not experience many negative events but who show high levels of negative affect. These centenarians may show mental health problems for perhaps different reasons not captured in our life events list. It is the smallest group of centenarians and we may label them the “dissatisfied” group. Group C contains centenarians who have experienced many negative events but do not show high levels of negative affect. These are our “resilient” centenarians, and about 20 percent of our centenarians fall in this category. Finally, Group D contains centenarians who have experienced many negative life events and show relatively high levels of negative affect. This is the second largest group, and we label them as our “vulnerable” group of centenarians.

The cross-tabulation alone does not show us whether one group of centenarians is more likely to emerge than others. We therefore computed configural frequency analyses to test for types and antitypes in this cross-classification (von Eye, 1990). This procedure allows us to conduct a probability test for each cell to evaluate whether a configuration of rows and columns in a cross-tabulation occurs more (or less) than expected by chance. Configurations that occurred more often than expected by chance are considered “types,” while configurations that occurred less often than expected by chance are “antitypes.”

The results suggest that Group A membership (i.e., “fortunate”) occurred more often than would be expected by chance \( (p = 0.02) \), whereas group B membership (i.e., “dissatisfied”) occurred less often than would be expected by chance \( (p = 0.04) \). There was a statistical trend suggesting that the resilient group C (i.e., “resilient”) occurred less often than would be expected by chance \( (p = 0.09) \).

Taken together, our person-centered data illustrate that resilient centenarians exist, but the group of resilient centenarians was not the most frequent group. The strongest group contained individuals who had not
experienced many negative life events and reported very low negative affect scores, perhaps pointing to a pattern of advantaged survivorship. Few negative events and high levels of mental health might have moved these centenarians into an elite group of survivors to begin with.

In addition to taking a person-focused approach, Masten (2001) noted that variable-focused approaches “use multivariate statistics to test for linkages among measures of the degree of risk or adversity, outcome, and potential qualities of the individual or environment that may function to compensate for or protect the individual from the negative consequences of risk of adversity” (p. 229). In the following illustrative example we again chose cumulative negative life events as the risk or adversity measure, personality (specifically competence, a facet of conscientiousness in the Big 5 framework) as the personal asset, and negative affect as a potentially negative consequence of adversity. As outlined by Masten (2001), we tested independent, mediating, and moderating effects. When testing the independent effect of negative life events and competence on negative affect, both competence ($\beta = -0.32, p < 0.01$) and negative life events ($\beta = 0.31, p < 0.05$) predicted negative affect. The model suggests that competent centenarians are less likely to show high levels of negative affect. Those centenarians, however, who have experienced many negative events throughout their lives are more likely to show poorer mental health.

An alternative model would place competence as a mediator between cumulative life events and negative affect. The illustrative results are shown in Figure 8.2. The model suggests that competence is a mediator between cumulative negative life events and negative affect. Those centenarians who had experienced many negative events throughout their lives were less likely to be competent, and lower levels of competence were associated with higher levels of negative affect. According to Baron and Kenny (1986), a mediator reduces or eliminates the effect of a risk factor.
on negative outcomes. In this example, the personality trait competence reduced the effect of negative life events on mental health problems (i.e., the path is reduced from 0.31 to 0.24), suggesting partial mediation.

The final model tested was a model of statistical moderation. The effect of competence as a moderator is established through the interaction term of negative life events and competence. The interaction term was not significant and, more importantly, the interaction entered as a separate regression block did not explain significantly more variance in the dependent variable, $F(1, 99) = 0.73, p > 0.05$. Competence, therefore, did not serve as a moderator in the stress-outcome relationship.

This example illustrates the importance of personality as a resilience factor when very old people reflect on their long lives. A long life replete with negative events could be disconcerting, but individual resources may change the overall nature of this relationship. Even though negative events erode the feelings of competence, competence – as a mediator – reduces the effect of stress on negative outcomes. Of course, we only provided illustrative examples; other personality traits (e.g., neuroticism or extraversion) or coping variables (e.g., cognitive or behavioral coping) may also function as salient mediators in the stress-outcome relationship. In the next section, we will discuss our approach to cognitive resilience.

**Cognitive resilience**

Given the multifaceted nature of “cognition” and the synergistic relation between cognition and functioning throughout the lifespan, the conceptualization of cognitive resilience is complex and its meaning can vary across age. Several issues arise when considering cognitive resilience in late life, including the following: (a) distinguishing the type of cognition assessed such as domain-specific abilities (e.g., memory, reasoning) or mental status (e.g., impaired, at-risk, or intact) and whether assessments are performance-based or subjective reports; (b) identifying criteria to distinguish a minimum level of acceptable performance or, as Masten (2001) notes, specifying what constitutes a “good” outcome; and (c) understanding the interconnectedness of cognition with other systems and functional outcomes (e.g., sensory functioning). Depending on perspective, cognitive abilities and status could be characterized as assets/risks or outcomes in their own right. As an outcome, cognitive resilience might describe individuals who are able to maintain adequate levels of cognitive functioning throughout very late life despite adversity and cumulative risk. For various individuals, an optimal cognitive outcome may include enhancement or maintenance of cognitive abilities, avoidance of impairment, or
achievement of minimal, legal cognitive competence. As a predictor, late-life cognitive resilience may typify individuals who maintain adequate everyday functioning despite initially low, currently declining, or impaired cognitive functioning. This section describes the cognitive abilities of oldest-old adults, followed by a review of findings on the impact of cognition on longevity, and finally by borrowing from the resilience literature we postulate how variations in cognition, including dementia, could contribute to successful adaptation of the oldest-old.

Cognition in later life

As previously mentioned, the conceptualization and assessment of cognition vary. For one, prior research has differentiated two broad classes of cognitive abilities comprised of several individual intellectual skills, and this distinction appears to remain important through very late life. Crystallized abilities, or those skills which rely on accumulated knowledge and experience, are generally maintained well into the seventies; however, fluid abilities which are considered more biologically driven peak in the early twenties and exhibit a gradual decline throughout adulthood (Schaie, 2005). Across studies, centenarians demonstrated a greater range of performance on measures of crystallized abilities; however, centenarians’ performance on fluid measures tended to be more similar, suggesting a possible floor effect in respect to these more age-sensitive abilities (Hagberg et al., 2001).

In contrast to the first approach, which focuses on more narrowly defined individual cognitive skills, assessments of problem-solving ability tend to be more contextual and incorporate actual real-life stimuli (e.g., prescription labels). “Everyday” problem-solving ability is considered to be a higher-order cognitive skill which depends upon the constituent intellectual abilities (e.g., Marsiske and Willis, 1995). In contrast to marked age-related differences observed in individual intellectual abilities, everyday problem-solving assessments may better capture the skills needed in late life. For instance, Poon and colleagues note the robust ability of oldest-old and centenarian participants to generate solutions to everyday problems (Poon et al., 1992a, 1992b). The ability to navigate everyday challenges is particularly important as we consider successful adaptation and resilience in very late life. The resilience of such abilities may be masked by reliance on domain-specific assessments.

A third approach to understanding cognitive aging stems from a more clinical and neuropsychological perspective aimed at understanding the mechanisms underlying non-normative cognitive changes such as the occurrence of dementia. From this perspective, global indicators
of cognitive functioning and neuropsychological measures are typically employed to distinguish individuals with dementia from those without cognitive impairment. Dementia prevalence rates vary with age, and the Alzheimer's Association (2007) estimates that one in eight persons in the USA over the age of 65 has dementia or Alzheimer's disease; this rate dramatically increases among adults aged 85 and older to one in two persons. However, despite an increased risk associated with greater age, not all centenarians have dementia. This raises doubts regarding the "eventuality" of dementia and establishes the need to identify factors related to cognitive resilience, including "functional and cognitive reserves" (e.g., Perls, 2004).

The impact of cognition and dementia on survivorship

The literature has shown with high consistency that cognition and survivorship are positively related; however, there remain many unanswered questions (see Gondo and Poon, 2007, for a review). The foremost question is which types of cognition are particularly important to survival? Second, if cognition is positively related to survival, then there exists a paradox that a good portion of centenarians are cognitively impaired; how can this paradox be resolved? A number of centenarian studies have shown that higher levels of cognitive and functional performances among centenarians predict survival (Gondo and Poon, 2007). The French Centenarian Study (Robine, Romieu, and Allard, 2003) found that mental status was predictive of eight-year survival in addition to health status, activities of daily living (ADL), and independent activities of daily living (IADL). The Tokyo Centenarian Study (Shimizu et al., 2001) found that the Clinical Dementia Scale (CDR) was predictive of survival; however, this effect disappeared after controlling for physical conditions. Another finding from the Tokyo Study (Gondo et al., 2006) was that the total functional scores of physical and cognitive functions predicted one-year survival above and beyond the predictive power of cognitive function alone. Finally, the Georgia Centenarian Study (Poon et al., 2000) showed that cognition was one of four predictors of the number of days of survival after 100 years; the other predictors were being female, father's age of death, and nutrition sufficiency.

If higher levels of cognition are predictive of survival, then how would one reconcile the prevalence of dementia among centenarians? This is indeed a paradox. The prevalence of dementia varies from about 42 to 80 percent from different studies around the world (Gondo and Poon, 2007), with a mean around 50 percent. Given that the average length
Resilience and longevity of life after contracting dementia is about eight years, it is reasonable to postulate that dementia among centenarians is most likely to be late onset. If this postulation is correct, then it could be further hypothesized that distal experiences and cognitive abilities prior to the onset of dementia may be important factors in the determinants of survival, and not just current-state cognition alone. Among models of resilience, Masten (2001) postulated that both the positive influence of “assets” and the negative influence of risks-adversities could work independently or jointly to impact outcome behavior or through moderator variables which in turn impact the outcome behavior. From this perspective, cognition could be an asset that is protective, dementia could be the risk-adversity, and both could impact longevity or resilience through a variety of mechanisms.

Variable and person-focused approaches to cognitive resilience

As noted by Masten (2001), it may be helpful to consider variable (i.e., individual and contextual factors) and person-related (i.e., profiles over time) predictors related to cognitive resilience. Both approaches are applicable to the study of cognitive resilience in later life, as cognitive aging is a dynamic process and one likely to occur with concomitant changes in both the individual and their environment. Examples of individual and contextual variables which affect cognitive development and adaptation in later life are early education, birth cohort, ethnicity, gender, and socioeconomic environment. More dynamic person-related variables include influences such as genetics (e.g., presence of APOE ε4 allele), health and physical status, mental health, emotional regulation, as well as developmental changes to the cognitive (e.g., dedifferentiation of abilities and terminal change and drop in ability level prior to death; de Frias et al., 2007; Siegler and Bosworth, 2002) and other systems (e.g., sensory functioning; Li and Lindenberger, 2002).

Illustrative examples: cognitive resilience as an outcome and a predictor

Similar to the cross-tabular approach taken with personality, we examined cognitive resilience as an outcome as well as a predictor. Table 8.2 depicts an indicator of cognitive resilience (i.e., global cognitive or mental status, as assessed by the Mini-Mental Status Examination; Folstein, Folstein, and McHugh, 1975) and educational attainment, an important precursor to late-life mental status.
Table 8.2. Cross-tabulation of educational attainment and cognitive status outcome

<table>
<thead>
<tr>
<th>Cognitive status</th>
<th>Education</th>
<th></th>
<th>High School Diploma</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Less than high school</td>
<td>59 (A)</td>
<td>19 (B)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>40.1%</td>
<td>12.9%</td>
</tr>
<tr>
<td>Low</td>
<td>High School Diploma</td>
<td>38 (C)</td>
<td>31 (D)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25.9%</td>
<td>21.1%</td>
</tr>
</tbody>
</table>

Note: Cognitive status was dichotomized: 0 = MMSE < 17; 1 = MMSE ≥ 17.

Similar to the findings for personality, individuals falling into each category can be categorized in terms of risk and resilience. As shown in Group A, lack of early education was a risk for some centenarians; individuals without a high school diploma or its equivalent were more likely to demonstrate a low Mini-Mental Status Examination (MMSE) score. However, a substantial number of individuals could be described as cognitively “resilient” (i.e., Group C). These centenarians maintained a high level of cognitive functioning in later life despite a relatively low level of educational attainment. Consistent with expectations, individuals in Group D could be described as “fortunate” because they possessed high educational attainment and maintained higher cognitive status. Although the smallest group, some centenarians (Group B) attained a high school diploma yet did not maintain high cognitive functioning in late life. The configural frequency analyses suggested that this configuration occurred less often than would be expected by chance ($p < 0.001$). In contrast, Group A occurred more often than would be expected by chance, resulting in a significant “type” for centenarians ($p < 0.001$).

Next, we examined cognition as a conceptual prerequisite of more complex functioning. Table 8.3 depicts the cross-tabular relation between MMSE score and centenarians’ ability to perform activities of daily living (i.e., ADL) as assessed by the Direct Assessment of Functional Status (DAFS; Loewenstein et al., 1989). The DAFS assesses objective ability to perform tasks in critical life domains such as communication, finances, personal care, and shopping. As evident in the table, cognitive status and functional ability were highly related. As shown in Group D, many centenarians in the sample could be described as “fortunate” because they exhibited high levels of both cognitive and functional performance. The second most frequent group was Group A, in which individuals can be described as “vulnerable,” given the correspondence between lower
Table 8.3 *Cross-tabulation of cognitive status and activities of daily living outcome*

<table>
<thead>
<tr>
<th>Cognitive status</th>
<th>Activity of daily living performance</th>
<th>Low</th>
<th>High</th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>76 (A)</td>
<td>13 (B)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>39.0%</td>
<td>6.7%</td>
<td></td>
</tr>
<tr>
<td>High</td>
<td>20 (C)</td>
<td>86 (D)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10.3%</td>
<td>44.1%</td>
<td></td>
</tr>
</tbody>
</table>

Note: Cognitive status was dichotomized: 0 = MMSE < 17; 1 = MMSE ≥ 17; A median split was used to distinguish relatively low and high ADL functioning within the sample.

cognitive status and lower ADL functioning. It is interesting to note that, as illustrated by Group B, very few individuals (6.7 percent) could be described as functionally “resilient” despite low cognitive status. Finally, individuals in Group C demonstrated high cognitive functioning yet have low ADL performance, thus suggesting other influential factors such as poor physical health. Based on configural frequency analyses, Groups A and D are “types,” meaning they occur more often than would be expected by chance (both p < 0.001). Groups B and C, on the other hand, are “antitypes,” meaning that they occur less often than expected by chance (again, both p < 0.001).

**Social and economic resilience**

The third resilience domain relevant to long-lived survivors concerns their social and economic resources. Centenarians have lived well beyond the years for which their social and economic resources were expected to last. Their ADL impairment may inhibit conversations and participation in social activities or restrict their mobility for obtaining support services. Centenarians may also be concerned about their dependency, along with the adequacy of their own resources to meet future consumption and health needs. However, friends, family, and government services do respond to those unique circumstances to support them, and some centenarians may have managed to maintain sufficient wealth to confront increased need. Hence Masten’s (2001) conceptualization of resilience in the face of extreme disadvantage seems quite apt for investigating the extent to which social and personal economic resources contribute to centenarian well-being. For that purpose, we will again focus on mental
health as measured by negative affect, and thus define social and economic resilience for centenarians as having sufficient socioeconomic resources to restrict negative affect below what would be expected because of deficits in functional health alone, or because of their negative life experiences.

The question of interest is how extremely old individuals are able to maintain a mental outlook that is as positive as among younger-old adults despite their relative deprivation on almost all other accounts. Based on a meta-analysis of 286 empirical studies of influences on subjective well-being in later life, Pinquart and Sörensen (2000) found no age-associated decline and they concluded that social networks were one of the most important positive influences. In the most comprehensive analysis available for the Berlin Aging Study, Smith and colleagues (1999) found that, except for subjective health, satisfaction with social activities had the strongest effects on overall well-being. Additionally, their path analysis revealed that satisfaction with finances was very important and that age was positively related to financial satisfaction, which suggests that reduced financial obligations or consumption needs may change the context of mental health assessment in very old age.

Results from the first two phases of the Georgia Centenarian Study are a prominent feature of the international literature concerning the influences of social support and centenarians’ economic resources on mental health (MacDonald, 2007). For example, we reported that Georgia centenarians’ annual incomes and poverty status were disadvantaged compared with Georgia sexagenarians and octogenarians and that centenarians were more likely to get help in the form of in-kind assistance (meals, food, and Medicaid) or income assistance (Goetting et al., 1996). Still, centenarians were not significantly different from sexagenarians and octogenarians on most aspects in a self-assessment of economic resource adequacy (e.g., “enough for emergencies,” or “to buy extras”). However, about one in five centenarians reported that their resources were insufficient (i.e., they did not have enough for their needs in the future, to meet emergencies, and that they needed financial assistance).

With respect to social resources, we noted that centenarians had fewer potential visitors, were much less likely to talk on the phone daily, and were more likely to list offspring as caregivers than were sexagenarians and octogenarians (Martin et al., 1996). Using the Georgia Study interviewer’s rating of the quality of social interactions, we also found that the measure of social resources was negatively affected by adverse cumulative life events, but that there were direct and positive effects of social resources on activities of daily living, and the interviewer’s rating of the centenarians’ mental health (Martin, 2002). Furthermore, adverse life
events were negatively related to centenarians' economic resources, and those adverse events had a negative influence on mental health (Martin, 2002). The current Phase 3 study is based on a population-based sample including residents of nursing homes and skilled nursing facilities, whereas the earlier phases of the Georgia study were restricted to community-dwelling centenarians. Presumably those centenarians requiring constant nursing care are the most disadvantaged, so new evidence of resilience due to social and economic variables in this sample would strongly confirm what those previous findings suggest.

**Measures of social and economic resources**

We focused on the percentage distributions of three measures for social and economic resources of centenarians, all of which are obtained from centenarians’ responses to the Duke Older Adults Resources and Services (OARS) questions (Fillenbaum, 1988). For social resources there are two measures, which are the social interactions scale and the number of types of care services the centenarians received. The social interactions scale is the sum of responses about how many people they knew well enough to visit them in their own or another person’s home, how many times they had talked with someone on the telephone in the past week, and how many times in the past week they had spent time with someone who did not live with them. To gauge the level of instrumental social support that centenarians receive, the number of care services counts how many of five types of caregiving they received, which could include personal care, nursing, supervision, household chores, and meal preparation help. The OARS perceived economic status scale is from self-report items that assess the centenarians’ perceptions about their economic resources (e.g., with respect to whether financial resources were sufficient to meet emergencies, and how well the amount of money they had took care of their needs). A large majority (81.1 percent) scored six or more for social interactions (nine-point scale maximum) and 79.2 percent received two or more of the five types of care services. Furthermore, over three-quarters scored seven or eight on perceived economic status.

**Illustrative examples: life events, social and economic resources, and mental health**

Cross-tabulations with social interactions and perceived economic status were obtained (Tables 8.4 and 8.5) to provide a person-focused assessment of the extent to which those resources are associated with ADL functioning from the OARS (Fillenbaum, 1988). For social interactions,
Table 8.4. Cross-tabulation of social interactions and activities of daily living outcome

<table>
<thead>
<tr>
<th>Activities of daily living</th>
<th>Social interactions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>36 (A)</td>
<td>23 (B)</td>
</tr>
<tr>
<td></td>
<td>28.3 %</td>
<td>18.1%</td>
</tr>
<tr>
<td>High</td>
<td>25 (C)</td>
<td>43 (D)</td>
</tr>
<tr>
<td></td>
<td>19.7%</td>
<td>33.9%</td>
</tr>
</tbody>
</table>

Note: A mean split was used to distinguish low and high ADL functioning and social interactions.

Table 8.5. Cross-tabulation of perceived economic status and activities of daily living outcome

<table>
<thead>
<tr>
<th>Perceived economic status</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Low</td>
<td>15 (A)</td>
</tr>
<tr>
<td></td>
<td>14.0%</td>
</tr>
<tr>
<td>High</td>
<td>9 (C)</td>
</tr>
<tr>
<td></td>
<td>8.4%</td>
</tr>
</tbody>
</table>

Note: A mean split was used to distinguish low and high ADL functioning and perceived economic status.

A large percentage of centenarian outcomes were as expected (i.e., Groups A and D: lower ADL functioning was associated with less social interaction and higher ADL functioning was associated with greater social interaction). Twenty percent of individuals (i.e., Group C) could be classified as "resilient"; these centenarians maintained superior ADL functioning despite lower social interaction. For Group B, greater social interaction and presumed support did not translate into superior ADL functioning, and that group included about 18 percent of individuals.

In terms of perceived economic status, the majority of centenarians reported greater economic sufficiency as well as higher ADL functioning (i.e., Group D). Interestingly, for a substantial proportion of individuals (i.e., Group B), higher perceived economic status was actually related to worse ADL functioning. Thus, greater resources did not appear to serve as a buffer against lower functional ability for these individuals. A small proportion of centenarians (i.e., Group C) could be described as
"resilient," that is despite lower perceived economic status these individuals maintained superior ADL functioning. The final group (i.e., Group A) represented 14 percent of the cases in which individuals were lower on both perceived economic resources and ADL ability. Configural frequency analysis tests confirmed that Group D was a more frequent type for both sources of support: greater social interaction and higher perceived economic status were positively related to ADL functioning.

However, neither the social interactions scale nor the perceived economic status scale provides an unambiguous standard for assessing what levels of those resources are sufficient to create resilience despite limitations due to functional health impairment or the impact of distal negative events. Hence additional variable-focused analyses were conducted to test whether those measures of socioeconomic resources mediate or moderate the influence of ADL impairment on negative affect. Similar analyses assessed whether the resource measures influenced the relationship of distal negative events on centenarians' negative affect. In that manner, the centenarians' negative affect scores provide a standard to compare the influences of the two types of limitations with those for social and economic resources.

As would be expected from the person-focused cross-tabulation discussed earlier, there was a significant negative relationship ($\beta = -0.19, p < 0.05$) between ADL impairment and social interactions. When social interactions was included in the model to predict negative affect, the effect of ADL impairment ($\beta = -0.08$) was not significant. However in that same model, there was a statistical trend for a negative influence of social interactions ($\beta = -0.16, p < 0.10$). Hence, there is some potential for concluding that support from the centenarians' social network mediates the negative influence of ADL impairment on their mental health.

The model for considering how perceived economic status may support mental health despite ADL impairment provided strong support for economic resilience of that type. In this case, there was a strong negative effect of ADL impairment on perceived economic status (Figure 8.3). When perceived economic status and ADL were both used as predictors of negative affect, the effect of ADL was not significant but perceived economic status had a significant negative effect. These results demonstrate the importance for centenarians of maintaining a resilient attitude that their economic resources are still sufficient to meet their needs despite the economic stress that is created by their functional impairments.

As an extension, we computed additional models to learn whether and how centenarians' social and economic resources may moderate the effect of stress from distal negative life events on their affect. That effort
yielded little support for the hypothesis that perceived economic status or social interaction moderates the direct effect of negative events on affect. However the use of an interaction term involving negative life events and perceived economic status provided evidence that centenarians’ current economic resources do moderate the distal influence of negative events. Centenarians with low economic status were predicted to have a higher mean value for negative affect than those with high economic status, regardless of the number of negative life events. Furthermore, centenarians’ negative affect was expected to increase to some extent due to negative events. By contrast, for centenarians with high perceived economic status, more negative events were associated with better affect. Evidently, centenarians with sufficient economic resources are able to resolve or pay for the consequences of negative life events such as health setbacks and thus maintain better mental health.

To summarize briefly, we found that perceived economic status mediates the negative influence of decreased functional ability on mental health. Additionally, the influence of negative life events as a stressor that may increase negative affect was moderated by perceived economic status, so that those who were economically better off managed to maintain positive mental health. Although the results of tests for mediation by social interactions were not as clear cut, the findings also suggested some protective influence for mental health. In our earlier work we reported that centenarians’ adverse life events were negatively related to both the quality of their social interactions and perceived economic status, and that both types of resources still contributed to their mental health (Martin, 2002). The present study yields the additional result that economic resources moderate the influence of negative life events on mental well-being. Furthermore, the negative influence of functional health impairment appeared to be entirely mediated by economic resource adequacy. This result may be an important clue for resolving the puzzle...
about how oldest-old individuals construct positive well-being despite severe health restrictions. Pinquart and Sörenson (2000) have suggested that the oldest people maintain their well-being through “downward age comparisons” and thus feel fortunate simply because they have survived. The findings reported here suggest that maintaining centenarians’ economic resources may be sufficiently protective for social and economic resilience that enhances mental health. Further research to examine how social support may enhance resources for meeting centenarians’ needs may be in order, particularly with respect to caregiving services and medical assistance.

Conclusion
We noted in the introduction that longevity and successful adaptation are intimately tied to resilience, and these concepts share many of the common mechanisms. Among these mechanisms are the accumulation of risks and threats throughout one’s lifetime and successful adaptation in dealing with these risks to achieve exceptional longevity. We also noted that researchers generally agree that there is not one secret to longevity, and it has been shown that different individuals employ diverse paths to achieve longevity. We believe this conclusion also applies when addressing individual differences in resilience among the oldest-old.

We introduced three types of psychosocial domains that could be major contributors to resilience among the oldest-old. First, we have identified specific personality types that are more prevalent among centenarians compared with octogenarians and sexagenarians and that centenarians tended to employ these characteristics to cope in challenging situations. As this point of our research, we postulated these “robust” personality types could be important facilitators toward successful adaptation and resilience. It is not known whether the absence of these characteristics would inhibit adaptation, or that these individuals would use other compensatory behaviors for their adaptation.

Second, cognition was found to positively relate to longevity (Gondo and Poon, 2007). It is clear that maintenance of cognitive abilities is an important facilitator to resilience associated with problem solving in the face of everyday challenges. In contrast, dementia hinders resilience. In the absence of pathology (e.g., dementia of the Alzheimer’s type), there are known normative changes in aging that are shown to be facilitative (e.g., crystallized intelligence or dictionary-type knowledge) and significantly lower in old age (e.g., fluid intelligence or learning of new materials). At this point of research, we do not have answers to the important
question of which types of cognitive skills are particularly important to survival and resilience.

Finally, data from the Georgia Centenarian Study show that maintenance of social and economic resources facilitates independence and secures care services which are intricately related to resilience. It is quite clear that personality and coping style, cognition, and social and economic resources played important protective roles in ameliorating risks and threats accumulated over the lifetime of the oldest-old. It is most likely that these contributors play direct, indirect, and interactive roles which could vary in different times in one’s lifetime. However in times of diminished capacities, these contributors to resilience may be most important at the end stage of life.

The three forms of resilience discussed in this chapter also have practical implications for all aging individuals. Because advancing to very old age does not come without challenges, it would be valuable for all adults to “prepare” for hardships in late life. A rich repertoire of resources and reserves can be helpful when challenges ensue. Older adults who maintain a robust personality and who have optimized cognitive resilience through life-long practice should be better prepared to master expected and unexpected challenges. Furthermore, it is important to maintain a strong social network or replace lost members so that support is available in times of adversity. Finally, solid economic resources can help take care of expenses that often accompany crises. These three resource areas are not obtained instantly during emergencies. Instead, building resources and reserves is a lifespan task for aging individuals, and building resources should be encouraged by educators, family members, and public policy leaders.

It is without question that personal, cognitive, and socioeconomic resilience make up a complex system of lifespan reserves. These levels of complexity remind us of a hypothetical question posed in lectures on centenarians by one of the authors (Poon). He often posed this scenario to his audience. A genie will grant one wish to prolong your longevity. One could pick only one of the following: wealth, health, or good cognitive functioning. Which one would you pick? The answer¹ can be found below.

¹ Health, wealth, or cognitive functioning – choose one. In surveying graduate students at the University of Georgia, 18 percent picked health, 5 percent chose wealth, and 77 percent chose good cognition. In surveying older adults in the Learning in Retirement group at the University, 5 percent chose health, 10 percent chose wealth, and 85 percent chose good cognition.
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