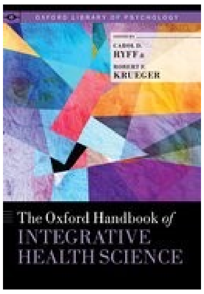

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CHAPTER

21 Cognition at Midlife: Antecedents and Consequences

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Abstract

Some key aspects of cognitive performance begin to decline in middle age. Emerging evidence indicates midlife cognitive functioning may hold clues about cognitive impairment and neurocognitive disorders such as Alzheimer's disease. The Midlife in the United States (MIDUS) study provides an opportunity to explore antecedents and consequences of cognitive health. Cognitive performance was measured with the Brief Test of Adult Cognition by Telephone (BTACT). Psychosocial and behavioral factors identified as protective for cognitive functioning are considered. These findings provide evidence of factors that can reduce or delay cognitive declines and attenuate social disparities in cognitive aging. The relationship between cognition and physical health is also considered. Cognitive abilities are examined as a resource with implications for subjective age and resilience in the face of adversity and challenge (e.g., stress). Next steps include charting trajectories of cognitive aging and identifying patterns and mechanisms that lead to optimal functioning in later life.

Keywords: cognitive performance, cognitive functioning, midlife, cognitive health, executive functioning, Brief Test of Adult Cognition by Telephone (BTACT), cognitive aging, cognition, physical health, cognitive abilities

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Introduction

Changes in cognitive abilities are experienced by a majority of adults as they make the transition from early adulthood to the middle adult years and then into old age. Losses in memory ability are among the most prevalent concerns (Lachman, 2004). A recent report by the Institute of Medicine and the National Academy of Sciences subcommittee (Institute of Medicine, 2015) emphasized the importance of differentiating normal cognitive aging from Alzheimer disease and other forms of dementia. Indeed, the committee called for greater attention to the majority of the aging population whose change in cognitive functioning may not be related to neurocognitive disorders; they recommended the collection and dissemination of population-based data on cognition. Maintaining good cognitive functioning is essential for functional health, well-being, productivity, and independent living throughout the adult years. The Midlife in the United States (MIDUS) cognitive project has contributed to the effort to characterize cognitive functioning in the middle years of adulthood, in a national sample, and to examine the associations with multiple biopsychosocial variables, in the context of normal cognitive aging.

This chapter is organized according to four main topics. The first summarizes the emerging results from the literature on midlife cognition and highlights the unique features of the MIDUS longitudinal study. The second section describes the MIDUS objective and subjective cognitive assessments with a focus on the properties of the Brief Test of Adult Cognition by Telephone (BTACT) cognitive battery. Third, we analyze p. 290 the psychosocial and behavioral risk and protective ↳ factors identified as antecedents of cognitive functioning as well as the association with physical health. Fourth, we provide evidence that good cognitive functioning can be conceptualized as a personal resource accounting for individual differences in stress processes, everyday cognition, and subjective age. We conclude the chapter with perspectives for future life span research on cognitive functioning.

Midlife Cognition: The Course of Cognitive Aging

The bulk of work on cognitive aging has focused on the later years of life. The majority of the studies are laboratory based with small samples, comparing young college students with adults over the age of 60 and examining under what conditions age differences are magnified versus attenuated (Salthouse, 2010). There are also a number of well-known longitudinal studies of cognitive aging (e.g., Health and Retirement Study [HRS], Seattle Longitudinal Study, Victoria Longitudinal Study, University of Manchester Longitudinal Study); these often begin with adults in their 50s or 60s and follow them over time. The results show there are differential patterns of change, with some individuals and some cognitive dimensions showing decline earlier than others, and most showing evidence of decline starting in the 60s (Hultsch, Hertzog, Dixon, & Small, 1998; McArdle, 2011; Schaie, 1994).

There is increased interest in exploring whether there are cognitive decrements earlier in the life course with a focus on prevention, although as yet few studies have focused attention directly on the middle years. For example, the Whitehall Study examined changes in cognition among middle-aged civil servants in Great Britain (Singh-Manoux et al., 2012). In that sample, declines were found on reasoning ability, memory, phonemic fluency, and semantic fluency as early as the mid-40s. In the PATH Through Life Project, a large community longitudinal study of middle-aged adults sampled from electoral rolls in the Australian Capital Territory, processing speed and reaction time were found to decrease in midlife as early as age 40, while verbal ability and memory increased between ages 42 and 46 (Anstey, Sargent-Cox, Garde, Cherbuin, & Butterworth, 2014). The Betula Project, a longitudinal study that included 1,000 participants from 10 age cohorts between 34 and 80 in Northern Sweden, revealed no decline in episodic memory before age 60 and improvements in semantic memory until age 55 (de Frias, Lövdén, Lindenberger, & Nilsson, 2007;

Rönnlund, Nyberg, Bäckman, & Nilsson, 2005). Based on extensive cross-sectional and longitudinal analyses from samples of convenience, Salthouse (2009) concluded that cognitive declines begin as early as the 30s. Thus, the findings about when and which cognitive dimensions change are mixed, inconclusive, and typically based on local, nonrepresentative samples. In addition, there is limited work focused on the psychosocial and behavioral factors associated with midlife cognition and differential changes therein.

The MIDUS cognitive project, with its wide age range (32–84 at Time 2) and 9- to 10-year survey interval, provides a rich set of data that can shed additional light on the nature of cognitive aging beginning in early adulthood and continuing into midlife and later adulthood based on a large nationally representative sample. We used a brief cognitive battery to measure multiple key dimensions that have shown evidence of age-related declines in previous research. Thus, we focused on the (fluid) mechanics of intelligence rather than the (crystallized) pragmatics (Baltes, Lindenberger, & Staudinger, 2006) with the goal of identifying factors that could protect against or reduce declines. We administered the BTACT to the MIDUS sample starting at the second wave of the study. As this battery was given by telephone with limited interview time available, all the tests used auditory stimuli and were reduced in length. We also administered a longer, in-depth cognitive battery to 302 MIDUS participants who were oversampled from the Boston area and tested on two occasions in 1995–1996 (ages 24–74) and 2004–2005 (*N* = 151; ages 34–84). This test battery was given in person and included tests with visual as well as auditory stimuli. Thus, in the Boston study sample we were able to examine changes in a wide range of cognitive measures over a 9-year period, and we also used the Boston study data to examine the validity of the BTACT. In this chapter, we review the findings of studies that have used the MIDUS data from the first cognitive assessment and the two waves of the Boston Longitudinal Study (BOLOS) to address questions about age differences in cognitive performance and the biopsychosocial factors that are related to individual differences in cognitive abilities.

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Cognitive Assessments

The Brief Test of Adult Cognition by Telephone: A Short, Comprehensive, and Valid Cognitive Battery

The examination of cognitive functioning in large, national samples of younger, middle-aged, and older adults presents multiple practical and methodological challenges. Given the amount of resources necessary for in-person cognitive evaluations, an alternative is cognitive testing by telephone. The cognitive battery used in MIDUS, the BTACT (Lachman, Agrigoroaei, Tun, & Weaver, 2014), is a comprehensive battery designed to monitor key domains of cognitive functioning across the life span. It includes seven subtests (word list recall immediate, backward digit span, category fluency, Stop and Go Switch Task [SGST], number series, 30 Seconds and Counting Task [30-SACT], and word list recall delayed) that measure key fluid cognitive dimensions (e.g., episodic memory, working memory, executive functioning, verbal fluency, inductive reasoning, processing speed) identified as relevant in the cognitive aging literature and that have been included in the National Institutes of Health Toolbox of Cognitive Assessments (Gershon et al., 2010).

In contrast to other existing phone cognitive batteries, a unique feature of BTACT is that it includes measures of speed of processing and reaction time (i.e., SGST and 30-SACT). As shown by factor analysis, the seven tests capture two intercorrelated factors, episodic memory (immediate and delayed word list recall) and executive functioning (the other subtests). The BTACT is convenient in that the administration time is only 20 minutes, and it is reliable, as shown by the significant test–retest correlations over a month and correlations between two parallel forms (Lachman et al., 2014). In terms of concurrent validity, the BTACT subtests and factors were significantly correlated with longer form tests administered in person to a MIDUS subsample from the Boston area (BOLOS) using a 90-minute cognitive battery. The Boston cognitive battery included four factors with similar cognitive domains: short-term memory, verbal ability, reasoning, and speed of processing.

Of note is that the short telephone assessment using the BTACT accounted for 59% of the variance in a composite score of the longer test battery. In addition, as expected, the BTACT was sensitive to age differences and showed the expected significant correlations with education and health indicators. Moreover, consistent with findings from other studies regarding the mode of assessment, when the BTACT was given by telephone, it yielded similar results to an in-person assessment.

In light of these results, the BTACT offers a promising and efficient tool for clinicians and researchers to assess individual differences in cognitive functioning in adulthood. The studies presented in this review from the MIDUS study all utilized the BTACT, and those from the Boston subsample (BOLOS) used the in-person test battery.

Self-Assessments: Linking Subjective Experience of Cognition to Objective Performance

Several studies (e.g., Beaudoin & Desrichard, 2011; Burmester, Leathem, & Merrick, 2016) have shown a modest correlation between memory-self assessments and memory performance. This suggests that self-assessments capture other factors in addition to the actual cognitive functioning and decline (e.g., age self-stereotypes, health symptoms). Research from the MIDUS study provides a valuable resource for the examination of the subjective experience of cognition in relation to objective cognitive performance in a nationally representative longitudinal sample of middle-aged and older adults. In MIDUS, participants rated their current memory compared to others their age and relative to their memory 5 years ago.

Examining subjective cognition is useful for a number of reasons, including that cognitive complaints, a characteristic of mild cognitive impairment, may be an early indicator of decline or dementia and can provide a basis for seeking further neuropsychological assessments (Jonker, Geerlings, & Schmand, 2000). Such warning signs can lead to opportunities for early interventions and treatment options as well as the time for individuals and their families to cope and plan for future care needs. In addition, examining subjective and objective cognition in tandem helps researchers and clinicians understand whether individuals have an awareness of cognitive problems and decline. If individuals are not aware of or are in denial of memory problems, they may be less likely to seek help.

Rickenbach, Agrigoroaei, and Lachman (2015) examined accuracy of memory level and change using parallel analyses with data from both the MIDUS and HRS (Juster & Suzman, 1995) that included self-reports of current level and perceived change in memory and in comparison to level and change in objective p. 292 cognition (episodic memory ↳ and category fluency). Results showed a significant number of participants with inconsistency in the correspondence between self-reported and objective memory. Specifically, MIDUS data showed that 26% of participants overestimated their memory (i.e., self-reported above average memory and demonstrated average or below average memory for their age). Conversely, 20% of participants underestimated their memory (i.e., self-reported average or below average memory and demonstrated memory that was above average for their age). Additionally, HRS data showed that approximately 20% of participants overestimated their memory across time (i.e., self-reported no memory decline despite experiencing decline over 2 years), and 12% of participants underestimated their memory across time (i.e., self-reported decline despite not experiencing decline). The research also identified sociodemographic, health, and personality factors related to inaccuracy; for example, high neuroticism and depression were associated with underestimation of memory ability.

Antecedents of Cognitive Aging: Risk and Protective Factors

Multiple psychosocial and behavioral factors have been examined in association with self-assessments of cognitive performance. In MIDUS, research has demonstrated that individuals who report engaging in less cognitive and physical activity and who reported worse physical health overall also reported worse subjective cognition (Lee, 2014b). Recently, Lee (2016a) also identified that participants who were older and female reported worse memory, consistent with past work reviewing memory complaint research (Jonker et al., 2000). In addition, lower levels and declines over 10 years in both control beliefs and positive affect were both associated with worse subjective cognition (Lee, 2016a, 2016b). Rickenbach and colleagues (2015) found that higher scores of depression were associated with lower memory ability self-ratings and greater perceived decline. These findings linking mood to subjective cognition are in line with other published work and suggest that mood, and depression in particular, may be part of a continuum of symptoms leading to cognitive decline (Panza et al., 2010).

Future research should expand the current findings in order to better understand and identify subgroups of the population (e.g., individuals with depression or poor physical health) who are more likely to report decline or changes in their cognition. In addition, research is needed to better identify the clinical implications of subjective assessments for identifying dementia risk in a national sample as opposed to clinical or convenience samples. The third wave of MIDUS data, in which the BTACT and self-assessments of memory were readministered for a second time, is well suited to contribute to the current understanding of these issues, with longitudinal data assessing health, well-being, and cognitive factors from multiple cohorts and a population-based sample in addition to a subset of participants for whom biomarker and neuroimaging data are also collected.

With respect to the factors associated with objective performance, while it is well established that many cognitive abilities decline, on average, with age, there are wide individual differences in the cognitive aging process (Salthouse, 2009). That is, while some are able to maintain cognitive functioning well into older adulthood, others show a much a steeper decline (Agrigoroaei & Lachman, 2011; Lachman, Teshale, & Agrigoroaei, 2015). Due to the longitudinal nature and breadth of coverage in MIDUS, researchers have been able to explore how various sociodemographic, psychosocial, and health factors relate to and predict cognitive functioning across the life span.

Sociodemographic Factors

Using the MIDUS 2 sample, differences in cognitive performance were examined as a function of age, sex, and education (Lachman et al., 2014). As expected, the results revealed significant age differences on all BTACT cognitive tests (Figure 21.1), with the highest levels of cognitive performance obtained for the youngest participants. We also examined change over 10 years using the longer Boston cognitive battery (Agrigoroaei & Lachman, 2011). There were significant mean differences showing decrements over time for short-term memory, reasoning, and speed of processing.

On the BTACT, sex differences varied by cognitive test. For example, women outperformed men in immediate and delayed recall tasks. On the number series and backward-counting speed task, performance was higher for men than for women. The findings are consistent with past work (e.g., Jorm, Anstey, Christensen, & Rodgers, 2004), showing that men perform better than women on reaction time and working memory tasks, while women perform better on memory tasks. Although some research has found no differences in the rate of decline for men and women (Barnes et al., 2003), other work has found that women show significantly less ↳ general cognitive decline than men (Ritchie et al., 2016). In the Study of Women Across the Nation (SWAN; Karlamangla, Lachman, Han, Huang, & Greendale, 2017), there was

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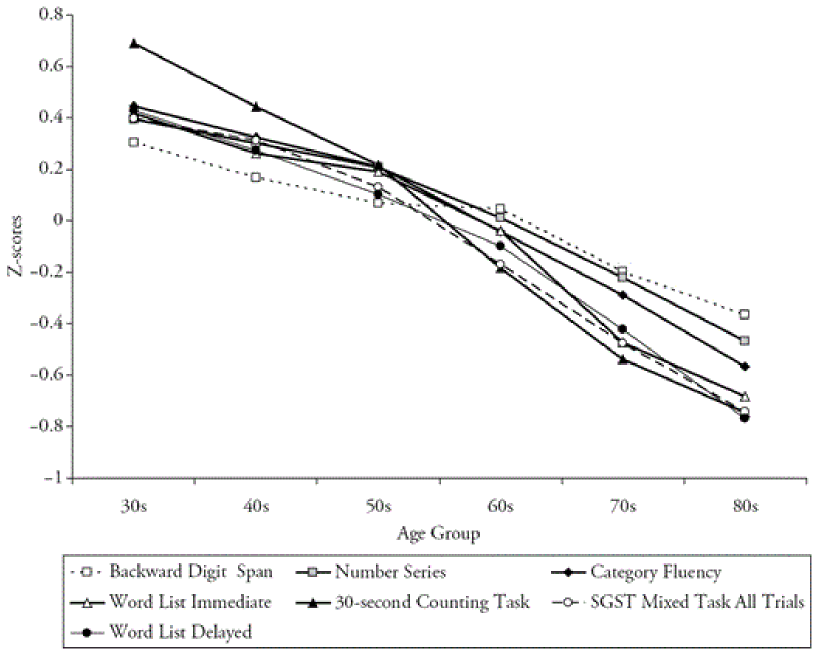
evidence for significant declines in cognitive functioning in midlife among women after age 50, although men were not included in the sample.

Figure 21.1



The BTACT cognitive subtests (*z*-scores) by age group. The Stop and Go Switch Task (SGST) latencies were multiplied by (−1) so that higher scores indicate a faster response time.

Differences in level of cognitive performance were also found by educational attainment (Lachman et al., 2014). In line with other studies (e.g., Habib, Nyberg, & Nilsson, 2007), those with greater levels of education tended to have greater cognitive functioning. Higher educational attainment was also associated with a lower risk for developing dementia (Hall et al., 2007). However, there is little clear evidence that the trajectories of cognitive change vary by education (e.g., Zahodne et al., 2011).

The association between education and cognitive functioning can be moderated by modifiable behavioral and psychosocial factors. For example, Lachman, Agrigoroaei, Murphy, and Tun (2010) found that engagement in cognitive activities (e.g., reading, writing, puzzles) helped to mitigate the negative effects of lower education on cognitive functioning. Those with higher education in general and those who engaged more frequently in stimulating cognitive activities had better cognitive performance. However, those with lower education levels who also engaged in frequent cognitive activity showed episodic memory performance comparable to those with higher education. This suggests that cognitive activity can be a compensatory mechanism for enhancing cognitive functioning for those at risk for poor performance.

Similarly, taking full advantage of the breadth and longitudinal aspects provided by MIDUS and BOLOS, Agrigoroaei and Lachman (2011) examined the cumulative contribution of psychosocial and behavioral protective factors (i.e., control beliefs, quality of social support, and physical exercise) to cognitive functioning and decline across 10 years. In MIDUS, they found that the more protective factors there were, the better the cognitive performance was, over and above well-established cognitive correlates such as health status and engagement in cognitive activities. Moreover, the episodic memory scores among people with lower education who engaged in more protective behaviors were more comparable to those of respondents with higher education. In BOLOS, participants with a greater number of protective factors
p. 294 showed less ↳ decline in reasoning over a 10-year period, especially for those with lower education. These

results suggest that educational differences in cognitive performance and change can be attenuated by modifiable psychosocial and behavioral protective factors.

Perceived Control

Another well-established predictor of successful cognitive aging is perceived control (Soederberg Miller & Lachman, 1999), which refers to one's personal beliefs and expectations about whether and how much they can influence outcomes. However, the exact nature of this relationship in the context of life span development is not fully understood. The expansive MIDUS dataset has allowed researchers to explore the individual differences in control beliefs across the life span and how this variation is associated with cognition (Lachman & Prenda Firth, 2004; Lachman, Rosnick, & Röcke, 2009). For example, Soederberg Miller and Lachman (2000) found that while middle-aged adults outperformed older adults on cognitive performance, middle-aged adults had lower scores on measures of general control beliefs compared to younger adults. Thus, although cognitive functioning is high in midlife, it is also a time of lower perceived control. Knowing that perceived control begins to decline in middle adulthood underscores the importance of identifying the mechanisms linking perceived control and cognitive performance.

Other lab studies have provided a complement to the longitudinal nature of the MIDUS dataset. For example, Lachman and colleagues found that factors such as strategy use, anxiety, and cognitive interference mediated the relationship between control beliefs and cognition (Lachman & Agrigoroaei, 2012; Lachman & Andreoletti, 2006). Specifically, Lachman and Andreoletti (2006) found that middle-aged and older adults who perceived greater control over cognitive functioning were more likely to use adaptive strategies, such as categorizing the words during a word list recall task, and in turn had better recall performance. In another lab study, anxiety and task interference were sequential mediators in the relationship between control beliefs and episodic memory, where less perceived control was associated with greater anxiety, which was negatively associated with episodic memory performance by increasing the probability of task interference (Lachman & Agrigoroaei, 2012). Using another longitudinal dataset, the HRS, past research has also found evidence that physical activity may play a mediational role in this control–cognition relationship (Infurna & Gerstorf, 2013), which is compatible with other work suggesting that engagement in activity (physical, social, and cognitive) may help maintain cognitive functioning across the life span (Hertzog, Kramer, Wilson, & Lindenberger, 2009).

Active Engagement

Active engagement is significantly associated with better cognitive performance. For example, Lachman et al. (2010) found that those in the MIDUS sample who engaged more frequently in cognitive activities had significantly better episodic memory. Similarly, Lin, Friedman, Quinn, Chen, and Mapstone (2012) also found that higher levels of cognitive activity were associated with higher levels of cognitive function. Cognitive activities can include daily activities such as reading, doing crossword puzzles, attending lectures, writing, and even the daily use of a computer. In fact, using MIDUS data, Tun and Lachman (2010) found that frequent computer activity was associated with enhanced cognitive function across adulthood into old age.

In the work domain, greater occupational complexity, as derived from objective ratings using the O*Net, was associated with better self-perceived memory among women and men and better episodic memory and executive functioning among women (Grzywacz, Segel-Karpas, & Lachman, 2016). Occupational complexity indicates the degree to which a job requires workers to identify complex problems, review related information to develop and evaluate options, and implement solutions.

While the relationship between engagement in cognitive activities and cognitive function may seem self-evident, research has shown that other types of activity (e.g., physical exercise; Colcombe & Kramer, 2003) are also protective of cognitive functioning. For example, using MIDUS data, Lee (2014a) examined how different types of physical activity (i.e., leisure, home, and job related) were associated with cognitive functioning. Participants who engaged in a higher frequency of leisure-related physical and cognitive activities showed greater executive functioning, while those who engaged in job-related physical activity displayed worse executive functioning. Lee (2014a) suggested that this relationship between job-related physical activities may be related to the type of jobs that involve physical exertion, as they are typically held by those with less education. Additionally, in the MIDUS sample, Lin and colleagues (2012) found that p. 295 greater engagement in leisurely physical activity ↳ moderated the effect of cardiovascular risk factors on episodic memory.

Social engagement is also related to cognition. Using MIDUS, Seeman and colleagues (2011) found significant positive associations between social support and frequency of social contacts and both executive functioning and episodic memory. Additionally, Tun, Miller-Martinez, Lachman, and Seeman (2013) found that higher social strain was associated with worse cognitive functioning, and that these effects were greatest for those with low general cognitive ability. Those with high levels of social strain and low levels of social support had the worst cognitive performance (Tun et al., 2013).

Personality

An extensive body of research has demonstrated that personality is related to cognitive functioning, although the patterns and strength of associations vary by which cognitive factors and personality traits were measured. Based on relatively small community samples, one consistent personality–cognition relationship appears to be the negative association between neuroticism and cognition (e.g., Denburg et al., 2009). Much of the work linking personality and cognition has been correlational; thus, the exact mechanisms and direction are not clear (i.e., if personality leads to cognitive changes or if cognitive changes lead to change in personality). One possible mechanism is that highly neurotic individuals are characteristically more anxious and susceptible to intrusive thinking and distraction, likely interfering with their ability to concentrate on a specific task (Munoz, Sliwinski, Smyth, Almeida, & King, 2013).

Another personality trait that is commonly linked to cognition is extraversion; however, the results vary as a function of cognitive domain. As an example, one study exploring sex and personality differences on cognition found that extraversion was positively related to processing speed (Pearman, 2009), while another study found that extraversion was negatively related to crystallized intelligence (Baker & Bichsel, 2006). One possible explanation could be that extraverts are less interested in intellectual activities or are less likely to develop effective study habits (Chamorro-premuzic, Furnham, & Ackerman, 2006).

Given the widespread assumption that personality is stable in adulthood, there has been only limited work looking at changes in personality (Roberts, Walton, & Viechtbauer, 2006) in relation to cognition. Using the MIDUS data, Graham and Lachman (2012) examined whether individual differences in changes in personality predicted cognitive performance and found that those who were more stable in personality had better cognitive functioning. Compared with those who changed in either direction, stability in neuroticism and openness to experience was related to better reasoning performance and faster reaction times. Among older participants, compared with those who increased in neuroticism, those who remained stable or decreased had faster reaction times. These findings are consistent with the view that personality stability may serve as a protective resource throughout adulthood. Given that the study used only one wave of cognitive data, it is unclear whether changes in cognition also led to changes in personality. Indeed, one viable alternative is that experiencing cognitive decline leads to increases in neuroticism. This is a research question that can be addressed with the third wave of the MIDUS study, as discussed in our conclusion section.

The MIDUS researchers have further identified how personality influences cognition by exploring potential moderators and mediators. Given the well-established gender differences in personality, one study was interested in exploring the moderating role of gender in the relationship between personality and cognition (Pearman, 2009). Results demonstrated that personality and gender, both separately and as an interaction, did in fact influence cognition. Specifically, in the BOLOS study, Pearman (2009) found that these relationships seemed to vary by cognitive task. For example, females had faster processing speeds, while males had better short-term memory, and those high in extraversion had faster processing speeds and better short-term memory. Enhanced short-term memory was also found for those low in conscientiousness. Additionally, the relationship between conscientiousness and processing speed was qualified by gender; of those who were high in conscientiousness, females had significantly faster processing speeds. No gender difference existed for those low in conscientiousness.

Recent work explored some of the mechanisms linking personality and cognition. According to Stephan, Boiché, Canada, and Terracciano (2014), both extraversion and openness to experience were associated with a higher likelihood of engaging in a variety of physical, cognitive, and social activities. The tendencies to consider new ideas, engage in new experiences, and to prefer variety are distinctive of individuals high in p. 296 openness and may lead ↳ to engaging in a multitude of different types of activities. This relationship between openness to experience and cognition may also be explained by greater cognitive ability of open individuals, which may promote their engagement in various activities (Stephan, Boiché, et al., 2014). As is clear, more work is needed to examine the mechanisms and directionality between personality and cognition.

Other studies have attempted to use personality to explain certain correlates of cognition, such as religiosity. Specifically, past work has suggested that high levels of religiosity are associated with lower levels of cognition (e.g., Lynn, Harvey, & Nyborg, 2009). Lewis, Ritchie, and Bates (2011) proposed that perhaps openness to experience, a common correlate of both religiosity and cognition, could help to explain this relationship. However, they found that even after controlling for openness to experience, the negative relationship between religiosity and general intelligence persisted (Lewis et al., 2011).

Physical Health

To a large extent, the problems we see in cognition in later life are due to physical health problems, more specifically to vascular disease processes such as hypertension, diabetes, and stroke (Spiro & Brady, 2008). In a seminal chapter, these authors highlighted the importance of integrating health into research and theories of cognitive aging at both individual and population levels. One of the emerging ideas is that, regardless of the type of physical health indicators (ranging from self-ratings to inflammation and tissue alterations), better physical health translates into better cognitive functioning and lower risk of dementia. Indeed, cognitive aging may be more a matter of health than of age.

In MIDUS, measures of self-rated health and functional limitations were significantly associated with the BTACT scores, over and above the role of age, sex, and education (Lachman et al., 2014). The BTACT cognitive factors were also associated with allostatic load, a marker of multisystem dysregulation that captures the biological cost of repeated exposure to stressors. The greater the number of dysregulated systems, the lower the cognitive performance. Notably, the association between allostatic load and cognition was obtained for adults of all ages, indicating the role of physical health for cognitive functioning across adulthood (Karlamangla et al., 2014).

In terms of the specific preclinical biomarkers and physiological systems, glucose metabolism was associated especially with executive functioning, and inflammation was associated with episodic memory. Dysregulation of the cardiovascular system (resting systolic blood pressure, pulse pressure, and heart rate) was negatively associated with both episodic memory and executive functioning. This is consistent with other studies that highlighted the role of vascular (e.g., the vascular hypothesis of cognitive aging; Spiro & Brady, 2008) and cardiac systems for brain function and ultimately for cognitive functioning (Lin, Heffner, Mapstone, Chen, & Porsteisson, 2014).

In conclusion, there are multiple theoretical and empirical arguments to consider physical health as an antecedent of cognitive functioning and decline. However, given the cross-sectional designs used in the majority of the studies and the evidence from cognitive epidemiology (Deary, 2010), longitudinal analyses are needed in order to examine the directionality of the association and ongoing processes linking physical health and cognitive functioning.

Stressful Life Experiences

Stressful life experiences may contribute to accelerated cognitive aging, especially among those who have experienced high stress levels. One MIDUS study compared parents of children with disabilities to parents of nondisabled children (Song, Mailick, Greenberg, Ryff, & Lachman, 2016). Compared to parents of nondisabled children, parents of disabled children, in particular mothers of disabled children, showed more pronounced age differences for episodic memory and executive functioning. Parents of disabled children experience more stress and report more negative parenting experiences. Taken together, the results suggest that the prolonged stress of raising children with disabilities puts parents at risk of steeper cognitive decline over time.

MIDUS Advances on Consequences of Cognitive Aging

Cognition and Stress Processes

The MIDUS cognitive project has enabled researchers to examine to what extent and how cognitive performance might account for individual differences in stress processes. Contrary to expectations, higher levels of cognitive ability were associated with an increased risk of exposure to stressors at home and at work (Stawski, Almeida, Lachman, Tun, & Rosnick, 2010). These results could suggest that individuals with higher levels of cognitive ability also experienced more challenges or led more engaged and complex lives, which p. 297 ↳ presented as stressors. However, despite more stressful experiences, individuals with higher fluid cognitive ability actually reported smaller emotional responses to daily stressors. Individuals with higher cognitive abilities also tend to demonstrate healthier levels of daily cortisol, a biomarker of stress (Stawski et al., 2011). These results suggest that higher levels of fluid cognitive ability may serve as a buffer, allowing those individuals to more ably cope with their daily stressors.

Stress responses may be particularly important for identifying individuals at risk for cognitive decline when the stressor itself is cognitive in nature. The impact of a stressor can be measured by monitoring the participant's cardiovascular activity. It has been suggested that cardiac vagal control in particular can indicate behavioral flexibility (Crowley et al., 2016; Porges, 2007). As such, a stress response can be operationalized by how fast an individual's heart rate returns to normal, a process that is vagally mediated (Mezzacappa, Kelsey, Katkin, & Sloan, 2001). The MIDUS Biomarker protocol used a stress induction paradigm involving a mental arithmetic task and a Stroop task to measure the role of trait anxiety on vagal recovery (Crowley et al., 2011). During the cognitive tasks, perceived stress increased by more than double on average compared to baseline. In turn, faster vagal recovery has been shown to be associated with better executive functioning (Kimhy et al., 2013) and reduced age-related executive functioning deficits in older adults (Crowley et al., 2016).

In another study, higher heart rate reactivity to a psychological stressor was found to be associated with better executive functioning of older adults (Lin et al., 2014). However, another recent research using structural equation modeling found no evidence that heart rate variability was related to executive functioning (Mann, Selby, Bates, & Contrada, 2015). Models were assessed with and without adjusting for several covariates that were found to be correlated with heart rate variability. Concordant with previous studies, the initial model without these adjustments found the path from heart rate variability to executive functioning to be significant. However, when age, body mass index, and the presence of diabetes were included in the structural model, the path from heart rate variability to executive functioning was no longer significant. This suggests that the relationship between heart rate and executive functioning may be due to such other factors that may be associated with both variables.

Some of the discrepant stress–cognition findings may partially be attributed to socioeconomic status (SES). Those with higher SES may be particularly vulnerable to cognitive stressors, as these individuals tend to have higher education levels and careers that demand higher cognitive performance. One study using the BOLOS sample found that following a cognitive stressor, older adults with higher ratings of SES demonstrated a heightened cortisol response, compared to younger adults and those with lower SES (Neupert, Soederberg Miller, & Lachman, 2006). These findings suggest that older adults with higher levels of SES might find cognitive stressors to be more of a threat because they are more invested in their performance. Another study found that subjective social status and beliefs about cognitive aging were associated with the stress response (Weiss & Weiss, 2016). Specifically, older adults with a lower subjective social status who also believed that cognitive decline was inevitable demonstrated a heightened stress response to a cognitive stressor. Although cognitive challenges may be more stressful to older adults, there is evidence that stress recovery from those challenges may be constant across the life span (Shcheslavskaya et al., 2010).

The association between cognitive performance and stress is also important in predicting physical outcomes associated with aging, such as frailty. Using both cognitive and biomarker assessments from MIDUS, one study examined the indirect effect of executive functioning on frailty status, specifically prefrailty, via multiple indicators of stress (Roiland, Lin, Phelan, & Chapman, 2015). Lower executive functioning was associated with prefrailty, a state of increased physical limitations that precedes frailty as defined by the Fried Frailty cutoff scores. In addition, lower executive functioning was associated with poorer stress regulation. The mediation analyses revealed that lower levels of executive functioning were associated with higher levels of stress exposure and poor restoration, both of which contributed to higher levels of prefrailty.

Everyday Cognition

Research from MIDUS has contributed a great deal to our understanding of everyday life in terms of stress, health, and well-being (Almeida, 2005; Charles, Piazza, Mogle, Sliwinski, & Almeida, 2013; Piazza, Charles, Sliwinski, Mogle, & Almeida, 2013). Recently, MIDUS research has also helped us to understand the role of cognition in daily life (Hahn & Lachman, 2015; Rickenbach, Almeida, Seeman, & Lachman, 2014). Research
p. 298 examining ↳ everyday cognition seeks to understand cognition outside of the laboratory in the context of social and other natural influences and in relation to basic cognitive abilities (Allaire & Marsiske, 1999, 2002; Poon & Rubin, 1992; Rogoff & Lave, 1984).

Using the advantageous BOLOS study design, which included weekly diaries embedded within a 9-year longitudinal study, it was possible to examine factors that may help promote everyday memory within the context of long-term cognitive change. Hahn and Lachman (2015) identified that memory decline over 10 years and low control beliefs were associated with greater everyday memory problems reported in everyday life. In addition, the use of selection, optimization, and compensation (SOC) strategies (Baltes & Baltes, 1990) buffered the negative effects of memory decline and low control beliefs on everyday memory problems. SOC strategy use is theorized to contribute to successful aging as a set of strategies that involves being selective about important goals, optimizing skills related to those goals, and compensating for losses in the context of age-related declines (Baltes, 1997; Freund, 2008) and, in this case, memory decline.

Future work should continue to investigate how day-to-day functioning is affected by long-term cognitive development while taking advantage of advanced statistical techniques, such as multilevel modeling, which can simultaneously estimate the effects of short-term variability and long-term development. For example, research is needed that examines how long-term changes in episodic memory, executive functioning, or processing speed affect the frequency, type, and perceived severity of specific everyday memory problems, as well as the ability to cope with daily hassles. As more individuals experience age-related changes in their cognition, data sets such as MIDUS will be important in determining which moderating factors contribute to greater independence and functioning in everyday life.

Cognition and Subjective Age

While much of the past work demonstrated that subjective age predicts cognitive performance (Stephan, Caudroit, Jaconelli, & Terracciano, 2014), there is recent evidence that cognitive aging leads to changes in subjective age. In one study, older participants who received a memory test felt on average 5 years older after taking a test (Hughes, Geraci, & De Forrest, 2013). Older participants were aged 55–85 and were recruited from either a Texas community or online through Amazon Mechanical Turk. A younger adult sample was aged 18–29 and recruited through Mechanical Turk. They were asked to complete a cognitive study either in the laboratory or online. Participants were asked to indicate their subjective age on an unmarked scale, then were given a 30-item free-recall test. Following the test, which took about 5 minutes, participants were asked to indicate their subjective age again on the unmarked scale, though they did not see their previous response. Over three replications, older adults indicated a higher subjective age after the test. Younger adults did not demonstrate the same effect, and older adults did not demonstrate an older subjective age after a vocabulary test (i.e., a test in a domain not typically associated with age-related declines). In a fourth replication, older adults were simply told they would receive a memory test but were asked to indicate their subjective age before receiving the test. Once again, older adults reported a higher subjective age after they were told about the memory test, suggesting the mere thought of taking a memory test was sufficient to induce an older subjective age.

Whereas Hughes et al. (2013) found that exposure to challenging cognitive tasks can increase one's subjective age, it did not address possible mechanisms. One hypothesis is that experiences with cognitive performance contribute to the construction of one's subjective age in comparing one's performance to a group of age peers. If one believes their cognitive performance is better than that of their peers of the same age, it could result in a lower subjective age. We found support for this hypothesis in the MIDUS sample. Cognitive performance was found to predict subjective age, and this effect was mediated by comparisons to one's peer group (Hughes & Lachman, 2018). Higher cognitive performance as well as better functional health were associated with more favorable comparisons on these dimensions relative to their peers, which in turn were associated with lower subjective age.

Conclusion and Future Directions

The MIDUS project allows a multifaceted, in-depth examination of normal cognitive aging in a large, national sample of younger, middle-aged, and older adults. Given the richness and interdisciplinary nature of the MIDUS longitudinal dataset, numerous psychosocial, behavioral, and biological factors have been examined as antecedents and consequences of cognitive functioning. As reviewed in this chapter, there is
p. 299 evidence that education; control beliefs; active cognitive, physical, and social ↳ engagement; personality; physical health; and stress are related to cognitive performance in adulthood (e.g., Agrigoroaei & Lachman, 2011; Graham & Lachman, 2012; Karlamangla et al., 2014; Lee, 2014a; Lin et al., 2012). In turn, cognitive functioning can have an impact on stress adjustment (Stawski et al., 2010); subjective age (Hughes & Lachman, 2018); and everyday memory problems (Hahn & Lachman, 2015). Other documented consequences of cognitive functioning are carrying out important everyday tasks, such as following medical regimens, making healthcare and financial decisions, performing at a job, remembering appointments, driving and navigating, planning activities, and countless other aspects that promote health, well-being, productivity, and independence. Thus, a notable strength of MIDUS is that it offers a rich approach to the nature of cognitive functioning, which is key for exploring links to health and well-being as the sample ages.

Several directions and perspectives for future research emerged throughout the chapter. Of interest for our future work is to examine to what extent individuals can prevent, protect against, reverse, remediate, or compensate for cognitive declines. With the newly available data from the second wave of the cognitive project collected for MIDUS 3 in 2013–2014, we can begin to examine differential patterns and trajectories of change over a 9-year period in both cognition and risk and protective factors. Compared to the cross-sectional approach, this will enrich our understanding of cognitive aging, with an emphasis on the early indicators of change and the biopsychosocial factors that are related to differential patterns of change. In addition, the longitudinal design can be instrumental in shedding light on the directionality of the associations between these factors and underlying mechanisms.

For example, the directionality of the association between physical health and cognitive functioning needs further evidence. As shown in this chapter, physical health has been conceptualized as an important antecedent of cognitive functioning. Yet, there is also evidence for the protective role of cognitive performance in terms of maintaining functional health (Johnson, Lui, & Yaffe, 2007) and decreasing the risk of mortality (Sabia et al., 2010).

Similarly, the study of the association between changes in personality and changes in cognition could benefit from longitudinal analyses, as it will be important to explore to what extent cognitive declines result in personality changes or changes in subjective age. More research is needed to understand the processes involved in linking change in personality and cognition and to consider whether personality traits serve as protection or vulnerabilities for cognitive declines.

The next frontier of work in MIDUS can begin to look more closely at the mechanisms involved in cognitive aging as well as at the role of contextual, societal factors accounting for cohort and period effects in cognitive functioning. We have shown that biomarkers such as inflammation and allostatic load are related to individual differences in level of cognitive performance (Karlamangla et al., 2014). In future work, we will explore whether biomarkers predict differential change trajectories; we can ask if those with the most favorable biological profiles are able to stave off cognitive declines, that is, to slow their cognitive aging. Moreover, we can examine whether stress markers such as cortisol mediate the relationship between health and changes in cognition.

A life span perspective provides the foundation for the MIDUS study, and there is evidence that early developmental factors have long-term health consequences. Childhood SES adversity (Miller et al., 2011) and cumulative SES adversity (Gruenewald et al., 2012) translate into poorer physical health in middle adulthood. Along the same lines, future studies using the MIDUS data can focus on the role of childhood experiences (e.g., nurturing parents, adversity), cumulative adversity or advantage, or social mobility on within- and between-person differences in cognitive functioning during the middle years. In addition, MIDUS, especially the oversample from the Milwaukee, Wisconsin, area and the recently added Refresher cohort, offers unique opportunities for future work to examine changes in cognitive functioning and variations by race, ethnicity, and birth cohort. In a recent study, Zahodne, Manly, Smith, Seeman, and Lachman (2017) found that education, income, chronic health conditions, and external control beliefs significantly mediated racial disparities in cognition in adulthood, but the nature of these relationships varied by age. Further work with longitudinal data will shed light on whether there are race and ethnic differences in the patterns and sources of cognitive change. By combining the MIDUS main sample with the Refresher sample, we can begin to examine cohort differences and retest effects in cognition. Previous work has supported the Flynn effect, which suggests that cognitive scores advance historically with each birth cohort, which could be accounted for by increasing p. 300 ↳ environmental complexity, nutrition, genetics, or educational advances (Trahan, Stuebing, Hiscock, & Fletcher, 2014).

In MIDUS, we will examine retest effects by comparing those tested once (Refresher cohort) and those who were tested on multiple occasions (MIDUS main sample). We will also be able to compare our findings with the existing evidence (e.g., Salthouse, Schroeder, & Ferrer, 2004) suggesting that retest effects are typically not found when assessments are made more than 7 years apart. Another interesting question to be explored with the longitudinal cognitive data is whether the two-factor structure of the BTACT cognitive battery remains invariant over the 9-year longitudinal interval and whether it shows an age-invariant structure (Hughes, Agrigoroaei, Jeon, Bruzzese, & Lachman, 2018).

Future work can also capitalize on the large cognitive database, collected at two time points 9 years apart, to explore to what extent we can use the constellation of cognitive test scores and change therein to predict onset of cognitive impairment or dementia. This may entail collecting additional data to locate and validate the BTACT scores and profiles within the context of established norms and cutoffs for neurocognitive disorders. In general, the MIDUS mission involves understanding pathways to health in adulthood, and cognitive abilities are a key component of health along with physical and psychological indicators. The vast array of opportunities to examine the plasticity of cognitive health in the context of changes in a wide range of biopsychosocial and lifestyle factors over time in a large and diverse national sample, from middle to later adulthood, makes MIDUS a promising resource for understanding and advancing the field of cognitive aging.

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