CHAPTER 10

Intellectual Functioning in Midlife

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One of the paradoxes of middle age is that it is viewed both as the "best of times" and as the beginning of the "worst of times." Middle age is often described as the "prime of life," when individuals are at the zenith of their careers, are at the highest levels of income and are most likely to be in leadership positions (Neugarten, 1968). Indeed, the founding fathers deemed that the United States presidency should be occupied by a person no younger than middle age; given the lower life expectancy in colonial times, 35 years would have been considered well into middle age. On the other hand, the approach of age 50 in our culture is characterized as "being over the hill."

These opposing views of middle age represent concerns not only with the physical aging process, but also with fears of possible downward shifts in competency and mental ability in midlife. Those beyond young adulthood are targeted for food supplements and herbal remedies said to increase mental alertness, to aid memory, and to maximize mental performance. Decreases in estrogen because of menopause are said to result in memory loss and possible dementia; women entering menopause are advised to adopt hormonal replacement therapy as an antidote for incipient mental decline (Kampen & Sherwin, 1994).

Does the research literature on cognition in middle age support either or both of these opposing views of changes in competency in midlife? Are middle-aged

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adults at their "prime" in mental ability, or are they "over the hill"? Do longitudinal studies report loss of cognitive functioning in women at the time of menopause? Do women exhibit earlier and more dramatic rates of decline in abilities than do men?

In this chapter we summarize selectively an extensive body of longitudinal research on cognitive functioning spanning the adult life course from young adulthood to old age. The Seattle Longitudinal Study will serve as the primary database for our discussion. Particular focus will be given to the middle years. It is critical, however, to examine cognitive functioning within a life-span context in order to address the questions of whether performance in midlife is at the "prime" or "over the hill."

Five major questions regarding cognitive functioning in middle age will be addressed. First, we examine the life-span trajectories of several basic mental abilities across adulthood and address the question of at what age is peak level of performance reached for each ability. Second, we consider changes in mental abilities from young adulthood to middle age. Third, we discuss in some detail the nature of change in mental abilities within middle age. Gender differences in trajectories, in peak performance, and in change are considered. Fourth, we shift from basic mental abilities to cognitively demanding tasks of daily living and consider changes in competency in midlife for these higher order, more complex life skills. Finally, we examine generational differences in basic mental abilities. Specifically, we address the question of whether the baby boom cohorts now in middle life are functioning at higher levels than their parents' generation when at the same age—thus testing the perpetuation of the American dream of each generation doing better than the last.

THE SEATTLE LONGITUDINAL STUDY

Research findings from the Seattle Longitudinal Study (SLS; Schaie, 1996) serve as the primary database for this chapter. The SLS is a longitudinal, cohort sequential study of adult cognitive functioning, examining changes in performance on a number of basic mental abilities from young adulthood (early 20s) to very old age (90s). Changes in participants' cognitive performance are followed at 7-year intervals, representing seven major testing cycles (1956, 1963, 1970, 1977, 1984, 1991, 1998). The study began in 1956 with 500 individuals being assessed, with mean ages of 22 to 67. Individuals are recruited at random from a large health maintenance organization in Seattle. At each testing cycle the parent population is stratified by age and sex and 25 men and 25 women are randomly selected at each cohort interval from young adulthood to old age. At each testing cycle all participants from prior cycles are retested and a new sample is drawn. Across the course of the study, individuals have been studied for 35-, 28-, 21-, 14-, and 7-year intervals.

Basic Mental Abilities

The focus of the SLS has been on individual change and generational differences i functioning on a set of basic mental abilities. These abilities have been studie primarily within a psychometric approach to cognition (Thurstone, 1938); how ever, several of the abilities are also recognized and studied within other approaches to cognition (Cattell, 1963; Horn, 1982). The findings summarized in this chapter focus on six of these basic mental abilities: Vocabulary, Verbal Memory, Number, Spatial Orientation, Inductive Reasoning, and Perceptual Speed.

Brief descriptions of each of the ability domains are given below.

Vocabulary

This ability represents the competence to understand ideas expressed in words. The range of a person's passive vocabulary used in activities such as reading and listening is represented. Vocabulary is assessed by the individual identifying a synonym for the stimulus word. Vocabulary is an ability that is not only salient in a psychometric approach to cognition, but is also central in text processing research (Dixon, Hultsch, Simon, & von Eye, 1984; Hultsch & Dixon, 1990; Meyer, Marsiske, & Willis, 1993) and in neuropsychology (Folstein, Folstein, & McHugh, 1975).

Verbal Memory

This domain represents ability to encode and recall meaningful language units, such as lists of words. The ability to recall lists of words under immediate and delayed conditions is assessed. Verbal memory is a domain of study also in an information processing approach to cognition (Craik & Salthouse, 1992). Moreover, deficits in verbal memory are one of the hallmarks of early dementia within a neuropsychology approach (American Psychiatric Association, 1994; McKhann et al., 1984).

Number

The ability to perform simple mathematical computations including addition, subtraction, and multiplication. The focus of the assessment is on computations being done quickly and accurately.

Spatial Orientation

This is the ability to visualize and mentally manipulate (rotate) stimuli in two- and three-dimensional space. It involves the ability to maintain orientation with respect to spatial objects and to perceive relationship among objects in space. Spatial orientation has also been studied with an information processing approach to cognition

(Craik & Salthouse, 1992) and is of concern in clinical studies of neuropathology (McKhann et al., 1984). This ability is central to applied skills such as map reading, way finding, and occupational skills such as navigation and dentistry.

Inductive Reasoning

This is the ability to recognize and understand patterns and relationships within a problem and to utilize these relationships to solve other instances of the problem. It involves the ability to foresee, to analyze, and plan, and to solve logical problems. Within the study of expertise, inductive reasoning represents a form of procedural knowledge. Within neuropsychology, it is represented as an executive function, and is believed to exhibit early decline in dementia (Marson, Ingram, Cody, & Harrell, 1995; McKhann et al., 1984). Reasoning as manifested in executive function is of critical importance in the study of decision making.

Perceptual Speed

This ability involves competence in quickly and accurately making simple discriminations in visual stimuli. This ability is also represented in information processing (Craik & Salthouse, 1992) and neuropsychological approaches to cognition.

It should be noted that each of these ability domains is represented at the latent construct level with respect to the findings presented in this chapter. That is, the data reported are for factor scores representing these abilities, rather than for single tests of the ability (Schaie, 1996).

AGE-RELATED CHANGE IN BASIC MENTAL ABILITIES

A Life-Span View of Cognitive Functioning: Peak Performance in Midlife

Overview

We begin by examining the life-span trajectory for cognitive functioning from young adulthood to old age. Figure 1 shows that the highest level of functioning for four of the six mental abilities considered occurs in midlife. For both men and women, peak performance on inductive reasoning, spatial orientation, vocabulary, and verbal memory is reached in middle age. It is only for two of the six abilities examined—perceptual speed and numerical ability—that the stereotypical trajectory of life-span change occurs. Perceptual speed is the ability showing the earliest, most linear pattern of decline, beginning in young adulthood.

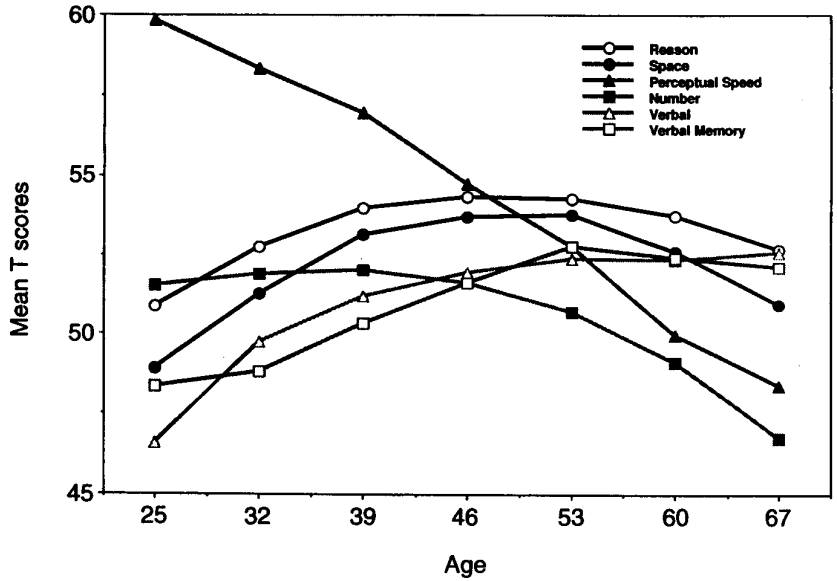

FIGURE 1 Longitudinal change in six abilities: Ages 25 to 67. From Schaie, K. W. (1994). The course of adult intellectual development. *American Psychologist, 49,* 304–313. Copyright © 1994 by the American Psychological Association. Reprinted with permission.

A life-span perspective of cognitive development suggests that midlife, the age interval of the 40s through the early 60s, is a period of maximum performance on some of the more complex, higher order mental abilities, such as inductive reasoning, spatial orientation, and vocabulary. Interestingly, peak performance levels occur in midlife for abilities traditionally characterized as representing both fluid intelligence (inductive reasoning, spatial orientation) and crystallized intelligence (vocabulary; Cattell, 1963). While both fluid and crystallized abilities reach a peak in midlife, the fact remains that across the life-span fluid abilities show an earlier trajectory of decline than crystallized; that is, fluid abilities begin to show reliable decline in the mid-60s, while crystallized abilities do not show reliable decline until the 70s (Schaie, 1996).

Gender Differences

Peak performance is reached somewhat earlier on average for men than for women for the four abilities reaching maximum levels in midlife. For men, peak performance on spatial orientation, vocabulary, and verbal memory is reached in the 50s. For women, peak performance on spatial orientation, vocabulary, and verbal memory is reached in the early 60s.

It is notable that women on average exhibit decline in perceptual speed somewhat earlier than men, with women reaching peak performance in the 20s with steady linear decline occurring thereafter through middle and old age. Decline for men on perceptual speed does not begin until the 30s.

There are gender differences not only in timing of peak performance but also in level (i.e., mean score) of functioning. Across much of young and middle adulthood the mean score of women is higher than that of men for vocabulary, verbal memory, perceptual speed, and induction (Schaie, 1996; Willis & Schaie, 1988). The largest gender differences in favor of women are on vocabulary and verbal memory. In contrast, men consistently have higher average scores on spatial orientation.

Given the focus of this chapter on middle age, it is important to consider age-related change trajectories at two intervals: (1) from young adulthood to middle age, and (2) short-term change within the middle-age period. Consideration of short-term change (i.e., change over 7 years) versus long-term change (i.e., change over 14 to 21 years from young to middle adulthood) may provide insight into the differing perspectives on cognition in middle age that have appeared in the literature.

Longitudinal Change from Young Adulthood to Midlife: Gain and Loss

Gain from Young Adulthood

Contrary to stereotypical views of intelligence and the naive theories of many educated laypersons, young adulthood is not the developmental period of peak cognitive functioning for many of the higher order cognitive abilities (Schaie, 1996). Figure 2 shows the cumulative change in *T*-score points between performance at age 25 (represented as 0 on the *y*-axis) and performance at six subsequent ages: 32, 39, 46, 53, 60, and 67 years.

The figure shows that for four (vocabulary, spatial orientation, verbal memory, and inductive reasoning) of the six abilities studied, middle-aged individuals are functioning at a higher level than they did at age 25. Improvement from young adulthood to peak performance in middle age is on the order of .30 to .60 standard deviation units. Gain from young adulthood to peak for inductive reasoning is approximately .35 standard deviation units, gain for verbal memory and spatial orientation is approximately .40 standard deviation units; and gain for vocabulary is .60 standard deviation units.

The increase in performance from young adulthood to middle age is particularly noteworthy for women. Women in midlife are performing on average one-half a standard deviation above their scores at age 25 on spatial orientation, vocabulary, and verbal memory. For vocabulary, women continue to exhibit at least one-half a standard deviation of increase from their performance in young adulthood into the 60s and early 70s. Men also are performing at peak levels in midlife, but the increase

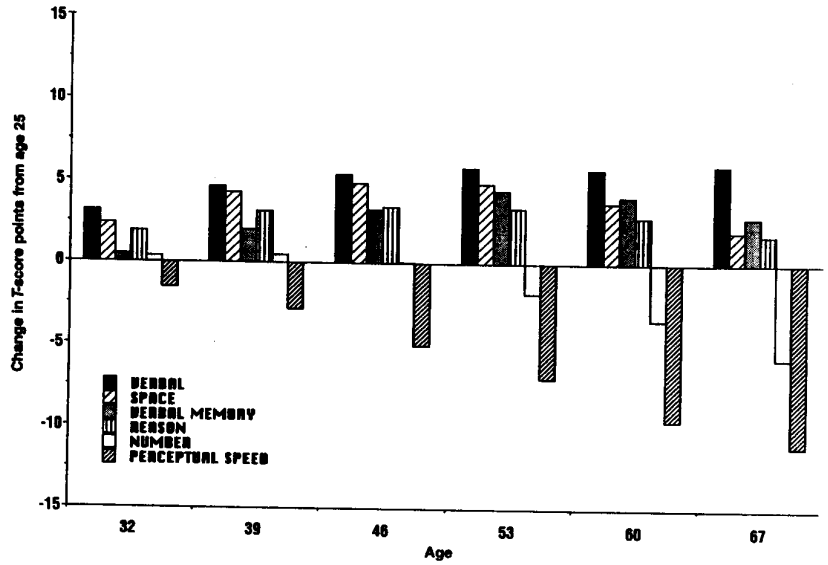

FIGURE 2 Cumulative change from age 25 to ages 32, 39, 46, 53, 60, and 67.

from performance in young adulthood is not quite so dramatic; the increase for spatial orientation and verbal memory is on the order of .20 to .30 standard deviation units.

Loss from Young Adulthood

In contrast, perceptual speed ability shows a steady and increasing decline from age 25 to middle age. By the late 50s to early 60s, individuals on average are functioning one standard deviation below their performance level at age 25. Women in particular show a decline in perceptual speed from young adulthood. Women show a decline of approximately 1.00 standard deviation unit, compared to a loss of .70 for men. Numerical ability that was measured by speeded arithmetic tasks also shows age-related decline, although the magnitude of the decline is much smaller than for perceptual speed. A decline of approximately .40 to .50 standard deviation units is shown by the mid-60s for both men and women.

Change across 7-Year Intervals during Middle Age

While there is significant cumulative positive change from young adulthood through much of midlife for many important abilities, the middle-aged adult may

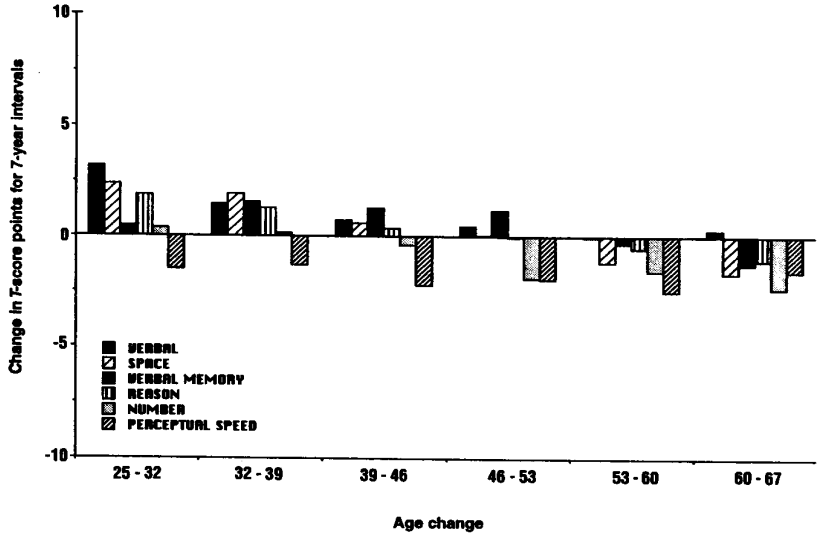

FIGURE 3 Ability change in 7-year intervals.

be more aware of short-term changes occurring *during* the 40s and 50s. Examination of short-term (i.e., 7-year) changes in the middle years suggest a different pattern of trajectories (Schaie, 1996).

Figure 3 presents the magnitude of changes occurring at each of six 7-year intervals in adulthood (i.e., 25–32, 32–39, 39–46, 46–53, 53–60, and 60–67 years). For each of the first three 7-year intervals (25–32, 32–39, and 39–46 years), there is positive change across the 7-year interval, with the exception of perceptual speed, and of numerical ability in the third interval. By the interval of 53–60 years of age, however, all abilities are exhibiting stability (i.e., vocabulary) or modest decline over the 7 years, while at the same time being at the peak level of performance compared to young adulthood! Men and women in their 50s are on average at their highest level of performance (compared to their scores in young adulthood), yet they are beginning to experience very modest short-term decline.

The middle-aged individual may have very different perceptions of his or her cognitive functioning, whether a long-term or short-term view of current status is taken (Schaie, Willis, & O'Hanlon, 1997). In a similar vein, findings from longitudinal data that covers the full adult life-span present a different picture of developmental trajectories in middle age than may short-term studies of change in midlife. The middle-aged individual's perception of his or her intellectual functioning may be more pessimistic than the longitudinal data would suggest for several reasons. Comparisons of change in functioning may be more likely to be made over shorter intervals. One may have a more vivid or accurate perception of oneself 7 years ago than 20 years ago. Moreover, comparison events (e.g., work and family responsibilities) may be more similar and more comparable over shorter time intervals.

COHORT DIFFERENCES IN ABILITIES: PARENT VERSUS BABY BOOM COHORTS

Study of developmental changes in cognitive functioning in midlife must include not only consideration of age-related (intraindividual) change, which has been described in the preceding sections, but also discussion of generational or cohort differences in level of cognitive functioning (Schaie, 1990, 1996). Prior cohort research has found that the nature of cohort effects varies across different mental abilities. Abilities such as inductive reasoning and verbal ability have shown strong positive cohort trends, with successive cohorts in the first quarter of the 1900s performing on average at a higher level when at the same chronological age as prior cohorts. In contrast, a negative cohort trend has been found for number ability, with earlier birth cohorts performing at a higher level than succeeding cohorts. Continuing changes in advances in health care, technology, educational experience, and cultural events suggest that cohort trends will continue to change with successive cohorts.

Given that those currently in middle age represent the large baby boom cohorts (Easterlin, 1987; Easterlin, Schaeffer, & Macunovich, 1993), it is of interest to compare their level of functioning in midlife to prior cohorts at the same chronological ages. Of particular interest are comparisons of level of cognitive functioning in the parent cohorts (median birth cohort 1924) of the baby-boomers versus the baby-boomers, when at the same chronological age. The baby boom cohorts have been defined as spanning the period from 1946 to 1960 and hence data on three baby boom cohorts (1945, 1952, 1959) are available in the SLS (Easterlin, 1987).

Figure 4 presents mean *differences* in *T*-score points between parent (birth cohort 1924) and baby boom cohorts (birth cohorts 1945, 1952, 1959) for the six basic mental abilities discussed previously. The parent cohort is set to 0. The figure addresses two types of issues: (1) trends between parent and baby-boomer cohorts, and (2) trends among the three boomer cohorts.

Parent versus Baby Boom Cohorts

Strong positive cohort trends are shown for two of the abilities, Verbal Memory and Inductive Reasoning, with baby boom cohorts scoring one-half a standard deviation or more above the performance of the parent generation. A positive cohort trend but of a lesser magnitude (approximately .25 standard deviation units) is shown for Spatial Orientation. Fairly flat cohort differences are shown for Vocabulary and

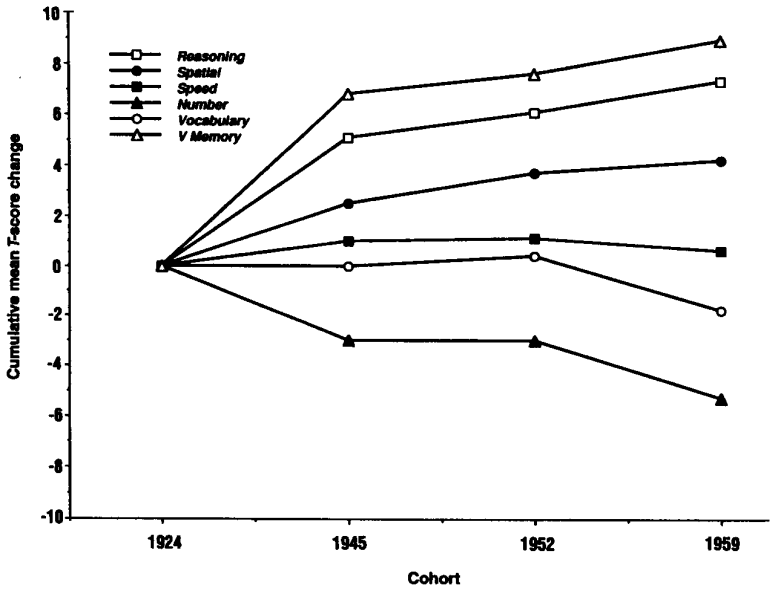

FIGURE 4 Mean differences in *T*-score points between parent and baby boom cohorts.

Perceptual Speed. Particularly notable is the negative cohort trend for Number (approximately one-third standard deviation).

The strong positive cohort trend for Inductive Reasoning has been found in cohort research with earlier cohorts, as has the negative cohort trend for Number (Schaie, 1996). The relatively flat cohort trend for Vocabulary is particularly notable since cohort research with earlier cohorts has shown a stronger positive trend. Prior research on cohort trends for Verbal Memory and Perceptual Speed are limited.

Trends within Baby Boom Cohorts

The differences among baby boom cohorts, spanning a 15-year interval, appear particularly modest, compared to the magnitude of cohort differences between parent and baby boom cohorts. Very slight positive trends (.10 standard deviation unit) are noted for three of the abilities, Inductive Reasoning, Spatial Orientation, and Verbal Memory. A negative cohort trend, particularly in what is known as the "tail" of the boomer cohorts (1959 cohort; Easterlin, 1987) was found for Vocabulary and Number. The negative cohort trend for Number continues a negative trend first observed in the late 1930s cohorts—a trend now extending over 25 years.

LONGITUDINAL CHANGE IN EVERYDAY SKILLS AND COMPETENCIES

Basic Mental Abilities and Everyday Activities

The mental abilities discussed above rarely manifest themselves in the daily lives of adults in the form in which they are studied in the psychological laboratory. Cognitive functioning in everyday life takes the form of tasks, such as comprehending medication labels, balancing a checkbook, remembering a shopping list, or figuring out an airline schedule (Barberger-Gateau et al., 1992; Fillenbaum, 1985). In the study of cognitive aging, these daily tasks have been studied as a form of everyday problem solving (Willis, 1991). Although these basic abilities and everyday problem solving appear, at first glance, to be distinctly different phenomena, research has shown that everyday problem solving often involves constellations of these basic abilities (Willis, Jay, Diehl, & Marsiske, 1992). For example, comprehending a medication label has been shown to involve inductive reasoning, verbal ability, and sometimes numerical skill. In some instances, perception speed is also involved.

Age-Related Change in Tasks of Daily Living

Are there age-related changes in the middle-aged adult's ability to carry out cognitively demanding tasks of daily living? Research on everyday problem solving is more recent and longitudinal data are more limited. The existing data within the SLS suggest that reliable age-related change does not occur until the mid-60s for everyday problem solving on tasks such as those described above (Schaie, 1996). A steeper pattern of decline becomes evident in the 70s and 80s.

The previous findings on decline in perceptual speed are of importance in relation to everyday problem solving (Willis et al., in press). Recent research indicates that those with slower perceptual speed show greater decline in everyday problem solving. Specifically, individuals who are slower when at baseline assessment or who exhibit a greater magnitude of decline on speed also show a greater decline on everyday problem solving. Decline in perceptual speed in relation to everyday problem solving has been found to be particularly salient for adults over the age of 70.

SUMMARY

When the trajectory of the six mental abilities is examined over the entire adult life course from young adulthood to old age, middle age is a life stage in which peak performance is found for several important basic mental abilities. In midlife both men and women score the highest on measures of four mental abilities—vocabulary, verbal memory, inductive reasoning, and spatial orientation. Of particular note is

that these four abilities represent the more complex, higher order domains of cognitive functioning. Inductive reasoning and, in some circumstances, spatial orientation represent the executive functions that are viewed within clinical and neuropsychology as the essential components for independent living and a productive lifestyle. These ability domains have been found to be significantly associated with success in professional occupations such as computer programming, dentistry, and piloting.

The peaking of verbal memory in midlife is of particular interest because memory deficit is one of the most common cognitive concerns among adults of all ages (Hertzog, Dixon, & Hultsch, 1990). Young adults, as well as middle-aged and older adults report similar types of memory problems, with the frequency of the problems reported increasing with age. Age at peak verbal memory performance is particularly noteworthy for women, as the highest scores occur in the early 60s, toward the later end of middle age. Although memory *complaints* in midlife do not appear to be well founded in most cases (with the exception of depression), *objective* memory loss in middle age is a major concern, given the norm of peak performance during this age period (Folstein et al., 1975). Hence, objective memory deficits prior to the 60s are one of the earliest and most salient factors associated with onset of dementia. It is perhaps because the "average" middle-aged adult is doing so well with memory performance that difficulties with verbal memory measures are so striking and often indicative of onset of pathologies.

Those familiar with the fluid–crystallized intelligence distinction may question the finding of peak performance for both abilities represented as fluid (e.g., inductive reasoning, spatial orientation), and crystallized (vocabulary). While both fluid and crystallized abilities reach a peak in midlife, the fact remains that across the lifespan fluid ability shows an earlier trajectory of decline than crystallized. Fluid ability begins to show reliable decline in the mid-60s, whereas crystallized abilities do not show reliable decline until the 70s or 80s.

The peaking of abilities in midlife suggests that, in some cases, substantial improvement in functioning has occurred since young adulthood, the stereotypical age for peak performance. The question arises of how much improvement, on average, occurs from young adulthood to middle age? Women in midlife are performing on average one-half a standard deviation above their scores at age 25 on spatial orientation, vocabulary, and verbal memory. The gain for men is on the order of one-fifth to one-third of a standard deviation. This gain appears to be most prominent from the 20s into the 30s. The significant increase in level of functioning in early middle age suggests that experiences associated with early career development and the assumption of adult responsibilities (e.g., managing finances) may contribute significantly to cognitive functioning. This gain in functioning appears to occur after the end of postsecondary education for most adults. The larger gain for women may reflect the increasing numbers of women entering the professions and maintaining careers during the childbearing years.

Equally noteworthy to the positive trajectories is the decline trajectory for perceptual speed, beginning in the 20s, particularly for women. Speed of responding has been characterized as closely related to central processing resources (Craik & Salthouse, 1992) and to basic neuropsychological functioning. Speed has shown to be associated with the rate of processing involved in more complex, higher order skills. For example, some form of speed of processing is involved in mental rotation and in working memory, associated with inductive reasoning. Decline in perceptual speed from age 25 to age 53 is on the order of one standard deviation for women and one-third of a standard deviation for men. Statistically, the magnitude of decline is impressive. The question arises of the extent to which statistically significant decline represents clinically meaningful changes. Some have suggested that considerable decline representing statistically significant changes can occur with relatively limited practical implications in some situations (Schaie, 1989a, 1989b); further inquiry is merited.

The opposing developmental trajectories for speed and for some higher order mental abilities suggest that cognitive functioning in the middle years may reflect that compensatory mechanisms are at work. Middle-aged adults peaking in abilities such as inductive reasoning and verbal memory may be employing higher order skills to compensate for loss in speed of responding. Salthouse has reported that older typists compensated for slower responding with the viewing of longer spans of information. These compensatory strategies may be possible due to high levels of functioning on abilities such as verbal memory and inductive reasoning.

The early decline in speed may also suggest the need to explore behavioral cognitive interventions in middle age. Most cognitive interventions may been focused on older adults, given that most complex abilities do not show reliable decline until the mid-60s (Willis, 1990). However, the earlier trajectory of decline for speed may argue that interventions in speed in midlife are warranted. The modifiability of processing speed, particularly in old age, has been demonstrated in the work of Ball and Owsley (1991), and enhancement of speed of responding has been demonstrated by Hoyer, Labouvie, and Galtes (1973).

A paradox occurs in middle age in that most adults are functioning significantly above their performance in young adulthood, yet by the late 50s some very modest instances of decline are occurring. These very early and modest instances of decline must be interpreted with considerable caution. First, the level of decline does not become statistically reliable until the 60s for spatial orientation and reasoning and until the 70s for verbal memory and vocabulary (Schaie, 1996). Thus, the decline, although detectable, is within the error of measurement. Nevertheless, it is possible that these early hints of decline are perceived by the middle-aged adult and serve as the basis for some of the anxiety regarding "being over the hill" expressed in midlife. These short-term changes may also be represented in recent reports of declines in the control group in the study of the effects of hormone replacement therapy (HRT) on cognition. It will become increasingly important in interpreting these

HRT studies that changes in performance be considered within the context of longitudinal research, noting the trajectory of functioning over longer intervals than is possible within short-term experimental studies.

Finally, we considered generational differences in cognitive functioning for the baby boom cohorts and their parents. Positive cohort trends for the baby-boomers were noted for inductive reasoning, spatial orientation, and verbal memory. These findings continue the positive generational trends that have been noted in comparisons of prior birth cohorts. Of particular concern, however, are the slowing of cohort differences for vocabulary and the negative cohort trend for number. The implication of the slowing of positive cohort trends is that fewer age differences (in comparison with younger cohorts) will be evident for the baby-boomers should they need to remain in the work force or in other forms of productive endeavors. The stereotypes of negative age decline will not be as readily reinforced if there is less difference concurrently between younger and older generations.

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