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C H A P T E R

9

PSYCHOMETRIC INTELLIGENCE AND AGING

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INTRODUCTION

■ Scope of Chapter

In this chapter we discuss the role of psychometric intelligence within the broader context of adult cognition. We then reflect briefly on why one should be interested in studying adult psychometric intelligence. Next we review some of the literature on the adult development of psychometric intelligence, giving due heed to the aspects of age differences, age changes, and generational shifts in ability performance. We then relate performance on measures of psychometric ability to competence in everyday living, as well as to health status and health behaviors. Finally, we review some work on the reversibility of cognitive deficit occurring across age. In providing substantive illustrations for the issues discussed we will lean heavily on our longitudinal studies within the context of the Seattle Longitudinal Study (SLS; Schaie, 1995), and the Adult Development and Enrichment Study (ADEPT; Willis, 1990, 1991). Other work has most recently been reviewed by Lindenberger (1994).

■ Hierarchical Model of Intelligence

The chapters in this volume represent several different approaches to the study of adult cognition. The section on information processing focuses on the processes by which adults process and acquire information; these processes include attention, speed, and various forms of memory (see Chapters 5, 6, and 7). The section on intelligence focuses on mental abilities as studied from a psychometric intelligence perspective and on applied cognition, including everyday intelligence and complex reasoning (see Chapters 10 and 11). Central questions addressed by each approach to the study of adult cognition include: How do adults of various ages differ in functioning? What changes in functioning occur as the adult ages? What personal and contextual factors influence functioning?

As each approach to the study of adult cognition has gained some maturity, there has been increasing interest in the *relationship* among these various approaches (Puckett & Reese, 1993; Salthouse, 1990; Sternberg, 1985; Willis & Schaie, 1993). How are information processes, mental abilities and everyday intelligence interrelated? Several theorists have proposed that intelligent behavior involves multiple forms of intelligence. Baltes and colleagues (Baltes, Dittman-Kohli, & Dixon, 1984) distinguish between the "mechanics" of intelligence, involving basic mental abilities and processes, and the "pragmatics" of intelligence concerned with everyday cognition. Similarly, in his triarchic theory Sternberg (1985) distinguishes between the contextual part of intelligence, concerned with adaptation to one's environment, and the componential part, focusing on cognitive mechanisms and processes (see Chapter 10).

While a comprehensive model of adult cognition would involve all of the various forms of intelligence, everyday intelligence is often considered to be particularly salient in middle and late adulthood (Baltes et al., 1984; Labouvie-Vief, 1985; West & Sinnott, 1992). Adults must apply their intellectual resources to the tasks of daily living, including occupations, family responsibilities, and the maintenance of an independent and productive lifestyle. A major question in adult cognition, therefore, is the relationship between the "mechanics" of intelligence and everyday functioning. In considering the interrelationship among the various approaches to adult cognition, Berg and Sternberg (1985) state: "A mechanistic theory is needed to specify the cognitive processes by which contextually appropriate behavior is carried out" (p. 348). The question then arises whether the mechanistic constructs and variables traditionally studied by cognitive psychologists (i.e., information processes and mental abilities) are relevant to the study of everyday intelligence (Park, 1992; Salthouse & Maurer, 1996; Sinnott), 1989; Sternberg & Wagner, 1986).

Our own research and that of others suggests that mental abilities and cognitive processes can be considered as "building blocks" underlying everyday intelligence (Schaie, 1978, 1987; Willis, 1991; Willis & Marsiske, 1991; Willis & Schaie, 1986, 1993). From a hierarchical perspective, basic cognitive processes and abilities are believed to be universal across cultures and contexts. When nurtured and directed by a particular context, cognitive processes and abilities develop into domain-related competencies that are manifested in daily life as cognitive performance (Berry & Irvine, 1986). This view is supported by several recent studies that have found significant relationship between everyday task performance and traditional intelligence measures. Fluid and crystallized intellectual abilities have been found to be related to everyday problem solving (Camp, Doherty, Moody-Thomas, & Denney, 1989; Crook & West, 1990; Diehl, Willis, & Schaie, 1995), interpersonal competence (Cornelius & Caspi, 1987), computer literacy (Garfein, Schaie, & Willis, 1988; Jay & Willis, 1992), and comprehension of printed materials (Willis, Jay, Diehl, & Marsiske, 1992; Willis & Marsiske, 1991; Willis & Schaie, 1986). Capon and Kuhn (1979, 1982) reported consumer behavior to be related to formal reasoning within Piagetian theory. Proficiency in leisure activities, including recalling TV shows, playing video games, and solving jigsaw and crossword puzzles, was found to be predicted by verbal ability (Cavanaugh, 1983; Tosti-Vasey, Person, Maier, & Willis, 1992), reaction time (Clark, Lanphear, & Riddick, 1987), and memory (Rice, Meyer, & Miller, 1988).

We propose that a *hierarchical relationship* exists among these various levels of cognition, such that cognitive processes and mental abilities are necessary but not sufficient antecedents for competence in tasks of everyday intelligence (Park & Kidder, 1995; Willis & Schaie, 1986, 1993). In terms of a hierarchy, information processes such as memory and speed are considered the most basic, least complex forms of cognition and are most directly associated with neuropsychological functioning (Salthouse, 1990). Mental abilities such as numerical, verbal, and reasoning abilities are viewed as the products or outcomes of information that has been acquired and processed. These abilities represent a middle level within the hierarchy. The upper, or most complex, levels of the hierarchy include everyday intelligence and postformal thought.

In constructing a complex structure, various types of building materials are used; each material makes a unique contribution to the completed structure. Somewhat analogously, tasks of daily living that require everyday intelligence are complex and multidimensional. For example, taking an over-the-counter medication requires comprehending the instructions, reasoning about the appropriateness of the drug for one's condition, and determining the correct dosage, as well as remembering to take the drug at the appropriate intervals. Several different mental abilities and cognitive processes are involved in completing such a complex task of daily living, just as a variety of materials is necessary in constructing a building (Park, 1992; Park & Mayhorn, 1994; Willis et al., 1992). Moreover, various tasks of daily living require different combinations and permutations of mental abilities and cognitive processes, just as different building materials are required for different construction projects.

Research in the building and construction industry occurs at multiple levels. At a basic level, there are the material sciences, which study the composition and durability of various types of material. This basic research has contributed much to the design and construction of complex structures. Similarly, much of the research in cognitive aging has been at the level of studying individual mental abilities (Carroll, 1993; Horn & Hofer, 1992; Lindenberger, Mayr, & Kliegel, 1993). Our knowledge of what factors influence performance on a specific ability and how a given ability changes with age has the potential to contribute much to our understanding of the more complex forms of everyday intelligence.

Given our position on the hierarchical relationship between mental abilities and everyday intelligence, we begin with a brief historical review of psychometric intelligence and then discuss in some detail the literature on the development of mental abilities in adulthood. We then present findings on the relationship between mental abilities and two domains of everyday intelligence: daily tasks required for independent living and health status and behaviors.

■ Why Should We Be Interested in the Aging of Adult Psychometric Intelligence?

Although there has been much criticism of intelligence testing, the fact remains that omnibus tests of intelligence have been quite useful in predicting people's competence in dealing with the standard educational systems in the United States and other industrialized nations. These tests have also been useful in predicting success in vocational pursuits in which job requirements depend upon educationally based knowledge or skills or involve high levels of analytic or basic problem-solving skills. Measures of specific abilities have also had utility in predicting competence in those situations where specific skills are important to successful job performance. Many have argued that motivational and other personality variables ought to have greater potency in predicting adjustment and competence in midlife than intelligence does, but little empirical evidence supports this proposition.

When dealing with the elderly, there is no question that the assessment of intellectual competence is of substantial importance. One must now ask questions such as who should be retired for cause (loss of competence) in the absence of mandatory retirement at a relatively early age (Salthouse & Maurer, 1996), whether sufficient competence remains for independent living (Fillenbaum, 1985), and whether a person remains able to conserve and dispose of his or her property (Grisso, 1986). All of these increasingly important issues essentially involve the assessment of the current level of intellectual functioning and a determination as to whether that level has sufficiently declined from a previous level to require interventions that might lead to increased dependence upon others.

Assuming that the preceding issues are of importance to our society, it becomes incumbent upon us to examine in detail the factual issues involved in the development of adult intelligence (Cattell, 1987; Horn & Hofer, 1992). Intraindividual decremental changes must be differentiated from interindividual differences that are expressed in the obsolescent behavior of older cohorts when compared with their younger peers. The ages at which developmental peaks occur must be described, and generational differences as well as within-generation age changes must be assessed. Perhaps of greatest importance is the identification of the reasons why some individuals show intellectual decline by early midlife while others maintain or increase their level of intellectual functioning well into advanced old age.

BRIEF HISTORICAL OVERVIEW

Students of the history of psychology know that applied psychology began with the investigation of psychometric intelligence. Early efforts involved procedures for the orderly tracking of mentally retarded children within the public school classroom (Binet & Simon, 1905) and the study of individual differences for the purpose of demonstrating their Darwinian characteristics (Galton, 1869). Many of the mental functions that early investigators described are still of contemporary interest. Alfred Binet provided a classic definition of intelligence: "To judge well, to comprehend well, to reason well, these are the essentials of intelligence. A person may be a moron or an imbecile if he lacks judgment; but with judgment he could not be either" (Binet & Simon, 1905, p. 106).

Early empirical studies of intelligence focused upon the question of how complex mental functions are acquired early in life (Brooks & Weintraub, 1976). Soon, however, the early applied psychologists began to trace the complexities of intellectual development beyond childhood. Some of these developments are associated with theoretical expositions of classical developmental psychologists, including G. Stanley Hall (1922), H. L. Hollingsworth (1927), and Sidney Pressey (Pressey, Janney, & Kuhlen, 1939). These authors raised questions about the age at which peak performance levels are attained and about the maintenance or transformation of intellectual structures across the life course, and they investigated the decremental changes they thought were likely to occur from late midlife into old age.

A number of empirical studies relevant to these questions soon followed. In the first standardization of the Binet tests for American use, Terman (1916) assumed that intellectual development reaches a peak at age 16 and then remains level throughout adulthood. The screening test for intellectual competence developed by army psychologists during World War I, the Army Alpha Intelligence Test (Yerkes, 1921), showed that the peak level of intellectual functioning for young adults might even be reached earlier, on average by age 13. Other empirical studies questioned these inferences. One of the first influential cross-sectional studies (Jones & Conrad, 1933) collected data on the Army Alpha on many of the inhabitants of a New England community who were between the ages of 10 and 60 years. Age differences observed in this study were quite substantial for some of the Army Alpha subtests but not for others. Wechsler's standardization studies, which led to the development of the Wechsler-Bellevue Adult Intelligence Scale, now known as the WAIS, found that the growth of intelligence does not cease in adolescence. He discovered that peak ages differed across various dimensions of intellectual functioning. Moreover, decrements at older ages were not uniform across the different measures he used to define intelligence (Wechsler, 1939).

Interest in intelligence testing reached a peak following World War II with the explosive expansion of clinical psychology and the widespread introduction into clinical practice of the WAIS and its derivatives (Matarazzo, 1972). Intelligence and/or aptitude testing became standard procedures in the public schools, and widely accepted aptitude/ability batteries such as the Differential Aptitude Test (DAT) and the General Aptitude Test Battery (GATB; cf. Anastasi, 1976; Cronbach, 1970) were introduced for purposes of employment counseling and employee selection. Disenchantment arose, however, following widespread criticism of the misapplication of intelligence tests in education (see, e.g., Kamin, 1974). Clinical psychologists began to realize that inferences drawn from profile analyses of intelligence tests were less useful than had originally been thought. Information gained on intellectual status often seemed to contribute little to the development of therapeutic interventions, which became of more central interest in clinical practice.

A resurgence of interest in the measurement of adult intelligence occurred in the 1950s and 1960s among the small group of developmental psychologists who had become interested in adult development and aging (cf. Riegel, 1977). A series of longitudinal studies of individuals followed from young adulthood into midlife on the WAIS, such as the Berkeley Growth and Guidance Study (Bayley & Oden, 1955), the New York Twin Study (Jarvik, Kallman, & Falek, 1962), and the Army Alpha follow-up of Iowa State World War I ROTC students (Owens, 1953, 1959) suggested that there was strong evidence that most intellectual abilities were maintained at least into midlife and that some abilities remained stable beyond that period of life. The senior author of this chapter reported findings from a study utilizing Thurstone's Primary Mental Abilities Test (Schaie, 1985; Thurstone & Thurstone, 1949) that peak ages of intellectual performance had shifted significantly upward by 1956 (Schaie, 1958). In a longitudinal follow-up of the original study after 7 years, he confirmed that ability declines occurred much later than previously thought (Schaie & Strother, 1968).

Norms for the recently revised form of the WAIS (through age 75) confirm the earlier finding that there is relative stability for the verbal subtests but substantial negative age differences for the performance subtests that involve perceptual speed (cf. Sattler, 1982). Evidence for the stability of this pattern into advanced old age has also been documented (Field, Schaie, & Leino, 1988; McArdle, Hamagami, Elias, & Robbins, 1991; Siegler, 1983).

The WAIS has enjoyed continuing popularity as a clinical assessment instrument (Frank, 1983). This test has also been included in several more recent longitudinal studies following older adults over time. It has been used in the Baltimore Longitudinal Study (Costa & McCrae, 1993; Shock et al., 1986), the Duke Longitudinal Studies (Busse, 1993; Palmore, Busse, Maddox, Nowlin, & Siegler, 1985), and the Berkeley Growth and Guidance Studies (Eichorn, Clausen, Haan, Honzik, & Mussen, 1981).

Although the WAIS remains popular for cognitive assessment in clinical situations, its factorial complexity makes it less attractive for assessing intellectual changes across age and time. As a consequence, most recent studies of intellectual aging in community-dwelling populations have utilized subsets of the primary mental abilities (cf. Cunningham, 1987; Johansson & Berg, 1989). The most comprehensive set of measures of primary mental abilities remains the Kit of Factor-Referenced Tests published by the Educational Testing Service (Ekstrom, French, Harman, & Derman, 1976). However, the most extensive work utilizing the primary mental abilities framework, providing information over the entire adult age range, has been done within the context of the Seattle Longitudinal Study, which has followed individuals over as long as 35 years and has studied age differences at six different points in time (cf. Schaie, 1993, 1994, 1995).

Recent attention has also been given to the confounding effects of the nature of test materials that ignore the requirements of older organisms (cf. Cornelius, 1984; Gonda, Quayhagen, & Schaie, 1981; Storandt & Futterman, 1982). These concerns have led to the development of tests with larger typefaces and other simplifications designed to make them more appropriate for work with the elderly (cf. Baltes & Willis, 1982; Schaie, 1985).

Work on psychometric intelligence has also been expanded to include measures of the more pragmatic aspects of intelligence (West & Sinott, 1992). The Educational Testing Service (1977) constructed operational definitions of everyday tasks, and more recently Willis (Willis & Marsiske, 1993) constructed a psychometrically based Everyday Problems Test (EPT), which measures performance on the Instrumental Activities of Daily Living (IADL). (For a more complete discussion, see Willis & Schaie, 1993, and the section on everyday intelligence below.)

ADULT INTELLECTUAL DEVELOPMENT

Rather different conclusions emerge when one examines cross-sectional studies that compare groups of individuals of different ages at one point in time than when one charts changes within the same individuals over time. For obvious reasons, cross-sectional data are generally not useful in predicting how individuals will change over age, because we can rarely match groups on other relevant variables than age that might produce the group differences. But cross-sectional data are indeed useful in informing us about differences in performance levels between age groups at a particular point in time. By contrast, longitudinal data are needed to chart age functions that allow the prediction of how a given individual will change across time. Since the early experiences of individuals from successive birth cohorts differ markedly due to societal changes in child-rearing practices and educational processes, we must also attend to the patterns of generational shifts to understand age differences at a particular point in time. (For discussions of the relationship between cross-sectional and longitudinal data, see Schaie & Willis, 1996, Chapter 8).

■ Cross-sectional Findings

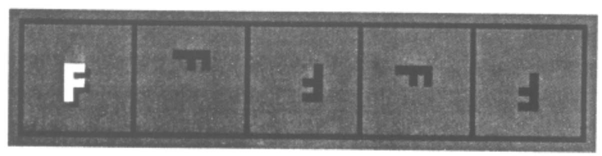
In the Seattle Longitudinal Study (SLS) we examined age difference patterns on five basic mental abilities at six points in time 7 years apart: 1956, 1963, 1970, 1977, 1984, and 1991. The abilities we selected, which account for a large proportion of individual differences in intellectual competence, include verbal meaning (recognition vocabulary), reasoning (inferences of rules and regularities from the observation of individual instances), space (being able to mentally rotate visual objects in two-dimensional space), number (checking the addition of sets of simple sums), and word fluency (vocabulary recall according to a lexical rule, that is, recalling words beginning with a given letter of the alphabet). Examples of test items are provided in Figure 9.1.

There does not appear to be a uniform pattern of age-related changes in adulthood across all intellectual abilities. An overall index of intellectual ability (IQ) therefore does not suffice if one wishes to understand age differences (cross-sectional data) or age changes (longitudinal data). To document this fact, Figure 9.2 shows cross-sectional data over the age range from 25 to 81 years for five abilities for the 1970 and 1991 study waves. Notice the upward shift in level across the two occasions. In 1970, sharp age differences occur after age 60 for all abilities, while in 1991 these differences are much more gradual. The cross-sectional data show two different patterns: three of the abilities appear to peak in young adulthood and show linearly accelerating age differences that are steepest for spatial orientation and inductive reasoning but less pronounced for word fluency. On the other hand, verbal meaning and

Verbal Meaning

Old **a. Good** **b. Ancient** **c. Wise** **d. Respected**

Space



Reasoning

a b w c d x e f   b y d g

Number

a.	b.
46	28
15	39
27	12
88	77

a. R W
b. R W

FIGURE 9.1 Examples of test items from the Primary Mental Abilities Test.

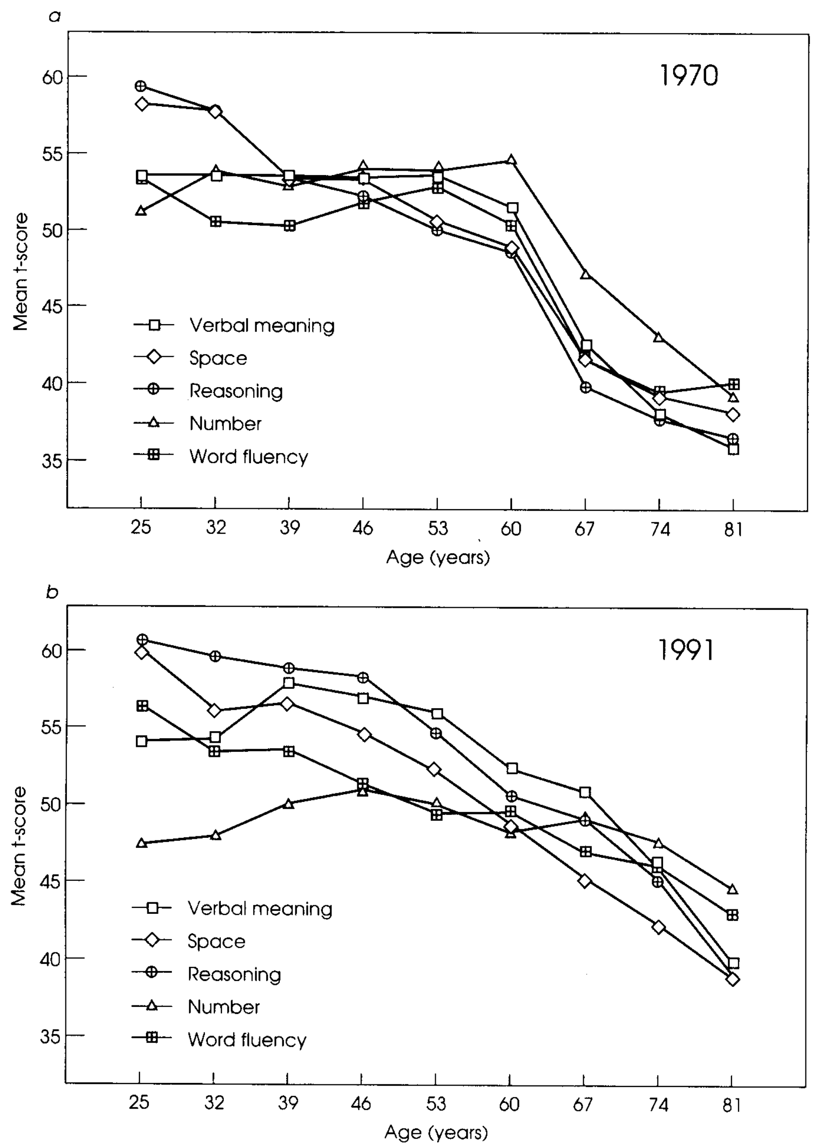


FIGURE 9.2 Cross-sectional age differences for five primary mental abilities in the Seattle Longitudinal Study in 1970 and 1991. (*Source:* Adapted from Schaie, 1995.)

number peak in midlife. However, verbal meaning, a somewhat speeded test, begins to show negative age differences by early old age. In 1970, number shows negative age differences after age 60 similar to the other abilities. However, in 1991 it has an almost level age differences profile through adulthood. Note that at each comparable age individuals were born 21 years later in the earlier than the later study wave. The differences in the shapes of the age profiles result from differences between the respective birth cohorts (see below).

■ Longitudinal Findings

Going beyond the between-group findings that confound age and differential experience, Figure 9.3 shows longitudinal gradients estimated by averaging all of the 7-year within-subject data accumulated over the entire course of our studies for a given age segment. Sufficient data are available to do this over the age range from mean age 25 to mean age 88. The longitudinal gradients are centered on the last actually observed mean for subjects aged 53.

The longitudinal gradients show at least a modest gain for all abilities from young adulthood to early middle age. But there remain differences among abilities in the attainment of peak age as well as the degree to which age changes accelerate with advancing age. There are, moreover, gender and cohort effects that differ by ability, which complicate matters. Systematic gender differences favor women on verbal meaning and inductive reasoning but men

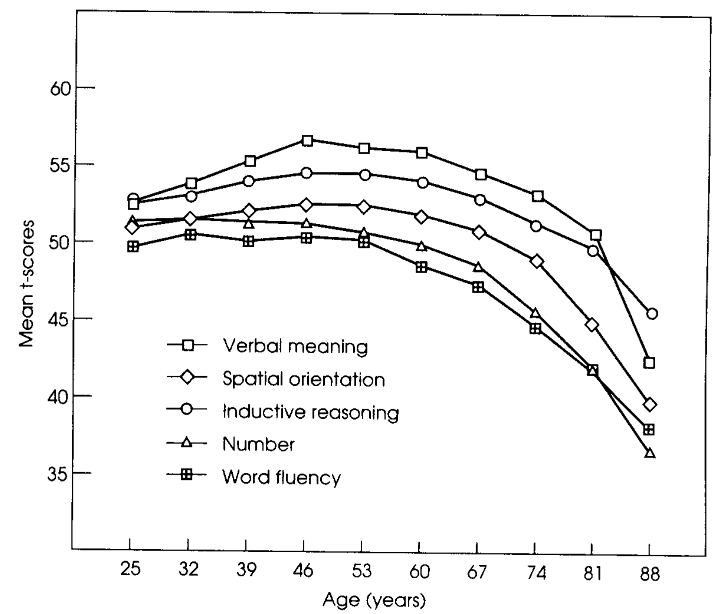


FIGURE 9.3 Longitudinal age gradients for five primary mental abilities estimated from cumulated within-subject age changes. (*Source:* Schaie, 1994.)

on spatial orientation and number. In the more recent longitudinal data, gender difference trends have emerged that suggest that women may decline earlier on fluid abilities, while men do so on crystallized abilities. Although fluid abilities begin to decline earlier, crystallized abilities show steeper decrement once the late 70s are reached (cf. Schaie, 1990, 1995; Schaie & Hertzog, 1983, 1986). (See Kaufman, Kaufman, McLean, & Reynolds, 1991 for gender differences on other tests.)

There does not seem to be a systematic sequence of which abilities decline first in a given individual. In the SLS study we have looked at the question of how many abilities decline in an individual by a certain age. We have found that by age 67 virtually everyone had declined reliably on at least one ability. But in these community-dwelling persons, even by age 88, no one had declined in all five abilities that we monitored (Schaie, 1989).

More fine-grained analyses also suggest substantial gender differences when age changes are decomposed into accuracy and speed (cf. Willis & Schaie, 1988). As men enter advanced old age, their performance loss tends to be due in greater part to speed than is true for women. One might assume that at comparable ages men are closer to death than women are; hence, the physiological infrastructure that mediates response speed has already experienced a greater reduction in efficiency.

Generational Differences

In the general population. Results from the SLS have conclusively demonstrated the prevalence of substantial generational (birth cohort) differences in psychometric abilities (Schaie, 1983, 1990; Schaie & Hertzog, 1986; Willis, 1989). These cohort trends differ in magnitude and direction by ability and can therefore not be determined from composite IQ indices. The magnitude of cohort differences for five abilities are shown in Figure 9.4. These cohort gradients are obtained by differentiating successive cohorts observed at the same age, with estimates based on cohort differences at up to five different age levels.

Almost linear positive cohort shifts were observed for inductive reasoning and verbal meaning, with a more spasmodic positive shift for spatial orientation. These cohort differences are substantial and account for differences of more than 1 population standard deviation (SD) between the earliest and latest cohorts. On the other hand, number skill peaked with the 1924 birth cohort and declined progressively thereafter by about ½ SD. More recently both cohorts are also at a disadvantage when compared with prior cohorts on the variable of word fluency. From these findings we concluded that the cross-sectional studies used to model age change overestimate age-related decline prior to the 60s for those variables that show negative cohort gradients and underestimate such declines for variables with positive cohort gradients.

Cohort-related differences in the rate and magnitude of age changes in intelligence remained fairly linear for cohorts entering old age during the first three cycles in our study (until 1970). They have since shown substantial shifts. For example, the rates of decremental age change have abated, while at the same time the earlier positive cohort trends have flattened as we began to study members of the baby-boom generation. Patterns of socialization unique to a given sex role within a specific historical period may also be major determinants for the pattern of change in abilities.

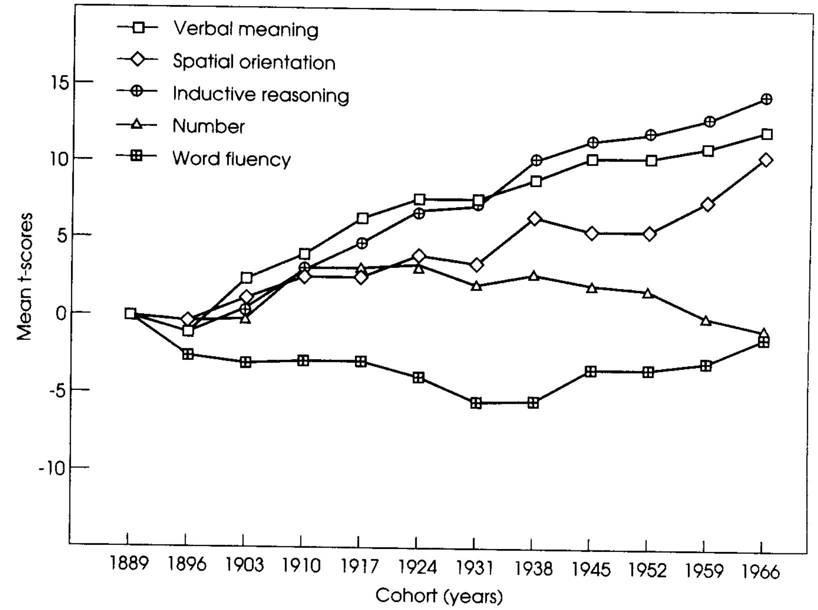


FIGURE 9.4 Cohort gradients showing cumulative cohort differences on five primary mental abilities for cohorts born in 1889 to 1966. (*Source:* Schaie, 1994.)

Within families To supplement the work on generational differences in abilities among unrelated individuals, we have recently studied family members of our longitudinal study participants (Schaie, Plomin, Willis, Gruber-Baldini, & Dutta, 1992). Most work in developmental behavior genetics has been conducted by means of twin studies (Plomin & McClearn, 1990). It has only recently been recognized that, because of the unique characteristics of twins, broad generalizations from such studies will be limited and corroborative data are needed from family studies of parents/offspring and nontwin siblings. In the past, such studies employed parents and their young offspring and young siblings; our study is the first effort to explore systematic family similarity through adulthood, as well as to test for stability of such similarity over time.

An average family similarity of about .25 was observed for the mental abilities (verbal meaning, spatial orientation, inductive reasoning, number, and word fluency) and measures of flexibility (attitudinal flexibility, motor-cognitive flexibility, and psychomotor speed). Similarities were found for both parents and their offspring (adult children) and for siblings (brothers and sisters). The magnitude of parent–offspring and sibling similarly differed for specific abilities, and the overall similarity was somewhat greater for parent–offspring pairs. The size of the correlations was also comparable to those found between young adults and their children in other studies (see, e.g., DeFries et al., 1976).

Because of changes in our society, it has been argued that there ought to be a reduction in family similarity for younger as compared to older parent–offspring pairs. The possible reduction in shared environmental influence is thought to be due to increased outside influences in the more recent generation. However, this proposition could be supported only for inductive reasoning, where the older and middle generations showed somewhat greater similarity than the younger generation. For other abilities we found stability and for some abilities (verbal meaning and spatial orientation) even an increase in family similarity for more recent generations. Correlating relative performance with the longitudinal target subjects over 7, 14, and 21 years, moreover, provided strong evidence for stability of family similarity over time and age.

In summary, there do not seem to be uniform age-related patterns of change across all abilities. Cross-sectional analyses make it seem that declines occur early for those abilities where there have been positive cohort trends (e.g., inductive reasoning) but underestimate age-related change for abilities where negative or curvilinear cohort trends have occurred (e.g., number). Parents and their adult offspring show substantial correlations in ability performance.

PSYCHOMETRIC INTELLIGENCE AND EVERYDAY COMPETENCE

One of the ambiguities in studying everyday intelligence is that there is no commonly agreed-upon definition of the term (Charlesworth, 1976; Puckett & Reese, 1993; Sternberg & Wagner, 1986). However, several characteristics are frequently cited. Everyday intelligence involves an adult's ability to perform adequately those activities considered essential for living independently in our society. It involves the application of cognitive abilities and skills (Salthouse, 1990). Everyday problems are experienced in naturalistic or everyday contexts (Wagner, 1986). Finally, everyday problems are complex and multidimensional when compared with laboratory intelligence tasks.

A major issue in the study of everyday intelligence is the identification of criterion tasks for assessing intelligent behavior in real-world contexts (Crook & West, 1990; West & Sinnott, 1992). Criterion tasks will obviously vary by age or life stage. In childhood and young adulthood, there is considerable consensus regarding biologically or societally defined developmental tasks (e.g., schooling, choosing an occupation, parenting). In middle and late adulthood, there are increasing individual differences in the range of environments and experiences encountered, and there is no comparable, parsimonious set of near-universal developmental tasks that have the generality of developmental tasks in childhood. How then can the criterion tasks for assessing everyday intelligence in later adulthood be derived? One approach proceeds from the assumption that certain classes of everyday activities are critical for adaptive functioning in many life situations. A major concern in old age is the maintenance of independent living. In this approach the focus is upon tasks associated with the activities that are essential for effective independent functioning (Grisso, 1986; Lawton & Brody, 1969). Those involved in the assessment of older persons and the provision of services to the elderly have identified seven domains of daily living, known as the Instrumental Activities of Daily Living (IADLs; Fillenbaum, 1985), that are considered essential for living

independently. These seven domains are: taking medications, managing finances, shopping for necessities, using the telephone, managing transportation, preparing meals, and housekeeping.

We have been conducting a program of research examining the relationship between mental abilities and older adults' competence in solving everyday problems involving printed materials (Diehl et al., 1995; Marsiske & Willis, 1995; Willis & Schaie, 1993). Tasks in each of the seven IADL domains have been examined: financial management (e.g., filling out a Medicare form), taking medications (e.g., reading a medicine bottle label), shopping (e.g., filling out a mail-order catalog form), meal preparation (e.g., reading a nutrition label), using the telephone (e.g., reading an emergency phone listing), managing transportation (e.g., reading a bus schedule), and housekeeping (e.g., reading instructions for use of a household appliance).

As we reported in earlier sections in this chapter, different mental abilities exhibit different patterns of age-related change in later adulthood. Therefore, the specific mental abilities that are related to everyday task performance are of interest. Cattell (1987) has differentiated between two broad domains of mental abilities. Crystallized abilities (e.g., verbal, numerical) are said to reflect acculturated influences, such as level of schooling; in healthy older adults, crystallized abilities remain stable on average, showing little or no decline until old-old age. In contrast, fluid abilities involve abstract reasoning and speeded responding; fluid abilities are said to be impacted by neurological assaults and to exhibit earlier patterns of decline, beginning on average in the mid-60s or earlier. Findings from the SLS support the differential rates of decline for fluid versus crystallized abilities. Thus, older adults' performance on everyday tasks would be expected to show different patterns of developmental change, depending on whether such tasks are more closely related to fluid or crystallized abilities.

In our research on the relationship between mental abilities and everyday tasks, we have found that more than half of the variance in older adults' performance on everyday tasks can be accounted for by mental ability performance (Willis & Marsiske, 1991; Willis & Schaie, 1986; Willis et al., 1992). Both fluid and crystallized abilities were found to account for everyday task performance, although a somewhat greater portion of the variance was accounted for by fluid abilities.

Causal relationships among variables cannot be determined by examining concurrent relationships. In our hierarchical model of ability–everyday intelligence relationships, basic mental abilities have been hypothesized to be salient antecedents of performance on complex tasks of daily living. To test this hypothesis, we examined whether performance on fluid and crystallized abilities at the first assessment occasion was a significant predictor of everyday task performance 7 years later. Both fluid and crystallized abilities were indeed found to be significant predictors. To further examine the reciprocal relationship between abilities and everyday task performance, a series of structural equation analyses was conducted (Willis et al., 1992). That is, the directionality of the relationship between abilities and everyday tasks was examined by contrasting models of abilities as predictors of everyday task performance versus models of everyday task performance as predictors of abilities. Findings indicated that fluid ability at the first assessment occasion predicted everyday task performance at the second assessment occasion 7 years later. Everyday task performance predicted ability at the second occasion less well. These findings provide support for our hypothesis that the level of performance on basic mental abilities is a significant antecedent of competence with everyday tasks involving printed material.

It has been suggested (Salthouse, 1990) that our findings of a relationship between mental ability performance and tasks of daily living may in part be due to the fact that both the tests of mental abilities and our everyday task measures involve printed stimuli. We therefore expanded these studies by assessing everyday problem solving through behavioral observation of the elderly performing tasks in their homes (Crook & West, 1990; Diehl et al., 1995). The elderly were observed performing prototypical everyday tasks in the three domains of telephone usage, medication intake, and meal preparation. Exemplar tasks included loading a pill reminder device, completing a patient record form, activating call forwarding on the telephone, and following instructions for use of a microwave. Sizable correlations were found between performance on the observational tasks and the mental abilities of fluid intelligence, crystallized intelligence, and psychomotor speed, with the largest correlations for fluid and crystallized intelligence. Path analyses showed that the aged's performance on measures of fluid intelligence was the strongest correlate of their practical problem-solving performance. The effects of psychomotor speed and memory span were mediated by their standing on fluid and crystallized intelligence. Age affected older adults' performance both directly and indirectly via its effect on cognitive abilities. The effect of educational level and health on practical problem solving was indirect via its impact on ability performance.

PSYCHOMETRIC INTELLIGENCE AND HEALTH

One of the first subjects that seems worthy of inquiry when one is concerned with the antecedents of individual differences in cognitive aging is the impact of health on cognition. The relationship between health and intellectual functioning is, however, not necessarily unidirectional. Recent reviews of the literature (Elias, Elias, & Elias, 1990; Siegler, 1988), suggest that this relationship may be reciprocal, that is, a healthy body facilitates intellectual competence and competent behavior facilitates the maintenance of health. Hence, we will consider the diseases that seem to affect the maintenance of cognitive functions but will also consider the role of intellectual functioning as a predictor of health status and health behaviors.

■ Relation to Health Status

The impact of disease on cognitive functioning was studied in a dissertation by Ann Gruber-Baldini (1991; also see Schaie, 1995, Chapter 10) for a sample of 845 subjects from the SLS who had been followed over at least 7 years. Prior research has suggested that ratings of poor overall health predict lowered cognitive functioning. In this study, measures of the number of chronic conditions, total number of physician visits, and number of days spent in hospital were examined. The number of chronic conditions had a negative influence on the performance level for verbal meaning, number, and word fluency and predicted a greater decline on verbal meaning and number. A greater number of physician visits predicted an increased likelihood of cognitive decline for reasoning and a later age of onset of decline for number.

Cardiovascular Disease

Research on the relation of specific diseases to cognitive functioning has focused mostly on cardiovascular disease (CVD), and in particular upon hypertension. Mixed results were found as to the direction of influence of hypertension on cognition. Earlier studies in the literature suggested that more severe CVD (atherosclerosis, cerebrovascular disease, etc.) has a negative impact on cognitive functioning (Hertzog, Schaie, & Gribben, 1978). However, much of this research was cross-sectional. Longitudinal studies in this area have often involved small samples, included a limited number of testing occasions (i.e., fewer than three points), failed to compare hypertension groups to groups with more severe CVD, and did not have information on cognitive functioning prior to disease onset.

In the analyses summarized here, multiple CVD groups were examined for the influence of the disease on cognitive functioning. Atherosclerosis was found to be associated with lower cognitive functioning and greater decline on space and number. Cerebrovascular disease was also negatively associated with cognitive level and increased the risk of and amount of cognitive decline. Hypertensives with other CVD complications performed more poorly over time than did uncomplicated hypertensives and normotensives. Noncomplicated hypertensives had higher performances and less decline than did complicated hypertensives and normotensives. The total number of hypertension episodes predicted an increased hazard of significant decline and overall level on word fluency but significantly later decline onset for spatial orientation and reasoning. Benign CVD was associated with a relatively lower rate of cognitive decline. Thus, the more serious CVD conditions (atherosclerosis and cerebrovascular disease) have generally negative influences, while benign CVD has more positive influences on cognition.

Arthritis

Only a few studies have examined the influence of arthritis on cognitive functioning, despite the high prevalence of this disease among the aged. Our results suggest that arthritics have lower functioning and greater decline on verbal meaning, spatial orientation, and inductive reasoning. Arthritis had a direct negative effect on spatial orientation level and change over 7 years. Dividing arthritics by age of onset, we found that persons who developed arthritis after age 60 had lower levels of and greater decline on verbal meaning, while persons who developed arthritis before age 60 had lower levels of and greater decline on inductive reasoning. A mixed pattern resulted for spatial orientation, with pre-60 arthritics experiencing greater decline while the post-60 group had lower overall levels of functioning by age 81.

Neoplasms (Tumors)

In prior research on neoplasms, Stone (1980) found that the presence of neoplasms had a positive effect on cognitive performance in the SLS, but she combined both benign and malignant tumors. The analysis described here distinguished between malignant and benign neoplasms and between skin (the most frequent) and other neoplasms. Results suggest that the positive effects found by Stone might be due to the high frequency of benign neoplasms. Persons with benign neoplasms (other than skin tumors) were found to have earlier onset of decline but less overall decline. Persons with malignant neoplasms and benign skin neoplasms had indirect negative influences on performance (through reduced activity). Results of the influence of neoplasms on cognition might be specific to type (malignant versus nonmalignant) as well as location (skin, bone, etc.) of the tumor.

Other Chronic Conditions

Also related to cognitive functioning were osteoporosis, hip fractures, and sensory problems. Osteoporosis and hip fractures were predictive of earlier decline on word fluency. Hearing impairment was associated with an increased risk of experiencing verbal meaning decline but with better performance and later decline on space. Vision difficulties predicted later age at onset of decline for verbal meaning and space.

In summary, because chronic diseases impose limitations on active lifestyles, they also tend to influence performance on measures of psychometric intelligence. This has been demonstrated most clearly for cardiovascular disease, arthritis, and diabetes.

■ Relation to Health Behaviors

Why are older adults with higher levels of mental functioning often in better health, and why do they suffer from fewer chronic diseases? Higher mental ability performance is associated with higher levels of education, occupational status, and income (Schaie, 1990). Adults who are advantaged in terms of education, occupation, and income often have access to better health care and have the financial resources to purchase such services. On the other hand, higher levels of mental ability may facilitate the acquisition of knowledge both about desirable health behaviors and practices (e.g., good nutrition, medical checkups, exercise) and about risk behaviors (e.g., smoking, excessive drinking, obesity) associated with certain chronic diseases (Park, 1992; Park & Kidder, 1995; Perlmutter & Nyquist, 1990; Rakowski, Julius, Hickey, & Halter, 1987). Likewise, those with higher levels of mental ability may be more likely to believe that they have control over their health and well-being (Prohaska, Leventhal, Leventhal, & Keller, 1985; Wallston & Wallston, 1982).

In a recent study within the ADEPT project, we have examined mental abilities as predictors of health behaviors and practices (Maier, McGuire, & Willis, 1994). We also examined whether internal locus of control beliefs were associated with health behaviors. Four classes of health behaviors were studied: substance abuse (e.g., smoking, alcohol consumption), positive nutrition behaviors (e.g., dietary reduction of sodium and fat), medical checkups (e.g., cholesterol, mammography/prostate, colon/rectal exams), and self-initiated health behaviors (e.g., exercise, use of seat belts, dental care). Older adults who had performed at a higher level on fluid and crystallized abilities several years previously were found to be more likely to engage in positive nutritional practices and to be more likely to engage in self-initiated health behaviors. Mental abilities were significant predictors of subsequent health practices even after age and educational level were taken into account. In contrast, mental abilities were not associated with avoiding certain risk behaviors. In addition, older adults with higher internal control beliefs also were more likely to engage regularly in health-promoting practices and behaviors.

Once again, these findings suggest a hierarchical relationship between mental abilities and everyday intelligence as reflected in health behaviors and practices. Higher ability functioning is a predictor of greater likelihood of engaging in positive health behaviors, particularly those behaviors initiated and under the control of the individual, such as good nutritional practices and health maintenance activities (e.g., exercise, dental care). Mental ability accounts for only a portion of the individual differences in health behaviors and practices. Certainly, factors in the physical and social environment (access to health care, cultural and ethnic variables), as well as the adult's personality traits and motivations, influence health behaviors, as does mental ability (Siegler & Costa, 1985). Nevertheless, the findings of mental ability as a significant predictor of practical problem solving in a variety of domains (health behaviors, nutrition, finances, transportation) argue for the importance of research to chart the course of mental functioning in old age. It would appear that decline in mental functioning in old age not only is of concern for cognition in the narrow sense but has implications for the individual's ability to engage in the everyday problem solving required in order to live independently in our society.

REVERSIBILITY OF DECLINE IN PSYCHOMETRIC INTELLIGENCE

In earlier sections of this chapter we reported findings indicating that there are wide individual differences in the rate and timing of decline in mental abilities. Contrary to ageist stereotypes suggesting that most older adults experience pervasive cognitive decline by the early 60s, the findings of longitudinal research indicate that decline in mental abilities does not begin on average until the mid-60s and that it occurs primarily for abilities involving abstract reasoning and speeded responding (i.e., fluid abilities). In contrast, decline in verbal abilities (i.e., crystallized abilities) occurs later, beginning on average in the mid-70s. Findings based on group means, however, are deceptive and mask the wide individual differences in when ability decline begins to occur for a given individual.

Age-related decline in mental abilities, even though not pathological in nature, can have serious consequences for the older adult. As we have reported, there are significant relationships between level of performance on mental abilities and a variety of tasks of daily living (e.g., managing one's finances, taking medication). Decline in the salient mental abilities can jeopardize the elderly's ability to carry out the tasks of daily living required to live independently in our society. In addition, our findings suggest that mental abilities are significant predictors of health behaviors that are important to maintaining one's health and preventing certain chronic diseases.

Even older adults who have not suffered a decline in mental abilities may be somewhat at risk for carrying out tasks involving technological advances and or new information and strategies. In previous sections, cohort differences in mental ability level have been reported. Positive cohort trends for abilities such as inductive reasoning have been shown. As a result, even older adults who have experienced no decline on inductive reasoning will be disadvantaged compared with younger cohorts, who on average perform at higher ability levels. Previous research has indicated that inductive reasoning is an important predictor of mastering new technologies, particularly those involving the computer (e.g., word processing, graphics creation; Garfein et al., 1988; Jay & Willis, 1992).

Are there behavioral interventions that could enhance older adults' mental ability functioning? While the significance of interventions that remediate ability decline appears obvious, interventions that improve the functioning of older adults with no prior ability decline are also important because of cohort differences in level of functioning. Our focus here is on interventions for community-dwelling older adults who are healthy and have no known neuropathologies. Certain chronic diseases are known to result in cognitive decline, and we are not suggesting that behavioral interventions would be successful in overcoming the impact of serious chronic diseases. Nevertheless, most older adults do not suffer from neuropathologies or multiple serious chronic diseases.

During the past two decades in cognitive aging research, there have been a number of studies that have demonstrated that behavioral interventions are effective in significantly improving the community-dwelling elderly's cognitive performance. Significant training effects have been reported for remembering names (Yesavage, Lapp, & Sheikh, 1989), episodic memory (Bäckman, Mantyla, & Herlitz, 1990), problem-solving tasks (Denney, 1982), memory span (Kliegl, Smith, & Baltes, 1990), perceptual speed (Hoyer, Labouvie, & Baltes, 1973) and fluid abilities (Baltes & Lindenberger, 1988; Willis, 1987; Willis & Schaie, 1994).

Virtually all of these training studies have focused on cognitive processes and abilities that show early normative patterns of decline. Hence, the assumption has often been made that improvement with training reflects primarily a remediation or reactivation of previous cognitive skill levels. Longitudinal research findings, however, suggest that such assumptions are too simplistic, given the wide individual differences in rate and pattern of decline. The qualitative nature of the training effects differs depending on the prior developmental history of an individual; for those suffering from prior ability decline, training effects may indeed represent remediation, while for those not suffering from prior decline, training gains reflect improvement over prior levels of functioning. In order to study these differential training effects, an intervention study would need to be conducted within an ongoing longitudinal research program so that the prior ability trajectory of the participants would be known and training results could be examined in the light of prior functioning. In the following section, we report on a program of cognitive training research within the Seattle Longitudinal Study that addresses these issues.

■ Seattle Training Study

Subjects in the Seattle Training Study, which began in 1984, had been participants in the SLS since 1970 or before (Schaie, 1995; Schaie & Willis, 1986; Willis, 1987; Willis & Schaie, 1994). Subjects' ability performance over the 14 years (1970–1984) prior to training was classified as having remained stable or having declined on two abilities, spatial orientation and inductive reasoning. These two abilities were chosen to be the focus of training for three reasons: (1) they exhibit a relatively early normative decline, (2) they show positive cohorts trends such that even elderly who had not experienced decline might be disadvantaged compared with more recent cohorts, and (3) they have been found to be salient predictors of everyday task performance. Only 22 percent of the subjects had declined on both reasoning and

space abilities over the interval 1970–1984, 47 percent had declined on neither ability, and approximately 15 percent had declined on one of the abilities but not on the other. Subjects were assigned to training on reasoning or spatial ability on the basis of their decline status. Subjects who had decline on only one of the abilities were assigned to training on the ability on which they had declined. Subjects who had declined on both abilities or who had remained stable on both abilities were randomly assigned to training on one of the abilities.

The training study involved a pretest–training–posttest design. Following the pretest, subjects participated in five 1-hour training sessions conducted in their homes. The content of these training programs has been described in previous publications (Schaie & Willis, 1986; Willis, 1987, 1990; Willis & Schaie, 1994). A posttest to evaluate training effects was conducted within 1 week of the end of training. A follow-up study was conducted 7 years later, in 1990 (Willis & Schaie, 1994). Subjects were pretested to assess their current level of performance and to examine the question of the temporal durability of training effects. They then took part in booster training on the same ability on which they had been trained in 1983. The booster training was very similar in format to the training program used in 1983. Subjects were posttested following the booster training.

Training Effects for Stable and Decline Subjects

Figure 9.5 (top) presents the mean inductive reasoning scores for stable and decline subjects trained on reasoning on three occasions: (1) in 1970, 14 years prior to training, (2) at the 1984 pretest, immediately before training, and (3) at the 1984 posttest. Similar findings are reported for subjects trained on spatial orientation in the bottom part of the figure (Willis, 1990). In 1970, 14 years prior to training, stable and decline subjects were performing at the same level on each ability. At the 1984 pretest, decline subjects were performing at a significantly lower level. Training resulted in significant performance gain for both stable and decline subjects, as demonstrated in their 1984 posttest performance. The nature of the training effects was qualitatively different for the two groups. For the decliners, training was effective in returning (remediating) their performance close to their 1970 score level. For the stable group, on the other hand, the effect of training was to raise their performance level above that previously demonstrated.

Figure 9.5 presents information on training effects in terms of mean scores. Change or modifiability of mental ability performance is an intraindividual phenomenon, and therefore assessment of training effects at the individual level is of particular interest (Schaie & Willis, 1986; Willis, 1990). Two questions can be examined: First, what proportion of stable and decline subjects demonstrated significant training gain from pretest to posttest? Second, what proportion of decline subjects exhibited remediation to their 1970 score level? With regard to the first question, approximately 50 percent of the subjects in each training group showed significant improvement from pretest to posttest. The second question deals with the proportion of decline subjects showing complete remediation of prior age-related decline. To assess remediation of decline, we examined the proportion of decline subjects whose performance at posttest was equal to or greater than their score fourteen years previously, in 1970. Approximately 40 percent of decline subjects exhibited complete remediation. Thus, the findings indicate that training is effective both for subjects who have decline and for subjects with no prior decline.

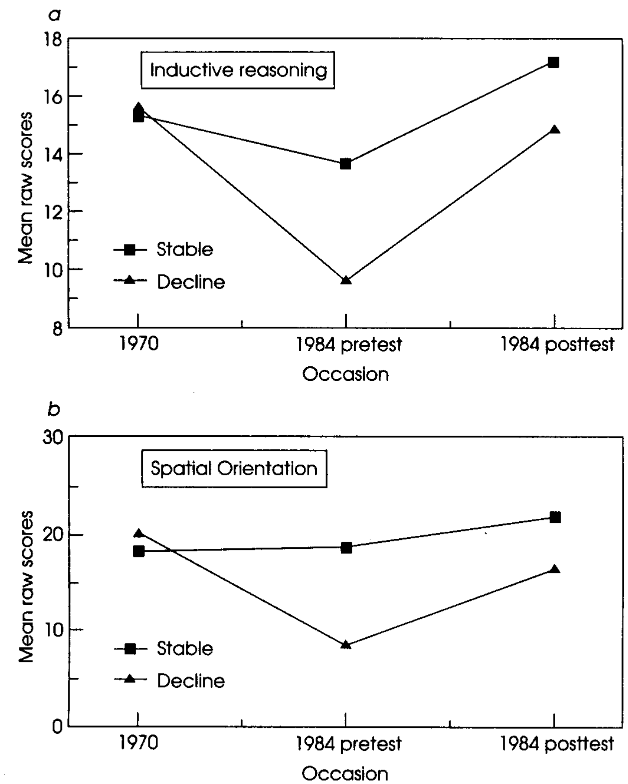


FIGURE 9.5 Mean gain from cognitive training on the abilities of inductive reasoning and spatial orientation. (*Source:* Willis and Schaie, 1994.)

Cohort Differences in Training Effects

Positive cohort trends have been reported for inductive reasoning and to a lesser extent for spatial orientation in cohort sequential research (Schaie, 1983, 1993). If there are cohort differences in level of ability scores, there is the question of whether training effects would differ by age/cohort. We examined training effects on inductive reasoning for three cohorts: the 1903 cohort, the 1910 cohort, and the 1917 cohort. At the time of training, these cohorts were 74, 67, and 60 years of age, respectively. Figure 9.6 shows the mean scores on inductive reasoning at four occasions: 1970, 1977, 1984 pretest, 1984 posttest. Significant age-related decline on inductive reasoning had occurred for the 1903 and 1910 cohorts prior to training (1970–1984 pretest). The performance of the 1917 cohort was relatively stable; they were middle-aged in the 1970–1984 interval. Note that, after training, the 1910 and 1917 cohorts were performing, on average, at a level above their 1970 base. In contrast, for the

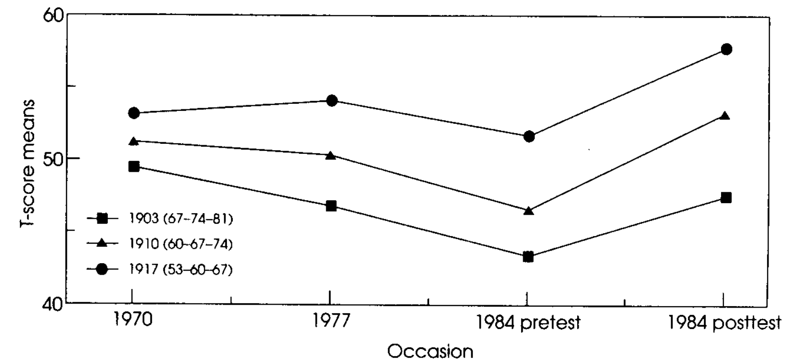


FIGURE 9.6 Cohort differences in training gains. (*Source:* Willis and Schaie, 1994.)

1903 cohort, remediation of age-related decline occurred. Note also that age/cohort differences in level of performance are present at all points of measurement. While training was effective for all three groups, the magnitude of the training effects was not sufficient to eliminate cohort differences.

Durability of Training Outcomes

It is important to consider intervention effects within a life-span context. The concern is not only that significant improvement be demonstrated immediately after training but also whether training has implications for patterns of cognitive development several years after the intervention (Willis & Nesselroade, 1990; Willis & Schaie, 1994). The longitudinal design of the Seattle study permits examination of these issues. Subjects initially trained in 1984 were reassessed in 1991; thus, the maintenance of training effects over a 7-year interval could be examined. Subsequently, subjects were administered booster training in 1991 on the same ability on which they had initially been trained in 1984.

Age-related decline would have been expected to have occurred over the 7-year interval (1984–1991) between initial and booster training, since by 1991 most of our subjects had advanced into old-old age. We were interested in comparing subjects' performance after the 1991 booster training with their performance prior to training in 1984. That is, given the increasing likelihood of age-related decline, was training effective in boosting or maintaining earlier levels of functioning?

After booster training, subjects trained on inductive reasoning were performing at a level above their 1984 pretest scores. Thus, the combined effects of initial training and booster training were sufficient to overcome whatever age-related decline had occurred during the 7-year interval. The durability of training effects was particularly evident for subjects initially classified as having decline on inductive reasoning. The durability of training effects on spatial orientation was somewhat weaker and more differentiated than that found for inductive reasoning. That is, only subjects initially classified as having declined on spatial ability were performing at a level above their 1984 pretest scores. Subjects initially classified as stable were on average functioning at the same level as they had prior to training in 1984.

Summary

Several conclusions regarding the durability of training effects and the potency of successive intervention efforts in 1984 and again in 1991 can be reached (Willis & Schaie, 1994). First, the long-term effects of training were most evident for subjects who had been classified as having declined on the target ability. That is, after booster training, decline subjects involved in each training program were performing at a level above their performance prior to training in 1984. There is suggestive evidence, therefore, that training may be particularly effective if it is begun after subjects begin to evidence decline. Second, training effects after the second training program were somewhat more potent and more durable for inductive reasoning. Both stable and decline subjects trained on inductive reasoning were performing above the level of functioning exhibited prior to training in 1983. Third, more subjects trained on a particular ability were functioning at a higher level on that ability than comparison subjects trained on another ability. That is subjects remained at an advantage on the ability trained in comparison with those not so trained.

SUMMARY AND CONCLUSIONS

This chapter began by placing psychometric intelligence into the broader context of cognitive psychology. We provided a brief historical review and then summarized major issues in the literature on psychometric intelligence by focusing on age differences and age changes in intelligence as well as on individual differences in patterns of change. We suggested that relatively little decline in psychometric abilities can be observed until the 60s are reached but that significant average decline may be observed by the 80s. Cohort (generational) differences in levels of intellectual functioning obscure these findings when attention is given only to age-comparative (cross-sectional) studies conducted at one point in time. As a consequence of the apparent plateauing of cohort effects for some abilities and negative effects for others, we can expect that age differences in adulthood may actually become more compressed over the next decade.

Although our understanding of gender differences in abilities has increased markedly, we still have almost no comparative work on intellectual aging within minority groups in the United States, nor do we have useful cross-cultural comparisons with intellectual aging in other societies. This would be an exciting topic for future research, particularly because cross-cultural research allows variation in the timing of substantial natural experiments (e.g., Great Depression, Cultural Revolution, and so on), that may affect intellectual aging; the Berlin BASE study (Baltes, Mayer, Helmchen, & Steinhagen-Thiessen, 1993) is a notable example.

We next focused on the field of practical intelligence. We described some work that has identified the dimensions of practical intelligence and examined the processes that link expressions of practical intelligence to the basic abilities, combinations and permutations of

which are likely to remain the common denominators in any attempt to predict performance on everyday tasks and on the dimensions essential to independent living.

We then noted the manner in which intellectual competence is effected by health status and identified the deleterious role of chronic diseases in accelerating intellectual decline. But we also noted the importance of good intellectual competence in facilitating health behaviors which may delay the onset of chronic disease and exacerbate its severity.

Cognitive intervention efforts have been successful in showing that intellectual decline in old age is not necessarily irreversible, and it has been demonstrated that formal intervention strategies exist that may help to extend maintenance of high levels of intellectual function in community-dwelling elders. The cognitive intervention research has also shown that much of the cognitive decline observed in the elderly may be due to disuse and is at least in part reversible. The effects of cognitive training have been shown to persist for as long as 7 years. The cognitive intervention techniques must now be transferred from the laboratory into a broader social context, whether by making laboratory training paradigms more widely accessible or by taking advantage of prescribed leisure activities that are both cognitively challenging and indigenous to the daily experience of older persons.

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