

## CHAPTER SIX

# Intellectual Development in Adulthood

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As for writing, I still write – at age 72. My experience is that I have to strive harder, tire sooner and come apart at the seams more completely than was the case when I was younger. The aging mind has a bagful of nasty tricks, one of which is to tuck names and words away in crannies where they are not immediately available and where I can't always find them (E. B. White in Taylor, 1984, p. 113).

There is often a mysterious growth of the mind, which we can trace to no particular efforts or studies, which we can hardly define, though we are conscious of it. We understand ourselves and the past, and our friends and the world better (Channing as cited in Taylor, 1984, p. 102).

These two quotations illustrate the tension that exists in the literature regarding age-related differences in intelligence across adulthood. The view that intelligence largely declines in adulthood has perhaps received the longest and most overwhelming support. Intelligence during adulthood is characterized by declines in the speed of mental processes, in abstract reasoning, and in several measures of memory performance (see Salthouse, 1991, for a review). However, much empirical and theoretical work characterizes adult intellectual development as being marked by progressive growth in the ability to integrate cognitive, interpersonal, and emotional thought so that the type of synthetic understanding of self and others that Channing spoke of is possible (see Labouvie-Vief, 1992, for a review). As will be seen throughout the chapter, in a life-span theoretical perspective these two perspectives are not considered to be inconsistent, but rather the development of intelligence is seen as a balance between

such losses and gains (Baltes, 1987; Labouvie-Vief, 1992).

The question of what happens to adult intelligence across the life span has sparked tremendous debate and controversy (see Baltes & Schaie, 1976; Horn & Donaldson, 1976; Schaie, 1974). Horn and Donaldson (1976) argued that intellectual decline is inevitable: "if one lives long enough, decrement in at least some of the important abilities of intelligence is likely to occur" (p. 701). Schaie (1974) referred to the view of declining adult intelligence as "at best a methodological artifact and at worst a popular misunderstanding of the relation between individual development and sociocultural change" (p. 802). As highlighted by Horn's focus on "important abilities," at least part of the controversy over adult intelligence as decline versus maintenance and improvement arose over different conceptions about the nature of adult intelligence and about development. Before reviewing the literature on adult intelligence, we must explore what is meant by intelligence and by development.

## DEFINITIONS OF INTELLIGENCE AND DEVELOPMENT

### Intelligence

Although a great deal of research in the field of adult intelligence has operated under the assumption that adult intelligence is "what an intelligence test measures," numerous theorists have raised concerns about using traditional intelligence tests to measure the intelligence of adults across the life span (Baltes, Dittmann-Kohli, & Dixon, 1984;

Berg & Sternberg, 1985; Demming & Pressey, 1957; Labouvie-Vief, 1992). Intelligence tests were originally designed to predict the academic success of children; however, such prediction is not relevant to older adults who are typically outside of the academic environment. Many theoreticians have described a different nature of intelligence across the life span (e.g., Labouvie-Vief, 1992) in which "domains of psychological functioning other than performance on intelligence tests gain in relative significance" (Baltes et al., 1984, p. 50). The focus in adulthood is on domains such as family life, health, personal and professional development, and social intelligence rather than school.

In this chapter, the term intelligence will be used to refer to *the mental abilities and processes involved in providing an optimal fit between oneself and one's environment*. This definition of intelligence has a long-standing history in the field of intellectual development. The view of intelligence as adaptation is the key to Piaget's notion of intelligence (1976) and has been present in many contextually based notions of intelligence (Berg & Sternberg, 1985; Sternberg, 1985). This view of intelligence makes apparent two aspects in the expression of intelligence: *abilities and mental processes that lie within the individual and how these abilities and mental processes transact the constraints and opportunities of the context*. Thus, intelligence does not reside solely within an individual's mind but in how an individual uses abilities and mental processes to transact with, adapt to, and shape his or her environment.

This view of intelligence is apparent in numerous theoretical positions on adult development and aging. For instance, the triarchic theory of intelligence proposed by Sternberg (1985) and extended to adult development and aging by Berg and Sternberg (1985) explicitly defines intelligence as residing in an interaction between the individual's abilities and processes and their expression within different contexts. In the triarchic theory, the context in which individuals must adapt may differ across adult development in terms of the demands and constraints that are present (e.g., shift out of the work context as a result of retirement). As these contexts shift across the life span, the abilities and processes necessary for successful adaptation may vary at different developmental epochs. Berg and Sternberg (1992) found through an examination of adults' concep-

tions of intelligence that adults perceived the abilities needed for successful adaptation as differing in importance across adulthood. Adults perceived intelligence to consist of three distinct subabilities (i.e., interest in, and ability to deal with, novelty; verbal ability; and everyday competencies) whose importance to the assessment of intelligence differed across development. For instance, characteristics associated with the interest in, and ability to deal with, novelty were perceived to be most important for young adults and less important for middle-aged and older adults, whereas characteristics associated with everyday competencies and verbal ability were considered to be more important for middle-aged and older adults than young adults.

P. B. Baltes and M. M. Baltes' (1990; see also Baltes et al., 1998) notion of selective optimization with compensation also focuses on the interplay between the individual and context. Individuals are posited to select across the life span from a variety of domains and goal possibilities those that can be enhanced and correspondingly to compensate for abilities and processes that may be showing elements of decline. Thus, individuals are thought to actively select out of some contexts and into others that can maximize their strengths and minimize their weaknesses in abilities and processes. For instance, older adults seem to leave jobs that require quick sensorimotor performance (Barrett, Mihal, Panek, Sterns, & Alexander, 1977), perhaps because they are selecting into other work environments that may rely less on their declining speed of performance. In addition, older adults report that they attempt to optimize and compensate at work through impression management (Abraham & Hansson, 1995). Many current theories of life-span development include this self-regulatory notion of intellectual development (Backman & Dixon, 1992; Brandtstädter & Greve, 1994; Heckhausen & Schulz, 1995) in which individuals regulate their own fit to changing contexts.

## VIEW OF DEVELOPMENT

The view of development adopted in this chapter is a life-span developmental perspective (Baltes, 1987; Baltes, Lindenberger, & Staudinger, 1998). As outlined by Baltes (1987, Baltes et al., 1998), this perspective views development as an expression of both ontogenetic, and cultural and historical changes. The

life-span developmental perspective again points to the importance of examining individual intellectual development as situated within, and in comparison across, the contexts in which it is expressed.

An important methodological issue within the field of life-span development, the influence of cohort effects, illustrates how an individual's intellectual development is situated within his or her historical context. Cohort effects were revealed by Schaie (1984) to be an important factor in understanding cross-sectional differences in intellectual development. That is, cross-sectional methods for examining intellectual development in which individuals of different ages are compared at one point in time confound age and cohort (generational membership or normative influences that are held in common with those in one's birth cohort). A comparison of age differences uncovered via a variety of methodological designs (e.g., cross-sectional, longitudinal, cross-sequential) revealed that a substantial proportion of the age-related differences in intellectual functioning could be accounted for by cohort effects. Thus, factors associated with historical time (e.g., years of education held by adults in different generations, generational differences in educational systems) were reflected in many of the differences that were thought to be representative of age differences in intellectual functioning.

Many of the tenets of life-span development are consonant with a view of intelligence as the individual transacting his or her context (Baltes et al., 1998). First, intellectual development is characterized by multidirectionality; that is, intelligence takes pluralistic forms across development (e.g., linear increase, maintenance, some decline, increase followed by maintenance and then decline), depending on the ability in question and the context in which that ability is examined. Second, great interindividual variability is posited to occur in life-span development, in part due to aspects of the contexts that different individuals traverse across development. Third, great plasticity (within-person variability) is found in intellectual performance, depending on the supportive conditions present within the context.

This chapter will review theoretical and empirical work that illustrates the development of adult intelligence (1) in the mental abilities and processes that are thought to be important for adaptation and

(2) in how those mental abilities and processes vary as they are applied across different contexts. Instead of an exhaustive survey of the research oriented toward individual abilities and processes situated in context, the review will provide illustrative research to support general principles of intellectual development. The chapter ends with a call for research that integrates these aspects of adult intelligence and questions and issues for the future of the field of adult intellectual development.

Research drawn from three theoretical perspectives will be used to review the existing literature on the development of adult intelligence: psychometric, information-processing, and contextual. These perspectives were chosen for two reasons: (1) because of their prominence in the field at the current time (see Berg & Klaczynski, 1996; Schaie, 1996a; Sternberg & Berg, 1992) and (2) because of their emphasis on the abilities and processes individuals use to adapt to their life contexts. The psychometric and the information-processing approaches focus on the abilities and processes that reside within the "individual." The contextual approach focuses on how the expression of those individual abilities and processes may vary, depending on the social and historical context in which intelligence is expressed. Although the perspective taken in this chapter is that abilities and processes do not reside within the individual but at the transaction of the individual and his or her context, the research literature has generally assumed that abilities and processes are within the head of the individual. Thus, the reader may initially get the impression that abilities and processes are a property of the individual that he or she applies in different contexts, which is not the perspective of this chapter. As will be seen in the concluding section, intellectual development from the perspective advanced in the paper should be examined as the *process* whereby the individual transacts with his or her context.

## INDIVIDUAL MENTAL ABILITIES AND PROCESSES

### Abilities

In specifying the number and kinds of categories of mental abilities that characterize intellectual development, the field has drawn heavily from work on the structure or nature of intelligence in

psychometrics. The psychometric perspective defines intelligence as those cognitive products that characterize intellectual differences between individuals at various developmental periods (Horn & Hofer, 1992; Schaie, 1996a). The field of adult intelligence had been dominated by the psychometric perspective until the 1980s (see Schaie, 1996a; Schaie & Willis, 1996, for a complete treatment of the psychometric perspective). This approach comes the closest to defining intelligence as "how well one scores on an intelligence test."

In the psychometric perspective, the nature of intelligence is first investigated by measuring the performance of individuals on specific intelligence tests. Statistical procedures are then utilized that summarize and illuminate the structure underlying the organization of individuals' performance on these intelligence tests. Distinct abilities can be characterized as those that do not cluster together and those that show different trajectories across development. Although issues of the number and kinds of mental abilities characterizing intelligence were a matter of great dispute (see Reinert, 1970, for a review), a consensus has emerged that adult intelli-

gence consists of a small number (2–12) of different components that remain largely unchanged in their organization across adult development (Horn & Hofer, 1992).

The following review will be restricted to three different abilities currently considered distinct in terms of their content and developmental trajectory: fluid intelligence, crystallized intelligence, and everyday intelligence (see Schaie & Willis, 1996). The psychometric literature (see Baltes et al., 1998, for a review) has uncovered that different abilities display different developmental functions (multidirectionality), that there is extensive variability in adult intelligence at any particular age (interindividual variability), and that there is great modifiability of adult intelligence (plasticity).

**FLUID AND CRYSTALLIZED INTELLIGENCE.**

One of the most robust and long-standing divisions of intelligence is the fluid and crystallized distinction of Cattell and Horn (e.g., Cattell, 1971; Horn, 1968). Fluid intelligence is said to be measured best by tasks that require adaptation to new situations and for which prior learning provides relatively little advantage. Crystallized intelligence is best measured by tasks in which the problem solving of the task has been learned as a result of education and acculturation, or both. Measures of fluid intelligence include tests of abstract reasoning, spatial orientation, and perceptual speed, whereas measures of crystallized intelligence include tests of verbal ability such as vocabulary and arithmetic abilities (see Figure 6.1 for example items from the Primary Mental Abilities Test (PMA), the measure that has been most extensively investigated by Schaie, 1996b).

**1. MULTIDIRECTIONALITY OF INTELLIGENCE.**


The multidirectionality of adult intelligence refers to the display of different developmental patterns by distinct abilities. Fluid intelligence has been described by Horn and Hofer (1992) as abilities that are vulnerable to aging. As can be seen in Figure 6.2, cross-sectional functions of these two different types of abilities are distinct, and cross-sectional declines are largest for measures of fluid intelligence.

FIGURE 6.1. Examples of test items from the Primary Mental Abilities Test (taken from Schaie & Willis, 1996).

**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	a.	R W
15	39	b.	R W
27	12		
88	77		

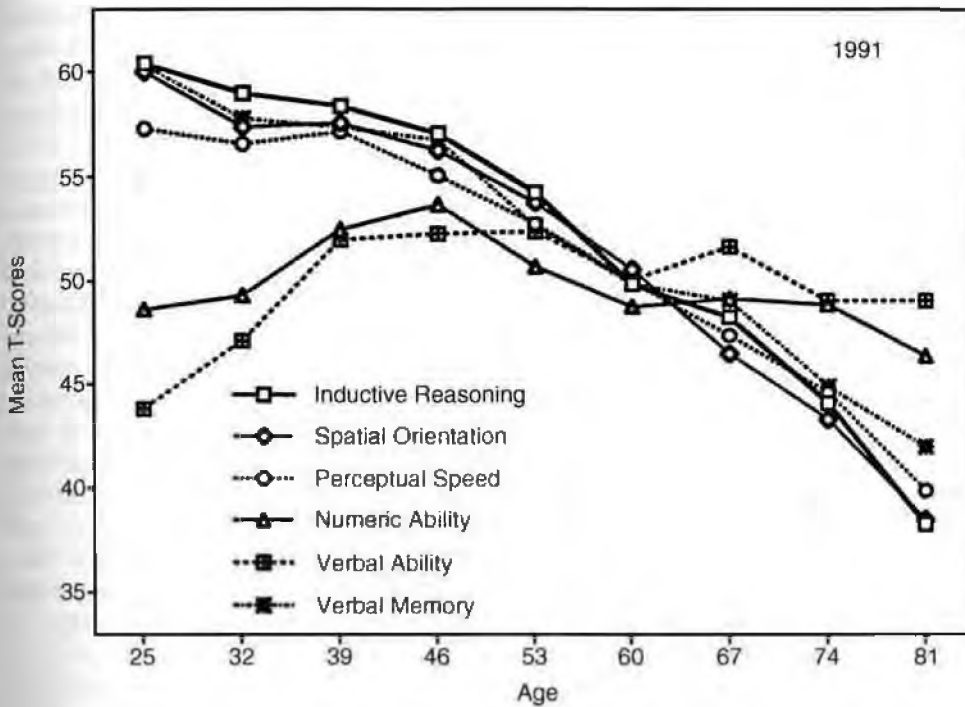


FIGURE 6.2. Cross-sectional age gradients in six primary mental abilities (taken from Schaie, 1996).

The developmental function of crystallized intelligence is largely stable until the sixth decade of life with decline thereafter. The findings reported above are for cross-sectional studies of intellectual development. Longitudinal research (in which the same individuals are followed across time) suggests that even for fluid intelligence, decline does not begin generally until between ages 60 and 70, whereas decline in crystallized intelligence occurs nearly a decade later after age 70 (Schaie, 1996b).

Because of these robust age-related differences in performance, much effort has been expended to try to explain the difference between these vulnerable and maintained abilities. The basic distinction between fluid and crystallized intelligence relies on the difference between abilities that are novel versus familiar and those that do not and do require the application of knowledge. Thus, the distinction has been interpreted as indicating differences in the ability to deal with novelty versus the ability to apply one's knowledge in relatively familiar settings. However, careful work that controls for the degree of task novelty for individuals across the life span has not been conducted. Some theorists (Cattell, 1963; Horn, 1968) have interpreted differences in

the functions of fluid and crystallized intelligence as reflective of a stronger genetic base to fluid intelligence, although heritability estimates for both abilities are about equal (Nichols, 1978).

The differences in developmental function of fluid and crystallized intelligence may be due, in part, to generational gains in intelligence referred to as the *Flynn effect* (Flynn, 1987). Flynn demonstrated generational gains in intelligence (ranging from 5 to 25 IQ points) across countries, and the largest gains occurred for tests of fluid intelligence rather than crystallized intelligence. Thus, cross-sectional decreases in fluid intelligence across age may not be attributable to declines in fluid intelligence in late life but to increases in the level of fluid intelligence expressed by young adults (reflecting later generations). Even longitudinal results can be influenced by these generational gains because longitudinal data may be based on revised norms that reflect these generational gains, thereby producing what appears to be intellectual decline for older adults in fluid intelligence. These findings are consonant

with the cohort effect uncovered by Schaie and others (see Schaie, 1996, for a review).

Multidirectionality of abilities is also present in the distinction between the mechanics and pragmatics of intelligence advanced by Baltes (1987; Baltes et al., 1998), which parallels the distinction between fluid and crystallized intelligence. In making the analogy to a computer, Baltes et al. (1998) refer to these two aspects as the hardware (mechanics) versus the software (cognitive pragmatics) of the mind. The mechanics contain the basic information processing of the cognitive system, irrespective of the content of those processes, and are indexed by the speed and coordination of elementary processing operations such as might be assessed on tests of simple discrimination, selective attention, and so forth. The pragmatics of intelligence refer to content-rich, experience-based declarative and procedural knowledge that one acquires during the course of socialization. As is true for the empirical findings on the distinction between fluid and crystallized intelligence, Baltes et al. (1998) found that abilities representative of the mechanics of intelligence declined linearly from young adulthood until old age, whereas abilities representative of the pragmatics were stable throughout the adult years. For instance, no age differences were found on measures of reasoning about life planning (representative of pragmatics); however, linear decline was found in the speed of comparing information in short-term memory (representative of the mechanics of intelligence).

**2. INTERINDIVIDUAL VARIABILITY OF MENTAL ABILITIES.** Variability in intellectual development not only occurs for individuals across intellectual abilities but for the same intellectual ability across individuals. That is, there is extensive interindividual variability for a single intellectual ability within a specific age group. Although Schaie's (1996b) work consistently revealed mean cross-sectional differences in overall performance, scores varied considerably within age group. Schaie (1988) explicitly studied this variability by examining the proportion of overlap in intellectual abilities with the distribution present for young adults (at age 25). Even in their late 80s, 53% of individuals overlapped with the distribution for young adults, thus scoring well above the mean for their age group on the verbal meaning subtest (a measure of crystallized in-

telligence). Even in late life, therefore, a substantial proportion of individuals perform comparable to a group of young adults in measures of crystallized and fluid intelligence despite general age differences in mean levels of performance.

Variability also exists in the longitudinal patterns of decline, maintenance, and improvement that individuals demonstrate. Schaie and Willis (1986) found that by categorizing older individuals (mean age = 72 years) as having declined versus having remained stable in their performance on the space and reasoning tests of the PMA over a 14-year period, the majority of individuals (46.7%) of the sample remained stable on both measures, whereas only 21% declined in both measures. Schaie (1989) further reports that even for those individuals who were followed into their 80s, virtually no one showed universal declines across all five subtests of the PMA. An extensive body of research has now been compiled to understand what distinguishes individuals who show substantial intellectual decline from those who show maintenance and improvement in intellectual development. Schaie (1996b) found that individual differences in the developmental function of intelligence are due to a host of factors such as genetic endowment, incidence of chronic disease, educational background, occupational pursuits, the stimulating versus passive nature of daily life activities, and personality styles such as rigidity and flexibility.

**3. PLASTICITY OF MENTAL ABILITIES.** Research on the intraindividual plasticity of intelligence has focused on the modifiability of intelligence through intervention. Over the last two decades substantial research has revealed that intervention can lead to significant gains in abilities such as problem-solving tasks (Denney, 1979), perceptual speed (Hoyer, Labouvie, & Baltes, 1973), and fluid intelligence (Baltes & Lindenberg, 1988; Willis, 1987). In general, intervention efforts have been aimed at those abilities that show the greatest decline: largely abilities of fluid intelligence and processes representative of the mechanics of intelligence.

Results from intervention studies indicate that the plasticity of human intelligence among older adults is substantial (see Willis, 1987 for a review). For instance, results from the Seattle Training Study, a component of Schaie's Seattle Longitudinal Study (Schaie, 1996b) indicate that intervention boosted

older adults' performance back to the level present more than a decade before. Schaie and Willis trained individuals in five 1-hour sessions in spatial ability or reasoning ability. For those who had shown decline in performance on either of these tests over the preceding 14-year period, training was effective in returning their performance nearly to the original level. For individuals who had remained stable over the preceding 14-year period, training raised their performance beyond the level they had demonstrated 14 years previously. Not only is training effective in the short run, but gains produced through training are maintained over as many as 7 years (Neely & Backman, 1993; Willis & Nesselroade, 1990). However, training effects are fairly limited to tests in which training occurs and do not extend to intelligence tests that are different in kind (e.g., training in fluid intelligence tests does not extend to performance on crystallized intelligence tests, see Baltes & Willis, 1982).

**EVERYDAY INTELLIGENCE.** Everyday intelligence is an ability that has only recently been examined within the field of adult intelligence (see Berg & Klaczynski, 1996, for a review). The examination of everyday intelligence arose as researchers were concerned with using traditional tests of intelligence (e.g., measures of fluid and crystallized intelligence) exclusively to measure the intelligence of adults who were largely outside of academic environments. A variety of definitions and distinctions exist regarding the meaning of everyday intelligence. Some define everyday intelligence as the expression of more basic fluid and crystallized abilities that permit adaptive behavior within a specific class of everyday situations (Willis & Schaie, 1986). Many current definitions involve distinctions between abilities critical for everyday intelligence and abilities that are required to perform well on more traditional measures of intelligence (e.g., measures representative of fluid and crystallized intelligence) (Neisser, 1976; Wagner, 1986). Much of the measurement of everyday intelligence has focused on solving problems that are ill-structured as to their goals and their solution (e.g., may not contain one correct answer) and that are frequently encountered in daily life (e.g., Cornelius & Caspi, 1987; Denney, 1989).

Everyday intelligence has been thought to be particularly important for measuring the intelligence of middle-aged and older adults, both by laypeople (see

earlier discussion of Berg & Sternberg, 1992) and theorists (Baltes et al., 1984; Berg, 1990; Sinnott, 1989). Everyday intelligence is thought to be used in individuals' work environments (Colonia-Willner, 1998; Wagner & Sternberg, 1985), in making routine decisions (Johnson, 1990), in dealing with complex health decisions (Meyer, Russo, & Talbot, 1995), and in solving tasks that are required to maintain independence (Willis & Schaie, 1993) in many daily life situations. Two issues have dominated work on everyday intelligence: (1) the extent to which everyday intelligence is a manifestation of other more traditional intellectual abilities such as fluid and crystallized intelligence, and (2) whether the pattern of age differences in everyday intelligence mirrors that of fluid or crystallized intelligence (see Berg & Klaczynski, 1996 for a review).

Research by Willis and her colleagues provides the best evidence that everyday intelligence is an expression of fluid and crystallized abilities. She approaches everyday intelligence as an adult's ability to perform activities considered essential for living independently (e.g., meal preparation, managing finances, using the telephone). Willis and colleagues utilized a variant of the ETS Basic Skills Test to measure everyday intelligence. This test is a multiple-choice test that contains items requiring individuals to read and abstract information from maps, medication labels, technical documents (e.g., IRS forms) and newspaper text. Such items have a single correct answer, are scored as either correct or incorrect, and are quite similar in their structure and format to traditional comprehension questions on intelligence tests. Willis and Schaie (1986) reported substantial correlations between performance on the Basic Skills Test and a measure of fluid ( $r = .83$ ) and crystallized ( $r = .78$ ) intelligence. Diehl, Willis, and Schaie (1995) reported that measures of fluid intelligence also predicted observational assessments of older adults that were designed to be variants of the paper and pencil measures.

Other researchers who have used more ill-structured measures of everyday intelligence have not found such strong evidence for the hierarchical nature of intellectual abilities whereby everyday intelligence is simply a manifestation of more traditional intellectual abilities. For instance, many researchers utilize measures that involve presenting adults with hypothetical problem scenarios and asking the examinees to generate multiple strategies for problem

solution (Denney & Palmer, 1981; Denney & Pearce, 1989; Denney, Pearce, & Palmer, 1982) or rate the effectiveness of a preset group of strategies (e.g., Blanchard-Fields, Janke, & Camp, 1995; Cornelius & Caspi, 1987). For instance, adults might be presented with a problem involving how to fix one's broken lawnmower or with a decision-making task regarding which insurance plan to purchase. Studies using such measures have found only modest relationships ( $r$ s range between .2 and .4) between measures of fluid and crystallized intelligence and measures of everyday intelligence (Camp, Doherty, Moody-Thomas, & Denney, 1989; Cornelius & Caspi, 1987).

The developmental function of everyday intelligence has been examined to determine if its direction is more similar to the pattern uncovered for crystallized or fluid intelligence. The pattern of age differences in everyday intelligence varies dramatically, depending on the criterion used for optimal everyday problem-solving performance. For instance, Denney and her colleagues (Denney & Palmer, 1981; Denney & Pearce, 1989) used the number of "safe and effective solutions" generated and found that middle-aged adults generated the most number of solutions, whereas young and older adults produced fewer solutions. Berg et al. (1994) found no age differences when utilizing individuals' own ratings of how effective they were in solving their own everyday problems. Cornelius and Caspi (1987) found that everyday problem solving increased with adult age when the criterion of how closely individuals' ratings of strategy effectiveness matched a "prototype" of the optimal everyday problem solver. Studies have also reported age differences in the strategies individuals report for dealing with everyday problems (more problem-focused or emotion-focused strategies), although inconsistencies exist in the pattern of results (see Berg et al., 1998, for a discussion), and disagreements occur as to whether a particular strategy type reflects more effective everyday problem solving (contrast Berg et al., 1998 with Heckhausen & Schulz, 1995); therefore, conclusions regarding the developmental function of strategy selection in everyday problem solving are equivocal.

Several studies examining everyday problem solving within a neo-Piagetian or postformal operational perspective (extending and reformulating Piaget's theory to the study of adult development) have

also found evidence for growth in late adulthood (Labouvie-Vief, 1992). The formal operational reasoning of late adolescents and young adults, with its focus on logic, is replaced with more sophisticated structures in middle and late adulthood that are characterized by more relativistic reasoning that involves a synthesis of logic, the irrational, emotive, and personal. Blanchard-Fields, for instance, (1986, 1994; Blanchard-Fields & Norris, 1994) found evidence of increases in everyday intelligence in some conditions using measures that tap the extent of integrative attributional reasoning (integrating dispositional and situational components) in social dilemmas.

These inconsistencies in the relation between measures of everyday intelligence and fluid and crystallized intelligence and in the developmental function of everyday intelligence are probably due to multiple types of everyday intelligence being represented by these diverse measures. Marsiske and Willis (1995), which is the only work to date on the structure of everyday problem solving, indicated that different measures of everyday intelligence are indeed measuring distinct constructs, which are not highly related. In addition, the inconsistencies may be due to the fact that everyday problem-solving measures range from those that are quite similar in structure and format to traditional measures of intelligence (e.g., ETS Basic Skills Test) to those that diverge greatly from intelligence test items (e.g., ill-structured hypothetical problems characteristic of daily living). Such diverse measures may not be equally reflective of how individuals adapt to their everyday environments.

**SUMMARY.** This review of the intellectual abilities that individuals use to adapt to their context presents a fairly complex picture of adult intellectual development that emphasizes variability at multiple levels of analysis. First, variability exists in the developmental function of intelligence, depending on the ability in question and the extent to which performance relies on accumulated experience and acculturation. Developmental differences are most prominent when assessed through abilities that require novel application (fluid intelligence) rather than familiar application (crystallized intelligence). Second, variability exists at any age between individuals, and there is some evidence that this variability is most prominent in late adulthood (see Morse,



1993, for a review). Third, variability also exists at the intraindividual level, for intervention studies have shown great modifiability of individual abilities at any age. Work on everyday intelligence reveals that this ability may show less decline across age than is present for fluid intelligence. The relation, however, between everyday intelligence and measures of fluid and crystallized intelligence depends on the specific criterion used to assess everyday intelligence.

### Mental Processes

Researchers who have examined the mental abilities individuals use to adapt to their life contexts have focused on end products such as one's performance on an intelligence test. Those who have focused on mental processes, however, address the question of how those mental products are produced through mental processes.

The mental processes that individuals use to adapt to their contexts and how those mental processes change across development have largely been addressed from the information-processing perspective. The information-processing perspective focuses on the processes (e.g., representations, strategies, executive processes, availability of resources) by which an individual performs an intellectual task (Salthouse, 1992b). The focus is on how individuals mentally solve an intellectual task through basic-level processes of encoding, retrieving, and comparing information, as well as higher order executive processes used to plan how to solve a problem and monitor one's solution strategy. A key developmental question within this perspective has been whether the age differences in mental abilities discussed previously can be isolated to particular processing components or whether they are due to a limited number of mental resources that impact many mental processes.

**LOCALIZATION OF AGE-DIFFERENCES IN PROCESSING COMPONENTS.** The emphasis of much of the work examining age differences in mental processes has been on localizing the specific processes responsible for the age differences seen in measures of fluid intelligence and understanding why those processes are intact with respect to crystallized performance. Because many models of mental processes are represented by flowcharts that map the order of the processes, Salthouse (1992b) refers to these efforts as identifying "which box is broken?" (p. 267).

These localization efforts begin by mapping out and measuring the cognitive processes that individuals go through when performing a specific task. In general, researchers have assumed that the processes and strategies characterizing young adults' performance will also characterize older adults' performance, although such an assumption may not always be valid (see Adams, Labouvie-Vief, Hobart, & Dorosz, 1990; Berg, Klaczynski, Calderone, & Strough, 1994).

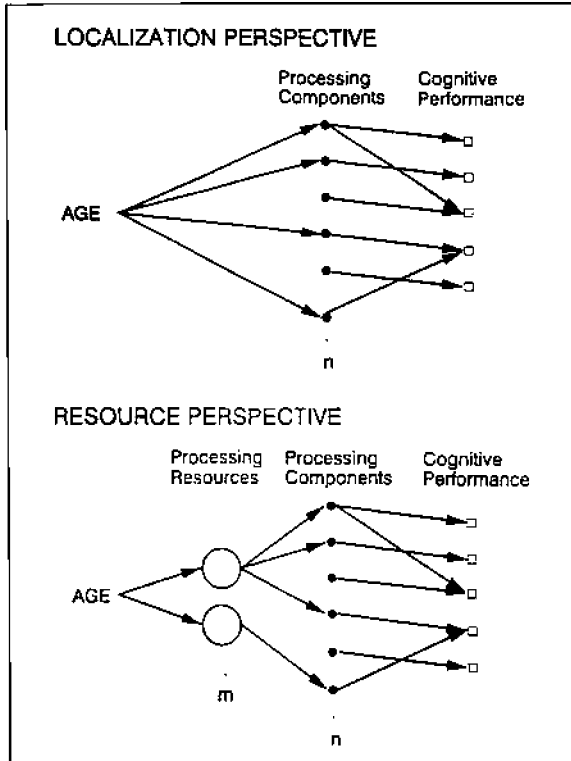
In mapping age differences in processes, no age differences have been found in individuals' metacognitive abilities. The term metacognitive abilities refers to individuals' knowledge about memory or cognition (e.g., relative difficulty of remembering different types of information) and individuals' ability to monitor their own cognitive processes (allocating time to study material not yet mastered, accurate judgements concerning cognitive performance). No age differences have been found in either type of metacognitive abilities (Cavanaugh, 1996; Hultsch & Dixon, 1990). Thus, older individuals are aware of their own cognitive functioning and are able to monitor its functioning as well as young adults.

However, age differences have been found in many other processing components to such an extent that some have concluded it may not be fruitful to isolate which of the "boxes" or components is broken or deficient. For example, research examining age differences in spatial visualization (see space subtest of PMA, Figure 6.1), a measure of fluid intelligence, typically shows age-related declines beginning in the 30s (see Figure 6.2). Numerous attempts were made by investigators to localize which process is responsible for these age differences. This work drew on models of mental rotations ability developed by Shephard and Metzler (1971) that specify processes involved in the successful completion of mental rotations items. These processes include a serial order of processing stages beginning with encoding the stimuli followed by an analog mental rotation of the stimuli into congruence, comparisons of the representations, and finally a motor response. Numerous studies (Berg, Hertzog, & Hunt, 1982; Cerella, Poon, & Fozard, 1981; Gaylord & Marsh, 1975; Hertzog, Vernon, & Rypma, 1993) reported that older adults were slower in each of the mental processes (e.g., encoding, rotating, comparing, deciding) than young adults. Thus, age differences could not be localized to any one particular process.

The results from work with the spatial visualization test is consonant with a large body of research that tries to localize age differences in a wide variety of abilities such as reasoning and memory (Salthouse, 1991). These failures to isolate the small number of processing components responsible for age-related differences in fluid intelligence performance led many theorists to speculate that a smaller number of processing resources are responsible for the large number of differences seen in processing components (see Figure 6.3). Thus, the processing resources view has been gaining support as a more parsimonious explanation of intellectual development than the localization approach.

**PROCESSING RESOURCES.** Two processing resources have been most frequently postulated and investigated as responsible for age-related differences in processing components: speed of processing and working memory capacity (Salthouse,

FIGURE 6.3. Schematic illustration of the difference between the localization approach and the reduced resources approach to cognitive aging (taken from Salthouse, 1991).



1991). Interestingly, these processing resources have also been theorized to be responsible for age-related changes in processing components during childhood and adolescence (Case et al., 1996; Kail, 1991; Salthouse & Kail, 1983).

1. *Speed of processing.* The idea that speed of processing may be a resource responsible for age-related differences in processing components comes from research showing that older adults' performance across a wide variety of tasks slows at similar rates (Birren, 1974). Several meta-analyses of young and older adults' performance suggest that older adults' performance on a wide variety of tasks with diverse procedures slows at a fairly constant function of young adults' performance (Cerella, 1990; Hale, Myerson, Smith, & Poon, 1988). Several large-scale studies have been conducted to examine the role of speed of processing in age differences in measures of fluid intelligence (Hertzog, 1989; Salthouse, Kausler, & Saults, 1988).

For instance, Salthouse et al. (1988) examined speed of processing (measured by the time needed to make relatively simple comparisons) and its influence on measures of fluid intelligence (e.g., series completion, geometric analogies, and spatial reasoning tasks). Depending on the specific measure used to indicate processing speed, between 13 and 32% of the age differences in measures of cognitive performance were associated with age differences in speed. Much higher estimates of the age-related variance in cognitive performance that is attributable to processing speed come from a study by Hertzog (1989). He found that controlling for measures of speed of processing (operationalized as perceptual speed, tasks such as number comparison, and finding As in a string of letters) in the performance of other cognitive tasks reduced the age-related variance in cognitive performance by an average of 92%. The results from a large number of studies (see Salthouse, 1992a, for a review) now provide moderate support for speed of processing as a resource responsible for some of the age-related differences in cognitive tasks.

2. *Working memory capacity.* Working memory capacity is a processing resource that has often been postulated as responsible for the age differences found in processing components. Working memory capacity refers to the amount of information that can

be stored and processed in a sort of mental scratch pad used when performing nearly every cognitive task. Age differences in working memory capacity have been implicated in age differences in nearly every type of mental ability: language and comprehension (Cohen, 1988; McDowd, Oseas-Kreger, & Filion, 1995; Hasher & Zacks, 1988) and spatial relations and abstract reasoning (Salthouse, Mitchell, Skovronek, & Babcock, 1989).

Numerous studies have explored whether age differences in working memory are associated with age differences in cognitive performance (e.g., Salthouse, 1992a; Salthouse, Mitchell, Skovronek, & Babcock, 1989). Salthouse (1992a) had subjects from 18 to 83 years of age perform the computation span and a variety of fluid intelligence tasks such as the Raven's Advanced Progressive Matrices, the Shipley Abstraction Test, paper folding, integrative reasoning, geometric analogies, and cube assembly. In the computation span task, participants were presented with a series of simple arithmetic problems in which they are asked to indicate the correct answer and to remember the final digit in each of the problems and respond accordingly at the end. The results from these studies indicate that working memory is associated with about 50% of the age-related variance in measures of cognitive functioning. Thus, working memory can be viewed as an important mediator of the age-related differences in many measures of cognitive function (Salthouse, 1991, 1992a, for reviews).

### Summary

The review of the mental processes that adults use to perform intelligence tasks indicates that age differences exist in several mental processes. Current thinking within the field indicates that the age differences found in many mental processes may be due to age differences in two processing resources: speed of response and working memory capacity. A substantial body of evidence is now accumulating that indicates that these two processing resources may be responsible for a substantial portion of the age-related variance in mental abilities or products.

### CONTEXT OF ADULT INTELLECTUAL DEVELOPMENT

The preceding review has focused on characteristics within the individual (abilities and processes) that

researchers believe are utilized as individuals adapt to their contexts across development. Although intelligence is viewed in this chapter as the mental abilities and processes whereby individuals adapt to multiple contexts, the literature thus far has not examined the process of adaptation. Rather, the literature has focused on the fact that abilities and mental components may be differently expressed in multiple contexts. Although the research reviewed portrays a view of the context as setting up specific constraints and opportunities to which the individual passively adapts, the view taken in the chapter is not as unidirectional or passive as it may seem. That is, individuals do not passively apply their abilities and processes to static contexts that contain different opportunities and constraints. Rather the adaptation process is a dynamic one in which the individual's abilities and processes as well as the context are simultaneously shaped and altered.

The theoretical perspective that has most often been used to understand the context of adult intelligence is the contextualist perspective (Berg & Calderone, 1994; Berg & Sternberg, 1985; Dixon, 1992). Such a perspective defines intellectual development as reflecting the specific contexts – sociocultural, biological, and historical – in which development occurs (Laboratory of Comparative Human Cognition, 1982; Rogoff, 1982; Vygotsky, 1978). From this perspective intellectual development is examined as occurring within different contexts. That is, intellectual development is posited to be disparate across groups of individuals who are situated in different contexts. To the extent that contextual demands and opportunities are different across the adult life span, different measurements of intelligence may be needed.

Although extensive studies detailing the context of adult intelligence at different times during development have not been conducted, much speculation has occurred as to how the landscape and context of adults across the life span vary in a way that influences intellectual development. The context of older adults differs from that of young adults in many ways. The proximity of older adults to formal schooling environments is much less than that of young adults who recently completed high school or are currently enrolled in college. Many fewer older adults are in daily contact with the work context, due to retirement, as compared with young

adults. Older adults differ from young adults in the complexity versus passivity of their daily life activities, which may be important for sustaining intellectual functioning (Scheidt & Schaie, 1978). Older adults may also differ from young adults in the frequency of social interaction (Antonucci & Akiyama, 1987), which may affect opportunities for collaborative problem solving.

For instance, as individuals move from young adulthood to late adulthood, there is a move away from contact with formal schooling environments. Differences in the number of years of education and the type of educational experiences that these years represent have been examined as an important factor in understanding cohort effects (Schaie, 1996a). In addition, Rogoff's (1982) treatment of the influence of formal schooling on cognitive performance suggests that intellectual performance may be influenced because most adults are not in formal schooling environments. The memorization, categorization, and speed of response required in most Western schools have been found to influence many aspects of cognitive performance, including spontaneous use of strategies to remember information, abstract reasoning, and the ability to draw formal logical conclusions (Laboratory of Comparative Cognition, 1982; Rogoff, 1982). In fact, comparisons of young and older adults who are both in formal schooling environments often show reduced or no age differences in intellectual performance (Jacewicz & Hartley, 1979; Parks, Mitchell, & Perlmutter, 1986), although interpretations of these data are complex.

Research on the context of adult intellectual development is in its relative infancy compared with work on the individual abilities and processes that reside within the individual. Research will next be reviewed illustrating two issues that have been prominent thus far in this work: (1) how intellectual development varies across different contexts and (2) how the social context may facilitate intellectual performance.

### **Variability in Intellectual Development across Different Contexts**

Research that examines how individuals adapt their mental abilities and processes to fit the specific contextual constraints and opportunities of the context and correspondingly shape their con-

texts to provide a better fit with their mental needs has largely been conducted for adults by focusing on only one specific age group (e.g., Lave, 1989; Scribner, 1986). For instance, Scribner (1986) found that adult dairy workers adapted their arithmetic strategies depending on the specific constraints of the size of boxes and number of bottles involved in the delivery order. Much less work has been done, however, comparing adults across the life span in the ways in which abilities and processes are adapted to fit contextual conditions. The research reviewed typically compares individuals of different ages who occupy disparate contexts to understand how contextual demands may reflect different intellectual abilities and processes rather than focusing on the same individuals and how they respond to different contexts.

**COMPLEXITY OF WORK ENVIRONMENTS.** One environmental variable that has been examined as being influential for shaping the development of adult intelligence is the complexity and stimulation of one's work environment. Kohn and Schooler (1983) examined the relation between the extent to which one's work-related activities involve independent thought and judgment (which they call *substantive complexity*) and *ideational flexibility* (a combined measure of fluid intelligence tests and responses to questions representing flexibility in dealing with complex intellectual activities). Results from their longitudinal study of men between the ages of 24 to 64 years of age indicate that the more substantive the complexity of one's job, the greater the incremental gains in intellectual performance over a 10-year period. The same relations between job complexity and intelligence hold for women doing complex housework (Schooler, 1984). Furthermore, Miller and Kohn (1983) found that individuals with greater ideational flexibility were involved in more intellectually engaging leisure activities (e.g., reading books versus watching television). Although these studies suggest that a complex work environment assists in maintaining intellectual functioning, these studies are unable to rule out the possibility that individuals who maintain their intellectual functioning are more apt to pursue and stay in challenging work environments. However, these results are consistent with those of researchers (Gribbin, Schaie, & Parham, 1980; Hulstch, Hammer, & Small,

1993) who found that engaging in more complex and stimulating daily life activities is related to modest facilitation of intellectual performance.

**DOMAIN OF EVERYDAY PROBLEM SOLVING.** A growing literature now exists that demonstrates that everyday intelligence is different when examined within different domains of functioning (Berg et al., 1998; Blanchard-Fields, Chen, & Norris, 1997; Cornelius & Caspi, 1987). The domain of everyday intelligence is used to refer to the context in which problems occur (e.g., school, work, home) and the types of demands present in problem contexts (e.g., interpersonal versus achievement). Sansone and Berg (1993) reported that the context of everyday intelligence differs across the life span such that domains of work and family are particularly salient during middle adulthood and domains such as family and health are more salient in late adulthood. Contextual differences are thought to be important in understanding developmental differences in everyday problem solving because developmental differences may reflect the reality that individuals occupy different contexts and thereby experience disparate problems across the life span. Berg et al. (1998) and Blanchard-Fields et al. (1997) found that the strategies adults used to deal with everyday problem-solving situations and the attributions they made for the behavior of individuals within the problem varied depending on the context in which everyday problems were couched. For instance, individuals reported utilizing strategies that were more interpersonally focused for more interpersonally relevant domains such as family and friends and strategies that were focused more on behavioral action for more achievement-oriented domains (Berg et al., 1998). Berg et al. (1998) reported that these context effects may have been observed because different contexts elicit different representations of problem situations and goal orientations, which subsequently influence strategy selection.

**FAMILIARITY OR EXPERIENCE WITH THE DOMAIN.** Individual differences in the familiarity of young and older adults with the materials and context of intellectual assessment have also been examined. Familiarity and experience with the contexts of intellectual assessment are important because in-

dividuals may express their abilities and mental processes differently when they are familiar with the constraints and opportunities of the context versus when they are unfamiliar with these features. Cornelius (1984) reported that older adults perceived traditional intelligence tests as less familiar than did young adults. Thus, comparisons of young and older adults on intelligence tests may place older adults at a relative disadvantage because they may be less familiar with how to apply their mental processes and products in specific intellectual assessment contexts.

Results have clearly shown that intellectual performance is superior for both young and older adults when assessed in contexts that are familiar to individuals – either when individuals are given materials with which they are familiar (Smith & Baltes, 1990) or when individuals are given extensive practice with the intellectual task (Berg et al., 1982). The research has been equivocal, however, as to whether differential familiarity is a factor that can help to explain age differences in intellectual performance.

Several studies now have examined the problem-solving performance of young and older adults with problems that were constructed to be more familiar or more normative for one age group or the other. Smith and Baltes (1990) found that adults performed best on measures of wisdom when the problems were more normative for the examinee's age group. Denney and colleagues also found that adults performed best when presented everyday problems more normative for their age group (Denney et al., 1982). However, Denney and Pearce (1989) found that familiar materials were not able to eliminate age differences in that older adults performed less well than young adults even when older adults were performing with materials that had been explicitly designed by older adults to be those with which they would perform better than young adults. Research examining how memory performance is facilitated by familiar materials is consistent (Barrett & Watkins, 1986; Worden & Sherman-Brown, 1983) in showing that older adults tend to perform better with materials with which they are more familiar (e.g., remembering words that were in frequent use during their adulthood years versus contemporary equivalents).

Another strategy for examining the role of familiarity with the abilities and operations under

examination has been to assess intellectual functioning in areas of relative expertise versus less expertise (see Bosman & Charness, 1996; Salthouse, & Mitchell 1990). This research has focused on how extensive amounts of practice, as would characterize individuals who practice some ability or process daily in their jobs (e.g., typists and reaction time) may alter the typical declines seen in measures of intellectual performance. Domain-relevant performance in which individuals have had extensive experience (e.g., chess and bridge experts, architects and their spatial ability, typists) tends to show a developmental trajectory of maintenance, whereas what appears to be the same process or ability assessed in a less familiar or contextualized fashion may demonstrate a trajectory of decline (Charness, 1981; Salthouse, 1984). For instance, Salthouse (1984) reported that typists varying in age showed the typical declines in speed of performance when assessed via a reaction-time task but did not show any age-related declines in speed of processing when typing. The maintenance of speed of processing with familiar materials appeared to be due to older adults' adopting a different strategy for typing than young adults. Thus, older adults may have compensated for some declines in intellectual functioning by adapting their cognitive strategies to fit optimally with the typing task. Research that examines familiarity with materials by giving individuals extensive practice with some task, however, does not often fully eliminate age differences and sometimes shows an exacerbation of age differences (see Berg et al., 1982; Denney, 1979). Thus, extensive practice may be required before individuals are able to fit their abilities and processes optimally to the constraints of the intellectual context.

### **Social Context of Adult Intellectual Development**

Recently, several investigators have examined the social context of adult intellectual development (see Baltes & Staudinger, 1996b, for a review). This work emphasized how the process of adapting to one's environment may involve other individuals as collaborators, support providers, and sources of information (see also Berg, Meegan, & Deviney, 1998; Berg et al., 1998). Schaie's (1996b) analyses of adult married couples suggests that one's spouse may serve as an important collaborator. His work indicates that

individuals' intellectual performance benefits from having a spouse who is performing better than oneself intellectually.

Work within the social context of intelligence questions the typical view of intelligence as residing within an individual's mind and instead begins to talk about constructs such as interactive minds (Baltes & Staudinger, 1996a) and the sociocultural mind (Rogoff, 1990) to illustrate the transactive nature of minds. Baltes and Staudinger (1996a) characterized interactive minds as implying

that the acquisition and manifestation of individual cognitions influence and are influenced by cognitions of others and that these reciprocal influences between minds contribute to the activation and modification of already available cognitions as well as to the generation (development) of new ones (p. 7)

Several studies now point to the important role that others play in the process whereby individuals use their mental processes and abilities to adapt to their context. Staudinger and Baltes (1996; Staudinger, 1996) have examined the social context of wisdom. Wisdom is operationalized as expertise in knowledge of the fundamental pragmatics of life. Their measure of wisdom taps the pragmatics of intelligence and involves problems that describe a difficult life-planning scenario (e.g., a middle-aged woman who desires to pursue career and educational opportunities for herself at a time when her adult son needs assistance with rearing his young children). Individuals are asked to solve this problem, and their responses are coded for the amount of procedural and factual knowledge individuals mention, an understanding of the contextual complexities present in the solution, a person's management of uncertainty, and so forth. Staudinger and Baltes examined the ability of individuals to solve life-planning problems under several conditions that varied the extent of social interaction. Anchoring the individual end of assessment was the typical form of assessment in which an individual was asked to perform the task alone. A condition designed to elicit a moderate amount of social facilitation was a condition in which individuals were asked to think about the task when informed by what another person, whose advice he or she typically seeks, would encourage them to consider. The greatest facilitation was expected when an individual was

allowed to discuss the task with another person and then respond individually. The results indicated that the best performance occurred when individuals worked in dyads and when working with the implied other (these conditions were not different from each other). Working individually (the typical form of assessment) was particularly ineffective compared with these other conditions. Thus, individuals' performance can benefit from face-to-face interaction with others as well as implied interaction.

Research by Dixon and colleagues further suggests the process whereby social facilitation may occur. For instance, Dixon and Gould (1996) examined the text recall of young and older married couples. Dixon and Gould (1996) and Gould, Kurzman, and Dixon (1994) found that older married couples performed as well as younger married couples on measures of amount of information recalled (in direct opposition to a large body of research, see Hultsch & Dixon, 1990). When the interaction patterns between husbands and wives were examined, older couples appeared to engage in more strategy discussion at a point when text recall was declining to a greater extent than did young adults. Dixon and Gould (1996) interpreted such results to mean that older adults may be compensating for their declines in individual recall through strategies that may elicit more text recall. Older married adults may be more able to engage in such strategies than young couples because of their extensive relational history (Berg et al., 1998).

The research on the social facilitation of intellectual performance has implications for older adults' collaborative problem solving in numerous tasks of everyday intelligence (e.g., calculating taxes, decisions regarding retirement planning, difficult medical decisions). Furthermore, this work is suggestive of a different type of intellectual assessment. For instance, Vygotsky's (1978) work suggests that the difference between individual performance and what an individual accomplishes with the assistance of others could be used as a measure of intellectual competence rather than individual performance alone. This zone is thought to reflect latent potential or soon-to-be developing competence. Although Brown and Ferrara (1985) suggested that such a form of intellectual assessment may be useful across the life span, this form of assessment has not yet been adopted in the field.

### Summary

The research reviewed illustrates the powerful role of the context in affecting the expression of intellectual abilities and processes and in potentially altering the course of intellectual development. Although the research in this area is still growing, the research suggests that intellectual development varies according to the complexity of one's daily life context and that the familiarity, content, and social nature of one's context influence the expression of many abilities and processes.

### CONCLUSIONS AND FUTURE RESEARCH DIRECTIONS

This chapter has painted a complex and rich view of the potential changes that occur across adult development in intelligence. The three perspectives (psychometric, information-processing, and contextual) utilized to review work oriented toward the view of intelligence as comprising abilities and processes situated in context each add an important, if not essential, dimension of intellectual functioning. The psychometric perspective begins by surveying the landscape of intelligence with a focus on intellectual products throughout the life course. From this perspective we see the variability that exists across different intellectual abilities, within an ability across persons, and within a specific individual across intervention. The information-processing perspective endeavors to understand the processes by which intellectual products are formed by examining the processes, representations, and strategies individuals use to perform specific intellectual tasks. Age differences in processes may well be due to more general processing resources (e.g., speed of processing and working memory capacity) that underlie many intellectual performances. The contextual perspective takes the intellectual products and processes investigated by the first two perspectives and places these in a larger sociocultural context. The complexity, familiarity, domain, and social nature of the context have influences on the form and content, as well as the quality, of the intellectual products and processes.

This chapter illustrates how research within the field of adult intellectual development has largely focused separately on the abilities and processes

that reside within the mind of the individual or on the differential expression of abilities and processes within different contexts, within rather different theoretical perspectives. However, as should be clear from the review, any measurement of intellectual performance draws on abilities and processes and is assessed within a context that has particular constraints and opportunities. Thus, we could reframe any of the research reviewed on any particular aspect of intelligence (e.g., abilities) and recast it as involving the other aspects of intelligence. For instance, research that examines age-related differences in measures of fluid intelligence has typically been framed as demonstrating age-related decline in basic-level abilities for which prior education and acculturation are of relatively little advantage. However, within the view of intelligence taken within this chapter, these age differences may be understood as showing age-related differences in processing resources expressed within an environment (the typical testing situation) that is less familiar to older adults than to young adults and that contains certain demands (e.g., highly speeded responses in an environment that is asocial). Too often work that is focused on a specific component of intelligence (e.g., context) neglects how other aspects of intelligent functioning may be involved (abilities or processes). A more complete, albeit complex, view of intelligence would emerge if research were oriented toward understanding all three of these aspects of intelligent performance (i.e., abilities, processes, and contexts) across adult development.

The view of intelligence advanced in this chapter as *the mental abilities and processes that an individual uses to fit optimally with his or her context* suggests, however, another avenue for research that focuses specifically on the process of adaptation. Because the contexts to which adaptation is directed differ across adult development, individuals must adapt their own mental abilities and processes to fit with the changing context and correspondingly to change the context to fit one's own mental abilities and processes better. However, as is illustrated herein, individuals' abilities and processes as well as their context are dynamically changing across adult development.

Research is needed that specifically addresses how individuals adapt to these changing abilities, processes, and contexts. For instance, research could ex-

amine how adults' mental abilities and processes are adapted in the face of contextual changes such as changing jobs, retirement, or loss of spouse (as potential collaborative partner) and correspondingly how individuals change their contexts to adapt to these demands (e.g., change job requirements to fit better with one's own needs, use friends as collaborators after the loss of a spouse). Furthermore, research must explore how individuals' awareness of changes in their own abilities and processes (e.g., speed of response, fluid intelligence) may foster cognitive adaptations such as compensations (e.g., Backman & Dixon, 1992) or contextual adaptations such as the use of memory aids or switching contexts (Dixon, 1992). Such research might explore how these adaptations take place during naturally occurring transitions and changes in contexts and abilities and processes as well as more experimentally controlled changes.

Multiple models of life-course change can be useful in guiding these research efforts. For instance, P. B. Baltes and M. Baltes' (1984) model of selective optimization with compensation addresses how individuals may consciously select out of contexts perceived to be inconsistent with current cognitive needs and into others that optimize fit. Backman and Dixon (1992) used the notion of compensation to understand how individuals may alter cognitive abilities and processes when a mismatch is perceived to occur between the individual and environmental demands. Brandtstädter and Greve's (1994) model of the self explores how individuals may change their intellectual goals to provide a more optimal fit between changing abilities, processes, and contexts. These models place the individual in an important role as regulator of his or her own life-span intellectual development. The self-regulatory process suggested by these models is in need of explicit empirical examination.

As research begins to examine this process whereby mental processes and abilities are adapted to provide an optimal fit to specific contexts, research will need to examine how factors that have not traditionally been examined as relevant for intelligence (e.g., personality, attitudes, stress, and coping strategies) may influence this adaptation process. Numerous personality correlates over the years have been identified with intellectual functioning. Modest relationships have been found between intellectual



functioning and perceptions of efficacy (Lachman & Leff, 1989), attitudes toward aging (Levy, 1996), and personality styles of rigidity and flexibility (Schaie, 1996b). Such personality characteristics have recently been incorporated into ideas about adult intelligence (Ackerman, 1996; Sternberg & Ruzgis, 1994). The integration of social, emotional, and cognitive factors in understanding intellectual development in adulthood has been underscored in neo-Piagetian models of intellectual development (Labouvie-Vief, 1992).

To conclude, the answer to the question of what happens to intelligence across adulthood is a complex one, which includes many qualifiers. The form of intellectual development depends on what one means by intelligence (i.e., what abilities are under consideration, the processes that are required by the intellectual performance) and on aspects of the context in which the performance occurs. Furthermore, the factors that influence intellectual development may differ for individuals whose contexts present different intellectual demands. Thus, both White and Channing (quoted at the beginning of the chapter) are correct in their characterization of adult intellectual development. It includes both the decline in quickness and memory and the growth of synthetic understanding of self and others that White and Channing described. The challenge for the future of the field of adult intelligence is how to incorporate these views of losses and gains into a vision of adult intelligence as optimally transacting the contexts of life. This future must include an understanding of how individuals incorporate and manage these gains and losses in the regulation of their own intellectual development.

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