12 Interrelations of Aging, Knowledge, and Cognitive Performance

Timothy A. Salthouse

University of Virginia, Charlottesville, VA, U.S.A.

Abstract

This chapter reviews the research literature concerned with the relation between age and knowledge and with the role of knowledge on the relations between age and cognitive performance. Although it is generally assumed that accumulation of experience with age leads to greater quantity or quality of knowledge, the empirical evidence from large-scale studies with representative samples of research participants suggests that while there appears to be an increase in knowledge from age 18 to about age 40 or 50, the dominant trend in later years of adulthood is one of either stability or decline. Among the hypotheses discussed to account for the lack of continuous growth in knowledge are generational confounds in education, losses offsetting gains, an asymptote on exposure to new information, and increased specialization of one's knowledge. Each hypothesis has some plausibility, but it is concluded that the reasons for the failure to find continuous age-related increases in knowledge are still not well understood. Several conceptual models of the role of knowledge on the relations between age and cognition are discussed, including moderation, mediation, and migration. Because interactions of age and knowledge have been inconsistent, and because statistical control of knowledge tends to increase rather than decrease the negative relations between age and measures of cognitive performance, the available empirical evidence seems to favor the migration interpretation. That is, age-related effects on cognition appear to be reduced among people with high levels of knowledge because people tend to "migrate" into higher knowledge groups with increasing age.

The realization that different cognitive variables have different age trends dates back to the earliest empirical studies on aging. For example, several studies published in the 1920s found larger age-related differences for measures of memory and reasoning than for measures of vocabulary and general information (e.g., Foster & Taylor, 1920; Hollingworth, 1927; Willoughby, 1927). Many labels have been used to characterize

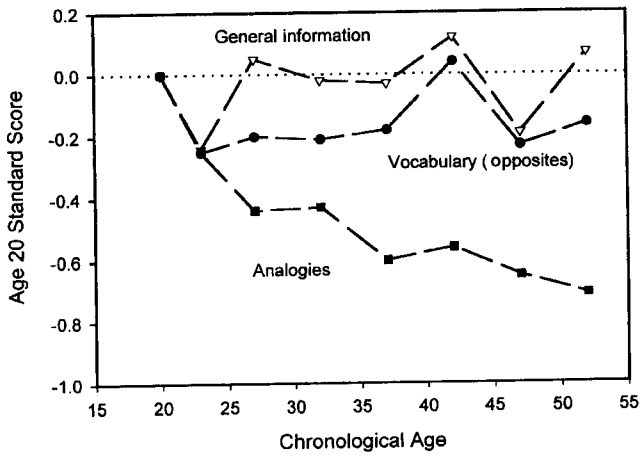


Figure 12.1 Age Relations on Three Different Cognitive Variables in a Sample of 678 adults.
Data from the Jones and Conrad (1933) study.

the two types of cognition (such as new learning versus reliance on stored information, educative versus reproductive abilities, fluid versus crystallized abilities, and mechanics versus pragmatics), but the terms *process* and *product* may be the most descriptive because the first term refers to the efficiency of processing at the time of assessment, and the second term refers to the cumulative products of past processing (see also P. Baltes, this volume; Wellman, this volume).

The different age trends can be illustrated with data collected by Jones and Conrad (1933) on three subtests from the Army Alpha test battery (see Figure 12.1). (The vertical axis in most of the figures in this chapter represents performance in standard score or z-score units to facilitate comparison across variables and studies. Sometimes a sample of young adults will be used as the reference distribution as in this figure, and other times the entire sample will be used as the reference distribution. In either case, the units along the vertical axis are standard deviations of the relevant distribution, and thus the scale is informative about the magnitude of the age difference relative to the distribution of scores in the reference sample.)

Notice in Figure 12.1 that across the range from 20 to 55 years of age the measures of general information and vocabulary tend to remain stable but that increased age is associated with lower scores on the analogies measure. This same general pattern has been reported many times, and it is now widely accepted that different types of cognitive measures can have quite different age trends.

There are two major implications of these findings. The first implication is that because the constituent variables exhibit different age relations, no single number will be meaningful as an index of overall cognitive ability across all of adulthood. That is, if cognitive ability is composed of both product and process aspects, then

it is not meaningful to refer to a single age trend in cognitive functioning. Jones and Conrad (1933) expressed this point elegantly by stating that the older adult derives more intellectual power from accumulated stocks of information than do young adults.

The second major implication of the different age trends is that there are at least two quite distinct phenomena to explain in the field of cognitive aging—the age-related decline in process aspects of cognition and either stability or increase with age in product aspects of cognition. The majority of cognitive aging research has focused on process aspects of cognition, in part because of an interest in remediating or preventing age-related cognitive decline. However, in this chapter, I focus on two issues concerned with aging and product or knowledge aspects of cognition. The first issue concerns the relation between age and measures of the quantity of knowledge, which might be expected to be positive because knowledge presumably derives from experience and experience is often assumed to increase continuously with advancing age. The second issue is the role played by knowledge on the relations between age and cognitive performance and particularly the ability of greater knowledge to offset the consequences of age-related decline in process aspects of cognition. This issue is particularly relevant to the P. Baltes and M. Baltes (1990) selective optimization with compensation (SOC) framework because of the possibility that optimizing one's knowledge in select domains might compensate for declines that may be occurring in other aspects of cognitive functioning (see also M. Baltes & Carstensen, this volume; P. Baltes, this volume; cf. Lerner, Dowling, & Roth, this volume).

Conceptualizations of the Role of Knowledge on Age-Cognition Relations

Before reviewing the relevant literature, it is important to clarify alternative possibilities for the role of knowledge on age differences in cognitive performance and ways that they might be distinguished. Because there has been relatively little research focusing on the interrelations of age, knowledge, and cognitive performance, most of the conceptualizations to be described were originally discussed in the context of research on the role of experience on age-cognition relations. Five possibilities, or models, all of which assume that there are positive effects of knowledge on cognitive performance, are represented in Figure 12.2. (The three functions in each figure correspond to different levels knowledge.) The five models and their main characteristics are (A) moderation, interaction between age and knowledge; (B) stability, no age effects; (C) decline, negative age effects; (D) mediation, no age effects but negative relation between age and knowledge; and (E) migration, negative age effects but positive relation between age and knowledge. This classification scheme is not exhaustive because there could be positive age effects, as well as different combinations of relations between age and knowledge with stability or decline. However, the five models portrayed in this figure appear to be the most plausible and theoretically interesting possibilities to account for the role of knowledge on age-cognition relations at the current time.

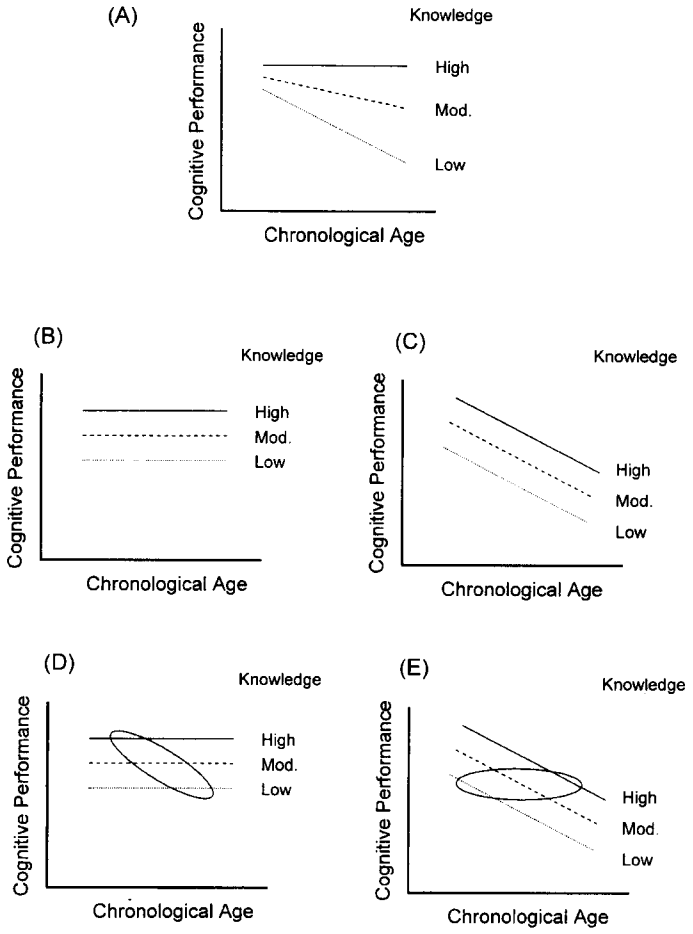


Figure 12.2 Schematic Illustrations of Five Alternative Models of the Joint Effects of Age and Experience or Knowledge on Cognitive Performance.

Panel A represents the *moderation model*. This is the view that knowledge moderates the relations between age and cognitive performance, such that there are large negative age relations among people with little relevant knowledge but small to nonexistent age relations among people with greater amounts of relevant knowledge. Some version of the moderation model is the most frequently mentioned possibility in the research literature concerned with experience, and the search for the predicted age-by-experience (or age-by-knowledge) interaction has been either an explicit or an implicit goal in many studies.

There are some cases, as with certain measures of reading or aspects of language comprehension or production, in which an interaction may occur that is attributable to an absolute or a functional measurement ceiling, in which almost everyone eventually achieves nearly the same high level of proficiency. However, because of the restricted range of assessment, the absence of age differences in these situations may be of only limited interest. That is, if the criterion activity can be mastered by virtually everyone, then there will likely be little or no sensitivity of the performance measures to variables such as age or additional knowledge. As an illustration, consider possible criterion variables reflecting proficiency in aspects of walking or talking. Because these tasks are mastered by most normal people, the range of variability would likely be highly restricted, and consequently it may be unrealistic to expect them to have relations with other variables. The moderation interpretation is more interesting when one can be confident that the interactions are not attributable to measurement artifacts, and yet people with high levels of knowledge still have smaller age-related declines than people with lower levels of knowledge.

Panel B represents positive knowledge effects but no age effects (stability), and Panel C represents positive knowledge effects with negative age effects (decline). In both cases, the age and knowledge effects are additive, and it is assumed that there is no relation between age and amount of knowledge. The same age trends are therefore expected at each level of knowledge.

Panel D represents a *mediation model* in which lack of knowledge is presumed to be responsible for the observed age-related decline. The flat lines signify that there is no relation between age and cognitive performance at any level of knowledge, but the ellipse indicates that increased age is typically associated with lower levels of knowledge within the population. When the emphasis is on experience instead of knowledge, this interpretation is known as the *disuse perspective* because it is frequently postulated that disuse functions as a mediator of age-related decline, as indicated by the admonition to "use it or lose it." The model in Panel D predicts main effects of experience (or knowledge) but no age-by-experience (or age-by-knowledge) interaction and a negative relation between age and experience (or there would be no evidence of disuse). Furthermore, this model implies that if a measure of the amount of experience (or knowledge) is statistically controlled, then the age effects on measures of cognitive performance should be substantially reduced. That is, if there is no disuse (in this case, because of statistical control), then little or no age-related decline would be expected. According to the mediation model, therefore, negative age-cognition relations are attributable to a negative relation between age and amount of relevant experience (or knowledge).

The mediation model differs from the other models under consideration because it asserts that lack of knowledge (or experience) mediates age-related decline observed in certain measures of cognitive performance. However, it should be noted that this interpretation is plausible only if there is a negative relation between age and relevant knowledge (or experience).

Panel (E) represents what can be termed a *migration model.* This model predicts a main effect of knowledge but with no interaction of age and knowledge, implying that the effects of knowledge are similar at all ages (or equivalently, that the age effects are similar across all levels of knowledge). The distinguishing feature of this model is that there is frequently a positive relation between age and knowledge (represented by the ellipse superimposed on the functions for each level of knowledge), as if with advancing age there is a "migration" of many of the individuals from lower to higher levels of knowledge. Because knowledge is positively related to many aspects of cognitive performance, no overall relation may be evident between age and measures of cognitive performance if the benefits of greater knowledge function to counteract the effects of any age-related declines that might have occurred in basic aspects of cognitive functioning. The migration model therefore implies that statistical control of knowledge would result in an increase in negative age differences because the greater knowledge effectively serves to offset any declines in basic processing efficiency that the individuals may be experiencing. In other words, the migration model attributes the absence of strong negative age relations in certain measures of cognitive performance to positive age-knowledge relations. This model may be the closest to what P. Baltes and M. Baltes (1990) refer to as *optimization with compensation* if the migration into higher knowledge levels is viewed as optimization and the greater knowledge is interpreted as compensating for declines in other aspects of cognitive functioning.

The mediation and migration models are similar in that in neither case is an interaction predicted between age and knowledge on cognitive performance, but instead there is either a negative (mediation) or a positive (migration) relation between age and knowledge that serves to alter the age-performance relations. However, the prediction from the migration interpretation is opposite that of the mediation interpretation because the age-knowledge relation is positive rather than negative, and thus control of knowledge should increase, rather than decrease, the magnitude of the negative age differences in measures of cognitive performance. Stated somewhat differently, in mediation the *presence* of a negative age relation is caused by a *lack* of knowledge, whereas in migration the *absence* of a negative age relation is caused by an *abundance* of knowledge.

The moderation and migration models are also similar in that both models predict high levels of cognitive performance among older adults with high levels of relevant knowledge. However, the underlying mechanisms in the two cases are quite different. In the moderation model, knowledge serves as a moderator of the age-cognition relations because the interaction indicates that people with high levels of knowledge exhibit smaller age-related declines in cognitive performance than people with low levels of knowledge. This model therefore implies that the impact of aging on certain aspects of cognitive functioning can be altered as a function of the amount of relevant knowledge. In contrast, the migration model attributes high cognitive functioning in certain samples of older adults to their higher levels of knowledge offsetting the

consequences of declines in basic abilities. Unlike the moderation model, in the migration model knowledge does not have a moderating or interactive role on the age-cognition relations, but rather age and knowledge are "confounded" such that increased age tends to be associated with higher levels of knowledge.

To summarize, the key features of the five perspectives, all of which assume positive effects of knowledge on measures of cognitive performance, are as follows: (A) moderation—interaction of age and knowledge, smaller age relations at high levels of knowledge; (B) stability—no age effects, no age-knowledge relation; (C) decline—negative age effects, no age-knowledge relation; (D) mediation—negative age-experience (age-knowledge) relations, control of experience (knowledge) reduces negative age differences; and (E) migration—positive age-knowledge relations, control of knowledge increases negative age differences.

In all except the moderation model, the effects of age and knowledge on cognitive performance are additive, and therefore to account for the age relations on measures of cognitive performance it is only necessary to explain the main effects of age and knowledge and any relation that might exist between age and knowledge. However, if the evidence were to support the moderation model, it would also be necessary to explain why the age-related effects differ as a function of amount of knowledge.

Age-Knowledge Relations

Before examining the research results concerning age and knowledge, it is useful to briefly describe how knowledge has been assessed in studies of aging and cognition. The most common method is by various tests of word knowledge, or vocabulary, in which the examinee is required to either produce or select an appropriate definition of a target word such as *pontificate* or *virulent*. When the questions refer to different types of information, the tests are assumed to assess general information. A number of specialized knowledge tests have also been used in which the questions refer to particular domains of knowledge, such as science, social science, or humanities. Examples of questions in these specialized tests are "What is the function of the kidney?" "What is a regressive tax?" and "Who was the composer of the Brandenburg Concertos?"

Many studies investigating age-related effects in cognition have administered some type of vocabulary test in small convenience samples. The typical finding in these studies is that the older adults in the sample tend to have higher vocabulary scores than the young adults. Although it is tempting to infer from these results that knowledge increases continuously with age, this conclusion may not be warranted because the samples in these studies are usually small and may not be representative of the general population because they often include only young college students and highly motivated older adults.

Problems of unrepresentative samples also plague studies involving age comparisons with other measures of knowledge. For example, Stanovich, West, and Harrison

(1995) reported that older adults were higher in measures of general knowledge (based on tests involving the recognition of authors, magazine titles, and so on) than college students. However, 73% of the older adults in their sample had college degrees, and 45% had advanced graduate degrees, and thus the two groups were almost certainly not equally representative of their respective age cohorts.

In a recent report, Ackerman and Rolfhus (1999) compared college students and adults between 30 and 59 years of age on several specially constructed knowledge tests. The adults had higher knowledge scores than the students, but within the adult sample the age correlations for the tests ranged from −.13 to .19 with a median of −.015. Their results thus provide no evidence of greater knowledge with increased age among the nonstudent adults in the sample. A small positive correlation of .19 between age and a composite measure of knowledge based on these same tests was reported in a later study by Ackerman (2000). However, the sample in that study was relatively young (mean age of 34.2 years) and unrepresentative of the population with respect to education (all participants had acquired a bachelor's degree, and 25% had also received advanced degrees).

One project with relatively large samples is Schaie's (1996) Seattle Longitudinal Study. Results from two vocabulary measures administered to new cross-sectional samples in the 1984 and 1991 waves of that project revealed an increase in the average score from the twenties to the forties, then a period of stability, and a decrease around age 70.

The most informative data on age relations are those derived from nationally representative samples, typically stratified on age, gender, ethnic group, educational attainment, and geographical region. The normative samples for standardized tests of cognitive ability possess these characteristics, and therefore they are particularly valuable for determining true age trends in relevant variables.

Figure 12.3 illustrates the age relations for the information and vocabulary subtest scores from the normative samples in the 1955, 1981, and 1997 revisions of the Wechsler battery. Notice that the mean scores increase from age 20 to about age 40 or 50 and decrease beyond age 50. The Kaufman Adolescent and Adult Intelligence Test (Kaufman & Horn, 1996) is another standardized test with norms from a large nationally representative sample. Figure 12.4 portrays the age trends on two measures of vocabulary from that test battery, double meanings and definitions. Once again, there is a slight increase to about age 50 followed by a decline. Finally, the Woodcock-Johnson Psycho-Educational Battery–Revised (1989, 1990) is unique because it includes three tests of specialized knowledge (in the topics of science, social science, and humanities). Figure 12.5 portrays the age trends for the three measures of knowledge in the normative sample for this battery.

The mean scores in all of these data sets exhibit a similar pattern—namely, an increase from the twenties to the forties or fifties, followed by a gradual decline totaling between one-half and one standard deviation from about age 50 to 80. Although not represented in these data, results from studies focusing on adults above the age of 70 indicate that there may be an acceleration in the decline of measures of vocabulary

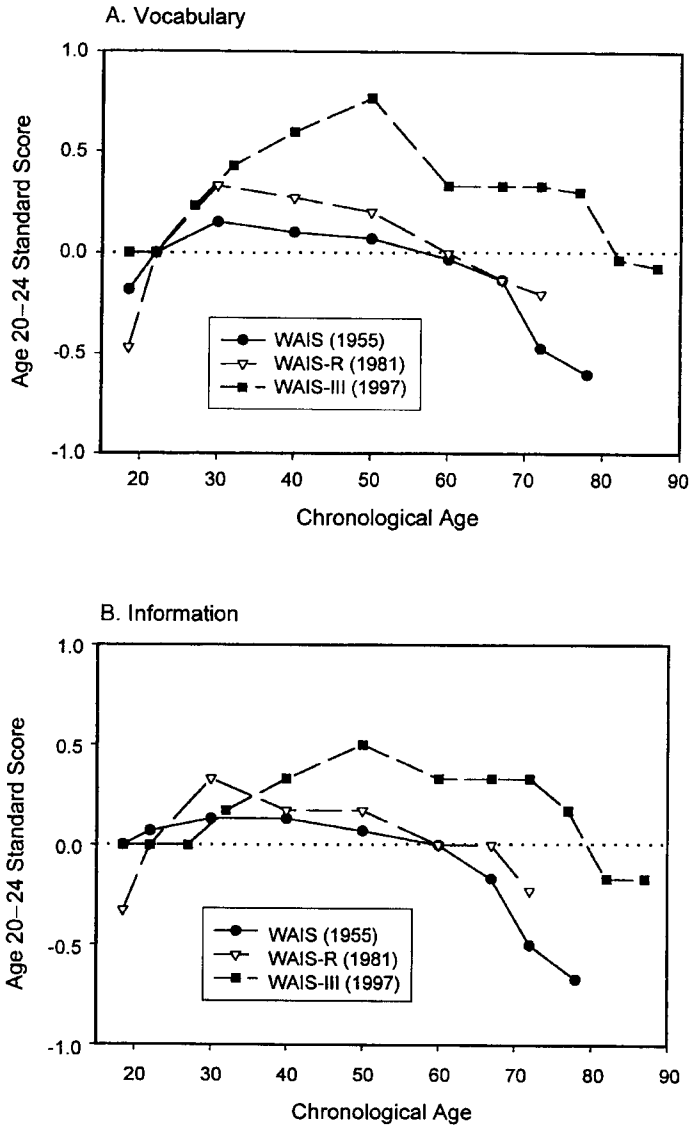


Figure 12.3 Age Relations on the Vocabulary (A) and Information (B) Variables from the Normative Samples in Three Versions of the Wechsler Battery.

Data from Wechsler (1955, 1981, 1997)

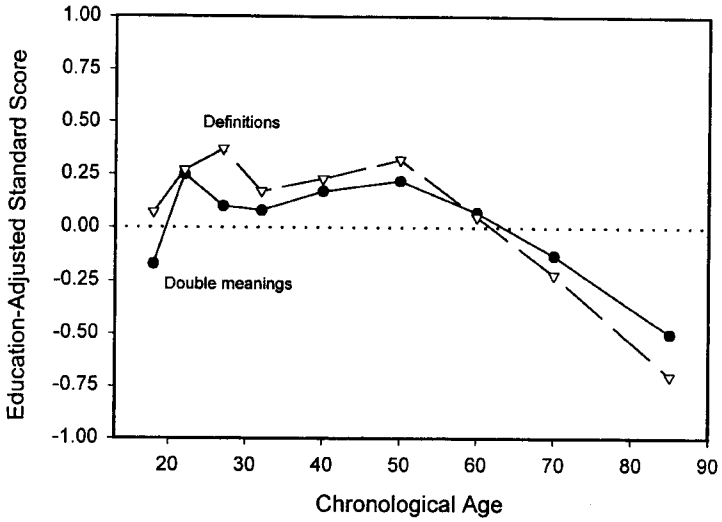


Figure 12.4 Age relations on Variables Assessing Word Knowledge from the Normative Sample (N = 1,500) in the Kaufman Adult Intelligence Test.

Data from Kaufman and Horn (1996).

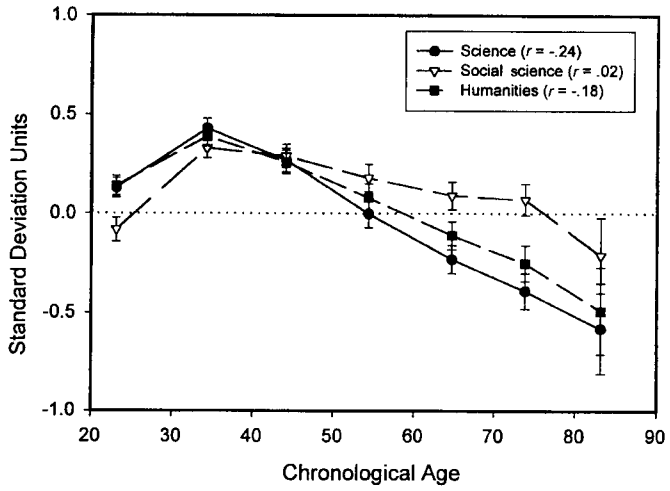
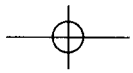


Figure 12.5 Age Relations on Three Tests of Specialized Knowledge for 1,184 Individuals with More Than Nine Years of Education from the Normative Sample in the Woodcock-Johnson Test of Cognitive Abilities.

Bars around each point are standard errors. Data from Salthouse (1998).



and knowledge at older ages (e.g., Hultsch, Hertzog, Dixon, & Small, 1998; Lindenberger & Reischies, 1999).

Assessments of other types of knowledge reveal broadly similar patterns. For example, Demming and Pressey (1957) developed three tests of what they termed *practical knowledge*. The tests, and sample questions in each, were as follows.

- *Yellow pages* Where in the yellow pages of the telephone directory would you look if you wanted to buy an Airedale—under heating equipment, kennels, shoe stores, real estate, dairy equipment?
- *Legal terms* A document controlling disposition of one's property at death is called a bond, title, contract, will, equity.
- *Occupations* The person to baptize a baby is a naturalist, notary public, nurseryman, magistrate, clergyman.

These tests were administered to two nonrepresentative samples—namely, inmates in a penitentiary and students attending evening classes. In both samples, the average scores increased to about age 40, but very few adults in either sample were above the age of 50, and thus there was no information in this study about the trend at older ages. However, a later study by Gardner and Monge (1977) found that the age functions for scores on specially constructed tests of knowledge of transportation, finance, and disease peaked in the fifties and then declined, which is the same pattern found with measures of vocabulary and general information.

Tacit knowledge relevant to management was recently assessed by Colonia-Willner (1998) in a unique sample of 157 midlevel bank managers between 24 and 56 years of age. The measures of tacit knowledge in this study were based on ratings of the desirability of alternative responses to various scenarios, which were scored in terms of how closely an individual's ratings resembled the ratings of "experts." Because the scores were deviations, lower values correspond to better performance (smaller deviations represent ratings that are closer to the expert ratings). All correlations between the tacit knowledge measures and age were positive, with a .28 correlation between age and the overall tacit knowledge score, indicating that increased age was associated with less tacit knowledge (a larger discrepancy from the experts).

A third example of a specialized type of knowledge concerns the concept of wisdom, which is often assumed to be a domain in which older adults have an advantage over young adults. Unfortunately, this assumption has been difficult to evaluate because of a lack of consensus about how wisdom might be assessed. One approach to the assessment of wisdom-related knowledge has involved tests of the comprehension or interpretation of proverbs because they are often considered to reflect fundamental principles of human existence. However, research on proverb interpretation has revealed either a pattern of stability across the adult years (e.g., Sorenson, 1938) or a pattern of age-related declines (e.g., Aftanas & Royce, 1969; Albert, Duffy, & Naeser, 1987; Bromley, 1957; Hamsher & Benton, 1978). Baltes and his colleagues adopted

another approach to the assessment of wisdom by proposing that an individual's level of wisdom could be assessed by his or her responses to selected life dilemmas, scored according to several theoretically determined criteria. This method of assessment has been used in a number of independent studies, and in none of them have there been significant age differences favoring older adults (Baltes, Staudinger, Maercker, & Smith, 1995; Smith & Baltes, 1990; Staudinger, 1999).

To many researchers working in the area of aging and cognition, a discovery of stability across most of the adult years is a welcome finding, particularly when contrasted with the widespread declines found in variables reflecting process aspects of cognition. Nevertheless, the absence of more dramatic and sustained increases in knowledge is puzzling because increased age is presumably associated with greater cumulative exposure and opportunities to acquire information, and thus one might expect knowledge to increase continuously across most, if not all, of the adult years.[1]

Several hypotheses have been proposed to account for the lack of continuous age-related increases in knowledge, but it should be recognized at the outset that they are probably not mutually exclusive and almost certainly are not exhaustive of the possible explanations for this phenomenon.

One interpretation of the failure to find age-related increases in knowledge is that there have been generational shifts in the average amount of education, and amount of education is usually positively correlated with knowledge. It has therefore been argued that age trends in knowledge might be altered if adjustments were made for the age differences in either the quantity or quality of education. There are two issues to consider when evaluating this interpretation—what is actually achieved by control of education, and the empirical consequences on age-knowledge relations of controlling amount of education. With respect to the first issue, there are at least three possibilities for how education might be related to level of knowledge across adulthood. One is that education has a direct influence on amount of knowledge by the increased opportunities to acquire knowledge during the period of formal schooling. A second possibility is that education has an indirect effect on level of knowledge by stimulating knowledge-seeking activities at later periods in one's life. Finally, it is also possible that amount of education is a proxy for general intellectual ability in that greater amounts of intellectual ability are presumably needed to gain access to higher levels of education. To the extent that this latter possibility is valid, then the results of controlling for amount of education may not be readily interpretable because education may actually be a surrogate measure of the efficiency with which knowledge can be acquired. At the current time, there is little relevant evidence that would allow these possibilities to be unequivocally distinguished, and it is likely that several of them are operating simultaneously.

Fortunately, at least some empirical results suggest that difficulties of interpretation may not be serious because control of education often has little effect on the relations between age and knowledge. For example, this is true in the nationally representative sample used in the norms for the Woodcock-Johnson Psycho-Educational Battery, even though the correlations between amount of education and the measures of knowledge

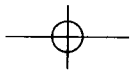
were in the .4 to .5 range. That is, the education-partialed correlations between age and knowledge were nearly identical to the unpartialed correlations (science, partial, $r = -.26$, original $r = -.24$; social science, partial $r = .02$, original $r = .03$; and humanities, partial $r = -.18$, original $r = -.19$).

A second interpretation of the lack of consistent age-related increases in knowledge is that losses offset gains, in the sense that the acquisition of new information may be accompanied by the forgetting of old information. The combination of the two opposing processes could lead to stability in measures of overall knowledge if the effects of the two processes are close to equilibrium. Unfortunately, this interpretation is difficult to investigate without detailed assessments over time of the same types of information in the same individuals.

A third interpretation is that after a certain point, increased age may be associated with progressively more restricted exposure to new and different experiences. This view suggests that there may be something analogous to an asymptote, perhaps around the period of middle adulthood, on opportunities to acquire new information. That is, some time after formal schooling is completed, there may be a decrease in the diversity of one's experiences, and consequently exposure to new types of information may become progressively more limited. This interpretation therefore implies that the reason for the lack of continuous increases in knowledge with advancing age is not because of any factors operating within the individual but rather because of a gradual constriction in the range of novel experiences as people grow older. It should be possible to investigate this interpretation by attempting to relate measures of the diversity or novelty of information exposure to measures of available knowledge, but research of this type has apparently not yet been conducted. Perhaps the closest research is the Kohn and Schooler project (e.g., Kohn & Schooler, 1983; Schooler, Mulatu, & Oates, 1999), in which relations between substantive complexity of work and measures of cognitive functioning were examined, but their assessments did not include measures of knowledge.

A fourth interpretation of the lack of continuous age-related increases in knowledge is based on the idea that one's knowledge becomes progressively more specialized with age and experience. That is, tests designed for the general population are necessarily broad and relatively superficial rather than highly specific and detailed, or else they would have very limited applicability. However, when an individual pursues vocational and avocational interests, much of his or her knowledge is likely to become increasingly more specialized, and these broad tests would probably fail to detect any increases in specialized knowledge that may be occurring. The idea that it may not be possible for a single test to assess all facets of one's knowledge because of its specialized and idiosyncratic nature has been recognized by several writers, including recently by Ackerman (1996) and Cattell (1972, 1998).

The specialized-knowledge interpretation is challenging to investigate because on the one hand, it is assumed that if tests could be specialized to the individual, then they might exhibit increases with age, but on the other hand, if the tests are too highly specialized, then it may be impossible to make any across-person comparisons.



Nevertheless, two types of evidence seem relevant to the selective specialization interpretation. The first consists of the examination of relations between age and specialized knowledge tests among high performers, or experts, within a given domain. That is, in some studies, the individuals were selected specifically because they had considerable experience with the relevant activity, and consequently they can be considered experts in that domain.

There are only a few studies of this type, and the samples are typically small, but the results are nevertheless informative. In an early study of 20 bridge players, Charness (1979) found a small positive correlation between age and score on a bridge knowledge test ($r = .16$), but in a later study (Charness, 1983) with 45 bridge players ranging from 21 to 71 years of age, the age-knowledge correlation was $-.40$. Pfau and Murphy (1988) reported a correlation of $-.12$ between age (across a range from 17 to 75) and chess knowledge in a sample of 59 chess players. Finally, Meinz and Salthouse (1998) administered a test of musical notation knowledge to 128 individuals who varied in amount of musical experience and found a correlation of $-.17$ between age and musical knowledge. The correlations between age and the measures of knowledge are therefore small and are more often negative than positive. Furthermore, it is important to point out that the failure to find strong positive correlations is not because the knowledge tests were not valid in the domains because the correlations between the knowledge scores and measures of skill or performance in the domain were quite high, ranging from .63 to .86.

The apparent implication of these results is that high levels of specialization can be achieved in a domain without evidence of age-related increases in relevant knowledge. This is surprising because one of the factors that might have been presumed to contribute to the older adults' expertise and high performance in the domain in greater knowledge.

A second method of investigating the specialized-knowledge interpretation consists of examining knowledge in topics grouped according to the individual's self-rated interest. The rationale is that if as people grow older they tend to specialize in a relatively small number of topics, then the relations between age and knowledge would be expected to be more positive for topics that the individuals rate as high in interest.

This prediction was examined in two recent studies in my laboratory (Study 3 in Hambrick, Salthouse, & Meinz, 1999, and an unpublished study). Individuals in both studies were recruited to participate in a project investigating determinants of crossword-puzzle skill, and the quantity of knowledge in different topic areas was hypothesized to be one potential determinant of puzzle-solving ability. The participants in the studies were first asked to rate (on a five-point scale) their levels of interest in 10 different topics (American history, American literature, art, geography, music, mythology, science, sports, world history, and world literature), and then their level of knowledge in each area was assessed with both multiple-choice and short-answer recall questions.