In A.W. Chickering (Ed.), The modern American College. San Francisco: Jossey-Bass, 1981, pp. 117-128.

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Intelligence

If it is assumed that one of the major purposes of college education is to challenge students to think through issues affecting themselves and society in increasingly sophisticated and complex ways, then it is important to know to what extent the intellectual skills required are likely to change over the adult life course. As in other areas of human development, early studies of intelligence focused on acquisition of functions and skills in childhood. But even some of the pioneer theoretical writers (Hall, 1922; Pressey, Janney, and Kuhlen, 1939) became interested in issues such as age of peak performance level, transformation of structures of intellect (ways of thinking), and the decremental changes assumed to occur in late midlife and old age.

Interest in intellectual development was whetted, for example, by Yerkes' finding, in his 1921 study of World War I soldiers, that the mental function of young adults was only at about an age-13 level. Indeed, Terman's original standardization of the Binet intelligence test for American use had assumed that intellectual development peaked at age 16 and then remained constant (Terman, 1916). Such assumptions were soon questioned, however, by data from other empirical work. Jones and Conrad (1933), on the basis of cross-sectional studies in a New England community, showed significant age differences across adulthood on some, though not other, subtests of the Army Alpha intelligence test. Similar findings from the standardization studies conducted during the development of the Wechsler-Bellevue intelligence test indicated that intellectual development does not end in early adolescence, that peak ages apparently differ for different aspects of intellectual functioning, and that age differences are not uniform across the full spectrum of abilities tapped by most of the major batteries measuring intellectual development (Wechsler, 1939; Schaie, 1970).

All these matters might be of purely historical interest if it were not for the fact that omnibus measures of intelligence have generally been found quite useful in predicting a person's competence in dealing with our society's educational system and later on succeeding in vocational pursuits in which educationally based knowledge and skills are required. Moreover, specific measures of ability, although less successful, have had some use in predicting ability to meet specific situational demands. The analysis of patterns of intellectual performance has also been found to be of help to clinicians in the diagnostic appraisal of psychopathology. In dealings with the mature adult, some determination of intellectual competence may be highly relevant to such questions as preparation for a second career, selection in and out of occupations requiring specific abilities, mandatory retirement, maintenance of individual living arrangements, and ability to conserve and dispose property (Matarazzo, 1972; Schaie and Schaie, 1977).

The plan of this chapter is, first, to consider the intellectual needs of students of different ages and the related problem of developing appropriate criteria for assessing adult intelligence and competence. Next we will consider how well different theoretical models of intelligence fit adults. From there we will go on to the practical problems of assessing intellectual competence across a large portion of the human life span—the kind of intellectual assessment that will be required for students in the future American college. Then we will review what is known about changes in intellectual ability and competence through adulthood. And finally, we will note some implications of adult intellectual development for higher education. It should become apparent that the intellectual needs of adults do differ by age, that measures of intellectual ability are useful only if their criteria have some meaning in themselves, and, perhaps most important, that old dogs can learn new tricks, given the right circumstances.

Intellectual Needs of Different Age Groups

Chickering and Havighurst, in Chapter One, suggested as a goal for college education the skills necessary to manage one's own occupation and family while maintaining sensitivity to community and world needs. Designing programs to further such ends requires comparing the background and current abilities of students with the situations and demands they are likely to face. Discrepancies between existing skills and those that are likely to be needed should be considered as a function of the time perspectives of the various age groups who will make up the future college.

Traditional 18- to 22-year-old students, on the average, can be expected to live fifty years or so beyond their initial college experience. They therefore need not only skills that will give them economic viability but also preparation for dealing with "future shock." Most projections suggest that they will have to function in a society that is moving toward greater cultural diversity, changing from an achievement orientation to a greater leisure orientation, and shifting its economy emphasis from the production of goods to the provision of services. Many older learners face the more immediate and critical challenge of overcoming obsolescence suffered from the vast technological changes that have occurred since their early educational experience. For this group, instruction should serve to update knowledge and also facilitate an active involvement with and use of systems and services available in present-day society. The most adaptive learning for many older adults will therefore focus on the here and now and the proximate rather than distant future.

Discussions such as that presented by Schaie (1977/78) regarding stages of adult cognitive development also suggest that different kinds of intellectual processes may be needed to accomplish the goals of different age groups. Schaie describes a stage in young adulthood characterized by a goal-directed, entrepreneurial style of achievement, which requires an efficient task-related, competitive cognitive style. A middle-adulthood stage characterized by the need to integrate long-range goals with the solution of current real-life problems calls for organizational, integrative, and interpretive intellectual skills. A later-adulthood stage characterized by the need to attain a sense of meaning in experience requires the ability to retrieve and attend selectively to information from the overload of material accumulated over the life span.

Thus, what students of different ages may want or need to learn by way of content and intellectual skills in order to enhance their functioning may differ markedly. This would not necessarily mean that completely separate academic programs would be required, though some courses in cognitive skill training might well be developed to meet the needs of different age groups. A careful consideration of the various contributions that persons in different phases of life experience and with different styles of cognitive function could make to discussions should be fruitful in designing multigenerational courses.

Intelligence and Competence Differentiated

Measures of intellectual function are useful only insofar as they predict abilities of interest. The early intelligence tests were designed to predict children's success in classical school subjects. The appropriateness of using the same measures across the life span and for a variety of situations has been called into question many times. Further, it has not always been clear whether observed deficiencies in prediction were a function of the methodologies of assessing intellectual function or the appropriateness of the criteria measures or both. In any case, for the young college student, performance as measured by grade-point average (GPA) may well be an important criterion for predicting relative standing in the competitive graduate school and job market, and general tests of intelligence have been helpful in predicting GPA. Even for the younger student, however, projections of future societal needs suggest that creative problem solving and behavioral flexibility may be equally important, and different sorts of tests will be needed to predict these variables.

For the older student, of diverse ages, much work remains to be done in developing criterion variables relevant to the life roles and societal requirements for competent functioning (see Schaie, 1977/78, for further discussion). The decision as to what kinds of tests are appropriate to use as predictors of success necessarily depends on what accomplishments or skills are seen as important. It may be, for example, that certain motor skills are important for younger students but much less important for older students. However, specific problem-solving skills may be important for both.

A recent distinction between intelligence and competence may be quite useful in confronting the questions of what to measure in assessing the abilities of adults. Connolly and Bruner (1974) distinguish between intelligence as passive and competence as active. Schaie (1978) describes *intelligence* as an inference of underlying traits, based on observations in many situations, and *competence* as a more situation-specific combination of intellectual traits, which with adequate motivation, will permit adaptive behavior. He also argues that traditional measures of intelligence are not likely to be very useful for predicting many of the more situation-specific skills of the older learner.

Another factor that must be taken into account when using tests with older students is the greater diversity of their skills and interests. This is only reasonable when one considers their wide range of experience over many years compared with the more uniform educational experience of students who have recently completed their secondary education. Thus, tests must be used that allow expression of abilities of many sorts.

Available information regarding scores on tests of intellectual abilities of younger and older persons can be quite useful in suggesting what learning goals might be appropriate for various age groups. Further, once learning goals have been outlined, such scores can also be used in designing the kinds of learning experiences that will be most successful in reaching these goals. In other words, what we are suggesting is that educational programs can be designed on the basis of currently available information to maximize older students' cognitive assets. What is also suggested by the literature is that a greater variety of educational programs will be required in order to optimize the learning of older students. The availability of such programs might have the effect of meeting more individual needs of younger students as well.

Intelligence and Plasticity of Behavior

Our whole educational system is based on the well-documented notion that there is a great deal of plasticity in the behavior of young persons. An increasing body of data regarding what and how older persons learn is also becoming available. This literature ranges from the study of how much practice improves performance in various tasks, to the effectiveness of teaching new strategies of problem solving, to an evaluation of various ways of presenting material to be learned. There are two kinds of issues that seem paramount in addressing the degree of plasticity in older students. The first concerns the effects of changing nervous system characteristics on tasks that involve, for example, speed of perceptual and information processing and storage in memory of newly learned material. The second seems to involve motivational and experiential factors, though changing physiology may also play a role. Whereas novelty seems to provide an adequate stimulus for information processing in younger persons, meaning and some degree of familiarity are required for material to be assimilated by older learners. The question is not, however, whether older persons can learn but how and what they can learn most efficiently. Obviously, the matching up of abilities, styles of learning, and reasons for learning will be a continuing and potentially fruitful task for educational designers. The remainder of this chapter will discuss issues and data that we hope will contribute to this design process.

Models of Intelligence

Any discussion of intellectual development must begin by specifying the nature of the construct whose development we wish to understand. We have already distinguished between the concepts of intelligence and competence. It will now be helpful to engage in a brief historical analysis of four different models of intelligence: (1) the notion of intelligence as a general construct, (2) multifactor theories of intelligence, (3) the distinction between fluid and crystallized intelligence, and (4) stage theories of adult intellectual development.

Intelligence as a General Construct. Spearman (1927) believed that all intellectual activities reflected some common factor, which he labeled the *g* factor. He observed that studies of the intercorrelations among test items show high agreement among the items that appear to be measures of intellectual functions. Indeed, omnibus tests of intelligence (such as the Binet test and its successors) have tended to be quite successful in predicting performance in certain educational situations. But a variety of *g* factors might be found if one were to examine test items predictive of performance in noneducational situations or, for that matter, in nontraditional educational situations.

Multifactor Theories of Intelligence. To test these theories, items are selected so that scores vary on significant aspects of intellectual performance in addition to correlating with a general factor. Resulting test batteries (of which the Wechsler tests are a prominent example) have only moderate correlations between their parts, although their sums (as expressed in total IQ) will measure competence for situations for which the particular combinations of component parts are important.

Thurstone (1938) studied the correlations among approximately sixty different measures of intelligence and concluded that one can identify a number of factors that have little or no relationship with one another. Thurstone's factors (as well as the even further explicated structure-of-intellect model of Guilford, 1967) represent latent variables, which can be measured only indirectly. Such factors may indeed be the building blocks of intelligence, but, unfortunately, knowledge of an individual's standing on any one of them will not help us predict competence either in a specific situation or across classes of situations, except in the unusual case where one and only one factor accounts for most of the differences among individuals in an observable behavior.

It is not likely that even the most rigorous search will turn up new factors accounting for individual differences in intelligence late in life; nevertheless, we still must be alert to the fact that some intellectual abilities may account for differences early in life but not later on and vice versa. Assessment strategies that have proven successful for the selection and counseling of young adults for particular educational programs may therefore be quite useless and misleading when applied to older students.

Crystallized and Fluid Intelligence. Abilities that depend primarily on sociocultural influences, such as number facility, verbal comprehension, and general information, form one class of intellectual abilities, which have been called the *crystallized* abilities. These skills are not innate but must be learned, usually as part of a person's formal education. Their level and maintenance will therefore depend heavily upon the content of the individual's educational experience during the formative years and upon vocational contexts during adulthood. Other abilities may be quite independent of acculturation; their function depends more upon genetic endowment, the neurophysiological state of the individual, and perhaps also incidental learning. These latter abilities, such as memory span, inductive reasoning, and figural relations, are called *fluid* abilities (see Cattell, 1963). It has been contended that crystallized abilities reach an optimal level in early adulthood and remain stable thereafter, while the fluid abilities show early decline in adulthood (Horn, 1970). Note, however, that the education to which older adults are currently exposed encourages learning facts (crystallized abilities), whereas younger students are more often involved in integrative learning (akin to fluid abilities).

Stage Theories and Adult Development. The Piagetian model of intelligence (Flavell, 1963) places emphasis on the development of biologically based cognitive structures that produce qualitative changes in the way cognitive operations are conducted as the individual matures. In principle, by the time adulthood is reached, Piaget's stage of *formal operations* should have been attained (Flavell, 1970). "Formal operations" involve identification of logical rules applicable to whole classes or types of problems—in other words, the application of abstract and integrative rules to problem-solving activities. But Piaget (1972) has recently admitted that not all adults attain the stage of formal operations, and that formal operations are not applied uniformly to all substantive areas of cognitive behavior (see also Schaie and Marquette, 1975).

A recent extension of this theory (Schaie, 1977/78) suggests the possibility of three adult stages: (1) an *achieving* stage, during which the young adult strives toward goal orientation and role independence, (2) a *responsible* stage, involving long-term goal integration and increased problem-solving skills, and (3) a *reintegrative* stage, during which there is relinquishment of occupational and familial responsibilities accompanied by the simplification of cognitive structures through selective attention to meaningful environmental demands. This kind of conceptualization is quite compatible with theories of adult moral development and of ego development (Erikson, 1964), and for that matter with Chickering and Havighurst's developmental task approach (see Chapter One of this volume).

Problems in Assessing Adult Intelligence. Studies of omnibus measures of intelligence in common use suggest that such measures are ill-suited for assessing the intellectual competence of middle-aged or elderly adults, in most situations. Furthermore, although studies of functional unities of intelligence, such as Thurstone's Primary Mental Abilities, may indeed explain most variance in individuals' abilities in early adulthood, other abilities—those relatively unimportant in youth—may require more detailed assessment in later adulthood. What then is to be done?

First, we must learn more about situations in which adults are required to display competence, and this requires a taxonomy of adult situations. Next, we must construct new measures of intelligence, based upon what we now know about adult intellect. Such measures must not rely upon novelty to be the impetus for the subject's response; instead, the tasks used must be meaningful and embedded in the life experience of the adult. Moreover, they must be attuned to the particular historical contexts of different age groups as well as to life cycle differences. Third, we must examine the mediating role of motivational variables and especially the effect on individuals over two or more points in time.

Research on adult intelligence requires sophisticated methods. Cross-sectional studies confound ontogenetic change with generational differences; longitudinal studies confound ontogenetic change with the effects of sociocultural change occurring between times of measurement (or what the sociologists call *period effects*). For most behavioral variables these confounding effects are substantial. It is therefore unlikely that findings of cross-sectional age differences will agree with findings obtained from longitudinal studies (see Schaie, 1967). In fact, many age differences reported in the research literature might be more parsimoniously interpreted as generational differences, and results from single-cohort longitudinal studies of human behavior may be no more than historical accounts of the life history of that particular generation (Schaie and Gribbin, 1975a).

Several alternative strategies, called *sequential methods*, have been proposed, in which two or more cross-sectional or longitudinal sequences are compared to determine the stability of observed findings. If one assumes that either age, cohort, or period effects are trivial, one can then estimate the specific magnitude of the two remaining effects. The interested reader will want to consult the references cited above for more detail. The important point is that results of studies that do not use the appropriate sequential method have only limited generalizability.

A further limitation on what we know about adult intellectual development is imposed by the problem of nonrandom drop-out of subjects from the panel studies upon which most of our better research findings are based. Two types of attrition occur. The first is attributable to psychological and sociological reasons, such as lack of interest, active refusal, change of residence, or disappearance. This type of attrition may be related to the investigator's skill in maintaining the original subjects in the study. The second type of attrition, over which investigator has no control, is the result of biological factors such as physical disease and individual differences.

Measurement of Intelligence

Although the statement "Intelligence is what intelligence tests measure" is quite simplistic. our assessments of intelligence do depend on our methods of measurement. So it is important to know in what manner we evaluate a person's intellectual function. In this section we will discuss the norms that should be used in measuring adult intelligence. the role of speed versus power tests. the difference between performance and potential. the developmental course of sex differences in intelligence. and the measures that seem to predict various types of educational abilities.

Age-Corrected Versus Absolute Norms. Most intelligence tests published commercially, such as the Wechsler Adult Intelligence Scale (Matarazzo, 1972), use age-corrected norms—that is. norms calculated by age group. There are several problems with this approach, if such tests are to be used as estimates of intellectual competence in educational situations. The most important problem is that if we are to predict abilities of any social consequence or utility, it is not sufficient to say that an individual can perform at average level for his or her age. What we must know is whether the test performance is at a level appropriate to some criterion of social or educational performance. Thus, if a given educational activity is programmed to the needs and abilities of younger students (such as career entry skills), then the test norms designed for younger students should be used to assess the abilities of the older students as well. However. it does not make sense to compare younger and older adults on the same norms for tests that do not have the same importance at different life stages.

A further problem is the fact that all such age-based norms found in the literature have been developed from cross-sectional studies and are thus cohort-specific. That is. as the norms age. they will overestimate level of performance on tests where there are unfavorable trends over time. It is to be hoped that manuals developed in the future will begin to provide adult norms in terms of the birth years for which specific norms were developed, rather than the age range, in order to overcome this problem (see Schaie and Parham, 1975, for an example of cohort-specific norms).

Speeded Versus Power Tests. Traditionally, tests of intelligence have used two different approaches, "power" and "speed." Power tests contain a series of items scaled in increasing order of difficulty, and items are presented to the examinee until a prescribed number of successive items are failed. For practical purposes, however, and particularly in group-administered tests. some time limit is also imposed. In this case we speak of a slightly speeded power test. Speeded tests, by contrast, present the examinee with a larger number of items of approximately equal difficulty, all within the scope of performance of the examinee. The examinee's performance then is the number of items completed within a specified period of time.

As we have already noted. one of the well-documented facts of adult development is the slowing of response speed (see Welford, 1977). This phenomenon should not have any effect upon pure power tests, and some have argued, therefore, that older adults should only be examined by means of power tests. Nevertheless. one aspect of competent intellectual performance is the ability to make an organized response within a reasonable length of time. Educators must thus decide whether or not speed of response—and how much speed—is required for performance in a particular situation. Obviously, speeded tests should be used with older individuals only if the problems to be dealt with require rapid responses. Such judgments are critical in planning educational technology—for example, programming Computer Assisted Instruction (CAI) modules—but are less useful in predicting whether older persons can profit from college instruction.

Matters become more complex with the slightly speeded power tests. For example, some of the factor-analytic work with the Wechsler Adult Intelligence Scale has shown that where a given subtest is a good measure of the intended construct for young adults, it may become a measure of response speed for older adults (Reinert, 1970). In the testing of older adults, the time limits must be sufficiently relaxed to permit the examinee to reveal whether or not he or she can solve the problem. Thus, tasks must be developed in which speed of response is not a critical element of successful performance. And while we are at it, we ought to consider removing also those constraints that tend to decrease speed of response, such as inappropriately small type size or anxiety-inducing instructions.

Performance Versus Potential. Existing tools for assessing intellectual competence, as well as new techniques specifically designed for older adult learners, will, of course, do no more than provide us with estimates of current performance. But a more important question may often be whether or not a potential older college student is likely to develop new abilities as a consequence of participation in a college program. While determining a minimally acceptable level of current performance may be essential, we also want to know what we can expect in terms of future intellectual development. In principle, such determination requires longitudinal data about individuals, but inferences from other sources may be possible. Some work, for example, has been done to predict stability or change in intellectual function from knowledge of individuals' life-styles (Schaie and Gribbin, 1975b). Another promising approach is the assessment of individuals' responses to brief experimental paradigms involving cognitive training—that is, instruction in problem-solving strategies for dealing with novel material of various types, such as figural relations (see, for example, Labouvie-Vief and Gonda, 1976; Plemons, Willis, and Baltes, 1978).

Again, work in this area will depend on a good understanding of what it is that we wish to determine. We suspect that clear performance criteria will be most useful in defining levels required for culturally valued aspects of education. However, measures of learning ability, such as those involving training paradigms, may be required to predict the individual student's potential for acquiring new skills. A combination of such measures, together with a better understanding of declines in performance due primarily to disuse of skills, may enable us to program more effective compensatory education programs for adults.

Sex Differences in Intellectual Development. Whether because of genetic differences or early socialization practices, men and women differ in their relative performance on tests of various intellectual abilities. In general, women seem to show superior performance in verbal skills and inductive reasoning, while men do better on tasks involving numerical and spatial abilities. But, although the differential between men and women remains fairly constant over the adult life span, within each sex the relative abilities tend to vary with age, owing to a different pattern of maintenance and decline.

This problem has received scant attention in the research literature but may be of considerable importance both for selecting adult college students and for developing programs designed to maximize successful performance of older students. Data from the Seattle longitudinal-sequential study of age changes in cognitive behavior illustrates this issue for men and women on two crystallized and two fluid abilities with differential age trends (see Schaie, 1978). When we examine the relationship of verbal to number skills, we find that at age 25 both men and women do better on number skills. By the fifties, however, women on average perform equally well on verbal and number skills, and men, by the sixties, do significantly better on number than on verbal skills. Turning to measures of fluid abilities, we find that at 25 men do about equally well on spatial and reasoning abilities, while women clearly do better on reasoning. But by the fifties this pattern is reversed; men do better on spatial orientation than on reasoning, while women do equally well on both abilities.

The reader must be cautioned once again that data such as these are based on cross-sectional studies reflecting age differences for today's adults. Shifting patterns in sex roles and occupational involvement for women may well change those age-related ability differences that are not of biological origin.

Predicting Educational Aptitude. What measures predict adults' educational aptitude? Any response to this question must of necessity be speculative, inasmuch as relevant predictive studies for older learners do not yet exist. What we have been saying regarding the needs and goals of older learners, however, suggests that educational aptitude may depend primarily on such skills as verbal meaning (recognizing words on vocabulary lists) and inductive reasoning. The peak of educational aptitude measured in this manner occurred around age 60, and at age 81 mean performance was still at 70 percent of the level of the 25-year-olds (Schaie and Willis, 1978).

Other variables, including personality, also correlate with measures of intellectual functioning. A composite flexibility score from the Test of Behavioral Rigidity (Schaie and Parham, 1975) has correlated around .60 with the composite IQ from the Primary Mental Abilities test until age 70. The motor-cognitive component of the flexibility score has shown a stable pattern across ages and across cohorts and a strong relationship with the IQ measure. The personality-perceptual component of the flexibility score, however, has shown positive cohort differences with increasing age but considerable intraperson stability even into the eighties. Thus, we can expect that successive groups of older learners will show greater personality flexibility.

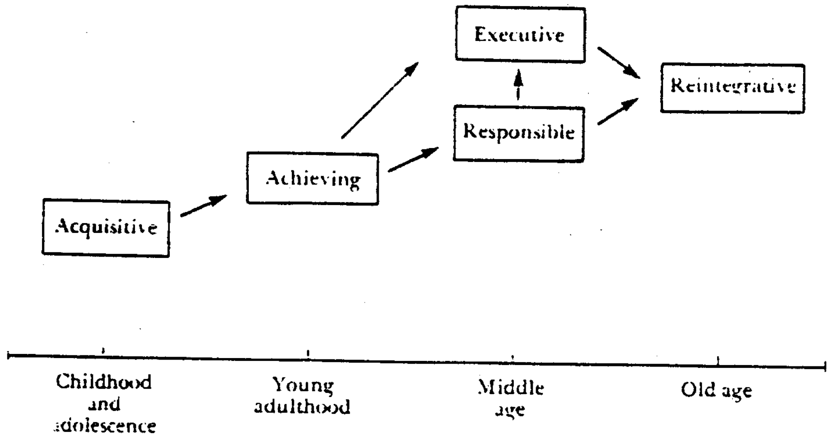
A review of the educational implications of the experimental literature on behavior of older adults provided by Schaie and Willis (1978) indicates that on the average older learners are less likely than younger learners to be able to process and sort large amounts of new information efficiently. However, the ability to consider the meaning and implications of focused problem areas in light of experience should be strong into advanced age.

Adult Intellectual Development

Three distinct phases of intellectual development can be described (see Figure 1). The first phase emphasizes from the attainment of intellectual skills in the late teens and early twenties (the traditional college period) and their application to personal and societal goals as individuals establish family units and enter the world of work. The second period, from middle age to early old age, is one of relative stability and integration accompanied by some trade-offs, as response speed and perceptual processes begin to decline. During this phase environmental supports and the fruit of experience provide adequate compensation. In the final stage, although there is narrowing of interests and more focused attention, such compensation no longer offsets accumulating deficits.

From Young Adulthood to Middle Age. When we discussed the issue of adult stages earlier in this chapter, we mentioned that one of the characteristics of the transition into adulthood is a shift from the acquisition of skills to the application of those skills to goal-oriented achievements. We may therefore expect that in this *achieving* stage more efficient and effective cognitive behavior will be found in activities that have role-related achievement potential. Even in early middle age, though, peak performance may already have passed for problem-solving abilities and educational activities that are task-

Figure 1. Stages of Adult Cognitive Development



Source: Schaie, 1977/78. Copyright by Baywood Publishing Co., Inc. Reproduced by permission.

limited and not clearly related to broader personal and social goals. However, goal relevance is strongly influenced by environmental factors, within biologically determined limits. We would therefore expect that adult peak performance may shift in chronological age, as the average age at which a task becomes most goal-relevant may be modified by environmental demands.

Some work from our longitudinal study of the Primary Mental Abilities may be illustrative (Schaie, 1979). Take the example of Verbal Meaning, a recognition vocabulary task. Here we find gains throughout early adulthood, but for three successive samples, born seven years apart, the peak ages shifted from 32 to 46 years of age. Gains have also been reported for scores on the Stanford-Binet until age 30 by Bradway, Thompson, and Cravens (1958) and until age 42 by Kangas and Bradway (1971). The latter study also reported gains on both verbal and performance parts of the Wechsler Adult Intelligence Scale, confirming results earlier reported by Bayley and Oden (1955) and by Green (1969).

From Middle Age to Old Age. Middle age brings with it further transformations in the cognitive realm. When the individual has mastered cognitive skills to the point of attaining role independence—satisfactory identity and self-sufficiency—he must then move on, motivated both by biological and societal pressures, to assume responsibility for others. Whether one assumes full responsibility for one's mate, offspring, or elderly parents or whether one becomes the leader of an educational, vocational, or other social unit, transition must now occur to a *responsible* stage, which for most individuals extends from the late thirties to the early sixties.[1]

[1] Figure 1 indicates in addition an *executive* stage. This stage is reached by some during middle age under the pressure of assuming responsibilities for whole societal systems rather than simple units. Such individuals would be expected to show further increment on laboratory tasks such as pattern recognition, complex problem solving, and inductive reasoning.

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The goal-directed but often egocentric style of the achieving stage will now be replaced by cognitive patterns that facilitate the solution of practical problems in the context of long-range goals and perceived consequences for the social units for which the individual has assumed responsibility. Translated into the formal measurement of intellectual ability, this means that we would expect further growth of problem-solving skills when measured by meaningful tasks, as well as maintenance and even slight growth of the crystallized abilities. At the same time we would expect, as individuals reach the sixties, decreased skill in task-specific situations, particularly when assessed by fluid ability measures or by speeded tasks, and perhaps more difficulty also in dealing with new items of information—as contrasted with the retrieval and integration of previously learned information.

Empirical studies reflecting behavior change over this period suggest that there is a maintenance of function for many abilities not involving speed of response (see Botwinick, 1977). And again, as over any long time period, sociocultural change leads to apparent differences between individuals decades apart in age, reminding us of the importance of understanding the level of earlier education when programming for the older learner. Our own studies suggest that until the late sixties differences in ability level between successive generations are most strongly implicated in any findings of cross-sectional age differences, with intraindividual change occurring primarily on highly speeded tests (Schaie and Parham, 1977).

Intellectual Changes in Old Age. The characteristic concern in old age with intellectual and emotional reintegration appears to shift the focus of intellectual performance from content to context. The transition to the *reintegrative* stage implies a shift from "What should I know?" through "How should I know?" to "Why should I know?" As a consequence, we would assume that motivational and attitudinal variables are much more involved in moderating intellectual competence at this stage than at other life stages.

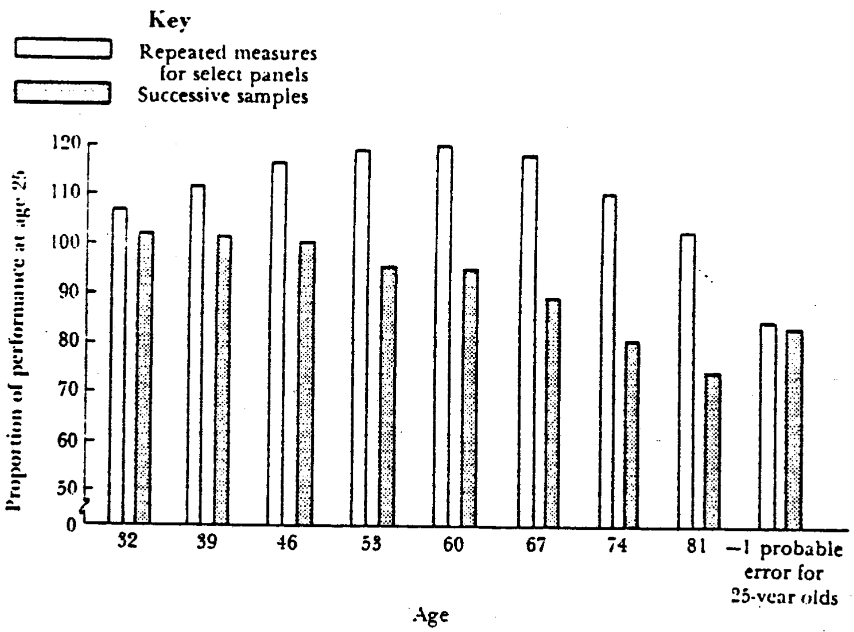
For us, the successful older person is one who rather than having disengaged from society has become reengaged in a meaningful fashion. But such reengagement at the cognitive level is achieved by much more selective attention to those intellectual skills and activities that have either remained meaningful or have attained new meaning. This is why we have to be very careful not to overinterpret the empirical findings of intellectual deficits in old age, and in particular the observation that greater decrements have been found on the fluid than on the crystallized abilities (Horn and Donaldson, 1976). Such findings may reflect a selective interpretation of existing data (Baltes and Schaie, 1976; Schaie and Parham, 1977).

Part of the difficulty in interpreting the evidence of intellectual deficits in old age is that most measures of abstract intellectual functions involve techniques that put older people at a disadvantage. For example, they are apt to use personally meaningless material and testing paradigms that stress response systems which are no longer relevant over those used in daily living situations. More situationally relevant measures may help deal with this issue in the future, but their construction is still in an initial stage (Schaie, 1978).

We would like to suggest that the apparent intellectual deficits shown by the elderly reflect a combination of obsolescence and the consequences of progressive decrements in the efficiency of the peripheral sense organs and of the timing mechanisms involved in transmitting impulses to the brain and alerting the organism to the availability of stimuli to which it should respond. But how serious are these deficits? The statistics reported in the scientific literature tell us simply that a phenomenon has been reliably demonstrated. The practitioner in addition must know the magnitude of the phenomenon in order to decide whether it requires specific professional action.

The author has tried to attack this problem by measuring the performance of individuals at various ages as a proportion of the performance of young adults (at age 25). Figures 2 and 3 present data from longitudinal-sequential studies on psychometric tests

Figure 2. Performance on Recognition Vocabulary at Various Ages as a Proportion of Performance at Age 25



(designed for the young) for recognition vocabulary and numerical skills. Note that the solid bars in the graphs represent estimates from change data involving repeated measurement of panels, while the broken bars represent estimates from successive random samples. The latter data provide a good estimate of proportionate age change in the general population; the former represent a highly selected panel.

An objective appraisal of the practical significance of cumulative age changes involves assumptions familiar to most educators. That is, we note that 1 Probable Error about the mean defines the middle 50 percent (average) range of performance if mental abilities are normally distributed (see Matarazzo, 1972, pp. 124-126). Hence, performance decrements are assumed to have practical significance in those cases where the cumulative loss for the older sample reduces its performance below the performance level at 1 Probable Error below the mean of young adults. Inspection of Figure 2 (Recognition Vocabulary) shows that such decrement is reached for the general population sample only at age 74, while the select sample remains at or above the young adult level into the eighties. Figure 3 (Number skills), while showing evidence of some age decrement, also tells us that the decrement for this ability does not reach practical significance at any age.

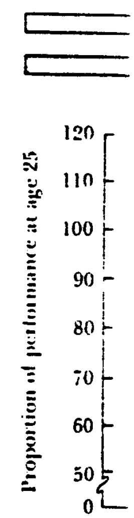


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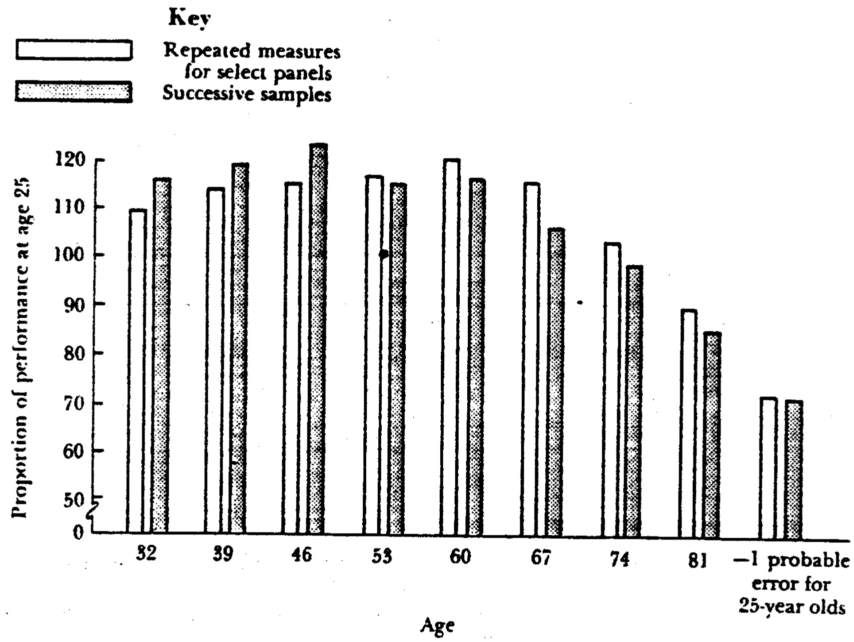
Figure 3. Performance on Number Skills at Various Ages as a Proportion of Performance at Age 25



Modifiability of Adult Intelligence

To what extent can intellectual performance be modified in later life? This is a basic issue in the education of adults. Here we will address the issue in light of the limited training literature and studies of educational motivation.

Training Studies. As we noted earlier, a significant portion of the apparent decrement in older people's intellectual performance can be attributed to lack of training and experience in the skills measured by available tests of intelligence. To what extent, then, can this deficit be overcome by learning? Some intellectual traits, set down early in life, may be relatively difficult to change. Other behaviors may be much more amenable to change at later stages of life. For firm conclusions to be reached, each cognitive function of interest must be studied using several different training techniques. Would-be researchers in this area must also consider the criterion question carefully in choosing measures of cognitive function to train for. That is, the information obtained should predict behavior of interest. If speed is of questionable importance to an older person's interactions with his environment, then time might be better spent trying to train for improvement on another measure of intelligence.

A small but growing literature has reported successful modification of apparent low-level function on intellectual variables such as figure relations and perceptual speed (for example, Hoyer, Labouvie-Vief, and Baltes, 1973; Labouvie-Vief and Gonda, 1976; Plemons, Willis, and Baltes, 1978). Further evidence for the importance of even simple changes in instructional or reinforcement conditions has been demonstrated (Birkhill and

Schaie, 1975). Labouvie-Vief and others (1974), provide a review of assumptions related to the use of behavior modification techniques with older adults and discuss alternative designs for such studies.

Role of Motivational Factors. An age-related increase in cautiousness has been reported in a number of studies of performance (Birkhill and Schaie, 1975; Okun and DiVesta, 1976; Reese and Botwinick, 1971). Botwinick (1973) has suggested that some age-related decline in ability may be attributable to an increase in cautiousness. Sensitivity to the way instructions create sets for responding as well as studies that encourage the use of different response strategies may be helpful in clarifying how much the performance of older persons can be improved.

The role of arousal or anxiety in the performance of older learners has been studied by Eisdorfer, Nowlin, and Wilkie (1970). However, conflicting results have led to differing interpretations as to whether, and under what circumstances, older persons may be over- or underaroused for optimal performance (Marsh and Thompson, 1977). Further studies are needed to help clarify this issue. Sensitivity to conditions that affect the motivational levels of learners of all ages is critical but may be of particular importance where other factors related to efficient performance become marginal. The goal of educational designers and teachers should be to provide the combination of instructional set and training techniques that can optimize the conditions for learning.

Sensory and Perceptual Changes

Of major concern to the college teacher with older students are those performance decrements related not so much to basic ability as to the decreasing efficiency of the peripheral nervous systems. Specifically worthy of note here are common changes in auditory and visual acuity as well as in perceptual speed.

Visual Acuity. Changes in the transmission ability and accommodation power of the eye begin at age 35 to 45 years. Progressive thickening of the crystalline lens interferes with transmitting and refracting light and decreases accommodative power. Yellowing of the lens reduces the amount of light entering the retina. Reduced sensitivity to the shorter wavelengths of the visible spectrum leads to greater difficulty discriminating between blue, blue-green, and violet colors (Weale, 1965). Circulatory and metabolic changes in the retina around age 55 to 65 years also result in reduction of the size of the visual field, along with decreased sensitivity to flicker and to low quantities of light. The brightness gradient of the image on the retina appears to be critical in determining visual acuity. Corrective lenses can improve visual acuity by increasing retinal illumination, but acuity can also be sharpened by increasing the contrast between the object and its surrounding field, or by increasing overall illumination (Fozard and others, 1977).

Auditory Acuity. The most common auditory deficiency with advancing age is presbycusis, a loss of auditory acuity for the high frequency tones (Corso, 1977). Functional decrement occurs in the auditory thresholds for pure tones, speech and pitch discriminations, and information for processing of dichotic stimuli. Some degree of hearing loss is found from about 32 years of age for men and 37 years for women (Lebo and Redell, 1972). The hearing level of men is higher than that of women at or above 2000 Hz but below that of women for frequencies of 1000 Hz and below. Impairment in pitch discrimination has been noted as early as the fourth decade (Konig, 1957). However, Corso (1971) has suggested that age-related performance decrements may reflect different criteria of judgments (such as cautiousness) rather than functional losses in the auditory sensory modality.

Substantial associations have been found between hearing loss and intellectual functioning as measured by subtests of the Wechsler Adult Intelligence Scale, the Primary Mental Abilities, and the Raven Progressive Matrices (Granick, Kleban, and Weiss, 1976; Schaie, Baltes, and Strother, 1964).

Perceptual Speed. Age-related slowness in behavior has been attributed to a slower mediation process in the central nervous system (Birren, 1965). No qualitative differences in central perceptual processes have been found between young and older adults; however, beyond 60 years of age the peripheral perceptual system operates more slowly (Walsh, 1976). Older persons thus appear to require a slower rate of presentation and increased task duration (Talland, 1966). The slower processing mechanism for incoming stimuli with advancing age suggests a need for self-paced or reduced presentation rate of materials as well as varying complexity levels.

It is important to distinguish clearly between those aspects of the older learner's intellectual competence that are related to perceptual speed and those that are related to sensory acuity. For the former, we need to consider alteration of pace and timing of programs. For the latter, we need to make sure that visual and auditory difficulties are corrected when possible, either by individual prosthetic devices or by means of carefully designed educational settings. Once again, we need to note the vast range of individual differences. While some sensory-perceptual decrement will occur for all of us if we live long enough, such decrement for many will be relatively insignificant or its onset will be quite late in life.

Implications for Higher Education

In the final section of this chapter we would like to speculate a bit about the implications of adult intellectual development for education. To do so, we will summarize what we perceive to be the goals and needs of older learners and ask whether or not it is realistic to assume that many older learners indeed have the intellectual skills required to meet their educational goals. We will then consider what changes might be required in educational technology to serve the older learner better and, finally, what we now know about such issues as age mix in college classes, characteristics and preparation of teachers of older learners, and the like. For a more extensive discussion of these issues the reader may wish to refer to Schaie and Quayhagen (1978) and Schaie and Willis (1978).

Goals of Adult Learners. A major objective of education in youth is the development of intellectual and social skills required for adequate functioning in a particular society. By contrast, adult education is directed toward maintenance and renewal of skills. Five distinct needs of adult learners can readily be identified: (1) help in understanding the changes in one's own body and behavior produced by maturation and aging, (2) help in understanding the rapid technological and cultural changes of contemporary society, (3) skills for coping with the personal consequences of technological and sociocultural change, (4) new vocational skills required for a career change or pursuit of other new goals, and (5) guidance in finding meaningful and satisfying retirement roles.

From late middle age on there is a substantial need for information about the biological changes related to aging, and in particular those changes that affect memory, learning ability, and the ability to engage in successful interpersonal behavior (see Schaie and Gribbin, 1975a). The kinds of needs discussed by Douvan in her chapter on intimacy are also pertinent here.

Maintaining some comprehension of one's environment and thus exercising at least a modicum of control over one's life are made difficult by the rapid technological and sociocultural changes described by Toffler (1970) in his popular analysis of "future shock." The traditional objective of lifelong learning has in fact been to interpret to adults past the stage of formal education those new technologies and social transitions that are likely to affect both personal behavior and the course of societies.

Comprehending sociocultural change is an important educational goal in its own right, but even more pressing is the need to overcome personal obsolescence. The education acquired in one's youth may no longer suffice for coping with the environment decades later. Updating one's education is not just a matter of acquiring additional information but also of developing new learning skills and techniques. Generational differences in level of function have been described by sociologists (Riley, Johnson, and Foner, 1972) as well as psychologists (Schaie, 1975). These discussions and the results of related empirical studies (see Schaie and Gribbin, 1975a) make it clear now that much of the apparent intellectual deficit shown by older people is not deficit at all but rather can be attributed to the relative obsolescence of older people's intellectual skills.

Adult education can be instrumental in overcoming the generational differences in information and skills that have resulted in the obsolescence just mentioned. Whether there is need for another period of "compulsory" education in late middle age or not may be of concern to future social policy planners. At present, however, we do see an increase in what has been called the "graying of the universities," as more individuals try to overcome their perceived disadvantage in dealing with social change by reentering the educational process.

From our discussion in this chapter we conclude that all the aforementioned educational goals are within reach of the average older adult, certainly until the early seventies, and for many even beyond. But because of the wide range of individual differences, careful assessment of specific abilities in relation to educational goals becomes essential. The dictum should be that, as far as intellectual competence is concerned, some older learners can accomplish any educational objective, most older learners can accomplish some carefully selected objective, and some, as at any age, will receive little or no benefit from education.

Educational Technology. Efforts to bring older learners into the educational system will succeed only if they are preceded by efforts to make educators aware of how the older learner differs from the younger, and to educate the older learners themselves on these matters so that they can enter the educational process with better understanding of their own needs, capabilities, and limitations.

The human aging process is frequently taken for granted as something that one learns to live with and that does not require special attention until there is a physiological or psychological breakdown. However, most adults are conscious of physiological and psychological changes, as well as of the social stereotypes assigned by an age-graded society (Maas and Kuypers, 1975; Neugarten and Datan, 1973). It is the stereotypes, and their consequences, that are particularly amenable to educational intervention. Recent work in the psychology of aging (see Birren and Schaie, 1977, for an extensive review) indicates that, although there is undoubtedly a decline in the peripheral functions with age, there is much compensation, and that the perceived behavioral deficit may be largely a consequence of deleterious role assignment to the old by the middle-aged (Schaie, 1973b).

The possibility that intelligent behavior may be a function of cognitive abilities plus performance-related, noncognitive factors has been discussed in the child development literature in relation to the performance-competence distinction (Flavell and Wohlwill, 1969). There is evidence that noncognitive factors, such as sensory deficits, motivation. and response speed, play an increasingly important role in intellectual performance with age. A current research thrust in adult psychology. therefore. is to determine whether various learning changes in later adulthood are due to cognitive or noncognitive factors (Woodruff and Walsh, 1975).

Some observed learning differences between age groups have been related to the increasing time required for the aging adult to acquire information and to retrieve new information from memory. Providing a longer acquisition and response period has been shown to improve the older adult's learning performance. Furthermore, the amount of material and the number of task demands presented at a given point in instruction have been shown to influence learning in later adulthood (Craik, 1977). Such findings would suggest the utility of a self-pacing approach, in which the number of task demands and the amount of information presented are carefully regulated. A programmed instruction approach, for example, can be effective with the older adult. The mastery learning approach developed by Bloom (1968) and the competency-based method in general also provide accommodation for variations in learning pace.

The incentives governing adult learning must be heeded more closely. Educators accustomed to working with the young may assume that novelty or change has an intrinsic appeal for students. However, novelty has much less value for older students. Acquiring new habits and taking risks may therefore have low incentive value. New material must have some personal meaning if it is to be learned well (see Schaie, 1978).

Programming of Higher Education. The educational system must adapt itself to an increasing number of students who return with a wealth of experience and a far better understanding than younger students of what they expect from education. These older students do not necessarily want a liberal education. Certainly, they do not need to be kept around the university to mature sufficiently to enter a vocational role. What they need is not a theoretical foundation for learning but new skills and information geared to their specific needs. It is quite reasonable to expect that far more intensive and specialized counseling activities will be required. More individualized courses of study may also be required since preparation is generally sought for work and leisure roles rather than for degrees (although degrees may be important if their lack prevents the mature student from entering new roles).

Although, as we have already noted, novelty per se has less incentive value for older students than for younger ones, older students may be better able to appreciate new sociocultural developments. For it requires experience and perspective to recognize true innovation. Thus, for the young everything is new, even if a skill or idea traces back to the dawn of humanity. It is the older students who can distinguish between traditional cultural values and skills and the technological or sociocultural changes that represent true innovation.[2] This means that teaching practices and resource materials that encourage a critical approach and active application of prior experiences are to be preferred over those that call for passive acceptance of authoritative views.

Individual variability in almost every type of intellectual capacity increases across the life span. The greater range of individual differences in adulthood should be of primary concern to the educator. Extreme individual differences in any student population (for example, exceptional children or disadvantaged children) has usually required an individualized instructional approach. Such an individualized orientation would seem

[2]The distinction between novelty as an ontogenetic and as a phylogenetic concept was called to the authors' attention by the eminent French philosopher Michel Philibert, whose thoughtful comments on this issue are gratefully acknowledged.

imperative for adults. Over the life span, the role of the teacher appears to change from director of learning to facilitator or resource person (Houle, 1974; Huberman, 1974). Whereas society and the educator direct the education of the young, the content and method of learning in adulthood are largely determined by the adult himself. The developmental changes in the learner across the life span suggest the need for qualitatively different types of teacher training for educators working with different age groups. The techniques of the typical college instructor may be inappropriate in teaching middle-aged or older persons. Teacher training institutions must take an active part in translating the available information concerning adult intellectual competence and adult learning into a delineation of the skills required of the adult educator.

The quality of life in any society can be measured by how successfully cultural continuity is maintained in a rapidly changing world. In our modern society, cultural obsolescence is a constant threat. It is a challenge even to decipher the service manuals accompanying new equipment, to say nothing of keeping up with the new developments in one's field. A great deal of attention has been focused on compensatory education for children coming from culturally or educationally deprived backgrounds. Much less attention has been paid to the fact that society is full of adults who need compensatory education to cope with sociocultural change. If we, as educators, recognize that the problems of older students are more often those of obsolescence than decrement, we will do a better job of educational programming.

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