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CHAPTER 7

Age Changes in Adult Intelligence

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The intelligence-quotient concept has been widely criticized in educational areas and other contexts. Nevertheless, the observations made by the student of behavior when he or she looks at the performance of young and old people on a variety of measures of intelligence may still be very useful, since many other socially significant behaviors can be predicted thereby. However, any discussion of intellectual functioning in adulthood requires attention, at least in passing, to some of the methodology issues involved in judging whether or not there is acceptable evidence on changes in intelligence from maturity to old age.

We often make the observation that older people tend to function systematically less well than younger people. One might, therefore, draw the conclusion that in the development of intelligence we reach our maximum peak as young adults; from then on we go downhill, slowly at first, more rapidly later. The life course of intelligence may be no different, then, than the life course of some other biological phenomena.

Even with this point of view, one might still ask whether developmental change in intelligence is a uniform phenomenon. Intelligence is not something tangible; it is a construct and as such is not different in its nature from other constructs. We make it more tangible by defining certain ways of measuring it through what we usually call an intelligence test. But a measure of intelligence, or IQ, is no more than a summary statistic; by summing over various dimensions that may be important for effective mental functioning, we can arrive at an index number by which we characterize the behavior of an individual. Thus, when we try to measure intelligence, we are measuring many different things. Although the life course of the summary index may indeed show growth and decline, it does not necessarily follow that such a life course would also be true for the components of intelligence.

We must keep in mind that there is not necessarily a direct isomorphic relationship between biological and psychological changes in the organism. Many aspects of

psychological developments depend very much on the interaction of the individual with the culture, and changes in an individual's behavior over his or her life course may be much more affected by changes in the culture than by bodily changes. Granted, there are some constraints. Only living organisms can answer questionnaires or take intelligence tests. One might reasonably assume, therefore, that intelligence will decline dramatically prior to death just as do other life functions. But there is no necessary reason why we have to accept the age decrement model for intelligence without first subjecting it to a number of serious questions. This chapter will examine two principal issues: (1) Is there any reason to suggest that the life courses of different intellectual functions are identical? (2) Is there any reason to accept inevitable decrement in the life course of intelligence?

STUDIES OF INTELLIGENCE IN ADULTHOOD

All of the early studies on intellectual development in adulthood have made use of what is known as the *cross-sectional method.* That is, in these studies the same intelligence test was given to a number of groups of people of different ages at the same point in time. For example, the Army-Alpha intelligence test was administered by Jones and Conrad in a New England community in the early 1930s. These investigators examined practically all persons in this small community from age 16 to 90, divided them up into subgroups by age, and were able to show that on many tests there was a peak in young adulthood and a drop thereafter. Similar findings were reported by Wechsler when he first reported age-related data with the Wechsler-Bellevue, an intelligence test whose revisions represent the standard measurement instrument used in clinical practice. Wechsler had to provide different norms for different age groups to adjust for these age differences (Matarazzo, 1972).

Let us now examine the methodological issues raised by such an approach. Whenever we consider the results of a cross-sectional study, we cannot assume a priori that differences between age groups have been caused by physiological age changes. People who differ by age frequently also differ by other characteristics. Most notably, they must belong to different generations; obviously there are no two individuals, say one aged 20 and one aged 30, who were born at the same time. Differences in age imply differences in life experience for which there cannot be overlap.

If we wish to understand the behavior of the aged, we must understand the particular kind of life experiences they have had. Different age groups must have had different life experiences, and it is frequently more plausible to argue that people of different ages differ on a given characteristic because they belong to a different generation, rather than because they differ in age. In fact, for many psychological variables it is much more plausible to argue that group differences are heavily affected by the particular circumstances of the environment that have changed. One of the major characteristics of our society is that it is in extremely rapid transition. In primitive agricultural societies change might not be an issue of concern, but it cannot be ignored in our case.

In order to solve the question of whether observed age differences are due to age or to generations, we would have to conduct some *longitudinal studies,* which follow the same individuals over their life course to find out if there are indeed age changes within the individual. Such studies are difficult to conduct, and few longitudinal studies may be found in the literature. Some of the more interesting longitudinal studies of intelligence include the Berkeley Guidance and Growth studies (Bayley, 1968); follow-up studies of Terman's *Study of Genius* in the late 1930s (Bayley & Oden, 1955); a study by Owens (1953), who retested men who were ROTC members at Iowa State University during World War I; Blum and Jarvik's study of aged twins (Blum, Jarvik, & Clark, 1970); and the Duke studies of normal aging (Eisdorfer & Wilkie, 1973).

Yet a problem also arises with the interpretation of data from longitudinal studies. We do not know to what extent observed changes in the behavior of individuals are due strictly to age and to what extent they were caused by some environmental event that occurred during the interval between our measurement points. Examples of such intervening events are transitory changes in nutritional levels due to war, depressions, and the like, and the dramatic changes in information transmission because of the introduction of TV. The latter event would affect one generation very much and another generation not at all, because they had either lived before the era of TV or within the era of TV. In other words, we need to differentiate between what change in function is due to age, and is thus characteristic of all members of a species, and what change is a transitory effect due to particular environmental events that occurred during the time period being examined. (For further elaboration of the distinction between age changes and age differences, see Schaie, 1967.)

Another issue is raised by the question of why we should expect that the course of different intellectual abilities should be the same. For example, Horn and Cattell (Horn, 1972) have proposed a model of intelligence that distinguishes between certain kinds of abilities that they call "crystallized" and others that they call "fluid." Crystalized abilities depend upon the acquisition of certain kinds of information and skills transmitted by the culture that are not available to the individual simply by virtue of his characteristics as a human being. Horn and Cattell argue that there is no reason to believe significant decrement should occur in such abilities, assuming that there is continued access to the content of our culture. But the second kind of ability, which they call "fluid ability," seems to be related to the physiological characteristics of the organism. If we accept the concept of a biological clock or of systematic age changes in the biological system, particularly with such variables as speed and reaction time, we would then reasonably expect that many abilities should indeed have a life course with an adult peak and some decrement thereafter. There could certainly be a significant difference in the life course of these two kinds of intelligence.

SOME RESEARCH EVIDENCE

Some research studies on the course of adult intelligence that my associates and I have conducted over the past twenty years or so shed light on these issues (see Schaie, 1979).

In our first study (Schaie, Rosenthal, & Perlman, 1953) we addressed the issue that there might be differences in intellectual functioning in the aged for different

abilities. Instead of giving the traditional speeded intelligence test, I used a test measuring the "primary mental abilities," developed from the work of Thurstone (1941). This test consists of five different tasks, measuring separate mental abilities. The first is called *verbal meaning*. In this task the subject is given a stimulus word, say *old*. From a list of four other words—say, *new, young, bad, ancient*—the subject is then required to pick the one most similar to the stimulus word. This is a test of a person's passive recognition vocabulary. The second task, *space*, consists of geometric figures, some of which have been rotated clockwise and others counterclockwise. The subject must pick the ones that have been rotated clockwise. This test of spatial visualization may be predictive of real-life situations such as finding one's way across town from a map, or of visualizing how a piece of furniture bought in kit-form might look when assembled. The third task, *reasoning*, which involves the identification of rules in complex letter series, is a test of inductive thinking. Fourth is an arithmetic task, *number*, which involves the checking of simple addition problems. The fifth task, *word fluency*, requires the production of words starting with a given first letter. This is a test of a person's active vocabulary recall.

I had felt in talking to some older people that one of their problems seemed to be that they did not respond as quickly as they once had. The test (except for word fluency, which can be administered only as a speeded test) was therefore administered under standard as well as nonspeeded conditions in order to maximize differences between functions if they were present (see Figure 7-1). For numerical skills, with no speed limit, our subjects performed virtually at the top of the adolescent group. For verbal meaning they also performed at a very high level. But on other variables, such as spatial visualization and abstract reasoning, people in their 50s still did well, while in the high 60s or 70s there appeared to be a substantial drop. The peculiar upturn for the oldest group may simply reflect that my few very old people were probably highly selected and not representative of their age group. (But see Schaie & Strother, 1968b.) The results of this study suggest that if there was decrement in the several functions, it certainly was not a uniform phenomenon.

The same study was repeated later (Schaie, 1958) with a more carefully selected sample of 25 men and women in each five-year age interval from 21 to 70 years. As shown in Figure 7-2, we again find peaks in young adulthood and differential decrement gradients for the different abilities thereafter.

Both of the preceding studies are, of course, cross-sectional in nature and consequently have the validity problems outlined earlier in this chapter. I became seriously concerned about these problems when I reviewed data on some of the longitudinal studies on adult development. The latter studies, in contrast to my own findings and those by Jones and Conrad and by Wechsler, indicated the absence of age decrement in intelligence, especially in the verbal abilities.

In fact, Owens (1953) reported some increment over a 30-year period and showed that his subjects now in their 50s scored higher than they had in their 20s. Similarly, the follow-up of the Berkeley Growth study (Bayley, 1968) showed that in mid-life adults performed better than they had as adolescents. I then took another look at some cross-sectional studies and found that the so-called peak age seemed to be less than constant. When Terman standardized the original Stanford-Binet in 1916, he

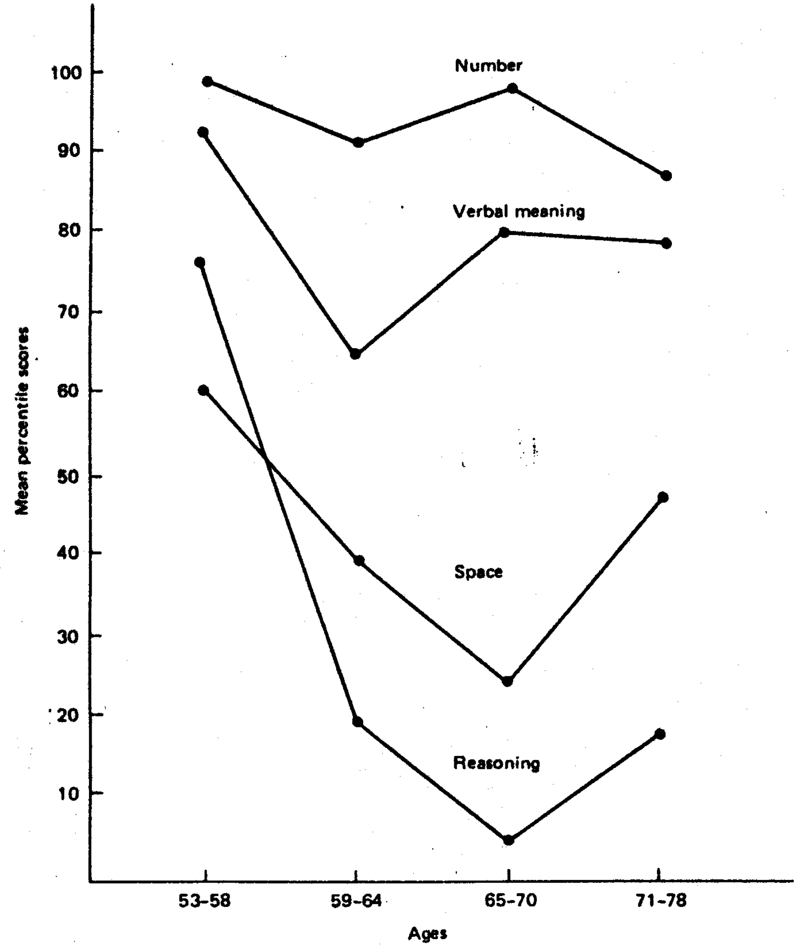

Figure 7-1. The primary mental abilities test administered as a power test to older persons. (*From Schaie, Rosenthal, & Perlman, 1953. Copyright by the Gerontological Society. Reproduced by permission.*)

assumed arbitrarily that adult intelligence peaks at age 16. In the 1930 study of Owens and Conrad the average peak occurs at about 20. When Wechsler standardized the Wechsler-Bellevue the first time around, his reference group was aged 20-24; when he restandardized for the newer WAIS version of his tests some 10 years later, the optimal level for some of them now was at ages 25-30. My own data collected in the mid-1950s suggested an average peak at ages 25-35. Curiously, the peak age of performance appeared to keep increasing (Schaie, 1970).

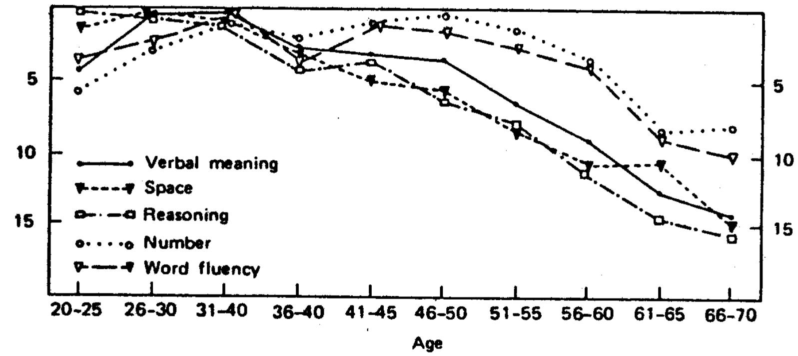

Figure 7-2. Performance differences on the primary mental abilities test from young adulthood to old age. (*From Schaie, 1958. Copyright by the American Psychological Association. Reproduced by permission.*)

Obviously, this discrepancy of findings requires explanation. We can approach the problem systematically by noting that different kinds of information are obtained in cross-sectional and longitudinal studies. Furthermore, if one compares results from different tests on different populations, one may be looking at some very special artifacts. It occurred to me, therefore, that one way in which one might solve the problem was to convert a cross-sectional study into a longitudinal one. In 1963 we conducted a follow-up study and retested about 60% of the sample I had first examined in 1956. This gave me a series of seven-year longitudinal studies (Schaie & Strother, 1968a). The advantage of this kind of design is that both cross-sectional and longitudinal data are obtained on the same subjects with the same measurement variables. Another concern is that in any study over time, peculiar test and retest effects may occur. Also, loss of subjects in longitudinal studies is not necessarily random. To handle this problem, we also obtained a new sample from the same population and age range seven years later, which we thought would be instructive with respect to the issue of shift in peak age of performance.

Our joint analysis of the cross-sectional and longitudinal data showed that scientists who from their cross-sectional studies argued that there was age decrement were right; but so were the other scientists who denied age decrement on the basis of longitudinal data. That is, in my studies we found that the cross-sectional data indeed showed apparent age decrement. But what we found was not really decrement; rather, we were talking about age differences. What I had shown was that different generations perform at different levels of ability. My longitudinal gradient within the generations looked quite level and showed only very mild decrement. Obviously, as it grows older, any given sample has a larger proportion of members who have some kind of pathology that interferes with their ability to respond; even for personal characteristics, such as inadequate visual correction, there would be a higher incidence in older people.

On the basis of our longitudinal studies we next contructed some composite age gradients. To demonstrate what happens when the appropriate cross-sectional and longitudinal data are compared, Figure 7-3 shows the age gradient for the verbal meaning test on the primary mental abilities test. If we examine the longitudinal data and compose the appropriate age gradient within generations, it turns out the peak is not at age 35, but at age 55. Even at age 70 the estimated performance is still of higher ability than it would have been at age 25.

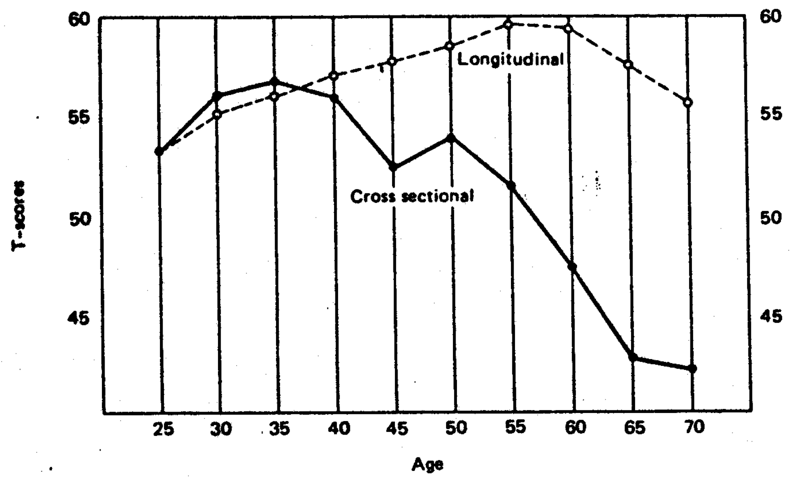

Figure 7-3. Comparable cross-sectional and longitudinal age gradients for the verbal meaning test. *(From Schaie & Strother, 1968a. Copyright 1968 by the American Psychological Association. Reproduced by permission.)*

Some of the results of our 1963 study were criticized because we had pieced together longitudinal gradients by considering data collected over a single 7-year period, which may have been an atypical period. In 1970 we were fortunate enough to be able to do another follow-up study of the same population (Schaie & Labouvie-Vief, 1974). We now have data for some people over a 14-year period, and data for many people for two distinct 7-year periods. We were now able to construct families of age gradients over a 14-year period. An example of our comparative cross-sectional and longitudinal data is shown in Figure 7-4. This figure shows data for the primary mental abilities variable of spatial visualization.

The left side of Figure 7-4 shows three cross-sectional gradients: the bottom one for data collected in 1956, the second one for 1963 data, and the third one for 1970 data. The shapes of these gradients are quite identical. But note the systematic displacement. That is, at each age, for consecutive seven-year periods, the later-born cohorts perform at a higher level than the earlier-born and, consequently, the peak

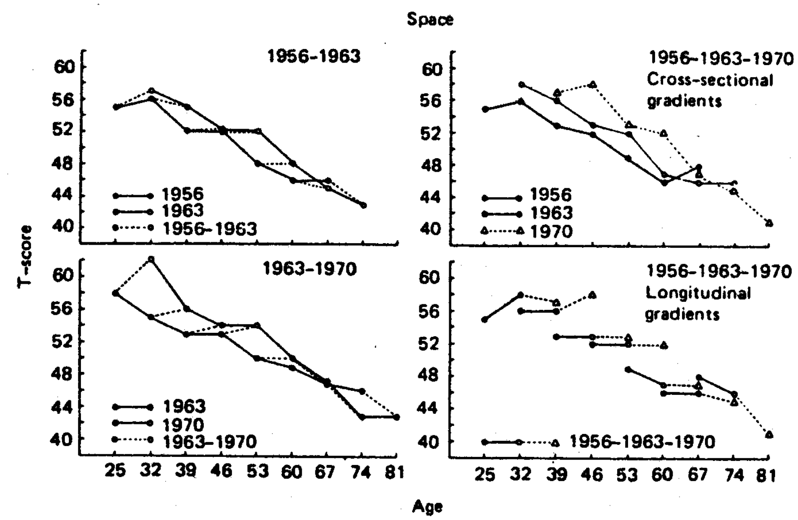

Figure 7-4. Cross-sectional and longitudinal age gradients for the space test from the primary mental abilities. The two graphs on the left depict changes over two different 7-year time periods for two different samples of subjects. The graphs on the right provide comparable cross-sectional and longitudinal gradients for a single sample followed over a 14-year period. *(From Schaie & Labouvie-Vief, 1974. Copyright 1974 by the American Psychological Association. Reproduced by permission.)*

ages keep increasing. This type of evidence can be accounted for only by generation differences; it confirms what some of us have suggested intuitively, namely, that we are smarter than our parents were, and that our children, in turn, are likely to be smarter than we are.

Now consider longitudinal data on the right of Figure 7-4. These are not estimates, but the actual data on the same people measured at three points in time, seven years apart. For the two youngest cohorts, ranging from the 20s to the 40s, spatial ability seemed to keep going up within these generations. For the next two cohorts, up to age 63, there is no change at all. The next gradient, which goes to about age 70, shows a minor decrement, and only for the very oldest cohort is there a significant drop. Even this drop must be viewed with caution because it could be characteristic of that particular generation. That is, it may be characteristic only for individuals who are now in this age range and who have had a history of infectious childhood diseases, which would be quite atypical for later cohorts.[1]

From these studies we can now conclude that on abilities where speed is not of primary importance there is very little change in intellectual function for an individual

[1] The findings reported here have been replicated in another data collection conducted in 1977 (see Schaie, 1979, 1982).

throughout adulthood. However, there are certainly marked differences between levels of function for successive generations. These differences are not just a matter of level but may also affect the rate of change. We may reasonably suggest that the present generation of old people, from age 70 on, experienced some intellectual decrement, although much less than we had previously suspected. But it is not at all clear whether such decrement will be found in future generations of old people. For one thing, many of the people whom we have looked at thus far have been individuals who are about to die. We probably happened to test them about three or four years before their death, and they may have already been in the stage before death, when a general decline of all functions is typically experienced (Riegel & Riegel, 1972). If we were able to examine persons who live until 90 or 95, we might observe no decrement at age 80. (For a more detailed popular discussion of these issues, see Baltes & Schaie, 1974.)

Although it is apparent from our studies that there is very little age decrement in intelligence in functions that do not require speeded response or are not affected by the slowing of reaction time within the individual, there are nevertheless marked differences in performance level between successive generations. Interestingly enough these findings hold equally for the so-called crystallized and fluid abilities; what differs among them seems primarily to be the extent of the generational differences. For practical purposes this means that, although many older people are functioning at least as well as they did when they were young, still the young of today function at a much higher level than those who were young 50 years ago. The implications of this conclusion for the practitioner, however, are dramatically different from those that would follow acceptance of the fact of intellectual decrement in the old (also see Schaie, 1980).

Our studies strongly suggest that in the areas of intellectual abilities and skills, old people, in general, if they are reasonably healthy, have not declined but rather have become obsolete. This conclusion might be viewed as a rather negative value judgment. That is not true at all, because obsolescence can be remedied by retraining, while deterioration would be irreversible. (For an example of a successful demonstration of cognitive training of older adults, see Plemmons, Willis, & Baltes, 1978).

If it can be shown that the real intellectual problem for older people is the fact that they are functioning at the level they attained in their younger days, but which is no longer appropriate for successful performance in contemporary society, it follows that we may be able to do something about this situation, rather than conclude that such individuals are simply deteriorated and bound to get worse. In such instances, the logical approach might be the development of compensatory education programs at about the time of retirement, perhaps comparable to the Operation Headstart programs attempted with culturally disadvantaged children (Schaie & Willis, 1978).

INDIVIDUAL DIFFERENCES IN CHANGES IN INTELLECTUAL FUNCTION WITH AGE

All the preceding material refers to findings on groups of people. What about the range of individual differences? Although it does not follow that all old people have declined intellectually, some indeed have—but so have some people at age 30. Our

longitudinal studies of individuals show that we have some remarkable individuals who gained in level of performance into their 70s; others have declined by their 30s. What can account for these individual differences?

Two major classes of variables may be important. First, we suspect the role of cumulative health trauma, which may vary widely across individuals. In other words, individuals who have had significant and accumulative physical illness may be at a disadvantage. The effect of such adverse health conditions has been shown in the case of cardiovascular disease (Hertzog, Schaie, & Gribbin, 1978). Second, we know that young children function at the upper limits of their intellectual capability in terms of intelligence if they have been raised in a rich and complex environment. The maintenance and growth of intelligence of an adult may also have much to do with the complexity of his or her environment. We have conducted a series of field interviews in which we looked at the complexity of adult life in terms of such variables as the nature of activities, the kind of books and newspapers read, the characteristics of a person's friends, daily patterns of activities, extensiveness of travel, and so on. Results of these studies show that people who live in a varied environment are often the ones who show continued growth throughout life, while those who live in a static environment may be the ones who most likely show some decrement (Gribbin, Schaie, & Parham, 1980).

How important are the differences in intellectual performance between young and old? Scientists are often impressed by a difference that is *statistically significant*. But what does statistical significance of a difference mean? All that is implied by the term is that the difference is reliable; if the same experiment were done again, we would expect again to find the same difference or one of similar magnitude. It does not mean that the difference needs to be great. In fact, if one has large enough samples, practically any difference will be statistically significant. Some of the differences shown in the graphs in this chapter are so small as not to make much of a practical difference. If an individual at age 30 is able to produce 40 different words in a three-minute period but at age 70 can produce only 36 words, it is doubtful whether this "decrement" is going to make a lot of difference in his or her life. All it means is that it takes a little more time to come up with the required answers or that he or she may have to refresh his or her memory by taking more notes. Other differences are of a large enough magnitude to have some implications. For example, the generational differences in spatial visualization are of enough significance to cause the Federal Aviation Authority to change their age limits for pilots. This age limit has gone up successively because successive generations have been functioning at higher levels. Generational differences may be significant enough so that, by comparison with younger people, older people may indeed be at a disadvantage and compensatory procedures may be indicated. But often such data are simply used as rationalizations to deny the elderly societal roles they could well handle if they were allowed to do so (also see Schaie, 1973).

Another reason to question the practical significance of some of the previous findings on age changes in the elderly is related to the validity of using the same tasks to measure intelligence at all ages. For example, some of the subtests on the Wechsler-Bellevue intelligence test measure different aspects of intelligence in young adulthood than in old age, simply because the skills required to solve the particular problems on these tests tend to change with age.

Some investigators have in fact prepared tests on which older people do better by using materials that are more meaningful for the mature adult (cf. Gardner & Monge, 1977). Especially in the area of verbal behavior it can be shown that tests can be designed deliberately to favor different cohorts by maximizing item contents of terms that were fashionable when the particular cohort was at the young adult age level. Thus, the same arguments that have been used to claim discrimination when tests built for middle-class white children have been applied to minority group members can also be applied when tests built for young adults are applied to work with the aged.

A final matter of concern when viewing the significance of lower test performance by the aged is the tendency toward cautiousness found in the elderly (Botwinick, 1973). Consequently, many elderly are less willing to guess test items about which they are uncertain, unless tests are set up in such a way that it is clearly to the old person's advantage to guess (Birkhill & Schaie, 1975). Young people in most test situations tend to make many more errors of commission than omission, but the reverse is true for the elderly. Perhaps the old are more cautious because they have been discouraged often for doing the wrong thing. Cautiousness may often be adaptive, but in this instance it may make the elderly appear less able than they actually are.

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