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ABSTRACT

Mandatory retirement because of chronological age is coming under increasing attack and, at least in the United States, it is likely that there may soon be legislative prohibitions against forcing individuals to retire because of age. As a consequence there is renewed interest in redefining retirement criteria in terms of a functional age concept which would give due attention to individual variability in the maintenance and development of behavioral competence. This paper calls attention to a number of problems with the undifferentiated use of the functional age concept and indicates a number of possible alternative approaches, some of which may be more appropriate for application to retirement issues than others. A distinction is made between functional age as a general index applicable to basic psychophysiological mechanisms and a matrix of functional ages referring to specific social or environmental situations. (Author)

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Introduction

Mandatory retirement because of chronological age is coming under increasing attack and, at least in the United States of America, it is not unlikely that there may soon be legislative prohibitions to retiring individuals for reasons of age. As a consequence there is much renewed interest in redefining retirement criteria in terms of a functional age concept which would give due attention to individual variability in the maintenance and development of behavioral competence. The purpose of this paper is to call attention to a number of problems with the undifferentiated use of the functional age concept and to indicate a number of possible alternative approaches, some of which may be more appropriate for application to retirement issues than others. In this context it will be necessary to distinguish between functional age as a general index applicable to basic psychophysiological mechanisms (for example, timing mechanisms involved in the feedback loop between cardiac and cortical functions governing behavior or efficiency of cortical functioning such as measured by the CNV), and a matrix of functional ages referring to specific social or environmental situations. In the first instance we would, of course, be concerned with ANS and CNS integrity as they affect behavior, in the latter instance our concern is with the measurement of behavioral competence in specific situations in individuals having specified characteristics.[1]

[1] A more comprehensive review of some of the methodological issues related to functional age may be found in Schaie and Schaie (1977).

Alternate Models of Functional Age

I will now try to identify what seem to be the major alternatives for defining functional age. First, we may note a straightforward longevity model, that is one based on functions which bear linear relations in individual differences in life expectancy, as measured at any particular point of the life span. Second, we have a model based on residual life expectancy. Such a model requires sets of linear relations of variables to individual differences in residual life expectancy, possibly with differential functions depending upon the life stage and generational membership (functionally defined!) from which residual life expectancy is to be estimated. The first two models seem to differ primarily in that the first probably involves identification of predominantly genetic parameters, while the second, when taken from a base past adolescence would largely entail differential impact of environmental parameters. (For a formal discussion of possible models for the segregation of genetic and environmental variance in developmental problems, see Schaie, 1975).

A third model seeks to define the linear relation of a set of behavioral functions which covary inversely with chronological age. The parameter to be fitted here is the individual's standing on such function as indicating that he is parallel, retarded or advanced on such function as compared to his chronological age peers. A fourth model defines a functional profile thought to be of maximal behavioral consequence, and is concerned in determining whether a given individual falls below or exceeds a profile characteristic of his or her chronological age by some critical value. A fifth model defines functions in relation to a criterion variable of adaptation or behavioral competence (see Schaie, 1976), and then places individuals in relation to either normative values or as proportions of optimal level. Finally, a sixth model is concerned with the capability of the individual to acquire or reacquire skills regardless of present performance level. Here the parameter to be estimated is the degree of plasticity of the human organism in relation again to some optimal plasticity level presumably attained in young adulthood. It should be noted here that models three and four assume an irreversible decrement model of aging, that model five explicates an adult stability model, and that model six involves the concept of decrement with compensation (Schaie, 1973; 1977).

Implications of Alternate Models for Retirement Issues

Life expectancy model. This model assumes that there is a set of parameters which are linearly related to longevity (e.g. Jalavisto et al., 1964). To find the best fit we would simply need to estimate the regression of such parameters upon chronological age at death. In principle a single-cohort longitudinal study would suffice, from that point in life at which all parameters thought to have predictive value could be assessed, until that point where all members of the panel had died. However, such a process, time-consuming as it would be, would not provide generalizable data without making the strong assumption that neither cohort differences nor secular trends were operating over the period for which data were obtained. The cohort-sequential (longitudinal sequence) approach would therefore be more desirable. Having obtained the appropriate regression equations we could then estimate functional life expectancy for a given individual and report his or her functional age in relation to the population average. Such an index would be quite useful for insurance schemes in that it would yield a value which would place all individuals in the same relative position with regard to their individual life expectancy. This index, of course, would tell us nothing about the functional capacity of the individual, and thus would not be helpful for issues of retirement.

Residual Life Expectancy. In contrast to the simple life expectancy model samples at many ages would need to be followed, each to their demise. Here is, of course, a natural illustration where several cohorts would have to be observed simultaneously over time. Regression equations, in this case, would be specific to each age level at which prediction of residual life-expectancy is made.

The second model may be more powerful in that it would be more realistic to fit measurements of an individual's state at a given chronological age to residual life expectancy, rather than to absolute life expectancy regardless of the age at which predictors are measured (Tamplin, 1959). Also, economic forecasters developing manpower plans disregarding mandatroy retirement, may well wish to have estimates of residual life expectancy for the staff of a particular industrial organization in order to estimate future labor turnover.

Behavioral Functions. The most commonly used model is represented in work such as that of Dirken (1972) and the Boston Normative Aging study (Bell, Rose & Damon, 1972). Although quite appealing, it is a most insidious approach, since it requires acceptance of the irreversible decrement model of human aging, and requires the search for age functions that decline while ignoring those which show different patterns. When based upon cross-sectional data it most likely will result in the definition of cohort rather than age functions. The age function approach requires a cataloguing of the entire domain of human capacity and performance, with subsequent factor or cluster analyses (e.g. Clark, 1960) to discover those variables which have similar age functions. Longitudinal sequences would be required to assure us that we are re ally talking about age functions (slopes) rather than differences between cohorts (levels). We would expect that while there might be a single optimal fit for any such cluster, the joint assessment of all, accounting for most of the individual differences in performance and capacity, is likely to be non-linear in nature, and would thus violate the model.

If a representative set of functions could be found then functional age would be defined as the regression of their linear combination upon chronological age. The resulting index would be most heavily weighted for those components which show decrement and would have the same questionable status as the mental age (MA) concept in the measurement of intelligence; that is, it would be an elegant exercise in fitting numbers to persons with no pretense of external validity (Schaie & Gribbin, 1975; Schaie, 1976).

Functional Profile. A much more reasonable approach is presented by the concept of a functional profile advocated by Heron and Chown (1969). Some basic flaws remain, however. The functional profile is also handicapped by the fact that age functions can be defined only where there is significant decrement. The functional profile will yield a series of indices, for each of which one could specify minima required for adequate performance in certain life situations.

Optimal Level. A somewhat different approach to functional age would be the definition of optimal levels for a given function. Such levels might well differ depending upon the life stage of the individuals as well as the societal requirements for performance on a given variable at a particular historical point in time (e.g. Schaie & Strother, 1968). Individuals' function could then be described as a proportion of optimal level. Such proportions could be regressed upon chronological age or birth cohort to determine linear functions. Ideally, however, assessments of proportion of optimal level could be related directly to criterion situations. If we assume that much of the variability in complex adult function is likely to be determined by inter-generational differences and socio-cultural secular trends, we might well be better off to switch from the concept of functional age to that of functional level.

Functional level in this model would be described as the ratio of observed performance to that proportion of optimal performance which would empirically be determined to be of average adequacy with respect to the criterion variable. Any normative data collected by age would be purely cohort-specific, and while they would characterize age differences in functional performance at a particular point in time, would have no relevance for the determination of age changes within individuals.

Plasticity Level. If one were to consider an age decrement with compensation model, it will not suffice to provide an estimate of the individual's functional level of performance, but one must further consider to what extent that level can be modified by suitable intervention. We are here considering the degree of plasticity of adult behavior, which becomes quite critical when we assume that many of the disadvantages of the elderly may not be accountable by physiological deterioration, but rather must be attributed to the lack of use, failure to acquire critical skills, or opportunities for performance. Young adults are presumed to be at an advantage in many situations of vocational and social consequence because of their greater learning efficiency and motor performance (Arenberg & Robertson, 1977; Welford, 1977). It would seem quite reasonable therefore to define functional age in terms of learning ability as well as performance functions. If decremental age changes are fairly limited, and differences in performance between young and old often predominantly a function of obsolescence rather than decrement on critical behavior it may then be more important to know the capability of individuals to learn new or relearn old skills, than to worry about a particular performance level.

What Variables Should be Measured by Age Functions

When age functions are to be applied to retirement issues we must then ask whether we wish to construct measurement batteries which will provide general estimates of the relative state of the individual or whether we wish to predict his relative performance under specific vocational or other life-role circumstances. The first question is concerned with the issue that a minimal relative level of certain basic psycho-physiological functions may be required in any situation of social significance before adequate performance may be possible. But such necessary level of function may not be sufficient to predict adequate performance in specific situations. We will therefore consider some reasonable approaches to defining classes of variables that might yield "necessary" functions, and then describe a possible approach to the determination of variables which are "sufficient" to deal with specific classes of situations.

Classes of Variables Suitable for Generalized Functions. Physiological or, more specifically, nervous system integrity is assumed to be related to behavioral competence and some data to that effect are available. But numerous older persons are found to maintain considerable behavioral competence in spite of serious physiological stress (e.g., a CVA), while others show substantial behavioral deterioration with little identifiable physiological pathology.

Blood pressure provides an illustration of a physiological measure which is thought to be important for functional capacity. It may, however, be important for a variety of reasons depending on the model of functional age held by the examiner. It would be a relevant measure for persons interested in life expectancy (models 1 & 2). A rise in blood pressure with age has been reported (model 3) though the contributions of age per se and the increased incidence of cardiovascular pathology in advanced age have not been fully sorted out.

Inclusion in a profile to be compared with a peer or ideal young age (model 4) would be useful, however, only as profile characteristics are related to behaviors of interest. Only models 5 and 6 which respectively propose a profile or a description of a person's ability to learn or adapt compared with an optimal or necessary functional level would seem to encourage an exploration of basic physiology-behavior mechanisms.

Correlational studies have suggested the relevance of blood pressure to behavioral competence (Birren & Spieth, 1962). A history of hypertension has been correlated with reduced scores on tests of cognitive function (Spieth, 1964). Further, increased scores on the Categories test have been reported with reduction in blood pressure via biofeedback of persons suffering from hypertension (Goldman et al., 1975). On the other hand, slightly elevated blood pressure in elderly persons has been correlated with better performance on cognitive tasks (Wilkie & Eisdorfer, 1971).

Blood pressure is simply one example of a physiological measure, the explication of whose importance to behavior would clarify its relevance as a measure of functional efficiency. Correlational studies are available which suggest the importance of many other physiological measures to behavior (see Table 1 for examples) and similar explorations of possible mechanisms should be valuable.

We would suggest, then, four classes of processes whose relevance to effective functioning are immediately recognizable and for which at least some central and autonomic measures are now available. The four classes of functions are: orienting processes, control processes, adaptability, and speed. Central and autonomic measures which have been correlated with performance on tasks which can be included in each of these categories are listed in Table 1. There is not sufficient time to discuss the relative merits of each measure in this context. It will be noted, however, that the central measures are all evoked potential measures; that is, they record brain activity time-related to stimulus or response occurrance rather than utilizing the spontaneously occurring EEG (cf. Marsh & Thompson, 1977). And, it is generally accepted that evoked potential measures reflect techniques of processing, evaluating or making decisions on the basis of information rather than the content of the information being handled (Schwartz, 1976). The goal of evoked potential measurement would be to assess the relative intactness of persons' abilities to deal with and respond to stimulation from the environment.

Classes of Variables Suitable for Specific Situations. When we turn to functions which may be of more direct concern in industrial (McFarland, 1973) or other competency-requiring situations we are faced with the general issues of external validity (see Schaie, 1976, for a broader discussion of external validity in the development context). First of all, we must have a better understanding of the classes of situations within which older people are expected to display competence. A first attempt in this direction has recently been reported by Scheidt (1976) who developed a taxonomy of competence relevant situations in older individuals. This taxonomy classifies situations in terms of four fairly independent dimensions: social character (social or non-social), activity level (high or low), commonality (common or uncommon), and supportiveness (supportive or depriving). A Q-sort containing five prototypic situations for each of the sixteen possible classes of situations is available to help define the characteristics of a particular criterion situation for the individual whose competence we are interested in.

Assuming the availability of a method of identifying the characteristics of the situation to which we wish to predict, we must then select measurement variables which are appropriate to the developmental level of the individuals to be tested. That is, we should not expect tasks which have construct validity for young adults to retain such validity for middle-aged or elderly persons. And, we must be sure that our tasks measure the constructs of interest rather than simply being measures of test-taking ability. The latter problem, incidentally will lead us to substantial increases in test-construction activity (for example of new approaches see Krauss & Schaie, 1976; Sinott, 1975). But we must not ignore either the large variety of measures which have shown previous promise in functional age studies in industrial contexts (see Kelleher & Quirk, 1973). What is at issue here is that such measures must be related to classes of criterion situations, and we must know much more than we now do on the task-by-situation interface before applications of functional age to societal concerns such as retirement becomes practicable. We will then be in a position to provide the student of functional age with a catalog of psychometrically valid procedures, from which choice can be made of those variables which are optimal and thus "sufficient" for the determination of age functions with respect to discrete criterion situations.

Some Concluding Remarks

I have attempted to summarize some different concepts of functional age and to note the methodological problems in applying these different concepts. In my judgment it is now necessary to move from functional age notions which remind suspiciously of the early work on mental age to a more sophisticated level which will emphasize adult plasticity, individual differences in patterns of abilities, and will lead to the development of non-chronological estimates of function that will improve our capability of assessing whether or not a given older person can maintain societal functions for their own and society's benefit.

Table 1. Classes of Generalizable Functions

Class of Functions	Possible Measures
1. Orienting functions, including: simple arousal, differential sensitivity to stimulus characteristics such as different intensity levels.	1. Early components of evoked potentials, including augmenting-reducing; contingent negative variation (CNV) o-waves; skin conductance responses, heart rate changes.
2. Control functions, including: attentional, inhibitional (dealing with distraction), expectancies, decision-making.	2. Later components of evoked potentials, including P300, CNV-E waves; heart rate changes; ANS/CNS synchrony.
3. Adaptability, including: learning and memory.	3. Classical conditioning, habituation, and biofeedback using autonomic and cortical measures.
4. Speed, including reaction time.	4. Evoked potential latency and recovery measures, timing components of ANS/CNS synchrony.

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