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THE ADULT GROWTH EXAMINATION: VALIDATION, ANALYSIS, AND CROSS-CULTURAL UTILITY OF A COMPACT BRIEF TEST OF INDIVIDUAL AGING

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ABSTRACT: A volunteer sample of 51 men and 56 women, ages 20 to 70 years, were tested in Nova Scotia, Canada, on the Adult Growth Examination (AGE), a brief compact standardized test of individual aging. The AGE consists of three subtests which yield a total score or body age (BA). Volunteers also completed background questionnaires and made a personal estimate as to what their body age would be (EBA). None of the analyses demonstrated significant sex differences. Of the full sample, the BA total score correlated .82 with chronological age (CA). Subtest correlations with CA were: hearing loss .69, near vision .78, systolic blood pressure .67. The BA was within plus or minus 10 years of CA for 67% of the sample, within plus or minus 5 years of CA for 47% of the sample, and equal to CA for 7% of the sample. The median BA and CA for the sample was 40 years; the median EBA was 35 years. EBAs were correct for 7% of the volunteers with a full sample average difference between EBA and BA of 7½ years. Further analyses are made and the relevance of the AGE test for cross-cultural research and practice is discussed, particularly in terms of isolating factors that lead to premature aging and resistance to aging.

RESUMEN. Se aplicó el "Adult Growth Examination" (AGE) a una muestra constituida por 51 hombres y 56 mujeres oscilando entre 20 a 70 años de edad en Nueva Escocia. Este instrumento es una prueba normalizada para explorar el proceso de envejecimiento. La prueba consiste en tres subtests que rinden un resultado total denominado "edad corporal" (BA). Los sujetos estudiados llenaron un cuestionario e hicieron una estimativa de sus respectivas edades corporales (EBA). En ninguno de los análisis se revelaron diferencias significativas entre los sexos. En la muestra total, la edad corporal total se correlacionó en un coeficiente de .82 con la edad cronológica (CA). Las correlaciones de los subtests con la edad cronológica fueron: pérdida de visión .69; visión cercana .78; presión arterial sistólica .67. La edad corporal oscilaba entre más o menos 10 años de edad cronológica para el 67% de la muestra, entre más o menos 5 años de edad para el 47% de la muestra y era igual a la edad cronológica para el 7%. Las edades corporales y cronológicas medianas para la muestra eran de 40 años; la edad corporal mediana estimada era de 35 años. Las edades corporales estimadas (EBA) eran correctas para el 7% de los voluntarios con una diferencia promedio para la muestra total entre la EBA y la BA de 7½ años. Se realizaron análisis subsiguientes y se considera la importancia de la prueba AGE para la investigación transcultural, particularmente en lo que se refiere a los factores aislantes que llevan a la vejez prematura a la resistencia a la vejez.

Some adults age much more rapidly than others. That this is so has been accepted throughout the history of man. *Why* this is so and what might

be done about it are questions that the scientific talent of man has only recently begun seriously addressing itself to. A first step towards gathering information and making change is to measure and quantify the aspect of interest. Until only a few decades ago the only way we had to quantify the individual rate of bodily aging was by the passage of external time since birth, a 'chronological' age based on the circuits of the earth about the sun but not on the obvious physical changes taking place on earth's inhabitants as they moved, each at their own speed, from birth to death.

In 1949 Benjamin recommended the standardization of a reliable test of individual human differences in bodily aging. Further suggestions for test items and useful procedures to follow were published by Murray (1951), Clarke (1960), Bourliere (1963), Jalavisto and Makkonen (1963), and Jalavisto (1965). In 1968 Morgan used data drawn from a 1962 United States national health survey (Linder, 1964) to illustrate the contemporary use and structure of a standardized age test, the Adult Growth Examination (AGE). Enough information had become available to construct a test for capturing the individual's rate of aging.

Over subsequent years the Adult Growth Examination evolved into a brief and painless test using compact and inexpensive equipment (so that ultimately maximum use could be made in medical and psychological settings including those with limited financial, time, and space resources). Of the many measures of man that change reliably during the passage of adult lifetime, eight emerged as most relevant for the AGE. Five of the measures (finger dexterity, glucose tolerance, cholesterol level, peridontal index, and dental decay index) became optional supplements to a basic test of three measures: hearing level at high frequency, near vision threshold, and systolic blood pressure (*Science Digest*, 1969; Morgan, 1969, 1970, 1971). Body age (BA) was the total score of the AGE and represented the median of the three subtests of hearing, vision, and blood pressure. In a reliability study of the brief three-measure test, test-retest correlations were .88 for BA total score and from .75 to .93 for the subtests with a BA standard error of measurement of 4.98 years (Morgan & Stevens, 1972). This study of 50 adult male Nova Scotians suggested AGE was a reliable instrument by traditional standards of test construction. It was now time to begin the process of validating AGE, demonstrating in some systematic way that it in fact does measure the rate of bodily aging of individual adults.

Validation studies of age and generation effects are full of disadvantages built in by biological hurdles such as the difficulty a mortal scientist has in observing more than one or two human generations. Our limited time (pending further research in aging) forces us to select cross sectional

analyses (studies of several generations made at one point in time) more frequently than longitudinal analyses (one generation across several points in time). Both types of analysis have drawbacks (Baltes, 1968) but good validation research should deal with them both. One longitudinal approach to evaluating the AGE test has begun: a large sample of men and women of widely varying adult chronological age were tested in 1970 . . . mortality will be checked at 10, 20, and 30 years from the date of testing. Presumably, if the AGE total score of body age is valid, then BA will be a better predictor of mortality than CA of the birth age. However, in the interim, cross validation studies are possible. Such a study follows.

METHOD

Measurement instrument. The Adult Growth Examination, basic three-measure test, derives in part from procedures and norms used in the 1962 United States national health survey of a carefully selected representative cross sample of several thousand adults (Linder, 1964). More recent norms derive from examinations of several hundred adults tested in western New York state and then in Nova Scotia, Canada (Morgan, 1971, 1970, 1969). The first subtest measure of hearing level threshold at 6000 cycles per second was recorded for the better ear after a rehearsal of both ears at 1000 cycles per second. Norms and procedures derive in part from Rosee (1953), Roberts and colleagues (1965, 1967, 1968), as described in Morgan (1971). The second subtest measure of near vision threshold (lens accommodation) was the closest measured distance for uncorrected binocular vision that a visual target of a sentence in ordinary newsprint (pica: 11 letters per inch) could be read without blurring. Norms and procedures derive in part from Roberts and colleagues (1964, 1967, 1968), Duane (1925, 1931), Hofstetter (1944, 1954), Tait (1951), and Rambo (1960), as described in Morgan (1971). The third subtest measure of systolic blood pressure was the average of three readings made at rest separated by the intervening activity of taking the other two subtests. Norms and procedures derive in part from Gordon (1964a, 1964b), and Florey (1969), as described in Morgan (1971). Raw scores on all three subtests convert to body age scores through the use of norm charts (Morgan, 1971). The median body age score of the three subtests is the total body age (BA) score.

Subjects. A volunteer paid sample of 51 men and 56 women, ages 20 to 70 years, were selected from across the entire province of Nova Scotia. The median age of both male and female volunteers was 40 years. The economic, education, and other demographic levels reflected that of the province generally.

Procedure. The volunteers took the basic ten-minute three-subtest version of the Adult Growth Examination. Prior to taking AGE they completed a brief background information blank. Following the test they completed another information form which included their personal estimate as to what their tested body age would be. Following the study, all participants received their individual results along with a careful explanation of their meaning.

RESULTS

While we would not expect body age to be identical with chronological age in every instance (indeed it is their difference that justifies the body age test), we nevertheless would expect much overlap. One might even use the body age test to predict chronological age and expect, if it is valid, relative efficiency. Using this as a validation inquiry, it was seen for the sample of 107 Nova Scotia volunteers that BA total score correlated .82 with chronological age, a highly respectable amount. There was little difference between male and female correlations on this or any of the other investigated points; accordingly sexes were pooled into a full sample of

TABLE 1

SELECTED ANALYSES OF ADULT GROWTH EXAMINATION (AGE) SCORES OF NOVA SCOTIANS OF BOTH SEXES AGED 20 TO 70 YEARS

Selected Analyses	Raw Scores	Age Scores	n
Correlation with chronological age:			
AGE total score for both sexes	.....	r is .82**	107
AGE total score for females only	.....	r is .83**	56
AGE total score for males only	.....	r is .81**	51
Subtest 1 — Hearing loss	r is .66**	r is .69**	107
Subtest 2 — Near vision	r is .57**	r is .78**	101
Subtest 3 — Systolic blood pressure	r is .69**	r is .67**	106
Median subtests 1 & 2	.....	r is .69**	101
Median subtests 1 & 3	.....	r is .78**	106
Median subtests 2 & 3	.....	r is .66**	101
Subtest intercorrelations:			
Subtests 1 & 2	r is .46**	r is .63**	101
Subtests 1 & 3	r is .47**	r is .52**	106
Subtests 2 & 3	r is .43**	r is .53**	101
Correlation with AGE total score:			
Subtest 1 — Hearing loss	r is .65**	r is .74**	107
Subtest 2 — Near vision	r is .64**	r is .81**	101
Subtest 3 — Systolic blood pressure	r is .84**	r is .85**	106
Median subtests 1 & 2	.....	r is .85**	101
Median subtests 1 & 3	.....	r is .89**	106
Median subtests 2 & 3	.....	r is .93**	101

**p: .01 for every product-moment correlation in the table.

107 subjects. Subtest raw scores correlated significantly with chronological age (.66, .57, .69 respectively) as did the subtest age scores (.69, .78, .67 respectively).

Occasionally, someone tested on the AGE is unable to take one of the subtests. In the present study, for example, six people were unable to take the near vision subtest and one the blood pressure subtest. Whether this stems from equipment failure or human difficulty (eg. blindness), the test needs to be evaluated on the basis of any combination of two subtests to properly assess effectiveness of the full test when a subtest cannot be used. Table 1, which illustrates these and other comparisons, suggests medians derived from any two subtests correlate significantly with age ranging from .66 to .78. These two-subtest combinations were also found to be nearly as reliable as the full test by Morgan and Fevens (1972) with test-retest correlations ranging from .81 to .95.

Subtest intercorrelations were moderately high ranging from .43 to .46 for the raw scores and from .52 to .63 for the age scores. This confirmed the common focus of all three measures and supported resistance to tests with more than three or so dimensions as being unnecessarily redundant.

All three subtests correlated highly and significantly with the total BA score. In the case of subtest age scores, ranging from .74 to .85, this is expected since the total score is derived from them. The raw scores also correlated highly with body age (.65 to .84) as did all two-subtest combinations (.85 to .93).

The significant raw score correlations with chronological age found in this study only confirm much earlier research by other investigators. Clarke (1960) also tested Nova Scotians (102 Ss) and found correlations with age to range from .57 for hearing loss to .65 for systolic blood pressure and .67 for near vision. Florey and Acheson (1969) found systolic blood pressure to correlate with age at .62 for white females, .59 for black females, .47 for black males, and .43 for white males using more than 3000 subjects aged 18 to 79 years.

Table 2 depicts further analyses and results of the present study. The overall standard error of estimate for AGE in this study was 9.3 years, with subtest standard errors of estimate ranging from 8 to 14 years. Two-subtest combinations ranged from 7½ to 10 years standard error of estimate. In predicting chronological age, the AGE test clearly distinguishes one decade from the next but cannot be relied upon to distinguish a difference of one or two years. This is still, of course, due to the fact that body age and chronological age are not synonymous in theory any more than they are in our test. A valid test of bodily aging would probably demonstrate most people to be within five or ten years of their birth age but few would have

TABLE 2

FURTHER ANALYSES OF ADULT GROWTH EXAMINATION (AGE) OF NOVA SCOTIANS OF BOTH SEXES AGED 20 TO 70 YEARS

Standard error of estimate (in years) of chronological age:		
AGE total score for both sexes	S.E.E. is 9.30 years	n — 107
Subtest 1 — Hearing loss	S.E.E. is 11.23 years	n — 107
Subtest 2 — Near vision	S.E.E. is 8.11 years	n — 101
Subtest 3 — Systolic blood pressure	S.E.E. is 14.33 years	n — 106
Median subtests 1 and 2	S.E.E. is 7.61 years	n — 101
Median subtests 1 and 3	S.E.E. is 10.05 years	n — 106
Median subtests 2 and 3	S.E.E. is 8.87 years	n — 101
Medians per item (M/I) frequencies (Morgan, 1964) by subtest:		
Subtest 1 — Hearing loss	M/I is 21*	n — 101
Subtest 2 — Near vision	M/I is 44*	n — 101
Subtest 3 — Systolic blood pressure	M/I is 36	n — 101
Distribution of AGE scores in relation to chronological age:		
BA equals CA: 7% sample		
BA older than CA: 50% sample		
BA younger than CA: 43% sample		
BA within plus or minus 5 years of CA: 47% sample		
BA within plus or minus 10 years of CA: 67% sample		
Average difference in years between BA and CA: 8 years		
Individual estimates of body age (EBA):		
For full sample (n equals 107), median EBA is 35 years		
Median BA and median CA is 40 years		
Average difference in years between EBA and BA is 7½ years		
Correct EBAs: 7%		
Sex differences:		
None of the above analyses demonstrated significant sex differences.		

* p: .05 (Morgan, 1964)

these ages identical and many would show a discrepancy of greater than a decade. Supporting these premises, the sample of 107 volunteers of this study yielded only a 7% instance of identical CA and BA; 50% or half the sample had a BA older than their CA, 43% the reverse (not a significant difference); 47% or nearly half were of a BA within plus or minus 5 years of their CA; 67% or nearly two thirds of the sample are within plus or minus 10 years of their CA.

Although the AGE basic test is already brief, equipment failure or time limitations might lead one to ask if any one subtest can effectively represent the full test or if any one subtest would be significantly better at this than the other two. Correlations in Table 1 suggest that the best subtest predictors of the total BA score are systolic blood pressure (.85) and near vision (.81) subtests; hearing loss seems a less effective predictor or sub-

stitute (.74). To confirm this by a more appropriate analysis, since medians are used, the nonparametric subtest evaluation of medians per item (Morgan, 1964) was employed for the 101 subjects taking all three subtests. The results, depicted in Table 2, confirm that hearing loss is significantly the least effective predictor of the total BA score while near vision appeared to be the most effective predictor and, therefore, the subtest of choice to represent the full three subtest examination when necessary.

Individual estimates of body age (EBA) averaged an absolute difference of 7½ years from tested body age. Seven per cent of the subjects estimated their body age correctly to the year. The sample's median BA and CA were the same, 40 years; the median EBA was a lower 35 years. The EBA of most subjects tested underestimated the difference between their CA and BA regardless of direction.

About a sixth of the volunteers were more than 10 years older (BA) than their birth age while about another one sixth of the sample tested at more than 10 years younger than their birth age. A non-quantitative observation is that these groups could be easily differentiated from each other by casual inspection of appearance, mood, and behavior. Two women, both born forty years ago, tested at a BA of 20 and 60 years respectively. They clearly looked twenty years apart in age: factors differentiating them and others like them need to be understood.

DISCUSSION AND CONCLUSIONS

The basic AGE demonstrates enough reliability and validity to justify its continued existence as a first approximation of bodily aging in individual human adults. However, the test must continue to evolve through expanded and ever more contemporary norms, further validity studies, and functional social applications. In this study, a distinction was made and quantified between chronological age, tested body age, and personal estimated age. Some work has been done on the self-concept of age or estimated age (Jeffers *et al*, 1962) and even more on aspects of body age (particularly medical and physiological) and on chronological age (particularly philosophical and physical). The key focus for the future, however, is most likely the field inter-relationship of all three kinds of aging. This has relevance for both research and practice in the psychology of aging.

Some research directions where the AGE test in particular may be of use would include cross-cultural analysis of living patterns that foster accelerated aging and early mortality or slowed aging and delayed mortality; evaluation of institutions, agencies, treatments, and occupations for

their impact on aging controlling for equal body age in research on other variables. Bortz and Bortz (1956) did some early work on race and differential aging; Morgan (1968) found black males aged faster than white males in their first decade of adult life, and that the move from 40 to 50 years represented the greatest decade of aging rate for women. Such findings need to be confirmed and then, more difficult, explained. The AGE test as an evaluation instrument, in areas where its efficiency percentage fairly describes an agency (Morgan, 1968b), might help determine the status of homes for the aged and innovative health treatments.

The AGE test also has applications to the professional practice of psychologists and health personnel, both by itself and embedded in multiphasic diagnostic batteries designed for psychological and medical use. An age score can be dramatic testimony to the individual patient that he is farther on the path from cradle to grave than he wished to believe. Presumably, poor age scores can be improved, or at least kept from deteriorating more rapidly, where proper health care and health improvement procedures are applied.

REFERENCES

Baltes, P. B. Longitudinal and cross sectional consequences in the study of age and generation effects. *Human Development*, 1968, 11, 145-171.

Benjamin, H. Outline of a method to estimate the biological age with special reference to the role of sexual functions. *Int. J. Sexol.*, 1949, 3, 34-37.

Bortz, W. M., & Bortz, E. L. Race and differential aging. *Hawaii Medical Journal*, 1956, 16, 134-175.

Bourliere, F. Assessing biological age. In P. Williams, C. Tibbitts, & W. Donahue (Eds.), *Processes of Aging*: I. New York: Atherton, 1963. Pp. 184-197.

Clarke, J. The aging dimension: a factorial analysis of individual differences with age on psychological and physiological measurements. *J. Gerontol.*, 1960, 15, 183-187.

Duane, A. Subnormal accommodation. *Arch. Opth.*, 1925, 54, 566-587.

Duane, A. Accommodation. *Arch. Opth.*, 1931, 5, 1-14.

Florey, C., & Acheson, R. M. *Blood Pressure as It Relates to Physique, Blood Glucose, and Serum Cholesterol.* Washington, D.C.: Public Health Service, 1969: PHS Publ. No. 1000, Series 11, No. 34.

Glorig, A., & Roberts, J. *Hearing Levels of Adults by Age and Sex.* Washington, D.C.: Public Health Service, 1965: PHS Publ. No. 1000, Series 11, No. 11.

Gordon, T. *Blood Pressure of Adults by Age and Sex.* Washington, D.C.: Public Health Service, 1964 (a): PHS Publ. No. 1000, Series 11, No. 4.

Gordon, T. *Blood Pressure of Adults by Race and Area.* Washington, D.C.: Public Health Service, 1964 (b): PHS Publ. No. 1000, Series 11, No. 5.

Hofstetter, H. W. A comparison of Duane's and Donders' tables of the amplitude of accommodation. *Amer. J. Optom.*, 1944, 21, 345-363.

Hofstetter, H. W. Some interrelationships of age, refraction, and rate of refractive changes. *Amer. J. Optom.*, 1954, 31, 161-169.

Jalavisto, E. The role of simple tests measuring speed of performance in the assessment of biological vigour: a factorial study of elderly women. In A. Welford, & J. Birren (Eds.), *Behavior, Aging, and the Nervous System*. Springfield, Illinois: Thomas, 1965. Pp. 13-25.

Jalavisto, E., & Makkonen, I. On the assessment of biological age: I. Factor analysis of physiological measurements in old and young women. *Ann. Acad. Sci. Fenn.*, 1963, AV, 1-38. (a)

Jalavisto, E., & Makkonen, T. On the assessment of biological age: II. A factorial study of aging in postmenopausal women. *Ann. Acad. Sci. Fenn.*, 1963, 101, 1-15. (b)

Jeffers, F., Eisdorfer, C., & Busse, E. Measurement of age identification: a methodological note. *J. Gerontol.*, 1962, 17, 437-439.

Linder, F. *Cycle 1 of the Health Examination Survey. Sample and Response*. Washington, D.C.: Public Health Service, 1964: PHS Publ. No. 1000, Series 11, No. 1.

Morgan, R. F. The M/I frequencies: a quick and computation-free non-parametric method of test item evaluation. *Psychol. Reports*, 1964, 14, 723-728.

Morgan, R. F. The adult growth examination: preliminary comparisons of physical aging in adults by sex and race. *Percept. Mot. Skills*, 1968, 27, 595-599. (a)

Morgan, R. F. Need for greater use of efficiency percentages to supplement reports of statistical significance. *Percept. Mot. Skills*, 1968, 27, 338. (b)

Morgan, R. F. How old are you? *London Sunday Times*, 1969, October 19, 39.

Morgan, R. F. How old are you really? *Canadian Magazine*, 1970, February 28, 2-4.

Morgan, R. F. The adult growth examination (AGE): Manual for a compact standardized test of individual aging. (Unpublished manual, California School of Professional Psychology, San Francisco, October, 1971)

Morgan, R. F., & Fevens, S. K. Reliability of the adult growth examination: a standardized test of individual aging. *Percept. Mot. Skills*, 1972, in press.

Murray, I. M. Assessment of physiologic age by combination of several criteria: vision, hearing, blood pressure, and muscle force. *J. Gerontol.*, 1951, 6, 120-126.

Rambo, V. C., & Sangal, S. P. A study of the accommodation of the people of India. *Amer. J. Opth.*, 1960, 49, 993-1004.

Roberts, J. *Binocular Visual Acuity of Adults*. Washington, D.C.: Public Health Service, 1964: PHS Publ. No. 1000, Series 11, No. 3.

Roberts, J. *Binocular Visual Acuity of Adults by Region and Selected Demographic Characteristics*. Washington, D.C.: Public Health Service, 1967: PHS Publ. No. 1000, Series 11, No. 25.

Roberts, J. *Monocular-Binocular Visual Acuity of Adults*. Washington, D.C.: Public Health Service, 1968. PHS Publ. No. 1000, Series 11, No. 30. (a)

Roberts, J. *Hearing Status and Ear Examination Findings Among Adults*. Washington, D.C.: Public Health Service, 1968: PHS Publ. No. 1000, Series 11, No. 32. (b)

Roberts, J., & Bayliss, D. *Hearing Levels of Adults by Race, Region, and Area of Residence*. Washington, D. C.: Public Health Service, 1967: PHS Publ. No. 1000, Series 11, No. 26.

Roberts, J., & Cohrssen, J. *Hearing Levels of Adults by Education, Income, and Occupation*. Washington, D.C.: Public Health Service, 1968: PHS Publ. No. 1000, Series 11, No. 31. (a)

Roberts, J., & Cohrssen, J. *History and Examination Findings Related to Visual Acuity among Adults*. Washington, D.C.: Public Health Service, 1968: PHS Publ. No. 1000, Series 11, No. 28. (b)

Rosee, B. G. Untersuchungen uber das normale Horvermogen in der verscheidenen Lebensaltern unter besonderer Berucksichtigung der Prufung mit dem Audiometer. *Ztschr. Laryng. Rhin. Otol.*, 1953, 32, 414-420.

Science Digest. Are you older than you think? 1969, 66, August, 20-21.

Tait, E. F. Accommodative convergence. *Amer. J. Opth.*, 1951, 34, 1093-1107.