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TRAINING, PRACTICE AND MENTAL LONGEVITY[1]

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"EVERY body knows," wrote Cohausen in 1742, "how grateful and refreshing we discern the breath of cows to be, which is thence supposed, exceedingly wholesome; . . . There seems, therefore, to be nothing forced or absurd, in conceiving that the warm, active, and balsamic particles thrown off by the lungs of young people into the air, which they respire, may give it such a quality, as when sucked in again by a person in years, shall communicate an extraordinary force to the circulating humors in his body, and so quicken and enliven them, as to bestow a kind of reflective youthfulness, which may for many years keep off and delay those infirmities, to which people of the same age are generally subject. The more we consider this doctrine . . . the more we shall be satisfied of the truth of this conjecture, and the more credible this invention of Hermippus will appear."[2] The indulgent smiles called forth by this hot-air paragraph of hope from a former generation give pause to anyone who undertakes a discourse on any phase of the subject of longevity. The perennial search for the *elixir vitae* stands as one of the seven extravagancies of the mind of man, and he who openly shows himself to be a prospector here or near here may expect to hear voices in concert quoting, "What fools these mortals be!"

Having answered to the description and having attended to these introductory formalities of the occasion may I then proceed to tell you what I intend to say. This paper will deal with normal longevity from a psychological viewpoint. It will not concern cen-

[1] Address of the retiring vice-president and chairman of the section on psychology, American Association for the Advancement of Science, Pittsburgh, December 28, 1934.

[2] J. H. Cohausen, "Hermippus Redivivus: Or the Sage's Triumph Over Old Age and the Grave." Tr. into English by J. Campbell. Edited by E. Goldsmid. In three volumes. Privately printed, Edinburgh, 1885, Vol. 1, pp. 20 and 27.

tenarians, nonagenarians, or even octogenarians. There will be no attempted consideration of the factors of race, heredity, climate, food, drink, rural *versus* urban surroundings, marital state, or medical care. These stock topics concerning a man's family, place and physical way of living constitute the subject-matter for the often trite inquirer, which, throughout countless generations, have been made about nearly every human who has happened to be an example of extended or abnormal longevity. I shall try rather to interrogate the ways of the mind than those of the body, inseparable though mind and body appear to be. The type and regimen of inner experience that perchance is positively correlated with preferred mental-life risk or prospect is what I desire to glimpse. The ancient query, "Can a man by taking thought add one cubit to his stature?" implied a prompt unreserved "no" as answer. But the familiar phrase, training accentuates psychological traits and practise makes perfect, we readily accept as applicable to the baby, the child and the adolescent. The young or moderately young by taking thought, we believe, can lengthen the attention span and the memory reach, increase the vocabulary, multiply discriminable differences, develop problem-solving techniques, accelerate directness in creative work, and in scores of other ways modify the mind and its complicated mechanisms of expression. What comes of such self-organization and regimentation when we reach older years? Is there any evidence to support the theory that our mental longevity will be appreciably influenced by the climb in psychological skills which we make early or moderately early in life and by the use-disuse ratio which we permit between our earlier and later decades? A modern court has ruled that, "less mental faculty is required to execute a will than to enter into any other legal instrument."[3] Can man through the mental gymnastics and by the continuance of psychological wakefulness associated with professional or avocational activities insure himself with nature for something in late life better than mere disposing memory or testamentary capacity, important though that may be to a few interested persons? This general question I should like to help to answer.

THE OLD-AGE TEST

The attainment to old age is the most ancient and honorable physical-mental test performance known to the experience of man. As a test it is presumed to have a very respectable degree of reliability and irreproachable validity. The test is given under natural rather than artificial environmental surroundings and the population concerned is adequate. The results appear to be trustworthy and permissible of broad generalizations; they are accepted by the majority, although being at the same time sharply criticized by smaller groups. The items which compose the test are mostly stock items which were selected long ago after a great deal of preliminary trying out of this material and that. There are slight variations of emphasis within the test from generation to generation but the general get-up and form of the examination appears to have remained much the same during the past few centuries in spite of the apparent danger from coaching. In fact coaching rather than being prohibited has come to be looked upon with socio-scientific favor.

Considering our problem in closer detail it is of course obvious that on the quantitative side we must not confuse old age with the year value for expectation of life at birth. The great change in life expectation as an average mortality value has been wrought in our statistics through the triumphs of medicine and public health in dealing successfully with problems of infant and child life risk. Richardson's[4] recent study of inscriptions on 2,022 Greek sepulchers shows an average age at death of 29.4 years. Probably, due to burial customs, this value is somewhat higher than Hippocrates and Galen would have given us had they been interested in a statistical approach to these matters. Results compiled in Geneva for the 16th, 17th and 18th centuries respectively show, 21, 26 and 34 years as mortality averages. In Massachusetts just before 1800 the value was 35 years and by 1890 we find 43 years. In 1900 for the U. S. registration states it was 49 with an increase to 51 for 1910, and averaged 56.4 for 1920. Now 15 years later we appear to stand at 59.3 years for males and 62.8 for females. One does not have to be either a biometrician or an actuary to understand readily that any ascertained gain in average life expectancy is meaningful chiefly by interpretation in reference to life expectancy found in different portions of the theoretical human life-span. It is now generally agreed that practically all of the widely heralded change has occurred in the decades below 50. Those who reach the half-century mark to-day have practically the same chances of life and death as had their parents, grandparents, and perhaps their earlier ancestors. For example the expectation of life at age 52[5] throughout our country holds almost as close to 21 years as does the percentage value for the oxygen content of outdoor air. It is a little less than 21 years for men of 52 and a little more for women of this age. The sex difference amounts to nearly a full year and appears to be statistically reliable. The progress

[3] N. Y. Sur. 1921. In re Tymeson's Will 187, N. Y. S. 330,114. Misc. Rep. 643.

[4] B. E. Richardson, "Old Age Among the Ancient Greeks," Baltimore, Johns Hopkins Press, 1933, p. 376.

[5] R. H. Lyman, Ed. "The World Almanac and Book of Facts." New York, World-Telegram, 1934, p. 292.

difference measured in less than half-century steps is small and doubtful, possibly about three tenths of a year since 1900, and this gain some have credited to the hospital accessibility enjoyed by large urban groups. Progress in scientific medicine and hygiene presumably must influence the tenability of the older decades of the human life-span and we seem to be justified in believing there has been some progressive upward shift even though old literature said three score years and ten with sometimes four score, and to-day this same formulation fits the facts. Perhaps it is not inappropriate to compare the Greek data[4] with the U. S. 1930 mortality tables. If we take the Greek cases recorded as dying at age 50 and older, a total of 332, the successive decades from the 6th to the 11th respectively show the following percentages: 38.0, 28.0, 19.3, 10.5, 3.3, and 0.9. The comparable percentage values for the United States in 1930 of persons 50 years and older are found to be: 23.0, 29.2, 29.8, 15.5, 2.3, and 0.2. The two series of values resemble one another. But the high point of death incidence in the Greek group falls in the 50's while for the recent Americans it is found between 60 and 79. The shift seems large enough to talk about, but it is not the time now to deal with this specific point in detail. The favorable shift that has occurred does not contradict the essential conditions leading to our conclusion that the long-life test continues in one generation after another to show a relatively unchanged mean score norm available in measurement and comparison and against which an x number of factors can be viewed.

Longevity as a Mental Test

As psychologists the factors that occur to us as particularly interesting for study in reference to old age are those having to do with the intellect in its aspects of endowment, performance ability and with training and experience. Traditionally wisdom has been associated with age and various features of primitive as well as civilized culture patterns have contributed to confer distinction and leadership on the old. Genius and eminence rank high in actuarial folklore and perhaps if we could get at the basic facts they would still bear out the resultant popular belief. The life-spans of 115 eminent ancient Greeks classified according to primary fields of achievement show averages that surpass what seemingly was for the bulk of their countrymen usual. I will mention four professional groups for each of which the number of cases is not too trivial: 38 philosophers lived on the average to 78.8 years, 26 writers (poets) 79.3 years, 25 writers (historians, critics) 78.4 years, and 10 orators, 71.6 years. The average was 77 years and 45 per cent. of the group reached the 80-year mark. An earlier piece of work than the study of Richardson on the Greeks was that by Cox[6] on the 282 most eminent men born between 1450 and 1850. In that investigation it was found that 42 lived 80 years or longer, whereas within an average group of this size only 3 or 4 might be expected to reach that age. The 22 philosophers slightly surpassed 68 life years, 43 poets, novelists and dramatists and 23 religious leaders averaged just under 68 years; 52 historians, essayists and critics did not quite reach a mean life span of 64 years, while the group of revolutionary statesmen got off with about 51. The total average for the 282 geniuses was 65.8 years. Undoubtedly it is a fair question to ask how far long life pushes a man toward eminence. Given 100 men of equal ability the 50 who live longest should of course achieve greater average distinction. It seems very clear, however, in this comprehensive study of the 282 distinguished persons that mental accomplishments in early and mature years and not chronological longevity constitute the social criteria of greatness. Hence the correlation between age and achievement is the more meaningful. Outstanding mental grasp and strength makes its professional business that of working with and creating values from physical, biological and cultural materials but as a rule such strength does not neglect incidentally to pass the old age test with an appropriately high score.

Human century plants breed from capable common stock and themselves tend to be above average in capability. Primitive environment and lack of education may have handicapped them in many instances, but it is not unreasonable to believe that mental alertness has survival value and will be found to correlate positively with those somatic and functional traits of skeleton, heart, endocrines, nervous system and so on which make for "long lasting." I am not acquainted with any more significant data on this phase of our topic than those published fifty years ago by Humphry[7] who with the aid of many interested British physicians secured information concerning nearly nine hundred persons who had attained the age of eighty years, including seventy-four centenarians. Intellect and memory constituted two of the several topics studied in these populations selected only for age. Discussing the then "present condition" of a group of fifty-two centenarians the statement made was: Intellect—forty-six returns, high 11, average 29, low 5, childish for 6 years 1. One was said to be slow in comprehending questions, but smart in reply. Memory: (a) recent events, thirty-nine re-

[6] C. M. Cox, "The Early Mental Traits of Three Hundred Geniuses." Vol. II, Genetic Studies of Genius, Stanford University Press, Stanford Univ., Calif., 1926, pp. 35–36.

[7] G. M. Humphry, "Old Age." Cambridge, MacMillan and Bowes, 1889, pp. 218.

turns; good 26, moderate 7, bad 6; (b) past events—forty-seven returns; good 39; moderate 4, bad 4. "One remembers and will quote a great deal of the Bible, another could repeat about 100 Psalms correctly." The temptation to give more of Humphry's results is great. What I have included are typical and I think significant. High ratings of intelligence exceed low ratings in the ratio two to one or better. We know from the rather recent experimental work on the course of the intelligence score curve in adulthood[8] that the correlation between age and score from the age of 20 to 95 years in homogeneous population is usually about $-.40$ in speed tests and $-.30$ where speed is not involved. The difference between the average scores in the twenty-year group and in the eighty-year group in a timed test is near 10 times the sigma of the difference. The drop between age 18 and age 85 is possibly 60 per cent. of the peak score amounting to fully 5 mental age years. When an old person is judged to be of average adult intelligence, unless we must allow for a very large chance error in the judgment, it is a fair assumption that his or her intelligence in early adulthood would have rated considerably above average. If we take this into account in reference to Humphry's findings for intellect in advanced age the significance of the findings appears to be increased and they are seen to conform the more strikingly with the long life trend found among men of eminence and genius.

The Intelligence-Experience Partnership

I have spoken of the correlation between human superiority and longevity in undoubtedly too simplified a formulation and the statements at this stage represent more a point of view than a fully demonstrated scientific finding. The nature-nurture knot is no less tight and stiff here than elsewhere. Professional groups, including, for example, judges, clergymen, and physicians show remarkably prolonged active careers and in insurance circles are termed preferred risks. The word "professional" implies training and practise of a high order as dominant features which characterize a type of life or of human being. From a multitude of psychological and educational studies we are convinced that those who present themselves as candidates for and who successfully carry through prolonged intensive professional training are at least of high average and more usually of superior intelligence. Mental endowment plus training constitute the effective partnership which through practice functions with such outstanding efficiency in the professional groups in comparison with the general population averages. We do not wish to dissolve this partnership, that would be perilous. We are curious to know who is who among the active directors and if practise is more than a well-trained shipping clerk. Anecdotal-descriptive treatments of what might now be called the ability-practise-age problem have been many particularly if we turn to the biographical and autobiographical literature. On the other hand, scientific psychology has been slow to follow the lead of Galton in attempting laboratory measurements with adult age as the chief variable. Only within the last decade have such studies begun to appear in our experimental literature and there are scarcely more than a dozen of them to date. It has been a real triumph to win the cooperation of men and women in all decades of life and I feel that my own research, the Stanford Later Maturity Study,[9] is distinguished by reason of the cooperation of older adults. More than 300 people 70 years of age or older have come to our testing laboratories to be tested and studied. There is a thrill in the realization that a new and important human territory is opening for scientific exploration and therefore to some extent we may believe, for better scientific control. So far the psychological experiments conducted on the influence of adult age have been attempts to measure the ratio between scoring ability and age along various strategic psychological arteries. Attention has been centered on the measurement and the correlations rather than on the populations. The experiments could not be set up specifically to emphasize the relative influences of native ability and of experience until the normative data were gathered. However, even in the exploratory stage there appear some experimental results which may be examined from this angle of interest as indicators of probable trends and of points of attack for further investigation.

Motility and Motor Functions

Physiological age exacts its tax year by year as the individual grows older; but psychological age adds to the personal capital stock of experience and bonds of association as real assets to be drawn upon. The presence of so-called senile tremor in its early unexaggerated stages is no doubt an annoying inconvenience. But as may be commonly observed there is a conspicuous lack of disability in consequence of it. Fine manipulations of the fingers as in sewing, writing or the use of instruments, even those of precision, are continued with great skill by many who have quite observable tremor. Even though loss of quickness and

[8] C. C. Miles and W. R. Miles, "The Correlation of Intelligence Scores and Chronological Age from Early to Late Maturity." *Amer. Jour. Psychol.*, 44: 44–78, 1932; C. C. Miles, "Influence of Speed and Age on Intelligence Scores of Adults." *Jour. Gen. Psychol.*, 10: 208–210, 1934.

[9] W. R. Miles, "Age and Human Ability." *Psychol. Rev.*, 40: 99–123, 1933. These studies have been supported by the Carnegie Corporation of New York.

accuracy in leg coordinations may serve to retire a 40-year old baseball player from the big leagues it is none the less true that in many of the motor functions the decline from a peak which may have occurred in the 20's or 30's is slow and apparently considerably retarded through the effect of occupational or other practise engaged in by the mature individual.

The influence of training and practise, the psychological assets, upon the physiological motor functions, is well illustrated with respect to a complicated skill in performance in the sport of trap-shooting, where not a few of the nationally famous expert champions are men considerably beyond middle life. Recently I have examined some data for 400 trap-shooters including their scores at a national tournament in 1932 gathered by Mr. Edward Pugsley, of the Winchester Repeating Arms Company. The scores measure visual reaction time by use of an electric circuit with a flashlight target, a chronograph and a gun. The ratings used are based on the first four reaction shots. A group of 28 trap-shooters in Class AA with an average age of 44.5 years averaged 191 sigma while 43 Class A men averaging two years younger, that is 42.3 years, gave the less good report of 198 sigma. Of more significance for our present problem than distinguishing between AA and A classes of trap-shooters is the matter of the regular relation of age to performance skill and here, in general, decrement does occur. One hundred and seventeen men whose ages were known to be between 20 and 49 inclusive gave an average reaction time of 200 sigma as compared to the average of 209 sigma for 58 men aged 50 to 85 years. All of the mean values are just a little higher for the older group, the reaction times averaging about 4.5 per cent. longer. For 33 trap-shooters aged 40 to 44, the average is 203, and for 26 aged 50–54 it is 206. But in the very young group the trend is reversed: 13 young trap-shooters from 10 to 19 years of age competing in this national tournament average 246. The extraordinary contribution of the trap-shooting test is in the example it provides of the counterbalancing effect of the psychological elements of skill, practise and experience upon the inevitable physiological ravages of age. Neither Galton's data gathered in 1884 and recently analyzed and published by Ruger[10] nor my own in the Stanford Maturity Research nor that of any of my associates duplicate this particular good example of the weight of experience counterbalancing the weight of years with respect to a motor skill. I believe that similar examples will be found in the realm of the skilled trades and occupations where men with zest and interest really exert themselves on materials and in tasks with which they are familiar. Trap-shooting is unique only in being highly standardized and scorable. Results from laboratory measures of motor functions elaborate and substantiate the interesting trap-shooting findings. Series of tests of speed of movement where the mental organization element is slight show the age decrement as fairly large; when the test includes the elements of selection and adjustment of the movement or movements with respect even to some fairly familiar or easy task, experience reduces the decrement. For example, in the simplest movement of the index finger of the preferred or dominant hand, that is, lifting the finger off a key and pressing it down again, shows a marked decrement with age. The much more complicated task of opening three ordinary letter size envelopes with a paper knife on the other hand shows less change with age. The correlation coefficients for these two contrasted functions for large groups of persons 20 to 90 years of age are $-.57$ for simple speed of movement, $-.46$ where a planful use of experience is even so slightly involved as in the task of letter opening. Well-practised complicated skills and especially those which do not tax strength too severely show the best degree of retention among the motor functions and here with thoughtful planning a great contribution to mental longevity may be made.

[10] H. A. Ruger and B. Stoessiger, "On the Growth Curves of Certain Characters in Man (Males)." *Ann. Eugen.*, 1927, 2, Pts. I and II, 76–110.

Sensory and Perceptual Functions

An old English proverb says that no agricultural laborer who is more than forty years old can hear a bat squeak. I am not aware that Galton made any calibrations on bats but with his famous whistle he did verify the effects of the auditory decrement with age. From his data as published by Ruger on 3,816 men, ages 25 to 81, a recently calculated correlation coefficient for age with highest audible pitch gives $r = -.482 \pm .008$. That our eyes tend to grow old rather early has been more generally remarked than has the downward course of the hearing function. Decreases in accommodation power and in visual acuity are among the first harbingers of age to which we give heed. Here Galton's adults, 3,850 men, ages 25 to 81, show a negative correlation of age with visual acuity, $r = -.512 \pm .008$. The results which more recent investigators have gathered in their laboratories closely agree with the trends indicated by these coefficients and show that we are, so to speak, up against an inexorable law of decline with respect to the simple physiological sensory functions. Fortunately ophthalmology and autology have come to our aid and we may expect the development of further mechanical techniques to supplement practically the slight preventive and remedial measures that may be applicable to sensory age-decrement. A tomb in

Florence bears an inscription which reads: "Here lies Salvino degli Armati, Inventor of Spectacles. May God pardon his sins." Although this sentiment is a little ambiguous I take it to indicate human gratitude to one who helped us in the more effective use of these functions in which we are little able to help ourselves.

When the sensory functions are employed in tasks more complicated than mere acuity tests, with opportunities for interpretation of content and meaning, the psychological factor enters and the results are less unfavorable for age. That is, the situation here is parallel to that mentioned in the field of simple motility as compared with more complex motor functions. In a tachistoscopic study of perceptual ability where letters, digits, words, sentences, colors and simple diagrams were employed as content by which to measure the amount grasped in a single visual exposure it was found that the correlation of perceptual score with age was −.43 which is considerably lower than the decrement coefficient for visual acuity and age. Then when the same subjects were tested for speed of reading a standard passage the coefficient became still smaller, reaching a value of −.27. From these and other similar results it seems that familiarity or naturalness in the test situation together with a degree of complexity which gives scope for individualized mental technique operates for an increase in scoring power in mature and older adults.

Perception in the old as compared with the young, although not as prompt or as great in span, is frequently joined with the quality of perseverance or persistence in consecutive efforts. This results in relative evenness of performance, a point for which old age should and often does receive due credit in industry. It appears to be a modification referable to practice and through it a broadening of perceptual interest can be achieved.

Learning and Memory

Blurred memory like blurred vision is frightfully conspicuous to him who has it. And as to the relation between memory and mental longevity doubtless many hold with Longfellow,

> "Whatever poet, orator, or sage
> May say of it, old age is still old age."[11]

But actually the annoyance and frustration caused by slight forgetting may be subjectively quite exaggerated and out of proportion to the actual amount of defect. Furthermore we may observe that it is a popular and wide-spread conversational habit among middle-aged people and even some adolescents as well as among the old to make disparaging remarks concerning their own memories. These faithful and hard-worked functions are talked about with the same unsympathetic objectivity and blatant candor that was once used in discussing cooks or maid servants. For a kinder and probably truer picture we may look again with profit to Humphry's data.[12] In his analysis of the returns relating to 340 males and 282 females 80 to 90 years of age we find that memory for past events is reported good in 82 per cent. of the men and 73 per cent. of the women, moderate in 11 per cent. of the men and 16 per cent. of the women, and bad in only 7 per cent. of the men and 12 per cent. of the women. Memory for recent events is reported as follows: good, men 64 per cent., women 54 per cent.; moderate, men 21 per cent., women 26 per cent.; bad, men 15 per cent., women 19 per cent. No comment need be made on what I am content to believe may be an unreliable sex difference here except to suggest that the matter of occupational necessity may bring practise more favorable to the men. My point is that memory function is not universally bad or even moderately bad among older people. To be sure, on the average, memory shows some decrement with age as we have measured it in successive decade groups of different individuals, but the memory decrement is not larger than that usually found for other mental functions. A straightforward memory task involving familiar material or concepts may be counted on to yield a negative correlation with adult age of about .40. However, if the material consists of nonsense syllables or involves mastering relations that are contrary to established mental associations the coefficient is more likely to be approximately −.60. Ruch[13] in one of the Stanford Later Maturity Studies has dealt especially with this matter of practise and memory as it relates to the use of previously familiar material. His results agree with those of Willoughby, Jones, Conrad, and Horn, and with Thorndike, Bregman, Tilton and Woodyard[14] in finding that the meaningful previously acquired content items could be learned with much less age deficit than was found for extensively reorganized or nonsense material where long-established mental association habits operated as interference to learning. When, in studies of adult learning, we classify the men and women in terms of the amount of formal schooling in three groups: college, high school and grade school, the three resulting sets of results fall in line with what we may suppose correspond to three grades of

[11] H. W. Longfellow, "Morituri Salutamus."

[12] *Ibid.*, G. M. Humphry.

[13] F. L. Ruch, "The Differentiative Effects of Age upon Human Learning." *Jour. Gen. Psychol.*, 11: 261–286, 1934.

[14] All summarized in W. R. Miles, "Age and Human Society." Ch. 15, C. Murchison (Ed.), Handbook of Social Psychology, Clark University Press, Worcester, Mass. In press.

training for practise. For example Price[15] with a reliable directions test, making use of immediate memory, found a correlation coefficient of −.51 and a regular point score decline per decade of 6.7 in the college population, 7.1 for the high school population and 9.6 for adults with grade school education. The greater decrement at the lower educational level must be in part a function or a correlate of less general ability, but the influence implied in experience is also demonstrated by individual differences within the three groups.

INTELLIGENCE AND AGE

The direct and positive relationship between human intelligence and chronological age during childhood and youth has probably always been obvious to man and was not difficult to demonstrate scientifically after appropriate tools had been developed for working with mental performance ability. In contrast adult minds have typically been thought of as continuing relatively unchanged except in accumulation of experience for several decades just as the skeleton of the adult having completed its growth was thought to undergo only slight modifications until the active processes of senile change set in late in life. Relatively few have had the insight and the temerity demonstrated by Montaigne when he said, "For my part, I believe our souls are adult at 20 as much as they are ever like to be, and as capable then as ever. . . ." Here he inserts a quotation, "if the thorn pricks not when it first shoots, it hardly ever will at all," and then continues. . . . "Of all the great human actions I ever heard or read of, of what sort soever, I have observed, both in former ages and our own, more performed before thirty than after; and oft times in the lives of the same man. . . . As to myself, I am certain that since that age both my understanding and my constitution have rather decayed than improved, retired rather than advanced. 'Tis possible that, with those who make the best use of their time, knowledge, and experience may grow up and increase with their years; but vivacity, quickness, steadiness, and other qualities, more our own, of much greater importance, and much more essential, languish and decay."[16] This mental dissection by Montaigne cuts rather too close to the quick for comfort and rather hastily discards much that might be called supporting mental structure. However, even though as individuals we may be loathe to admit it, since self-evident decline is not usual, still our practical experience does show that many perhaps most of the easily measurable human capacities decline with respect to the compound quantity-quality output after we pass middle age and before we have reached old age. Serious scientific work in this field has only recently begun and the preliminary data so far published comparing the various psychological abilities throughout the life span are almost entirely based upon measurements of different individuals within the decades and semi-decades where comparison is made. Quite regularly it has been found that the maximal scoring ability occurs between the ages of 18 and 49 whether the test be of general intelligence or of a more restricted aspect of mental activity. Performance tasks which strongly emphasize the factor of speed somewhat penalize the old but tests given with unlimited time seldom fail to show some progressive decrement throughout the last four or five decades of life. The correlation coefficients found between scoring ability and age for the range from 25 to 95 years extend from small plus or nearly 0 values to minus .65 with the usual correlational value falling near −.3. Not all measurements thus far taken show a clearly continuous decline from the late 20's to the early 90's. For some there is a fair plateau until perhaps the late 40's or early 50's. For others there is scarcely any change even in advanced age.

We may survey briefly some of the experimental results for adult age which have been found in this broad field of judgment and reasoning which we call intelligence. Let us examine first some of Galton's measurements.[10] He had in all seventeen, which included three judgment tests: (1) sense of perpendicularity, error measured in degrees; (2) error of bisection; and (3) error of trisection, in both of which the score was in percentage of the length, bisected or trisected. The published data include about 3,815 cases with age range between 25 and 81 for each of the three. The correlations between age and score turn out most interestingly to be practically zero: perpendicularity $+.058 \pm .011$; bisection $+.071 \pm .011$; and trisection $+.033 \pm .011$. Clearly, with this type of task which closely approximates the activity involved in the fundamental spatial judgments of adult life there is no decrement with increased adult age. And yet these judgments correlate decidedly with intelligence and we know that the feeble-minded or the very young can not make them. Results for similar functions show similar results in the more recent Stanford Study. From these we may turn to a kind of test in which experience varies more profoundly and practical as well as theoretical intelligence is measured. The Stanford battery of 1932 included the McFarland Coat Assembly Test (by snaps a complete garment is to be put together from 9 pieces) and a painted block assembly test (a painted 3 inch cube

[15] B. Price, "A Directions Test Arranged as an Interview and a Determination of Adult Age Effects Therewith." Stanford Univ., Calif., 1933. Unpub. Ph.D. Thesis.

[16] M. de Montaigne, Works, New York, 1872. Vol. I, "Of Age," p. 467 ff.

that has been cut into 1 inch cubes has to be reassembled). What happened in the case of the coat test? The men showed the usual decline with increasing age, the women did not. For them the influence of experience was so usefully complete that even though the garment design was novel they succeeded about equally well decade by decade up to the 70's. On a repetition of the task the women made relatively less gain than the men for they were already nearer their physiological limit of speed, and insight due to experience had been present from the first. The men made a great improvement on the second trial; for them the experience and practise of the first trial was unique and therefore highly important. In the block test the situation was not reversed, the women showed a less good performance but also less age decline than the men. Actually, as indicated by the two coefficients: for the women $r = -.330 \pm .03$; for the men $r = -.435 \pm .029$. Putting together a series of blocks isn't mechanical enough to baffle the average woman but a group of men in the 50's and 60's with experience in mechanical fields exceeded other men of the same ages and equal general schooling by a difference that is 2.5 times its standard error.

Coming now directly to what are generally called intelligence tests we find that the scores for the Otis Omnibus Test continue to show in one population after another the same age decline and the same experiential retardation in this decline that appeared in our first study. But when the test is broken up into its elements by functional type into verbal, reasoning and mathematical items and when we sort the responses of four hundred men and women representing all the adult life decades we find a differential scale of decline with age from the least to the most affected of these three general types. Representative samples from several tables of correlations will illustrate the trends. For men and women of the general population (combining those of grade school and high school education) the correlation coefficients of scores with age from 25 to 90 years run as follows: Synonym-Antonym, +.013; Vocabulary, −.043; Analogies, −.105; Logical Selection, −.091; Proverbs, −.164; Arithmetical Problems, −.237; and Number Relations, −.262.

This finding that language functions, examined differentially, are relatively impervious to old age change and represent basic assets for mental longevity has been demonstrated by other investigators also. Clinical medicine has always counted on the language function in its patients. Hollingworth[17] in 1920 pointed out that the old succeed well in tests of completion, opposites and word-building; Thorndike[18] and associates have more recently amassed further data in these matters in their study of learning; and Babcock's[19] use of their present vocabulary in estimating the earlier intelligence of deteriorated patients is a practical application of this finding based on further corroborative data.

At present no definitive answer can be given to the question of how large a rôle is played by training and practise in producing the decline differential between language and reasoning. If reasoning and arithmetic as representatives of types of mental function were practised as continuously as language tends to be they too might show a slim and trim correlational figure. Of course what we actually believe is that in many an individual such practise and such substantial fruits of practice are to be found hence the great amount of individual difference which is present in the period of later maturity.

Old Age a Test of Practise

Brightness and dullness, experience and inexperience, mutually enhance each other in this world of human affairs. He would be stupid indeed who tried to abolish one or the other in any of these pairs. If into a fire-fly is injected a little adrenin he quits being intermittent and remains illuminated all night long. But the treatment is not supposed to be of benefit to the fire-fly. I have not discovered any psychological adrenin to change our human mental intermittency and deficiency into steady powerful light and most of us would quite properly hesitate to be inoculated were the substance at hand. It is neither the elimination of contrast among men nor an unchanging plateau in our own experience that we seek. The final orientation of my thesis to-night will be clearer if I remind you that just fifty years ago our eminent chairman Dr. James McKeen Cattell invented the term "individual differences" and published the first experimental psychological studies devoted to the subject.[20] In this jubilee year of that epochal event in scientific psychology I am glad to affirm my belief in the basic importance of this great principle. My thesis to-night is that training and practise account for a large amount of that considerable gain which is possible to each one of us, from year to year, within the range from less to more that represents

[17] H. L. Hollingworth, "Psychology of Functional Neuroses," New York, Appleton, 1920, pp. 259. See Ch. 12, pp. 187–199, "Mental Ability and Chronological Age in Adults."

[18] E. L. Thorndike, E. O. Bregman, J. W. Tilton and E. Woodyard, "Adult Learning." New York, Macmillan, 1928, pp. 335.

[19] H. Babcock, "An Experiment in the Measurement of Mental Deterioration," *Archives of Psychol.* (New York) 1930, 18: No. 117, pp. 105.

[20] J. McK. Cattell, "The Inertia of the Eye and Brain." *Brain*, 8: 295–312, 1885. See the last paragraph. Note the objective non-introspective character of this early psychological paper.

our own natural minimum or maximum potentiality. It is this modifiable or extensible aspect which, contributing to the individual differences, found among men and women of mature and late age provides the most practically controllable and definitely trustworthy psychological insurance and affords the most probable prospect of mental longevity.

I therefore conclude by quoting the closing sentence in the paper of 1896 by Cattell and Farrand,[21] "There is no scientific problem more important than the study of the development of man, and no practical problem more urgent than the application of our knowledge to guide this development." The study of man in maturity shows that his psychological progress is not bound utterly to the lowest level of his physiological decline. Through appropriate training and practise, continued mental elasticity and organized effective control, may extend mental longevity.

OBITUARY

NATHANIEL LORD BRITTON[1]

THE Board of Managers of The New York Botanical Garden desires to place on record the following minute in regard to the passing of Nathaniel Lord Britton, which occurred on June 25, 1934:

The history of The New York Botanical Garden is inseparably interwoven with the name of Dr. Nathaniel Lord Britton. In originating and developing the idea of a great institution in the City of New York, to be devoted to the study of the plant sciences and to the public display of plants and plant products of scientific, economic and horticultural interest, the time and the place most fortunately met the man who possessed the rare qualities that could guide this ambitious undertaking to distinguished success. Making a definite start with an act of the state legislature in 1891, incorporating The New York Botanical Garden, the project was steadily advanced until in 1895 the $250,000 required under this act for its initial endowment had been raised by subscription, the Commissioners of Public Parks had set aside for the purpose 250 acres of land in Bronx Park (afterwards increased to 400 acres), and the Board of Estimate had appropriated $500,000 for the erection of suitable buildings. During all this period of preliminary organization, Dr. Britton, with able associates, was the motivating spirit. A board of managers had already been elected, with Cornelius Vanderbilt as president, Andrew Carnegie as vice-president, J. Pierpont Morgan as treasurer, and N. L. Britton as secretary. Seth Low, president of Columbia University, accepted the chairmanship of the scientific directors, and an affiliation between Columbia University and the Botanical Garden was arranged. On June 17, 1896, Dr. Britton was elected director-in-chief of the garden, a post that he held with unflagging energy for a little more than thirty-three years. Retaining a connection with Columbia University as professor emeritus, he soon exhibited an altogether remarkable ability in combining the qualities of a technical research worker with those of a practical administrator and a successful author of scientific books. Dr. Britton soon perceived that the West Indies and Central America offered a largely untouched field for exploration by systematic botanists as compared with the northeastern United States. He participated personally in no less than thirty expeditions to the West Indies, mostly at his own expense. The results of Dr. Britton's studies are recorded in very numerous publications, of which some of the principal ones are the "Illustrated Flora of the Northern United States and Canada" (three volumes—with Judge Addison Brown), the "Manual of the Flora of the Northern States and Canada," "North American Trees" (with Dr. J. A. Shafer), the "Flora of Bermuda," "The Bahama Flora" (with Dr. C. F. Millspaugh), "The Cactaceae" (four volumes—with Dr. J. N. Rose), the "Botany of Porto Rico and the Virgin Islands" (two volumes, with Mr. Percy Wilson) and several important contributions to the "North American Flora." Dr. Britton was the leader in organizing and developing the "Scientific Survey of Porto Rico and the Virgin Islands," of which five volumes of the projected eighteen and eighteen parts of other volumes had been published at the time of his death. To this remarkable record of scientific achievement in the way of printed pages must be added the constructive leadership that resulted in a little more than a third of a century in building out of raw materials one of the leading botanical institutions of the world. In grateful recognition of the eminent services of Dr. Britton the Board of Managers adopts the following resolutions:

Resolved, That the Managers of the New York Botanical Garden deeply deplore their loss in the death of Doctor Nathaniel Lord Britton, their Secretary from March 21, 1895, to August 1, 1929, and Director-in-Chief of the Garden from June 17, 1896, to August 1, 1929. Doctor Britton combined to a remarkable degree the social, administrative, and scientific qualities that were

[21] J. McK. Cattell and L. Farrand. "Physical and Mental Measurements of the Students of Columbia University." *Psychol. Rev.*, 3: 618–648, 1896.

[1] Minutes of the Managers of the New York Botanical Garden and of the Council of the New York Academy of Sciences.