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WHAT SHALL WE EXPECT OF THE AQ?

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The AQ, or accomplishment quotient, procedure is one of the most recent, not to say most promising, acquisitions of the educational psychologist. Its implications have been subject to no little confusion even among the originators of the technique, as will be evident when we consider its derivation in more detail below.

The educational problem of motivation, as a partial solution from which the AQ hypothesis was derived, involves in its widest aspects the problems of the ultimate aims of education; the administrative problems of sectioning, retardation, promotion, and elimination; the pedagogical problems of motivation and differential treatment; and the research problems involved in the measurement of educative capacity and of educational product.

† | We may or may not agree to delegate to the educational philosopher the task of determining the ultimate aims of education. By unanimous agreement, the realization of those aims is at present left to the school administrator, the pedagog and the educational psychologist. By pointing out some of the limitations, as well as advantages, of certain postulates and "axioms" connected with the AQ hypothesis, the authors hope to show the probable effect of the hypothesis upon administrative and testing practices, to point out some new ends or aims of education that may soon come to the foreground of public discussion, and possible resulting changes in school administrative procedures. Thus the authors will raise many questions without attempting to answer them adequately, if at all. The man of practical affairs may be inclined to remonstrate that our remarks are

destructive criticism rather than suggestive of constructive programs. On the contrary, the authors hold to the point of view that an awareness of our ignorance is of as much value in pointing out the road to progress as a knowledge of our accepted scientific "truths."

A COMPARISON OF THREE CURRENT AQ CONCEPTS

The accomplishment quotient is advocated by Franzen,¹ and under the name "achievement quotient" by Monroe and Buckingham,² as a measuring device for combining in an effective way the results of educational and mental tests into a measure of *educational achievement relative to the pupil's capacity to progress*. Essentially the same purpose is served by a different statistical technique developed by Pintner.³

The AQ is to be considered as the "degree to which a pupil's actual progress has attained to his potential progress by the best possible measures of both,"⁴ or as a "simple method of comparing a pupil's achievement age with his mental age (learning capacity)."⁵ Apparently there is no single word in the English language which adequately expresses what is meant by the term AQ. In its statistical derivation *it is quite as abstract a concept as π or r* . Its formula is:

$$AQ = \frac{EQ}{IQ} = \frac{\frac{EA}{CA}}{\frac{MA}{CA}} = \frac{EA}{MA} \quad (1)$$

where,

AQ = Accomplishment, or achievement, quotient

EQ = Educational quotient

IQ = Intelligence quotient

EA = Educational age

CA = Chronological age

MA = Mental age.

¹ Franzen, R.: The Accomplishment Quotient. *Teachers College Record*, Vol. 21, No. 5, Nov., 1920, pp. 432-440.

² Monroe, W. S. and Buckingham, B. R.: Illinois Examination. *Teachers Handbook*, University of Illinois, Bureau of Educational Research, July, 1920, p. 31.

³ Pintner, R. and Marshall, H. A.: A Combined Mental-educational Survey. *Journal of Educational Psychology*, Vol. 12, No. 1, Jan., 1921, pp. 32-43.

⁴ Franzen, R.: *loc. cit.*, p. 436.

⁵ Monroe, N. S. and Buckingham, B. R.: *loc. cit.*, p. 11.

Pintner's method consists essentially of transmuting educational test and mental test scores into index values ranging from 0 to 100 for a given age, average ability in each being 50. The method assumes a normal distribution of both mental and educational talent. Pintner uses as his measure of motivation:

$$\text{Difference} = \text{Educational index} - \text{Mental index.} \quad (2)$$

This measure is "the difference between a pupil's native capacity and his actual accomplishment."¹

According to Franzen, an AQ of 1.00 indicates "optimum accomplishment" or "what a pupil is able to do under the best conditions;" and according to Monroe and Buckingham, it means "that the pupil has achieved exactly as well as the average of the pupils of his mental age;"² while, according to Pintner, an index difference of zero, occurring when the mental index is equal to the educational index, or a corresponding AQ of 1.00, apparently means that the pupil is doing educationally exactly what "is usually accomplished by children of like mentality."³

According to Franzen, an AQ less than 1.00 means that the pupil is doing school work which is less than normal for his mentality, and, according to Monroe and Buckingham "if a pupil's achievement quotient is 0.75, we have evidence that he has achieved only 75 per cent as much as the average of the pupils of his mental age;"² while, according to Pintner, "a minus difference means that the child is doing less educational work than he has the ability to accomplish"³ although, as noted below, he does not imply that a plus difference indicates that the pupil is doing more work than he has ability to accomplish.

According to Franzen an AQ of more than 1.00 is impossible, as represented in his statement: "One's differences when EQ is subtracted from IQ are always positive when they are large enough to be significant and small enough to seem spurious when they are negative . . . It is safe, therefore, for practical use to assume that the optimum accomplishment is 1.00;"⁴ and according to Monroe and Buckingham, "If the pupil's achievement quotient is 130, it means that he has achieved 30 per cent more than the average of the pupils

¹ Pintner, R. and Marshall, H.: *loc. cit.*, p. 37.

² Monroe, W. S. and Buckingham, B. R.: *loc. cit.*, p. 11.

³ Pintner, R. and Marshall, H.: *loc. cit.*, p. 38.

⁴ Franzen, R.: *loc. cit.*, p. 436.

of his mental age,"¹ while according to Pintner, "a plus difference means that the pupil is doing more educationally than has usually been accomplished by children of like mentality."²

Pintner, and Monroe and Buckingham find many pupils making "more than average accomplishment for their mental age," Pintner specifically stating that "it is useless to attempt to set up any such ideal standard (of what ought to be accomplished under ideal conditions where each child is working up to the limit of his capacity); in contradistinction, Franzen states, "we can measure the approximation to ideal educational performance of any one child in any one elementary school subject through the approximation of this accomplishment quotient to 1.00." It is evident that even among the originators, there is a great difference of opinion in regard to the meaning to be attached to any A.Q. Part of this disagreement, no doubt, will be eliminated once all compute their indices in identical statistical fashion, and on the same tests.³

THE DISAGREEMENT IN TERMINOLOGY INVOLVED IN THE A.Q. HYPOTHESIS

Dr. Otis has pointed out to us the errors of terminology in which we are likely soon to be involved in regard to the various ratios. We find research workers talking of a *reading quotient*, that is, of the ratio of reading-subject-matter age to chronological age; of a *reading-accomplishment quotient*, that is, the ratio of reading-subject-matter age to mental age; and finally of a more general accomplishment quotient in the sense of the ratio of average subject-matter ages in a number of school subjects to mental age. By early agreement, research workers may decide upon adequate definitions of standard terms and thereby prevent ultimate hopeless confusion. It may be noted that the term used for the more general accomplishment quotient must be defined in terms of *the subject-matter ages to be included while also taking into account how they are to be combined or weighted* if we are to hope for even approximately valid comparisons of the work of various research workers. A pupil's general A.Q. evidently depends in a very real way upon his election of subject matter and so cannot be

¹ Monroe, W. S. and Buckingham, R. B.: *Loc. cit.*, p. 38.

² Pintner, R. and Marshall, H.: *loc. cit.*, p. 38.

³ Part of the confusion is due to the fact that Franzen used the Stanford Revision Individual Test while the other investigators used Group Intelligence Tests.

expected to be as constant even as his IQ. Likewise, mental age needs to be defined in terms of what tests shall be used and how they shall be combined if we are to hope for any reasonably comparable results in intelligence measurement from different research workers, or even from the same research worker in successive instances. In this article, unless specifically noted otherwise, we have taken the term "accomplishment quotient" to mean either the subject-matter-accomplishment quotient or the more general accomplishment quotient. Our discussion of the limitations of the Q procedure will hold for either the more specific or the more general case.

DIFFICULTIES INVOLVED IN THE NORMS USED, AND IN THE SELECTION OF STANDARD TESTS

One cause for confusion in the interpretation of the meaning of a given AQ lies in the difference in procedure used in computing norms. Monroe and Buckingham, and Pintner, follow the customary procedure in determining a norm; namely, finding that score which is the median for a given age and calling that score the norm for the age. Franzen finds the average age of all people who make a given score, thereafter calling the given score the norm for the average age thus found. Thus, stated in statistical terminology, the former workers make use of the regression of score on age, while the latter makes use of the regression of age on score. The regression of age on score, it will be noted, is the customary regression line used in such problems as that of predicting the age at death from a statistical measure of the person made prior to the event. The adoption by all workers of the other regression line, if proven statistically advisable, is not an impossible task. We point out below that the use of the other regression line in norms does not do away with what seems to us to be a very real objection to the AQ procedure.¹

The question of equivalence of scores on tests constructed by different research workers is also in a state of flux, as are many of the statistical implications of mental and educational measurements of which the controversy regarding the two regression lines in norms is but one example. Otis is advocating the use of a line, which when plotted lies between the two regression lines for converting mental test scores of one scale into "equivalent scores" on the other, disregarding the

¹Recent reports show that local community selection is so great that "blanket" norms are often meaningless. See Chapman below.

fact that there is no true equivalence of two test scores.¹ Without true equivalence of different mental and educational scales, we cannot expect identity of interpretation of AQ's secured by different workers using different mental test, educational tests, or both. We are continually being reminded nowadays that the IQ was devised as a brightness measure for one intelligence scale, the Stanford Revision of the Binet Scale; and that, consequently, the IQ procedure is not in strict scientific usage applicable to other scales than the Stanford scale.² If the AQ procedure is to have a monopoly on Stanford IQ's, it necessarily must have a monopoly on Stanford MA's, for it will be seen that the CA's cancel out in equation (1), leaving only two simple variables, EA and MA. We need but one of these invalidated in order to have the whole fractional equation invalidated.

And whose EQ shall be considered a standard one? Not only does this point to an inadequacy of the AQ procedure but of the IQ and EQ procedures as well. There is good reason for believing that the IQ is not the best possible brightness measure, even in the case of the Stanford Scale. As hinted at by Toops and Pintner³ there are an infinite number of comparatively simple equations of the first degree—not to mention higher degrees—of the type,

$$IQ = \frac{(MA) + k}{(CA) + k} \quad (3)$$

which will fulfill the requirements of yielding: (1) A ratio of 1.00 for perfectly normal individuals, (2) ratios of more than 1.00 for individuals brighter than normal, and (3) ratios of less than 1.00 for individuals who are duller than normal. A particular one of this family of curves may fulfill better the additional desirable requirement of approximate constancy through the grade-schools ages than does the present IQ formula. The IQ equation can be thought of as the simplest possible case of the more generalized mathematical ratio,

$$IQ = \frac{(aM^n + bM^{n-1} + cM^{n-2} + \dots + M) + K}{(a.C^n + b.C^{n-1} + c.C^{n-2} + \dots + C) + k} \quad (4)$$

where M equals mental age, and C equals chronological age. Among

¹ Thorndike, E. L.: On Finding Equivalent Scores in Tests of Intelligence. *Jour. of Appl. Psych.*, Vol. 6, No. 1, 1922, pp. 29-33.

² Trabue, M. R.: Some Pitfalls in the Administrative Use of Intelligence Tests. *Jour. of Educ. Research*, Vol. 6, No. 1, 1922, pp. 1-11.

³ Toops, H. A. and Pintner, R.: Curves of Growth of Intelligence. *Jour. of Exp. Psych.*, Vol. 3, No. 3, 1920, p. 235.

the "infinite-infinite" number of possible equations, there is probably one which will fit the empirical facts better than the one now used.

TECHNICAL DIFFICULTIES IN SECURING ALTERNATIVE STANDARDS OF CAPACITY AND ATTAINMENT

Fairly comparable IQ's, EQ's and AQ's *can only be obtained by at least taking into account the reliability coefficients of the different educational and mental tests respectively.* That is, concretely, an IQ secured by the Jones Mental Test can only hope to measure exactly the same thing as an IQ secured by the Johnson Mental Test if the Jones Test correlates perfectly with the Johnson Test. Not even equal correlation with the same identical criterion of intelligence solves the problem. As an illustration, *suppose two tests, 1 and 2, are totally uncorrelated with each other, they will yet correlate each with a valid criterion of intelligence to the maximum extent of 0.71.* This may be shown by substituting the values, $r_{12} = r_{13}$, and $r_{23} = 0$, in the formula for the multiple correlation coefficient involving three variables when the multiple correlation coefficient is a maximum, or 1.00. Thus:

$$1.00 = r_{1.23} = \sqrt{\frac{r_{12}^2 + r_{13}^2 - 2r_{12}r_{13}r_{23}}{1 - r_{23}^2}} \quad (5)$$

Substituting the above values,

$$1.00 = 2r_{12}^2, \text{ whence } r_{12} = r_{13} = \sqrt{.50} = 0.71$$

If it were possible to construct two "intelligence" tests, a group test and an individual test, which would correlate zero with each other, both might yet correlate equally with a "valid criterion of scholarship" as highly as 0.71; and yet on the one test an idiot would as likely as not be rated genius, and *vice versa* which argues neither for the group test nor for the individual test. This problem must be settled on another basis than statistical theorizing since it is practically impossible to design two tests according to the above specifications. To determine socially *valid* and *comparable* AQ's we must consider validity, correlation with an adequate criterion, as well as correlation between the two intelligence and the two educational tests used by two different research workers. The two forms of test may be perfectly reliable and yet not measure at all what we would have them measure. The conclusion is obvious. We need not a commercialized multiplication of scales and an equally thoughtless diversity of

statistical techniques but an ultimate soundness of method. The very equation of the AQ, if written in another form

$$EA = (AQ) (MA)$$

$$\left(\begin{array}{c} \text{educational} \\ \text{achievement} \end{array} \right) = \left(\begin{array}{c} \text{educational} \\ \text{environment} \end{array} \right) \left(\begin{array}{c} \text{mental} \\ \text{capacity} \end{array} \right)$$

means that educational achievement is equal to mental capacity as it is acted upon by an educational environment (motivator) which varies in its intensity for individual pupils from somewhat more than zero AQ to somewhat more than 1.00 AQ. It would be but mockery to say that any one of our multitudinous intelligence scales measures "mental capacity" when scarcely any of them correlate highly with each other, none correlates highly with the social acts wherein intelligence functions, and some do not correlate very highly even with themselves in their alternative forms. A ratio of such unreliable variables is necessarily less reliable than either of its components.

In securing his measure of capacity, Pintner uses non-verbal intelligence tests "to get as far away from language and the things taught in school" as possible. Yet his educational norms are still based on what is now taught. Pintner quite rightly wishes to get an "ultimate measure of ability or rate of doing work" which he hoped to get in non-language tests. It is known, from the work of Herring,¹ Gates, the N. I. T. tests, and others, that non-language intelligence tests do not correlate nearly so well with ability to get along in school (as the school subjects are now taught) as do verbal tests. It has been found that the more verbal the tests the higher their correlation with an "adequate" criterion of intelligence or of ability to get along in school. We need only consider the limiting case of an intelligence test which is so "non-verbal" as to correlate zero with achievement in order to see that the *measure of capacity must correlate highly with the measure of attainment*. The real requirement is that the test used shall be as little susceptible as possible to improvement through practice or coaching.

THE EXPERIMENTAL GROUP WHICH DETERMINES "CAPACITY" NORMS SHOULD BE MAXIMALLY MOTIVATED

Without testing "maximally motivated" pupils to determine our norms of "potentiality," we can but approximate an ultimate measure

¹ Herring, J. P.: Verbal and Abstract Elements in Intelligence Examinations. *Jour. of Educ. Psych.*, Vol. 12, No. 9, 1921, pp. 511-517.

of the capacity to do school work. We need not deny our slow but steady progress in measurement.¹ It will do no harm, however, to realize that so long as our mental tests correlate with an "adequate criterion" to the extent of less than 0.71, "all other unrelated factors" will correlate with the same criterion to a greater extent than 0.71; and further, that "a composite of all other unrelated factors including also some factors common to the first mentioned test," such a composite as it would be impossible to approximate in an almost "totally different" type of test, would correlate with this same criterion considerably in excess of 0.71. Not until we construct intelligence tests which will correlate to the extent of 0.87 with such a criterion will we reduce to half the standard deviation of the criterion its standard error of estimate.

Evidently there is no method whereby *statistically* we can determine when a child is maximally motivated. The best we can do is to arrange an experimental class with the best conditions and incentives to maximal effort that the best pedagogical judgment can devise and then measure what educational product is produced. The person who can arrange greater incentives in a subsequent experiment will secure a greater educational product. "Maximal motivation without neglect of essential school activities" would yield the best norms—"balanced" norms. Scientific method requires that such a group be used as the experimental group in constructing the tests of capacity and achievement. Even then we are in exactly the same position as the time study men of industry who decide that a fair day's work is what the average man produces. In the long run what is considered fair is what the workers will agree to accept as a fair day's work; it is

¹ Pressey, S. L.: Suggestions Looking toward a Fundamental Revision of Current Statistical Procedure as Applied to Tests. *Psych. Rev.*, Vol. 27, 1920, pp. 466-472.

Ruml, B.: Reconstruction in Mental Tests. *Jour. of Phil., Psy. and Sci. Meth.*, Vol. 18, No. 7, 1921, pp. 181-185. (A criticism of Pressey above.)

Pressey, S. L.: Empiricism versus Formalism in Work with Mental Tests. *Jour. of Phil., Psy. and Sci. Meth.*, Vol. 15, No. 16, 1921, pp. 393-398. (The reply to Ruml's criticisms.)

Ruml, B.: The Need for the Examination of Certain Hypotheses in Mental Tests. *Jour. of Phil., Psy. and Sci. Meth.*, Vol. 17, No. 3, 1920, pp. 57-61.

Kelley, T. L. and Terman, L.: Dr. Ruml's Criticism of Mental Test Methods. *Jour. of Phil., Psy. and Sci. Meth.*, Vol. 18, No. 17, pp. 459-465. (Reply to Ruml directly above.)

Chapman, J. C.: Some Elementary Statistical Considerations in Educational Measurements. *Jour. of Educ. Research*, Vol. 4, No. 3, 1921, pp. 212-220.

not necessarily a scientifically determined quantity of work in spite of its scientific appearance, its abundance of fine but unreliable measurement.

SOME CURIOUS PHENOMENA NOTED IN THE USE OF THE AQ

Let us inquire into the educational treatment accorded subjects of low AQ by Franzen. We see "unmotivated" pupils, discovered by the AQ procedure, given special educational treatment with the general result that their AQ's are brought up to 1.00, but not beyond it. What may be one explanation of this case? It has repeatedly been shown by Kirby, Chapman and others that motivation leads to distinct improvement. In fact, Thorndike¹ tells us that there is no reason to believe that in many functions the acceleration of improvement within the ordinary physiological limits need be a negative one provided *we furnish sufficient motivation*. Franzen used the Stanford Test while the other workers used group tests; he likewise used a different regression line in computing his norms. Aside from these differences, is it not likely that his subjects did improve up to the given expected point, the goal of 1.00 AQ, and that then improvement did stop with few going beyond AQ's of 1.00, because the teacher and pupils were led to believe that an AQ of 1.00 was satisfactory; that is, that the "motive" to improve was greatly lessened or suddenly became of zero value as soon as an AQ of 1.00 was reached? If, as will be shown shortly, half or more of the dull pupils can expend more than "normal effort," why cannot *all of humanity* do more than an AQ of 1.00? It probably can! Why, then, if sufficient incentive is provided, should not at least half of his school system do more than the *average amount of school work usually done by people of the same mental age in school systems in general*? Does not the greatest value of the AQ, after all, consist not in its measuring value but in its incentive value—its value in getting the teacher and pupil *interested in progress*? The graph of progress is a very real incentive to the pupil—so very effective because it compares his educational attainment with himself; because he is competing with himself, and is not required to beat out pupils of greater ability. For, even if of low IQ and he works up to an AQ of 1.00, he is doing "just as well" as the pupil of greater intelligence who does more work and achieves a greater EA. Is mental capacity to be likened to the

¹ Thorndike, E. L.: *Educational Psychology*, Vol. 2, 1913, p. 257.

fabled beggar's wallet which can be filled only so full before it will be filled to overflowing and burst from its very opulence? And, yet, may it not be good school policy for the present to keep the AQ from going above 1.00, in order to insure that the school will not put too much emphasis merely on the things which the tests measure, and allow opportunity for securing some of the appreciations or attitudes which, though intangible, are valid objectives of education? The EQ aims only to measure education as it now is, and not as it ought to be. Granted the truth of the hypothesis, the AQ procedure is a very real incentive method, as shown by the fact that the correlation of about 0.6 between EQ and IQ at the beginning of Franzen's experiments was pushed to about 0.9 by intensive stimulation of his pupils to effort.

Another curious phenomenon, noted by Pintner, is that there are more bright people not working "up to capacity" than dull ones who are "doing more than is expected on the average of pupils of their mental capacity." Another investigator in an unpublished report finds a correlation of—0.40 between MA's and AQ's in the case of pupils of Grades V to VII. Is there not significance in this fact which we may interpret from the known facts of the school situation itself? Is it not a remarkable coincidence that the "below normal" in intelligence are for the more part *above* average in motivation while the "above normal" in intelligence are for the most part *below* average in motivation? We are often inclined to accept the generalization that all good things are positively correlated; correlation and not compensation is the rule in human nature. Either human nature is perverse in its schoolroom duties, or the school methods are badly at fault.

Both statistical methods evidently assume that the *immediate* ideal in education should be to raise the AQ of all "poorly motivated" pupils to 1.00. This makes the statistical assumption that all pupils in all school subjects of a "perfectly adjusted and maximally motivated" school should have an AQ of 1.00; or, all plotted points would lie on a straight line of regression when the subject-matter ages in a given school subject are plotted against mental age; or that, stated differently, in a properly motivated school working up to maximal capacity, the correlation between mental age and subject matter age is 1.00. There is much empirical evidence which will cause us to doubt this ultimately perfect correlation. In the most highly correlated of physical *sizes* of bilateral members of the human body, such as the length of the right arm correlated with the length of the left

arm—not to mention the lesser correlations of the physical capacities of such bilaterally symmetrical members—the correlation is always somewhat less than unity. Should we then expect a perfect correlation between mental capacities? Franzen finds that remedial educational measures recommended for pupils with AQ of below unity brought a majority up to unity, and as above pointed out, he believes that AQ's above unity are spurious, at least when using his methods of computation. The same educational procedure applied to the pupils already at an AQ of 1.00 might have produced some very large AQ's.

A partial explanation of this curious phenomenon will now be presented. It seems likely that the AQ results are *in part* due to the statistical assumptions underlying the accomplishment index technique rather than to an ultimate soundness of method. If we assume, for the moment, that there is not a perfect correlation between educational age and mental age, in a "maximally motivated school" (one in which teaching, school environment and "effort" are ideal) educational index regresses upon mental index and *vice versa*. As will be shown below, pupils of high IQ are then more likely than not to be lower in EA than their MA "would warrant," and conversely, pupils of low IQ are more likely than not to have an EA higher than their MA "would warrant."

If we assume normal correlation of the EQ and IQ, when r is less than 1.00, we obtain a surface of distribution of the two, when plotted against each other, similar to that of Fig. 1. The line cc , drawn at an angle of 45° to the horizontal, would represent a line of perfect correlation; i.e., a line on which would be plotted all persons whose EQ's exactly equal their IQ's. Consequently all persons happening to fall on this line have AQ's exactly equal to 1.00. Any person lying above this 45° line, is found to have an EQ greater than IQ, and will therefore have an AQ greater than 1.00. Such a person is P. Conversely, any person lying below this 45° line has an AQ which is less than 1.00. Such a person is Q.

The regression of y on x , or yy , is so drawn that it bisects each vertical array.

Its equation is $y = r_{xy} \frac{\sigma_y}{\sigma_x} x$. Let us now consider any given vertical array of people having IQ's less than 1.00; i.e., subnormal in mentality. Such an array will be any vertical array to the left of the average (Mx) of the IQ's such as is represented by hkl s. Half of the area of the array is included above the line of regression of y on x ; that is, 50 per cent. in $jklm$. But the area of persons in the array with AQ's greater than 1.00 is represented by the area, $ikln = jklm + jmn$ = 50 per cent. of the array + the area, jmn . That is: *more than half* (as represented by the excess area, jmn) of any unselected dull persons have AQ's greater than 1.00 solely by reason of geometrical necessity, irrespective of whether the hypothesis that EQ can be brought up to IQ is ultimately sound or not; that is, a correlation surface of less than 1.00 always has such an area as yoc . Conversely, by consideration

of any vertical array *h k l s* of brighter than average persons, more than 50 per cent. have AQ's less than 1.00 solely by reason of geometrical necessity, as above. It then follows that (1) the measuring validity of the AQ is thus far an unproved postulate, and that (2) the demonstrated bringing of low AQ's up to 1.00 by special

FIG. 1.

educational treatment is no proof of a fundamentally perfect relationship between mental ability and educational achievement. As a corollary to (2), if it be assumed that fundamentally there is not perfect correlation of EQ and IQ, then even in a perfectly sectioned school, geometrically it would be expected (be perfectly "normal") to have more than half of the dull people with IQ's more than 1.00 and half of the bright people with AQ's of less than 1.00. The area *yoc* diminishes in size as *r* becomes larger, but does not disappear until *r* becomes 1.00. Thus the AQ, as a statistical measure, is the old problem of trying to lift one's self by one's boot straps. In all the above it is assumed that the distribution of both IQ's and EQ's is normal, which may or may not be true.

It should be noted that, with all its defects, the AQ method *will pick out* the school or the individual who has an AQ of such magnitude that it *would seldom happen in a normal correlation plot* between EQ and IQ. Like the IQ, a difference of 0.01 in AQ in the case of two people with AQ's respectively of 0.65 and 0.66 is a different amount from the difference between two persons with AQ's of 0.99 and 1.00 respectively. Perhaps by a more complicated mathematical procedure,

wherein we calculate the probability of a child "working up to capacity," we may yet improve the measuring value of the AQ as well as secure its value as an incentive method.¹ A rough empirical beginning in this direction has been made by Pintner in setting up his $\pm$ boundry lines of "normal effort." We may reiterate the time-worn statement: The simplest explanation is by no means necessarily the truest. At best, under present circumstances, using norms computed in the usual way (norm = average score for a given age), AQ's of more than 1.00 seem just as logical and just as necessary (although at present not as abundant, as heretofore pointed out) as AQ's less than 1.00. The explanation thus suggested by the geometrical approach is that both the positive and negative differences so far found, likewise all AQ's not 1.00, are entirely due to the lack of perfect correlation between the mental and educational indices, part of the differences indicating true school maladjustment, and part being as yet undetermined.

The use of the regression of age on test score in norms will alter the proportions of the above diagram but will not eliminate AQ's of more than 1.00, if both MA's and EA's are computed by the same method.

Whether the AQ can be brought up to 1.00 or to 1.50 or to any predetermined figure, depends to a very great extent upon the EA used, the nature of the scale or examination, the norms used and the school subject under consideration. Presumably a child with good arithmetical ability might be easily brought up to an AQ of 1.00 in the "four fundamental operations" of arithmetic since his EQ, the numerator of equation (1), might be easily brought up to normal, while it might be found much more difficult to bring him up to an AQ of 1.00 in an arithmetical test dealing largely with arithmetical reasoning. We no longer talk of the "rote memory type" and "logical memory type" of person, but we know that there are apparently rare cases of "special abilities" and "disabilities" in school subjects, and even in different parts of the same school subject. Neurologists and psychologists disagree regarding their neural basis, and proper remedial treatment. Such cases of "disability" are "real enough" to the teacher to be labeled with the term, even though theoretically they may prove to be non-existent.

¹ Since writing this article, the authors have been privileged to read an as yet unpublished manuscript by J. C. Chapman wherein he demonstrates to his own satisfaction that the difference, between educational age and mental age, obtained from a single testing, is quite too unreliable for individual readjustment of pupils.

EDITOR'S NOTE: Dr. Chapman's article is published in this issue.

OTHER POSSIBLE EXPLANATIONS OF THE LESS THAN UNITY CORRELATION BETWEEN EA AND MA

Pintner's norms are based on the very pupils upon whom he reports. Pintner assumes that anyone whose educational index is more than eight points advanced over his mental index is advanced in motivation, and *vice versa*. Had he called "advanced" all people who were on the plus side, and "retarded" all who were on the minus side, then with these two groups he would find approximately 50 per cent of retarded motivation and 50 per cent of advanced motivation. In the light of an article by Toops and Pintner¹ dealing with pupils of the same city, and social status similar to that of those who determine Pintner's intelligence norms, it becomes evident that one very important reason for so many of the mentally advanced pupils being retarded in accomplishment is the fact that many bright pupils are promoted by chronological age rather than by ability to progress and so have not had the chance to come up to normal by being given opportunity to do advanced work. In the article cited it was found that only 15 per cent of the total of 1218 pupils were advanced in school one semester or more, while, by the same standard, 37 per cent were retarded in school one semester or more. With such a state of affairs, it undoubtedly is true that many dull pupils are attempting too difficult work, while it is assuredly true that many bright pupils are not attempting as difficult work as they are capable of doing.

Another factor which always operates in mental measurements is attenuation. The fact that at present the correlation between mental and educational indices is less than 1.00 may be partly explained by the inaccuracies in the measurements which always tend to attenuate, or lower, the correlations.

Undoubtedly other reasons for the less than 1.00 correlation are to be found in "special abilities or disabilities" and interest, actual laziness, etc. Other bad conditions in home and school exert their influence also. It will be found that most of the bright but less than 1.00 AQ pupils are doing *above average work in the grades they are now in*, where merely "passing" performance is acceptable. Pintner, Coy, Whipple, Coxe, and others have shown that motivation and more and better school work is the almost inevitable result when mentally advanced pupils are promoted in school to that point where they have

¹ Toops, H. A. and Pintner, R.: Mentality and School Progress. *Jour. of Educ. Psych.*, Vol. 10, No. 5-6, 1919, pp. 253-262.

the competition of pupils of about the same mental ability, or rates of progress.

Dr. May, as the result of a preliminary investigation of the relationships of the hours spent in study, intelligence and school marks of college students, advises the writers that in the case of his subjects there is a decided negative correlation between hours spent in study and intelligence; this certainly means that bright students, able to "get by the passing mark" with little study prefer to spend a proportionately larger amount of their time on other than study activities; consequently, by consideration alone of the very objective measure of number of hours spent in study, it is very evident that such bright pupils would be readily able to accomplish more if required to do so by being placed in a section of bright pupils where competition between the extreme members of the class would be more truly real competition.

(Continued in January)