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Age Changes in the Primary Mental Abilities In a Group of Superior Older People

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Although it is recognized that the problem of declining intelligence with age may preferably be handled by longitudinal studies, we are faced with the difficulty that the major longitudinal studies (1, 4) have not yet reached the stage where rapid decline has been indicated by previous cross-sectional inquiries. The interpretation of the results of these genetic studies are complicated also by the effects of attrition, which while serious enough with younger populations, are unavoidable in a longitudinal study reaching the later years. Furthermore it is doubtful whether the methods of the original selection of these developmental samples remain useful and valid as time passes. No adjustment is possible however, in a longitudinal inquiry, if as the result the sample ceases to be adequate and representative.

Since we are faced with the immediate problem of supplying data for decisions regarding our present aged population, on whose mental abilities no genetic records are generally available, it is desirable to investigate possible improvements on the less costly and more immediate cross-sectional approach.

The major criticisms of cross-sectional studies of intelligence may be summarized under four headings (see also 3, 9). The first of these criticisms is concerned with differences in educational background within the sample. It is

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held that in view of the changes in the availability of educational opportunities, the younger sub-samples will be at an advantage over the older groups. Unless extremely large pools of subjects are available it is difficult however, to equate educational background of the sub-groups if the whole adult age range is to be considered.

A second criticism is concerned with the effect of range of talent on the slope of the gradient of decline. In view of the strangeness of psychological testing to older subjects it is likely that volunteers from the older age groups will represent more restricted portions of the range of talent. As a result some investigators have reported the leveling off of curves of decline in the seventies. Other investigators, while successful in obtaining reasonably broad samples for the younger age groups, had to use homes for the aged for their older age groups, thus tending to report very abrupt decline.

The disabilities of older people with respect to speeded tests have been repeatedly stressed, yet few attempts have been made to provide appropriate corrections or employ tests where speed is not at issue. Regardless of whether old people perform slower or fatigue more easily, the effects of speed needs to be controlled to make cross-sectional comparison valid.

Coupled with the problem of fatigue is finally that of motivation. It has been argued that while younger people look upon most tests as a challenge and vie to perform well, older people expect defeat, and see little reason in exerting themselves in a cause which seems of little value to them.

As serious as these criticisms appear to be, much improvement is possible when one confines oneself to a study of that phase of the developmental range where most rapid decline has previously been noted (2), namely from age 70 on. It is then possible to show significant changes with rather small samples, and where only small samples are required it is of course much easier to satisfy the demands for comparability and homogeneity of the sub-samples. The present paper is designed to present the results of such an

inquiry based on a very limited and admittedly extreme sample, whose special characteristics however, are quite suitable to meet some of the stated objections to cross-sectional inquiry.

Subjects

All subjects were volunteers who had been obtained from the membership of a retired university faculty group or who had responded in writing to appeals in the university district newspapers and all were retired academic or professional workers. Subjects were interviewed before being accepted for the research project, at which time it was explained to them that about eight hours of their time spread over several days would be required for physical examinations, psychological testing and interviews. At this time all subjects were given an opportunity to withdraw if they so desired. No pressure was exerted on anyone to participate and it is thus concluded that all subjects were at least as highly motivated as may be expected from the average volunteer group.

The sample consisted of 25 male and 25 female college-graduates over 70 years of age, and with a mean age of 76.5 years. The sample was quite homogenous in educational and social background. All subjects had at least the bachelor's degree and often additional graduate training. The physical examination found all members of the group in from fair to superior physical condition and no psychiatric complaints were noted by the examining physicians. A psychological test to detect brain damage (Stein's symbol gestalt) proved negative in all cases.

Procedure

In order to obtain estimates on more specific aspects of mental ability than would be yielded by a global score, we selected Thurstone's S.R.A.

Primary Mental Abilities test (intermediate form), which yields separate scores for the primary abilities of Verbal-meaning, Space, Reasoning, Number and Word-fluency (10). This test was chosen because its components were derived from a thorough factorial study of many tests of intelligence, and because it yields relatively pure estimates of the factors identified. Previous work with this test with older subjects has also shown that its range of difficulty as well as its reliability are adequate (8). The separate factor scores are also useful in studying the influence of speed and other factors on performance in selected aspects of ability.

Since it has frequently been urged that older persons are penalized on speeded tests such as the P.M.A. it seemed desirable to obtain an independent estimate of psycho-motor speed. Previous work had further indicated the possibility of rigidity acting as a suppressor variable with respect to mental ability in the older age groups. Schaie's Test of Behavioral Rigidity (5) was therefore used to obtain scores for psycho-motor speed and motor rigidity. In addition the Wechsler Memory Scale was administered to obtain estimates of memory loss (11).

Although most of the tests used are group tests, they were all administered as individual tests and in random order to ensure greater reliability.

Results

The subjects were rank-ordered by chronological age and divided into 5 groups of 5 males and 5 females each. A comparison by X^2 showed no significant differences in years of education among the five groups. Standard P.M.A. scores with means of 50 and sigmas of 10 were then computed for all individuals by use of Thurstone's conversion chart using norms for the 17-year old group (10). Comparable standard scores for the speed and rigidity measures were com-

puted using Schaie's tables for his young population group (6). Comparable scores on the memory scale were computed by use of Wechsler's norms for his 20-30 year group (11). Table 1 gives the mean scores for each of the five sub-groups on all the test variables and Figure I affords a graphic view of the smoothed curves of decline which seem to prevail.

The statistical analysis using the t-test to evaluate the mean differences between the young and old sub-groups showed significant decline at the 5% level on all P.M.A. factors except for verbal fluency. This last factor seems to rise until the late seventies and then also shows decline, but since the mean for age 84 is still somewhat higher than for age 71, no significant decline on this factor is shown in the population studied.

Significant decline is also shown for motor-speed and memory as well as for motor-rigidity (a low score on the latter indicating high rigidity). Figure II indicates the slopes of decline for these variables.

Analysis of the Corrected Measures

The next step in the analysis was to examine whether the decline in the P.M.A.s indicated by table 1, would be affected if corrections could be made for the effect of lowered speed, increased rigidity and of memory loss. The already described independent measures of these effects were therefore correlated with the P.M.A. scores. Complete intercorrelations among all measures used were computed on the IBM type 604 electronic calculating punch using the standard score method (7), and are given by table 2. Most of these correlations are significant and the development of correction formuli appeared indicated.

Partial correlations were next obtained for the relationship between the PM.A.'s and memory, with the effect of speed partialed out, and for the correlation between P.M.A.'s and rigidity with the effect of both speed and

memory held constant. Correction formuli could then be written such that the effect, first of speed, then of speed and memory, and finally of speed, memory loss and increased rigidity were held constant. Since all scores were in equivalent T-score form this could be done by subtracting the obtained scores on the correction factor from 50 (the mean), multiplying by the square of the adjusted correlation coefficients and adding to the obtained P.M.A. scores. Table 3 gives the correction constants, and table 4 lists the new sub-group means subsequent to these corrections. Figure III finally shows a plot of the corrected smoothed means. It may be seen from this figure that while the curves level off considerably for all factors except space as the result of these corrections, they still show a marked decline, and the relative positions of the different abilities remain unchanged. Word fluency remains the single exception, and seems to increase rather than decline with age after these corrections are made.

Both raw and corrected scores were computed for a composite I.Q. score, curves for which are shown on the graphs. This score similarly shows significant decline before and after correction.

Discussion

Previous attacks upon the results of cross-sectional studies of mental ability have generally concerned themselves with the lack of comparability among sub-samples, expecially with respect to prior education and experience with test material. The present study seems free from such difficulties since it studies age changes within an older group of comparable background and education and over a narrow age-span. (In spite of all precautions taken however, it must be concluded that the results of the present study are similar to those observed in previous work with unselected samples of wider age ranges.)

The argument of unfair comparisons because of reduced speed in such tests as the P.M.A. has been further countered by employing appropriate corrections. Since no significant changes materialized, further corrections were made for memory loss and for increased motor-rigidity, which are often cited as concomitant changes. While all these factors show substantial relationships with selected mental abilities, and while it is shown that their influence tends to lower performance, it seems evident that they alone cannot be held responsible for the decline in mental abilities shown in this study. On the other hand a glance at table 3 will show that correction for further factors showing concomitant loss with age may be rather wasteful. After the necessary partials are attracted to allow for the variance accounted for by the corrections for the effect of speed and of memory, it was found that the correction for a third factor (rigidity) became minute, even though the zero-order correlations between this factor and the Mental Abilities had been substantial.

The present results further indicate that even while in a superior group performance may still be well above the average of the young general population, significant decline from previous performance must be considered for certain abilities, even if speed, memory loss and rigidity are separately considered. Certain abilities, noticeably verbal-meaning, word-fluency and arithmetic ability, seem to hold up well enough in a superior group to permit above-average functioning even at an advanced age. On the other hand it was shown that on the factors of space and reasoning even this group showed marked deficit.

Summary

Thurstone's primary mental abilities test was administered to 25 male and 25 female college graduates ranging in age from 70 to 88 years. Independent measures of speed, memory loss and increased rigidity were also obtained.

After rank-ordering by age into five sub-groups, significant decline within the group is shown on all abilities except Word-fluency. When scored in terms of young adult norms, mean scores remain above average on Verbal-meaning, Word-fluency and arithmetic ability.

All scores were corrected for the effect of loss of speed, memory and of increased rigidity. While the slopes of the age gradients level off, significant decline seems to prevail and no change occurs in the relative order of the different abilities.

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Table I.

Mean T-Scores for sub-groups. (Young Adult norms).

Mean Age	V	S	R	N	W	IQ	Sp.	Mem	M-Rig.
71	58.5	41.9	46.4	57.9	47.6	54.3	44.2	39.4	46.4
73	57.1	37.6	44.1	55.6	54.0	51.6	44.2	43.6	46.8
75	59.4	38.2	40.6	58.1	60.1	54.1	43.8	41.8	45.7
79	52.8	35.9	39.8	53.4	48.3	45.4	41.6	34.1	41.0
84	45.8	33.5	32.0	48.0	48.3	40.5	33.2	29.0	37.9
D_{1-5}	12.7	8.4	14.4	9.9	-0.7	14.2	11.0	10.4	8.5

Table II

Test inter-correlations

	S	R	N	W	IQ	Sp.	Mem.	M-Rig.
Verbal Meaning	.348	.612	.300	.172	.630	.676	.375	.501
Space		.361	.193	.093	.470	.145	.266	.263
Reasoning			.395	.354	.757	.674	.571	.462
Number				.287	.784	.411	.318	.325
Word-fluency					.570	.396	.452	.025
Composite-IQ						.667	.554	.445
Speed							.410	.318
Memory								.406
Motor-Rigidity								

Table III

Proportion of variance successively accounted for by the effect of speed, memory and motor-rigidity (coefficients used in the correction-formuli)

	Speed	Memory*	Motor-Rigidity**
Verbal-meaning	.457	.146	.090
Space	.021	.229	.029
Reasoning	.454	.448	.062
Number	.169	.179	.025
Word-fluency	.157	.346	-.065
Composite-IQ	.445	.413	.052

*After the effect of speed has been partialled out

**After the effect of speed and memory have been partialled out.

Table IV

Mean T-scores after corrections for the effect of speed, memory loss and increased motor rigidity.

Mean Age	V	S	R	N	W	IQ
71	63.0	44.6	54.0	61.1	52.0	61.4
73	61.0	39.2	49.8	57.8	56.9	57.0
75	63.8	40.3	47.4	60.7	63.5	60.5
79	59.5	39.6	50.5	55.6	53.9	55.4
84	56.8	37.8	47.3	53.9	55.4	54.0
D_{1-5}	6.2	6.8	6.7	7.1	-3.4	7.4

Fig. I: SMOOTHED SUB-GROUP MEANS FOR THE PRIMARY MENTAL ABILITIES AND COMPOSITE I.Q. SCORES

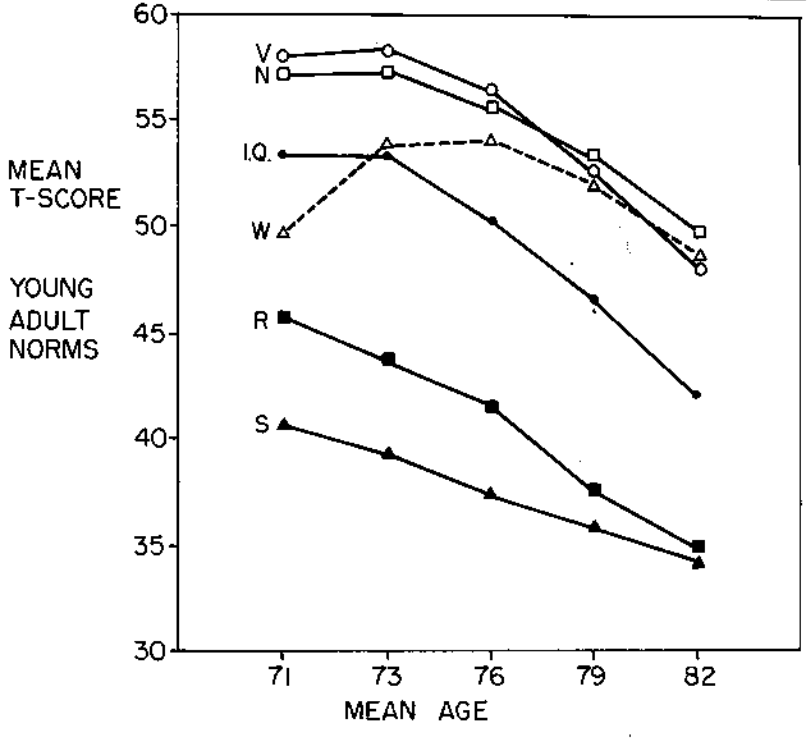

Fig. II: SMOOTHED SUB-GROUP MEANS FOR THE RIGIDITY, SPEED AND MEMORY SCORES

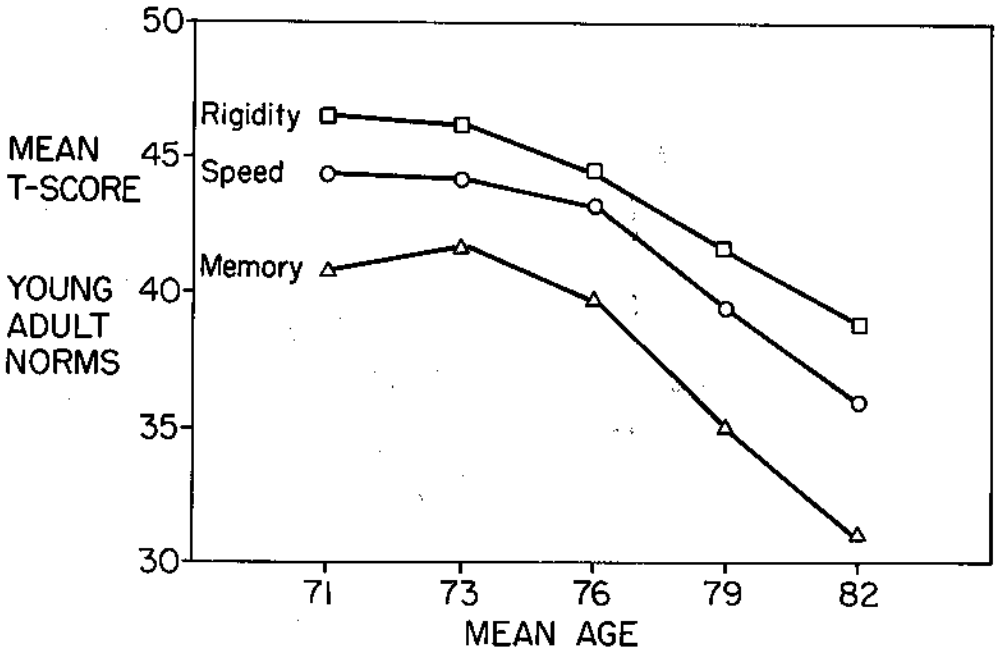

Fig. III: P.M.A. SCORES CORRECTED FOR EFFECT OF SPEED, MEMORY LOSS AND RIGIDITY