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Abstract: Examines the secular decline in Japan of the strength of Spearman's g, which is measured by the value of the intercorrelations of the subtests of the Wechsler Intelligence Scale for Children-R (WISC-R) and the Wechsler Adult Intelligence Scale (WAIS-R) among low-intelligence groups. Occurrence of a similar decline in France; Strength of Spearman's g as partly a function of common environmental factors.

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A SECULAR DECLINE IN THE STRENGTH OF SPEARMAN'S G IN JAPAN

It has been found in the United States and in Scotland that the subtests of the WISC-R and WAIS-R are more highly intercorrelated among low-intelligence groups than among high. The value of the intercorrelations is a measure of the strength of Spearman's g, and hence Spearman's g is apparently stronger among populations with low intelligence. Since intelligence has been increasing over time, it should follow that the strength of g has shown a corresponding decline. Evidence from the standardization samples of the WISC and WISC-R in Japan shows that this is the case.

It has been shown by Detterman and Daniel (1989) that the mean intercorrelations between the subtests of the American standardization of the WISC-R and WAIS-R are higher in low-ability groups than in high. We have found that this phenomenon is also present in the Scottish standardization of the WISC-R (Lynn, 1992). It appears therefore that Spearman's g is more powerful, or accounts for a greater proportion of the variance, in populations with a low level of intelligence as compared with those in whom the level of intelligence is higher.

It is interesting to question whether this rule holds over time. Intelligence levels in the populations of the economically developed nations have increased over the last half century (Lynn & Hampson, 1986; Flynn, 1987). It should follow that among contemporary high-intelligence populations the magnitude of test intercorrelations should have fallen, reflecting a decline in the power of Spearman's g.

Sampling differences preclude the use of the USA standardization data to test this hypothesis. We have however tested this prediction by examining the mean intercorrelations of the subtests of the WISC and the later WISC-R in France and found that the predicted decline has occurred (Lynn and Cooper, 1993). In addition, we found that the decline was greatest in the correlations between the verbal and performance subtests, rather less among the performance subtests, and lowest among the verbal subtests. The purpose of the present paper is to examine whether a similar secular decline in subtest intercorrelations has taken place in Japan.

METHOD

The WISC was standardized in Japan on 1,070 6-16-year olds in 1951, and the WISC-R on 1,100 6-16 year olds in 1975. The two standardizations therefore provide a period of 24 years over which to test for a decline in the magnitude of the intercorrelations. The correlation matrices for the 12 subtests for the 7-year, 10-year, and 13-year-old age groups are published in the manuals. The correlations between the WISC and WISC-R subtests were first normalized through Fisher transformations, and averaged for each age group. These means were calculated for the whole test, for the verbal and performance subtests separately, and for the verbal-performance correlations.

It would be more conventional--though a less direct test of our hypothesis--to compare factor or component loadings for the WISC and WISC-R at each age range. However, as the number of subtests in the WISC and WISC-R is not large, the hyperplanes would not be well defined. This could well result in the "best" rotation for simple structure being difficult to determine. This will affect the relative magnitudes of the loadings on the Verbal and Spatial factors, and could thus account for any differences in the mean transformed loadings on these factors. In addition, the distributional properties of congruences coefficients are not well understood. This would make it difficult to make statistical inferences about the stability of factor loadings over time. Our preferred technique of examining mean correlations overcomes all these difficulties.

RESULTS

The main results are shown in Table 1. Shown first are the means and standard deviations of the 66 transformed intercorrelations of all the subtests of the WISC and WISC-R for the 7-, 10-, and 13-year-olds. The penultimate column gives the value of t for testing the significance of the difference between the two means. It will be seen that there is a statistically significant decline in the mean intercorrelations for each of the three age groups.

The next three rows show the mean of the 15 transformed intercorrelations of the verbal subtests. Although some decline is evident from the WISC to the WISC-R, it is not statistically significant for any of the three age groups. Shown next are the means of the 15 transformed intercorrelations between the performance subtests. Here there are statistically significant declines for all three age groups. The last three rows show the decline in the 36 verbal-performance correlations. Here again there are statistically significant declines for all three age groups.

The final column in Table 1 shows the values of t, which were obtained after correcting the original correlations for unreliability. As complete reliability data were not provided for the digit span and coding subtests, these have been omitted from this analysis. Thus, the number of correlations averaged in the four analyses reported in this column was 45, 10, 10, and 25.

In order to investigate further the changes in the verbal, spatial and the cross-correlations and to identify any interactions with age, a factorial analysis of variance was performed on the (uncorrected) transformed correlations. This analysis used pupil age (7,10,or 13 year) category of correlation (verbal, spatial, or verbal-spatial) and year of testing as factors.

It can be seen from Tables 1 and 2 that the correlations were affected by age, being higher for the two older groups. There were also differences in size between the verbal and spatial subtest correlations and their cross-correlations; the verbal subtest intercorrelations were the highest, and the other two were equal. The massive decline in mean correlations from the WISC (administered in 1951) and WISC-R (administered in 1975) parallels the results shown by the t-tests in Table 1. In addition, the highly significant 2-way interaction indicates that the verbal intercorrelations, spatial intercorrelations and the cross-corelations did not decline to equal extents over this period. Correlations between the verbal subtests remained similar (the mean transformed correlation falling from 0.49 to 0.41) whereas the spatial subtest intercorrelations and the cross-correlations declined substantially (0.38 to 0.17 and 0.39 to 0.18). No other interactions approached significance.

DISCUSSION

The principal objective of the study was to ascertain whether there has been a substantial secular decline in the mean intercorrelations of the Wechsler subtests in Japan from the WISC, standardized in 1951, to the WISC-R, standardized in 1975. The results show that there has bee a significant decline for 7-, 10-, and 13-year-olds. It is generally considered that the mean intercorrelation between the subtests of the Wechslers is a good measure of the strength of Spearman's g because the subtests cover a good range of major abilities. The results therefore indicate that the strength of Spearman's g has declined over the 24-year period. The results are consistent with the findings that Spearman's g is weaker among populations with higher intelligence. Intelligence has been increasing among Japanese children (Lynn and Hampson, 1986), as among children in other economically developed nations, and therefore a secular decrease in the strength of Spearman's g would be expected. The results show that the expected decline has occurred.

We believe that the central point of interest in the results is that they suggest that the strength of Spearman's g is partly a function of common environmental factors affecting all abilities. Suppose that there are a number of independent abilities the strength of which is determined by their own genes. A favorable environment consisting of good nutrition and, possibly, general cognitive stimulation would foster the development of the neurophysiological processes underlying all abilities and hence bring them into positive correlation. This could be sufficient to explain the phenomenon of Spearman's g, which consists of the positive intercorrelation of all cognitive tests. Our results indicate that such a process does explain part of Spearman's g, since with the improvement of environmental conditions over time, leading to an increase on all cognitive tests, the environmental variance has decreased, leading to a decrease in the variance of intelligence, found in Britain and Denmark (Lynn and Hampson, 1986; Teasdale and Owen, 1989). The secular reduction in environmental variance would lower the intercorrelations between the subtests and the strength of Spearman's g, as we have found in both Japan and France. It is an interesting question whether Spearman's g would disappear completely in a group of subjects raised under identical environmental conditions. This would resolve the long-standing problem of whether Spearman's g is a basic power entering into the performance of all cognitive tests, as Spearman believed, or whether it is simply an artifact arising from common environmental variance acting on all abilities. Unfortunately, such a study would be difficult to carry out.

Our proposal that the secular decline in the strength of Spearman's g is the result of a decline in environmental variance is consistent with the results showing that Spearman's g is stronger among low-intelligence groups. When the heritabilities of intelligence are analyzed in terms of socioeconomic status, it is found that heritabilities are greater among high-intelligence groups than among low (Scarr, 1971). This means that the environmental variance is less in higher intelligence groups. The lower environmental variance will entail a reduction in the test intercorrelations among high-IQ groups reported by Detterman and Daniel in the United States and confirmed in Scotland.

Why has the secular decline in intercorrelations between tests been greater for the performance tests than for the verbal? The explanation would seem to be that verbal abilities have a greater heritability than performance and nonverbal abilities, as reported by Scarr (1971) for the United States, by Tambs, Sundet and Magnus (1984) for Norway, and Fischbein (1981) for Sweden. The lower heritability of performance and nonverbal tests would explain why these have increased more than verbal tests with environmental improvement over the last half century, a finding that has been obtained in a number of countries (Lynn and Hampson, 1986; Flynn, 1987). The greater reduction in environmental variance over time for performance on nonverbal tests, as compared with verbal, explains why the test intercorrelations from the performance tests have shown a greater decline.

The final problem is why there has been a substantial reduction over time in the cross-correlations between the verbal and performance subtests. The explanation is probably that the two abilities are under the control of independent genes. The positive intercorrelations that are invariably found between the two abilities will arise partly from common environmental variance. When the common environmental variance is reduced over time, as it apparently has been, the correlations between the two sets of abilities will fall.

We turn finally to the discussion of three possible artifacts in the results.

A. COMPARABILITY OF THE WISC AND WISC-R

It is possible that the differences in item content may account for the differences in the correlations previously noted. However, when those scales, which had been most heavily modified (Similarities and Picture Arrangement) were eliminated from the analysis, near-identical results were obtained. As the other scales had only undergone minor modification, it seem unlikely that the change in item content can explain these results.

B. DIFFERING RELIABILITIES OF THE SCALES

A decline in mean correlations similar to that previously noted would be found if some or all of the subtests of the WISC were more reliable than the corresponding subtests in the WISC-R. This is not the case. The t-tests performed after correcting the original correlations for unreliability (shown in the final column of Table 1) revealed precisely the same declines in correlations as did the analysis based on the uncorrected correlations. It is interesting to note that the reliabilities of the Japanese WISC and WISC-R subtests were highly similar with mean coefficients alpha of 0.72 and 0.73 for the age ranges in question.

C. INCREASED FACTOR PURITY OF THE WISC-R

Correlations between WISC subscales could be caused by each of the subscales being contaminated by other abilities, test-taking attitudes or other irrelevant factors. The process of cleaning up the factors for WISC-R may thus have led to a reduction in the intercorrelations. However correlations between scales in the United States WISC and WISC-R are typically "in the 0.80's" (Kaufman, 1979, p. 125), which approaches the square root of the product of the reliabilities of some of the subtests, and indicates that there is a very substantial overlap between the corresponding WISC and WISC-R scales. Hence it seems that the increased purity of the WISC-R scales is unlikely to account fox the effects that we reported.

Factor analytic work supports this assertion. Kaufman (1979,pp. 123-129) summarizes a number of studies and observes that there is a "striking correspondence" between the two major factors found in the WISC and WISC-R in the United States, with Swerdlik & Schweitzer (1978) reporting congruences of 0.98. As congruence coefficients reflect similarities in absolute magnitude of loadings, this suggests that any declines in mean correlations are unlikely to be attributable to the increased purity of the scales. The upshot of this discussion is that we believe these possible artifacts can be ruled out and that there has been a genuine and substantial reduction in the strength of Spearman's g in Japan over the period 1951-1974.

NOTES

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TABLE 1

Mean Fisher-Transformed Intercorrelations between Sub-Tests in the Japanese

WISC and WISC-R as a Function of Age

Legend for Chart:

A - Tests
B - Age
C - WISC; Mean
D - WISC; S.D.
E - WISC-R; Mean
F - WISC-R; S.D.
G - t
H - t; (corrected)

A	B	C	D	E	F	G	H
All	7	0.33	0.16	0.19	0.13	5.19[c]	4.93[c]
	10	0.45	0.16	0.26	0.16	7.07[c]	4.65[c]
	13	0.44	0.18	0.24	0.16	6.48[c]	4.40[c]
Verbal	7	0.40	0.11	0.36	0.11	1.04	0.79
	10	0.51	0.13	0.42	0.17	1.63	0.67
	13	0.55	0.18	0.46	0.13	1.54	1.55
Performance	7	0.33	0.17	0.18	0.10	3.00[b]	4.67[c]
	10	0.46	0.13	0.17	0.12	6.35[c]	4.06[b]
	13	0.36	0.18	0.18	0.13	3.13[b]	1.84[a]
Verbal/	7	0.30	0.17	0.13	0.09	5.05[c]	4.03[c]
Performance	10	0.43	0.18	0.23	0.12	5.57[c]	4.17[c]
	13	0.43	0.16	0.18	0.10	7.64[3]	4.10[c]

a p<0.05

b p<0.01

c p<0.001 (1-tailed)

TABLE 2

ANOVA on Fisher-Transformed Correlations between WISC or WISC-R Sub-Tests for 3 Age Ranges

Legend for the Chart;

A - Source
B - Sum of Squares

C - DF
D - Mean Square
E - F

A	B	C	D	E
Age	.655	2	.327	16.003[c]
r-type	1.940	2	.970	47.406[c]
Test	3.065	1	3.065	149.800[c]
Age x r-type	.134	4	.034	1.639
Age x test	.082	2	.041	1.992
r-type x test	.303	2	.152	7.411[c]
Age x r type x test	.067	4	.017	.814
Residual	7.734	378	.020	--

Key:

test WISC or WISC-R

age 7, 10 or 13 years

r-type verbal sub-test intercorrelations, spatial sub-test intercorrelations, or verbal/spatial cross correlations

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