

THE NON-VERBAL REASONING ABILITY OF JAPANESE CHILDREN MEASURED BY NAGLIERI'S (1985) MATRIX ANALOGIES TEST — SHORT FORM

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Using a newly-developed group test of children's non-verbal reasoning ability (Naglieri's (1985) Matrix Analogies Test — Short Form [MAT-SF]), the study examined the performance of 451 Japanese Children, ages 6–12 years, and its relationship to school achievement. Test reliability was high. There were no significant gender differences. High achieving students scored significantly higher on this test in comparison with their average and low achieving peers. Across all age levels from 6 to 12, Japanese children consistently earned higher MAT-SF scores than North American samples (American and Canadian children). This result suggests that Japanese children may have an advantage in non-verbal or visuo-spatial reasoning in comparison with North American children. Whereas this study further supports the reliability and validity of the MAT-SF, it may be necessary to develop representative and relevant norms to aid test interpretation in non-North American countries and cultures.

A series of studies in which the non-verbal tests were administered to Japanese children (Lynn, 1977, 1982; Lynn, Hampson & Bingham, 1987; Misawa, Motegi, Fujita & Hattori, 1984) indicated that Japanese children achieved a higher mean of non-verbal intelligence score in comparison with American children. Stevenson and Azuma (1983) criticized the comparative studies of Lynn (1977 & 1982) commenting that the test was flawed because over 92 percent of the subjects used in the Japanese standardization for the Wechsler intelligence tests (WISC and WISC-R) came from higher socio-economic status and urban residence, and therefore, the Japanese sample was not representative of the Japanese population as a whole. Motegi (1984) provided an explanation for this, saying that the Japanese subjects were drawn from the 98.5 percent of the Japanese population which lives in towns of more than 5,000 inhabitants. In the light of Motegi's argument, Lynn's comparative analysis is acceptable.

Challenging the studies of Lynn, Stevenson's research group (Stevenson, Stigler, Lucker, Lee, Hsu & Kitamura, 1982; Stigler, Lee, Lucker & Stevenson, 1982; Stevenson, Stigler, Lee, Lucker, Kitamura & Hsu, 1985) conducted cross-national research using children from three countries, America, Japan and Taiwan. For the sample of the three countries, Stevenson and his colleagues used 5th grade children from three cities; Sendai for Japan, Taipei for Taiwan, and Minneapolis for the

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United States. A total of 2,155 children were selected for analysis from 20 classrooms in each city; 453 children in Minneapolis, 932 children in Taipei, and 770 in Sendai. These three cities are similar in size and economic status. The findings of the study contradicted those of Lynn.

Analyzing the research data of Stevenson's group, Stigler et al. (1982) found cognitive tasks were not effective in predicting the mathematical scores attained by Japanese, Chinese, or American children. The conclusions of this study did not support differences in the general cognitive functioning of Chinese, Japanese and American children. In opposition to the studies of Lynn (1977, 1982), Stevenson et al. (1985) rejected the relation between the superiority of Japanese children in mathematical ability and a generally higher level of cognitive functioning of the Japanese people. They arrived at the resolution that the high achievement of Chinese and Japanese children must be related to their experiences at home and at school. However, the sample in Minneapolis was representative, not of all American children, but "of children from white, English-speaking native-born families" (Stevenson, et al., 1982, p. 719). Thus, the sample of American children was controlled to have a specific group of white American children.

The longitudinal study of Japanese and white American children aged between 3 and 9 years (Lynn, 1987 for study, and Lynn, 1988 for review) suggested that there were no significant differences between 3 and 9 years while at 10 years and upwards Japanese children obtained higher means on Spearman's *g* than white American children. Lynn (1988) added that the difference of around 4 IQ points in average would not have much effect on higher educational achievement. Like Stevenson's group (Stevenson, et al., 1982; Stigler, et al., 1982; Stevenson, et al., 1985), Lynn (1988), in his current study, also attributed Japanese children's superiority in non-verbal intelligence to "an effect of the efficiency of Japanese schools" (p. 60) since the difference in IQs between Japanese and white American children occurs at the age of 10 and upwards.

Recently, Naglieri (1985) published the Matrix Analogies Test — Short Form (MAT-SF) which can be quickly administered to groups of children. The American standardization study demonstrated the psychometric soundness of the test and a 1990 NASP (National Association of School Psychologists) convention reporting preliminary data from different cultural and language groups concluded that the 'test travels well'. However, some variability was observed in the performance of children from the different samples with Canadian children (Saklofske, Yackulic, Murray, & Naglieri, 1990) scoring slightly higher at younger age levels. Thus, further research with a wide range of children from different countries and cultures is required to support the robustness of MAT-SF as a measure of intelligence as well as to establish appropriate norms, where necessary. Thus, the present study, using a newly-developed non-verbal reasoning test of MAT-SF, contains the double-fold purposes: (1) to compare Japanese children's performance in non-verbal reasoning with the North American samples in order to examine a longitudinal change in differences in the average scores, and (2) to establish the internal quality and reliability of MAT-SF

when applying it to Japanese children who belong to culturally and linguistically different settings from North America.

METHOD

Subjects:

451 Japanese children (226 boys and 225 girls) from the Elementary School affiliated with Ehime University in the city of Matsuyama, a medium-size Japanese city participated in this study. All subjects were enrolled in grades 1–6 and were in the 6 to 12 year age range. Almost all children came from middle to upper middle class family backgrounds.

Materials and Procedures:

MAT-SF for the non-verbal measure of ability which was developed for American children at the ages of 5–17 was administered in 25 minutes to the students as a group during the class hour in 25 minutes. The test contains 34 six option multiple choice items for the use of abstract designs of the standard progressive matrix type. In addition, classroom teachers rated each child's academic achievement based on performance averaged across all subject areas.

RESULTS

The MAT-SF performance data of Japanese children were analyzed to examine the internal quality and reliability of MAT-SF, to compare Japanese MAT-SF performance with that of North American children, and to compare the MAT-SF performance of Japanese children based on subjects' characteristics.

Item Analysis and Internal Consistency

As shown in Fig. 1, item difficulty indexes (ratio of correct answers) by item

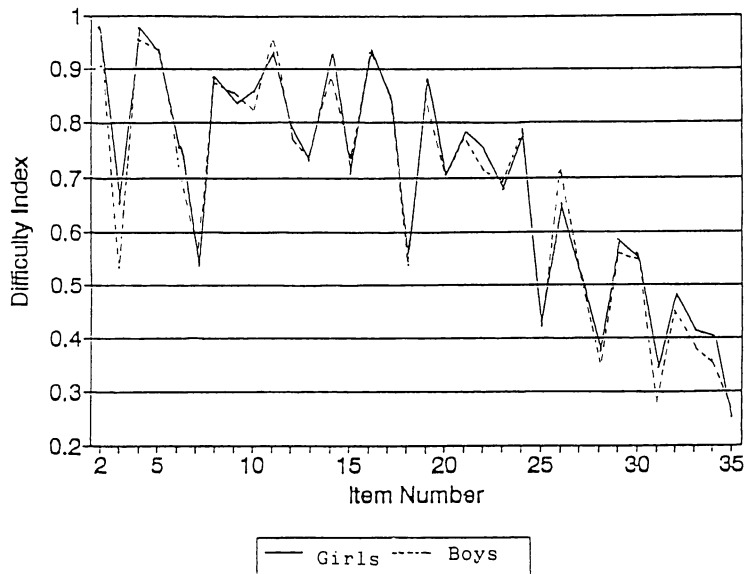


Fig. 1. Item difficulty by gender among Japanese children.

position indicated that several of the test items #3, #7, and #18 were relatively difficult for Japanese children while #4, #11, #14, #16 and #19 were relatively easy for them. This was also the case for Canadian children (Saklofske, et al., 1990). Thus, the test items are not necessarily ordered according to their difficulty level; the position of these items in MAT-SF might be reconsidered. However, except for these few items, there seems to have been overall similarities in difficulty trends in both Japanese and Canadian children—the difficulty indexes decreased or increased according to item position. In addition, as shown in Fig. 1, only a little gender differences were observed in the difficulty indexes of all test items in Japanese children.

Furthermore, internal consistency reliability of MAT-SF indicated that test reliability of the Japanese sample for MAT-SF was very high: Cronback's alpha was .89 and odd-even item reliability was .92. These reliability figures were comparable with those described by Naglieri for the U.S. standardization study (Naglieri, 1985). Since both reliability estimates of the Japanese sample exceeded .80, MAT-SF would be applicable to measure non-verbal reasoning ability of Japanese children as designed for American children.

Comparisons to North American Children

The study examined the performance of Japanese children on MAT-SF in comparison with North American children. In contrast to both American (Naglieri, 1985) and Canadian (Saklofske, et al., 1990) data, as graphically presented in Fig. 2, Japanese children earned consistently higher MAT-SF mean scores across the 6–12

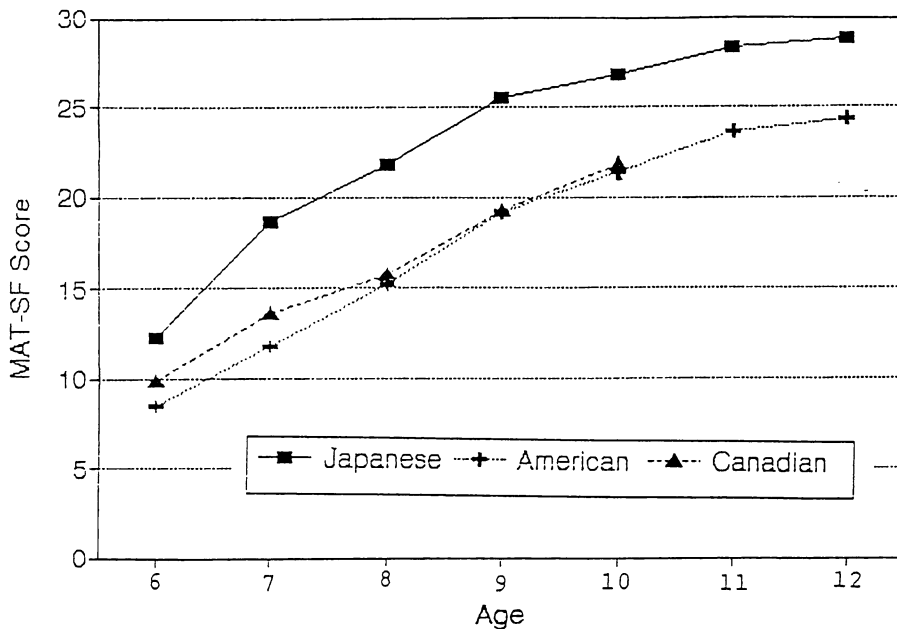


Fig. 2. MAT-SF scores by age among Japanese, American and Canadian children.

Table 1. Means and Standard Deviations of MAT-SF Scores among Japanese, American and Canadian Children

Age	Japanese			American				Canadian			
	<i>N</i>	<i>M</i>	<i>SD</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>d</i>	<i>N</i>	<i>M</i>	<i>SD</i>	<i>d</i>
6	43	12.3	4.7	369	8.4	4.6	3.9	93	9.8	4.8	2.5
7	75	18.6	6.6	362	11.8	6.0	6.8	125	13.6	6.6	5.0
8	70	21.8	5.1	348	15.2	7.0	6.6	140	15.7	6.6	6.1
9	81	25.5	3.8	367	19.1	6.9	6.4	141	19.3	6.7	6.2
10	83	26.8	3.5	431	21.3	6.4	5.5	130	21.7	6.1	5.1
11	70	28.3	3.1	377	23.5	5.5	4.8	—	—	—	—
12	29	28.8	2.5	382	24.3	5.0	4.5	—	—	—	—

Note: *d* indicates the differences of the means compared to the means of Japanese children.

year age range (see Table 1 for means and standard deviations of these groups). At the age of 6, Japanese children already scored 3.9 points higher than the American standardized sample, and 2.5 points higher than Canadian children. The differences of the means increased up to 6.8 points at the age 7 level in comparison with American children, and 6.2 at the age 9 level in comparison with Canadian children. According to the American standardization sample, the mean of the 17 year-old group showed 27.9 points, which is still lower than 28.3 points for Japanese children at the 11 year level. In addition, a ceiling effect seems to appear in Japanese children at the 11 year level; the mean at this level indicated 28.3 points (the MAT-SF maximum point score is 34.0), and the standard deviation decreased to 3.1 points. Since Japanese children obtain the much higher means across all age groups of 6–10 years in comparison with both American and Canadian children, Japanese children must have an advantage in tasks which require non-verbal reasoning ability.

Performance of Japanese Children based on Subjects' Characteristics

The influence of four factors (i. e., subjects' gender, age, grade and rating of school achievement) was analyzed by a series of one-way ANOVA. First, the means of MAT-SF performed by boys and girls did not indicate a significant difference; boys and girls performed very similarly on MAT-SF. Second, scores attained within the seven age groups (ages 6 to 12) showed a highly significant difference [$F(6,444) = 91.88, p < .0001$].

Furthermore, scores attained within six groups (from grades 1 to 6) showed an extremely high significant difference [$F(5,445) = 147.84, p < .0001$]. There were no interactions among the factors of gender, age and grade examined by MANOVA. Therefore, the highly significant differences indicated by age and grade suggest that developmental factors have a strong effect on children's non-verbal reasoning ability.

Finally, the relationship of MAT-SF to school achievement was examined using teachers' 3-point ratings of students. The result of on-way ANOVA indicated a significant difference among three groups of high, average and low achievers [$F(2,448) = 7.19, p < .001$]. Further analysis of multiple comparisons indicated that

high achieving students scored significantly higher on MAT-SF ($M=25.01$, $SD=6.16$) compared with average ($M=22.98$, $SD=6.48$) and low achieving ($M=22.20$, $SD=7.10$) students. The same analysis, which was performed separately for boys and girls, suggested that this tendency was stronger for girls. Thus, there is some evidence to support the criterion validity of MAT-SF in relations to teachers' ratings of students' school achievement.

DISCUSSION

The present study was conducted for two reasons: (1) to investigate the non-verbal reasoning ability of Japanese children in comparison with American and Canadian children, and (2) to explore the applicability of MAT-SF in a non-North American cultural and linguistic situation.

Performance of Japanese Children

As previous studies indicated (Lynn, 1977, 1982; Lynn, Hampson & Bingham, 1987; Misawa, Motegi, Fujita & Hattori, 1984), the present study also showed that the non-verbal reasoning ability of Japanese children was superior in comparison to that of American and Canadian children. Across all age levels Japanese children earned consistently higher MAT-SF means than American and Canadian children. In addition, although Lynn (1987) found that a significant difference between white American and Japanese children in means on Spearman's g appeared from the age of 10 years, a relatively large difference in the means of MAT-SF between American/Canadian and Japanese children was evident from the age of 6 years and upwards. At the age of 6, Japanese children obtained 12.3 points on average, which is 3.9 points higher than the average attained by American children and 2.5 points higher than that of Canadian children. The difference between American/Canadian and Japanese children increased from the age of 7 years.

The ceiling effect tends to appear in Japanese children at the 11 year level, which is much earlier than in the American standardized sample. Japanese children already showed 28.3 points at the age of 11 with a small standard deviation of 3.1. The mean for 12-year-olds reached 28.8 with a very small standard deviation of 2.5, in comparison with 24.3 points with a standard deviation of 5.0 points for the corresponding age of American children (a Canadian sample is not available for this age level). Even though the sampling of Japanese children may represent a higher social family background than the American standardization sample, the result for 12-year-old Japanese children which indicated almost two standard deviation higher than the American norm is too large to be perceived or disregarded as a sampling error.

The present longitudinal study on MAT-SF performed with Japanese children from 6 to 12 years suggested their superiority in non-verbal or visuo-spatial modes of reasoning. The change in means of MAT-SF scores between American/Canadian and Japanese children is not observed at any age level. Consequently, the study supported the finding of visuo-spatial advantage of Japanese children suggested by

Lynn et al. (1987). However, it is not sufficient to account for this advantage of Japanese children by "an effect of efficiency of Japanese schools" (Lynn, 1988, p. 60) since Japanese children performed better across all the age levels. The advantage in visuo-spatial reasoning ability among Japanese children should be considered to be acquired through the interaction of inherited and environmental determinants.

Reliability and Validity of MAT-SF for Japanese Children

Tests purporting to measure intelligence range from single scales that can be administered in a very short time to more comprehensive batteries such as the Stanford Binet and Wechsler-type tests. While the information that can be gleaned from these latter tests is potentially much greater in contrast to brief measures, problems may arise when they are administered to children who differ culturally or linguistically from the standardization group. For this reason as well as economy of time, tests which contain abstract figural stimuli or matrices to measure non-verbal reasoning ability have been extensively employed by psychologists. Thus, the present study investigated the applicability of a newly-developed non-verbal reasoning test for the use of the Japanese population.

According to the results of MAT-SF analysis, as with the Canadian sample (Saklofske, et. al., 1990), item difficulty indicated that some of the test items were found to be relatively easy (#3, #7 and #18), while others were relatively difficult (#4, #11, #14, #16 and #19) for Japanese children. Thus, the rearrangement of test items might be considered in the future. Despite a large difference across every age level between the means of Japanese children and that of the American standardization sample, internal reliability of MAT-SF in the Japanese data was very high in both reliability of Cronback's alpha and odd-even item reliability. In addition, the Japanese children performed better than American/Canadian counterparts from 6 to 12 years. Thus, although the test was designed to be used for American children of ages 5-17, testing limits of the applicable ages (both lower and higher limits) should be carefully examined for Japanese children.

Furthermore, high achieving Japanese students scored significantly higher on the test in comparison with their average and low achieving peers. This result provided some evidence to support the criterion validity of MAT-SF in relation to teachers' rating of student's school achievement. Therefore, MAT-SF would be applicable to measure the non-verbal reasoning ability of Japanese children. In summary, the MAT-SF continues to show good reliability as a measure of non-verbal intelligence with children who differ culturally from those for whom the test was originally designed. However, the results point to the potential need to establish local norms for this test when employing it in settings other than the U.S.

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