Perfortnance of Japanese and Japanese-American Children on the Motor Accuracy-Revised and Design Copying Tests of the Southern California Sensory Integration Tests

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This study investigates whether cultural differences affect children's performances on the Design Copying (DC) and Motor Accuracy-Revised (MAC-R) Tests of the Southern California Sensory Integration Tests. The DC and the MAC-R were administered to 98 children who were born in Japan and lived there at least during the first year of life and to 82 children who were of Japanese descent but who were born in America. Average test scores of the Japanese and Japanese-American children were compared with those of the American children, on whom the tests were standardized. Results of the tests requiring right-hand performance revealed that both groups of Japanese-descent children performed better than the standardization group of American children; the Japan-born children performed the best. We base these findings on the influence that culture has on the development of a child.

Professional interest in the use of sensory integration testing and procedures has been increasing not only domestically but also internationally. Japan reflects this trend. In the United States, occupational therapists rank highest among the health care professionals that administer developmental tests for screening and evaluation; the tests most frequently used by these professionals are the Southern California Sensory Integration Tests (SCSIT) (1). There has been a growing interest in the SCSIT in Japan, where the tests are currently used to identify sensory integration deficits in Japanese children. However, the Japanese are concerned with the accuracy of these tests because the scores are interpreted using the normative data reported by Ayres (12) on American children. This is because the SCSIT has not been standardized on Japanese children (2).

Normative data provide a frame of reference for interpreting individual test scores (3). The American norms on the SCSIT are based on performances of American children; however, these norms may underselect or overselect Japanese children as dysfunctional if Japanese children perform differently. Therefore, we undertook this study to determine if differences exist on the Motor Accuracy-Revised (MAC-R) and the Design Copying (DC) tests between the performances of children in the Japanese sample and those in Ayres' normative sample. To allow for a more precise interpretation of the source of any detected dif
ferences, we included a Japanese-American sample as a third comparative group. This group of children, who were of Japanese heritage but were culturally influenced by American customs and practices, served as a control group to measure the effects of culture on test performance. We thought that if significant differences were found between the performances of the American and the Japanese children, but not the Japanese-American children, those differences could be attributed largely to a culture effect.

Review of the Literature

Cross-cultural studies on child development emphasize the importance of environmental influences. Brazelton et al. (4) conducted a comparative study of 100 Zinacanteco infants from southeastern Mexico and 100 American infants. Results showed a marked difference in the development of the infants because of the cultural differences in child-rearing techniques during the first year of life. The Zinacanteco newborn is customarily wrapped in layers of blankets, which constantly suppresses the infant's motor activity. The infant's face is kept covered except when he or she is fed. This results in minimal social and visual stimulation during the first year of life; however, this practice does produce maximal kinesthetic and tactile stimulation. We found that the Zinacanteco infants developed in a fashion parallel to that of American infants, but the Mexican infants showed about a one-month delay in all aspects of development during the first year. Despite this delay, the Zinacanteco infants were reported to demonstrate smoother less tremulous motor activity than their American counterparts.

Using the Bayley Motor Scale and the Denver Developmental Screening Test (DDST), Solomons and Solomons (5) compared the test results of 300 Mexican infants living in Yucatan with those of American infants; these tests were performed during the first year of life. The Mexican infants were divided into the following groups, based on their backgrounds: those from working class families, those from middle to upper class families, and those from Mayan-speaking families. No differences in performance were found among the Yucatean infants, regardless of sex or sociocultural group. However, when these infants were compared with their American counterparts, they were found to be significantly advanced through the first 8 months of age. When the Yucatean and the American infants were 10 months old, their performances on the Bayley Motor Scale were comparable; however, at 12 months of age, the performances of the Yucatean infants were delayed. Items on the Bayley Motor Scale are largely concerned with the prehensile functioning of the infant prior to 9 months of age. The researchers noted that at this time the Yucatean infants demonstrated excellent eye-hand coordination. But, toward the end of the first year, items on the test are concerned with locomotion. Because of this shifting emphasis and the decline in the Yucatean infants' performance, we feel that the Yucatean infants may be delayed in their gross motor development.

Solomons and Solomons (5) discussed many cultural factors that could account for the early acquisition of fine motor skills and the later delay in gross motor coordination that seemed to characterize the Yucatean infants. For example, Yucatean infants are almost continuously carried by the caretaker; these infants are seldom placed on the floor to crawl, and they sleep in hammocks because of the heat. Also, families from poorer households typically do not possess furniture on which the infants can cruise. These factors all discourage gross motor development. Therefore, this study suggests that environmental factors along with child-rearing practices distinctive to a culture may be associated with the motor performance of infants.

A delay in the acquisition of gross motor coordination (relative to American counterparts) was also found in Welsh children. Following a pilot study that suggested the norms on the DDST might not be applicable to the children living in Cardiff, Wales, the DDST was standardized on 668 children living in Cardiff (6, 7). Results indicated that the Welsh children scored slightly lower on the gross motor scale at the age of one year than did the American children (7). For example, Welsh infants were reported to "rolls over" three months later than American infants did. However, the Welsh children were a little more advanced in language skills and personal-social development. However, the American and Welsh children showed no significant differences in fine motor development (6).

Children in Wales and Mexico were more advanced in fine motor development but were slower in gross motor development than their American counterparts. However, African infants appeared to be able to sit, stand, and walk about one month earlier than American infants (8). This difference was attributed to child-rearing practices specific to the African cultural group studied. For exam-
ple, over 80% of mothers in Kolkwet (northern Kenya) teach their babies to sit during the fifth or sixth month of life. Thus, we concluded that the motor development in infants is associated, to some extent, with the way they are customarily treated in their cultures (8).

Cross-cultural differences in child development have also been studied in Japanese children. Using the DDST, Ueda (9) obtained normative data on children living in Tokyo, Japan. Significant differences were found in gross motor development in early infancy between Japanese and American infants. The test bench marks, such as prone, head up, prone, chest up, and roll over, were passed at a later age by the Japanese infants than by the American infants. For example, Japanese infants rolled over 2.2 months later than their American counterparts did. Ueda attributed these differences in timing to the Japanese custom of placing infants in the supine rather than the prone position (10,11), he felt that such action might discourage certain aspects of gross motor development.

In summary, the literature we reviewed suggests that differences in child development exist across cultures. Researchers have attributed these differences, in part, to culture itself, which they define as the patterns of beliefs, values, and behaviors shared by social groups. If developmental differences across cultural groups do exist, then such differences may affect the children's performances on the SCSIT. In this study, we hypothesized that performances of Japanese children on the MAC-R and the DC of the SCSIT would differ significantly from those performances of the American group. However, because the literature review suggested that such differences were probably due, at least in part, to cultural practices, we further hypothesized that Japanese-American children would perform more like the American group than the Japanese group.

Methods

Subjects

The design of this study included two comparative groups: a Japanese group and a Japanese-American group. The Japanese group was comprised of 98 children who, at the time of the study, resided in either Los Angeles or Orange Counties in California. All had been born in Japan and had lived there during at least the first year of life. The Japanese-American group consisted of 82 Japanese-American children residing in the same counties. Subjects were obtained either from Sunday schools of Christian and Buddhist Churches or from the Torrance Unified School District.

The two groups were subdivided by one-year intervals into seven age groups, ranging from 4 to 10 years. These age groups corresponded to those on which the original normative data on the tests were obtained, with the exception that in the normative data, the groups were divided by six-month intervals (12). We used the estimates of subject variability from a preliminary study conducted by Tsuchida (2) and the sample size formula for comparing two independent groups by Schlesselman (13) to determine how many subjects were needed in each age group. We concluded that a sample size of at least nine Japanese children and nine Japanese-American children for each age of the seven age groups was sufficient to detect small-group differences with 80% power at a 5% significance level.

Procedures

Both groups were given the MAC-R and the DC between February and September, 1982. All testing was performed by an occupational therapist certified in the administration and interpretation of the SCSIT (12). Test presentation for successive subjects tested was randomized to counteract an effect of test order. Children had to complete the MAC-R in 60 sec.

Results

The raw scores on the MAC-R were converted into adjusted scores following the procedures outlined in the test manual (12). For each test (the DC and the MAC-R), a two-way analysis of variance was performed to compare the two Japanese groups and the seven age groups. Because the raw data on Ayres' normative sample were unavailable, we could not include these data in our analyses. The significance level was set at .05. When significant differences were found, multiple comparisons were made using Duncan post hoc comparisons.

To compare the Japanese and Japanese-American groups with the American group, it was necessary to use the published average scores for each age group (12). For each test and the Japanese or Japanese-American groups, we made comparisons with these normative statistics, using one-sample t tests. The normative means were regarded as the true means. Because the data in the test manual were presented in six-month intervals and because the Japanese and Japanese-American samples were divided into age groups of one-year
Figure 1 shows the means for the three cultural groups. The mean right-hand MAC-R adjusted scores of the Japanese group were consistently higher than those of Ayres' normative sample at all age levels. The differences were statistically significant at ages 5, 7, 8, 9, and 10 years ($p < .001$). In the comparison of mean test scores between the Japanese-American group and the American group, statistically significant differences were found at ages 6 and 10 years ($p < .001$).

For the left-hand MAC-R adjusted scores, statistically significant differences between the Japanese and the American groups were found at ages 5, 9, and 10 years (see Figure 2). In these age brackets, the Japanese group performed better than the American group. In contrast, when the Japanese-American group was compared with the American group on mean left-hand MAC-R adjusted scores, no significant differences were found, except at age 10 years ($p < .001$).

Figure 3, as we mentioned, presents the mean DC test scores for the three cultural groups. The mean test scores on the DC of Japanese children consistently exceeded the scores reported for re-

intervals, the two sets of means representing each year interval in the manual were averaged and then utilized in the statistical analysis. To accommodate the fact that 42 $t$ tests were performed (two ethnic groups × seven age groups × three subtests), a conservative significance level of .001 was used ($0.05/42 = .001$, approximately). This approach is called the Bonferroni method.

Figures 1–3 show the means for the three groups on the right-hand MAC-R adjusted scores, the left-hand MAC-R adjusted scores, and the DC scores. The two-way analyses of variance that compared the cultural groups (Japanese vs. Japanese-American) and the ages revealed the following. For the means on the right-hand MAC-R, there was a significant difference between cultural groups ($p < .05$) and a significant effect due to age ($p < .001$), but no significant interaction was found. On the average, the Japanese performed significantly better than the Japanese-American group (see Figure 1). For the left-hand MAC-R, there was a significant age effect ($p < .001$), but no significant cultural differences or interactions were found (see Figure 2). For the DC, there was a significant age and cultural effect ($p < .001$) along with a significant age-culture interaction ($p = .031$). Duncan’s multiple comparisons showed that in five out of seven of the age groups, the Japanese group performed significantly better than the Japanese-American group, but that for age groups 4 and 7 years, there were no differences (see Figure 3).

Figure 1, as we mentioned, also presents the mean right-hand MAC-R adjusted scores for the American group. The mean right-hand MAC-R test scores of the Japanese group were consistently higher than those of Ayres' normative sample at all age levels. The differences were statistically significant at ages 5, 7, 8, 9, and 10 years ($p < .001$). In the comparison of mean test scores between the Japanese-American group and the American group, statistically significant differences were found at ages 6 and 10 years ($p < .001$).

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Discussion

The findings of this study can be summarized by the following three statements.

1. In general, performances of the Japanese and the Japanese-American groups exceeded those of Ayres' normative sample, with the mean test scores of the Japanese group being the highest.

2. In right-hand performance (the right-hand MAC-R and the DC that utilizes the right hand), Japanese children generally performed statistically significantly better than Ayres' normative group; however, in left-hand performance (the left-hand MAC-R), differences between the groups were marginal.

3. No significant differences were found among the three cultural groups on any of the tests at age 4 years.

However, these results must be interpreted cautiously as it is possible that, because the Japanese children had Japanese first names and the Japanese-American children had English first names, the testers' knowledge of group placement may have biased the results. But the objectivity inherent in the scoring procedures for both tests probably diminished this effect if indeed it was present.

The first conclusion of this study, that the Japanese children performed better on these tests than did the Americans, is not surprising because prior research suggests that Japanese children exceed American children in fine motor coordination (2, 9). However, we must monitor our interpretations because the Japanese sample tended to draw on affluent children, whereas Ayres' normative sample was comprised of children from lower middle and middle class backgrounds (South Bay area of Los Angeles).

The fact that the test performances of the Japanese-American children generally fall in between those of the Japanese and the American children may be interpreted to suggest an effect of cultural practices on fine motor development. Although the Japanese-American children tended to perform significantly better than the American children, they did not do so to the extent that the Japanese children did. Japanese children may receive different amounts of exposure to Japanese child-rearing customs, customs which may be associated with better development of fine motor skills. Prior research has suggested that American child-rearing practices encourage a high
rate of happy vocalization and motor activity in infants (14). In contrast, Japanese child-rearing practices have been described as resulting in a less motorically active and a more quiet infant (15). The results of this study suggest that the differences in the American and Japanese cultures may be associated with the expression of fine motor ability in middle childhood.

The second conclusion of this study can also be interpreted as a cultural effect. As depicted in Figures 1 and 3, the Japanese children, rather consistently and from an earlier age, perform better than Ayres' normative children on tests that require right-hand use (the right-hand MAC-R and the DC). In contrast, differences between the Japanese and American groups on the test that require left-hand performance (the left-hand MAC-R) were significant only at ages 5, 9, and 10 years. Thus, it appears that the superiority of left-hand coordination in Japanese children emerges in later childhood.

The third conclusion of this study is that certain Japanese cultural practices could be responsible for the superiority of Japanese children in fine motor skills. Essentially, we found that the three groups were similar at age 4 years, but that by 5 years appreciable differences existed, especially in right-hand performance. Between the ages of 4 and 5 years, most of the children of Japanese descent had been enrolled in Japanese preschools, which emphasize the practice of fine motor activities, although those born in Japan probably had been so to a greater extent. These preschools emphasize training in right-hand use and in the development of fine motor skills through activities like brush drawing, paper folding, and penmanship exercises. Soohoo (16) found that the rate of fine motor development among Asian-American children accelerated after the children reached school age. A similar effect seems apparent in this study and suggests that the superior performances of the Japanese, and to a lesser extent the Japanese-American children, may be associated with the cultural emphasis on fine motor skill acquisition, which characterizes Japanese preschool programs. The children had the following amounts of hand training: the Japanese children had the greatest, the Japanese-American children had less, and the children in Ayres' normative sample had the least.

This study has several important practical implications. The findings suggest that when the test results on the DC and the MAC-R are interpreted using the available normative data, they may be underselective of Japanese and Japanese-American children with dysfunction. Second, these tests may lack sufficient sensitivity to be used meaningfully with 4-year-old children.
In summary, the available American normative data from the MAC-R and the DC must be applied cautiously to Japanese and Japanese-American children. It is likely that performance on other SCSIT would show similar differences. In addition, performances of other ethnic groups on the SCSIT will probably differ from the performances of the normative sample, on which the SCSIT was standardized. The findings of this study suggest that future cross-cultural studies on the SCSIT are needed to assure valid decisions about whether or not dysfunction is present.

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