Manual Dexterity of South African Children Growing in Contrasting Socioeconomic Conditions

M. C. Verdonck, M. Henneberg

Key Words: dexterity functions • hand functions • poverty (socioeconomic factors)

Development of optimal conditions for child growth is one of the aims of public health policies. Monitoring child growth is typically done by means of anthropometric evaluation. Although easy to execute, this type of evaluation provides only indirect measures of functional characteristics. Because achieving good functional abilities seems more important than attaining a certain physical size, anthropometric surveys of child growth should be complemented by assessments of functional abilities. Such assessments fall into the domain of community occupational therapy, specifically in terms of health promotion and population screening. Community service by occupational therapists is especially important in developing countries where an enormous demand for primary health care exists. Effects of socioeconomic background should also be taken into account in evaluation, planning, and execution of treatment of individual clients because the client's optimum level of performance may vary accordingly.

In South Africa, poor socioeconomic conditions have been associated with smaller body size of children (Cameron, Kgamphe, Leschner, & Farrant, 1992; Henneberg & Louw, 1990, 1993; Richardson, 1978). However, little is known about how differences in socioeconomic status (SES) influence motor development beyond the fact that smaller body size detracts from performance in tasks that depend on body frame size or amount of muscle (e.g., long jump, grip strength). There are indications that South African children from lower socioeconomic backgrounds have slower reaction times and lower muscle strength than their more economically advantaged counterparts (Henneberg, Brush, & Harrison, 1995; Henneberg, Warton, & Hollinshead, 1987). Functional impairments of persons who have grown up in impoverished conditions may negatively influence their ability to perform manual labor as adults and thus contribute to the perpetuation of the cycle of poverty. Therefore, the aim of this study was to assess the influence of poverty on manual dexterity in order to ascertain whether remedial action is necessary.

Manual dexterity can be defined as “the ability to make skillful, well-directed, arm and hand movements in manipulating fairly large objects under speed conditions” (Fleischman, 1964, p. 23). In terms of the American Occupational Therapy Association’s (1994) Uniform Terminology, manual dexterity includes the following performance components: sensory integration (tactile, proprioceptive, visual processing, perceptual skills); neuromuscular performance (postural control, strength, range of motion, reflexes to a certain degree); and motor performance (gross and fine motor coordination,
crossing the midline, praxis, visuomotor integration). The Box and Block Test of Manual Dexterity (BBTMD) (Mathiowetz, Volland, Kashman, & Weber, 1985) was selected because it is suitable to conditions of mass surveys in poor areas, its results correlate well with other widely accepted tests (Cromwell, 1976), and its norms have been established on a large sample of American adults and children (Mathiowetz, Federman, & Weimer, 1985; Mathiowetz et al., 1985). No reports of application of this test to South African children are known.

Method

Participants

The present study is part of a larger ongoing project that is examining physical growth and development of “Cape Coloured” children (Henneberg et al., 1987; Henneberg, & Louw, 1990, 1993). Two samples of children classified under the previous administrative rules as Cape Coloured were study participants. This population is unique to South Africa and is the result of centuries of mixing of local Khoi and Bushman with European, Asian, and black African immigrants.

The first sample, consisting of 52 boys and 53 girls aged 6 years to 17 years, had been examined in September 1994 in primary schools in Zoar and Deysseldorp in the Western Cape. These children came from poor, rural backgrounds; the majority of their parents were farm laborers; and many of the parents were employed only intermittently. Their home language was uniformly Afrikaans. The second sample was that of urban children aged 6 years to 17 years comprised this sample. Home language of these participants was either English or Afrikaans. The majority of all participants were right handed (97.1% of the rural sample, 96.1% of the urban sample). SES was determined by parental occupation (South African Central Statistical Service Report, 1991).

Instrument

The BBTMD applied in this study used 150 26.5-mm wooden cubes and a 605 × 305 × 85-mm wooden box. The box was divided into equal halves by a wooden partition that was 165 mm high and 12 mm thick. Our dimensions differed from those of the equipment described by Mathiowetz, Volland, et al. (1985), which included 25-mm cubes and a 537 × 254 × 85-mm box.

Procedure

All participants were tested by the first author, who is fluent in both Afrikaans and English. Each participant was seated on a chair in front of the box, which was placed lengthwise on the table with the partition exactly in front of the participant. The size of the chair and height of the table depended on the participant’s body size. Two chair sizes and two table heights were available. Individual care was taken to seat the participant so that his or her feet rested firmly on the ground and the top of the partition of the test box was approximately 10 cm below his or her chin.

The interview was conducted and instructions given in the participant’s home language. Hand dominance was ascertained through interview, aided when necessary by a simple task test (e.g., lifting a pen, combing hair). Right-handed participants were instructed as follows: “I would like for you to pick up one block at a time with your right hand, carry it to the other side of the box, and drop it. Make sure your whole hand crosses the division. Do not throw the blocks but be as quick as you can.” The examiner then demonstrated the action with the hand opposite to the participant’s dominant one. A trial of moving three to four blocks was allowed before the actual test. The score was based on the number of blocks transferred from one compartment to the other within 1 min. After the test for the dominant hand, the same procedure was performed by the other hand, with blocks initially placed in that hand’s compartment and the transfer occurring in the opposite direction.

Data Analysis

Routine statistical methods of calculating arithmetic means and standard deviations, linear regression equations, and partial correlations were used. Significance of results was tested by means of t tests and F tests, using a conventional .05 level of significance.

Results

Out of 20 age, gender, and SES groups, average scores for right hands were higher than those for left hands in 15 (75%) (see Table 1). The average of individual right–left differences was positive and significant at the .01 level (paired t test). Because more than 95% of participants were right handed, these results indicate better dexterity of the dominant hand. Among 168 right-handed participants, 114 (68%) had higher scores for the right hand, 12 (7%) scored exactly the same for both hands, and 42 (25%) had higher scores for the left hand. Five (63%) of the 8 left-handed participants had higher scores for the left hand, 1 (13%) had the same score for both hands, and 2 (25%) had higher scores for the right hand. Thus, 119 (68%) of the 176 participants whose handedness could be firmly established scored better with the dominant hand.

Average scores increased until 12 to 13 years of age. After this age, there seemed to have been no appreciable increase. In all age groups, means for poor participants
Basic Statistical Parameters of Distributions of BBTMD Scores Across Samples

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Hand</th>
<th>Poor</th>
<th>Middle Class</th>
<th>Poor</th>
<th>Middle Class</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>n</td>
<td>M  SD</td>
<td>n</td>
<td>M  SD</td>
</tr>
<tr>
<td>6-7</td>
<td>R</td>
<td>8</td>
<td>46.4 6.0</td>
<td>1</td>
<td>57.0 0.0</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>8</td>
<td>44.5 7.8</td>
<td>1</td>
<td>51.0 0.0</td>
</tr>
<tr>
<td>8-9</td>
<td>R</td>
<td>8</td>
<td>47.6 7.0</td>
<td>11</td>
<td>59.0 5.6</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>8</td>
<td>45.2 5.2</td>
<td>11</td>
<td>53.4 5.6</td>
</tr>
<tr>
<td>10-11</td>
<td>R</td>
<td>7</td>
<td>54.0 10.3</td>
<td>9</td>
<td>64.7 3.8</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>7</td>
<td>51.3 9.2</td>
<td>9</td>
<td>61.9 5.0</td>
</tr>
<tr>
<td>12-13</td>
<td>R</td>
<td>11</td>
<td>68.8 7.5</td>
<td>10</td>
<td>76.7 6.6</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>11</td>
<td>64.7 7.0</td>
<td>10</td>
<td>72.1 6.1</td>
</tr>
<tr>
<td>14-15</td>
<td>R</td>
<td>15</td>
<td>69.7 6.6</td>
<td>1</td>
<td>79.0 0.0</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>15</td>
<td>66.4 6.7</td>
<td>1</td>
<td>60.0 0.0</td>
</tr>
</tbody>
</table>

Note: BBTMD = Box and Block Test of Manual Dexterity; R = right; L = left.

Discussion

Our finding that South African children from a lower socioeconomic background have poorer results on the BBTMD than South African children from a middle-class background and American children (despite some difference in the equipment) indicates that poor living conditions negatively influence manual dexterity (see Table 2). This influence does not diminish with age. Although our study did not include adult participants, we suggest that the effect of poverty on dexterity will persist at least into early adulthood because the increases in manual dexterity after puberty seem to be small as indicated by both our study and American norms (Mathiowetz, Volland, et al., 1985). Two performance components relevant to BBTMD—strength and neuromuscular reaction time—were studied in larger samples of Klein Karoo Cape Coloured children and compared with middle-class counterparts from Cape Town (Henneberg et al., 1995). It was found that both the specific muscle strength and the time of neuromuscular reaction to a visual stimulus were poorer in Klein Karoo children and did not catch up with age. This may contribute to the lack of change in BBTMD results with age in our study.

Diminished manual dexterity of persons living in poor conditions may have several causes. Nutritional deficiencies may impair neural development and formation of muscle tissue (Benefice, 1992; Dasatur, Daver, & Manghani, 1979; Dasatur, Dewan, Manghani, & Udani, 1977). Psychosocial deprivation, regardless of nutritional status, is thought to impair cognitive (Jacobsen, Edelstein, & Hofmann, 1994) and motor development (Keogh & Sudgen, 1985) through child-rearing practices that lack in the availability of stimulatory toys and activities. Low habitual activity resulting from low energy intake may also con-

Figure 1. Plot of right hand Box and Block Test of Manual Dexterity scores of poor and middle-class participants against exact decimal age. Note: ■ = poor, + = middle class.
Table 2
Z Scores of BBTMD Results of South African Participants Versus American Norms

<table>
<thead>
<tr>
<th>Age Group</th>
<th>Hand</th>
<th>Poor</th>
<th>Middle Class</th>
<th>Girls</th>
<th>Middle Class</th>
</tr>
</thead>
<tbody>
<tr>
<td>6-11</td>
<td>R</td>
<td>23</td>
<td>-2.33 1.64</td>
<td>21</td>
<td>-0.82 0.99</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>23</td>
<td>-2.20 1.53</td>
<td>21</td>
<td>-1.22 1.12</td>
</tr>
<tr>
<td>12-17</td>
<td>R</td>
<td>29</td>
<td>-0.74 0.89</td>
<td>12</td>
<td>0.13 0.55</td>
</tr>
<tr>
<td></td>
<td>L</td>
<td>29</td>
<td>-1.90 0.90</td>
<td>12</td>
<td>-0.56 0.97</td>
</tr>
</tbody>
</table>

Note: BBTMD = Box and Block Test of Manual Dexterity; R = right; L = left.

tribute to diminished manual dexterity (Ferro-Luzzi, 1985).

Because manual dexterity of children and youths differs depending on their socioeconomic background, this should be kept in mind when evaluating and treating clients. Specifically, clients from lower socioeconomic circumstances should not be expected to fit a priori the general norms.

Intervention at a community level should take place as early in the lives of children as possible. It should be based on the principle of developmentally sequential activities that are appealing to a child. Providing children of poor socioeconomic backgrounds with simple task-oriented activity programs that can be implemented by parents or nursery or primary school teachers may improve fine coordination.

Acknowledgments

We thank Mr. B. Klomfas for building the test box and making the blocks and Ms. L. Rothberg who acted as a research assistant. We also thank the study participants for patient collaboration, their parents, and school authorities. This study was funded by the Medical Research Council of South Africa.

References


