# The Effect of Seated Positioning Quality on Typical 6- and 7-Year-Old Children's Object Manipulation Skills

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OBJECTIVE. The purpose of this study was to examine the effect of optimal seated positioning in individually fitted furniture versus suboptimal seated positioning in standard classroom furniture on typical 6- and 7-year-old children's object manipulation skills as measured by the In-hand Manipulation Test (IMT).

METHOD. An experimental research design was used to compare IMT performance of two groups of 20 children. One group was positioned in standard, too-large classroom furniture that did not support an optimal seated position, and one group was positioned optimally in furniture fitted to each child for tabletop activities, which allowed for hip flexion to 90°, and foot placement on the floor, and the table to be at flexed elbow height.

RESULTS. Independent groups' $t$ tests indicated that children who were optimally positioned performed significantly better ($t = -2.77$, $df = 38$, $p < .01$) than children who were tested in the too-large standard classroom furniture. The difference between groups was greater on the more difficult object manipulation items ($t = -3.29$, $df = 38$, $p = .001$) than on the easier items ($t = -1.38$, $df = 38$, $p = .08$). Age and gender may have differentially affected the results.

CONCLUSION. The study's results suggest that the fit of furniture relative to the child's size may have a significant impact on a young, typical child's object manipulation skills. Complex hand skills, such as those involving in-hand manipulation with stabilization, appear to be more affected by the quality of the child's seated position than are simpler, more well-established skills. Findings suggest that test administrators should strive to test young children in the most optimal seated position possible, particularly when the test involves complex hand skills. Further study is needed to assess the impact of the fit of furniture on hand skills in children with disabilities and on children's performance of other tasks.

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One of the most important roles in a child's life is being a student. As students, children are required to use fine motor skills in the classroom setting. McHale and Cermak (1992) found that children in elementary school engaged in activities that required fine motor skills for 30% to 60% of their school day. In their study, a fine motor activity was defined as a "task that required major use of one's hands" (McHale & Cermak, p. 900). While a variety of activities were documented, the fine motor activities that seemed to occupy most of the children's classroom time were pencil and paper tasks (McHale & Cermak).

Fine motor skills include a number of hand skills, one of which is in-hand manipulation. In-hand manipulation is "adjustment of an object within the hand after grasp" (Exner, 2001, p. 290). In-hand manipulation skills allow a person to move an object in his or her hand in order to use the object or release it efficiently (Exner, 1990). Exner (1990) further categorizes in-hand manipulation skills into five distinct skills: finger-to-palm translation, palm-to-finger translation, shift, simple rotation, and complex rotation. These in-hand manipulation skills are used in a variety of classroom activities, including preparing the pencil to write, turning

the pencil over to erase, cutting with scissors, handling papers, constructing projects, and manipulating coins.

## Development of the In-hand Manipulation Test

In order to accurately assess children who may have fine motor skill deficits, standardized assessments are necessary (Exner, 1993). As no standardized assessments that assess in-hand manipulation skills exist (Exner, 1993), Exner is in the process of developing the In-hand Manipulation Test (IMT), which is designed to be used by occupational therapists to identify children who might have a deficit in this skill area. Exner has used the process of instrument development described by Benson and Clark (1982) to develop the IMT. According to Benson and Clark, instrument development is completed in the following four phases: planning, construction, quantitative evaluation, and validation.

The IMT is designed to assess the quality and speed of 3- to 8-year-old children's in-hand manipulation skills. The test has two sections: IMT-Q (the quality section), and the IMT-S (the speed section). Both parts are composed of tabletop activities that are designed to elicit spontaneous in-hand manipulation skills in children. The test is administered only to the child's preferred hand.

The Quality section of Draft #11 of the IMT-Q contains 55 items (Exner, 1995) that are embedded within an activity-type format; the child's focus is upon the activity or "game" rather than the hand movement. The specific in-hand manipulation skills and number of items used to test each skill are in Table 1. Approximately half of the test items include having the child hold one or more objects in the palm of the hand while the fingers manipulate another object. These items are referred to as items "with stabilization," because an object is stabilized (held) in the palm. Items in which only one object is in the child's hand during manipulation are referred to as "without stabilization."

Tiny, small, and medium object sizes are included in the IMT (Exner, 1993). Tiny refers to objects with a maximum dimension of less than 1/2"; small refers to objects at least 1/2" but less than 1"; medium refers to objects that are at least 1" in one dimension (Exner, 1993).

The IMT-Q has been assessed for validity and reliability in a number of studies by Towson University occupational therapy graduate students. With an earlier version of the test, Haddaway (1994) studied test–retest reliability in a group of twenty 5- and 6-year-old typical children; the total test score intraclass correlation coefficient (ICC) was .90. When using the same version of the IMT-Q, Allen (1994) obtained a test–retest ICC of .84 for the test–retest

**Table 1. Content of the In-hand Manipulation Test—Quality Section (IMT-Q)**

| In-hand Manipulation Skill | Number of Items Without Stabilization | Number of Items With Stabilization |
|---|---|---|
| Finger to Palm Translation | 4 | 7 |
| Palm to Finger Translation | 5 | 8 |
| Shift | 5 | 4 |
| Simple Rotation | 6 | 4 |
| Complex Rotation | 7 | 5 |
| TOTAL ITEMS | 27 | 28 |

reliability of the total test score in a sample of 14 typical 7- and 8-year-old children.

Various construct validity studies have been conducted, including those that address the ability of the test to discriminate between typical children and those with known fine motor problems and those that assess relationships of in-hand manipulation skills with other skills involving object manipulation. Wingrat (1995) compared the performance of 24 typical 6–8-year-old children with 22 children in the same age range who were classified as clumsy. She found statistically significant differences ($p < .001$) for total test scores and for the total of the test scales with stabilization and test scales without stabilization. Miles-Breslin and Exner (1999) found that a discriminant analysis correctly classified 83% of 3–8-year-old typical children and children who had spastic diplegia with fine motor problems. They also found a statistically significant difference ($p < .001$) in performance between the two groups of children.

Tydlacka (1997) studied the relationship between IMT-Q scores and teacher ratings of children's fine motor performance in the classroom. She found that the Pearson $r$ Partial Correlation Coefficient (with age partialed out) for a sample of twenty-nine 5- and 6-year-olds was moderate ($r = .46$) and statistically significant at the $p < .01$ level. For a group of thirty-four 7 -and 8-year-olds the correlation was moderate ($r = .33$) and significant at the $p < .05$ level. Studies of IMT-Q scores with other skill areas (self-care skills, Israilov, 1997; scissors skills, Root, 1997; coloring skills, Lesnik, 1997) in one or more segments of the 5- to 8-year-old age group found the relationships to be low to low–moderate but statistically significant ($p \le .05$).

However, strong psychometric properties are not sufficient to insure valid results when tests are used in clinical practice. A standardized test must be used correctly, in accordance with test instructions for administration and scoring (Campbell, 1989). Lewko (1976) surveyed pediatric therapists regarding the kinds of assessments they were using to evaluate motor development, whether these instruments were suitable, and how much therapists knew about information in the administration manual. Many of the therapists surveyed were found to be using the standardized

tests incorrectly. Campbell stated that "at best it [using standardized tests incorrectly] represents poor service to clients. At worst, it represents unethical practice that may produce considerable harm by resultant mislabeling, expensive provision of unnecessary services, or failure to identify and treat problems amenable to developmental therapy" (1989, p. 7). In order to provide a basis for stressing the importance of following the directions for test administration, the test developer needs to know the impact of the directions on children's actual test performance. For example, if a therapist is unable to have a table and chair of the correct size for the child during testing, he or she needs to know if this could significantly influence the child's performance as reflected in the score.

## Positioning To Facilitate Optimal Use of Hand Skills

Effective postural control is considered to influence a child's ability to use distal control. The biomechanical frame of reference emphasizes the principle that "for controlled movement, the human body must provide a stable center from which the head and limbs can move" (Colangelo, 1993, p. 233). A key principle of neurodevelopmental treatment is that distal movements rely on a basis of proximal control (Bobath & Bobath, 1972). As Case-Smith, Fisher, and Bauer (1989) point out, functional distal control appears to depend upon trunk and shoulder girdle stability.

One way these principles have been used is to suggest that sitting at a table and chair that fit a child appropriately, thus supporting the child's postural control, can influence the child's ability to effectively use his or her hands. For example, when occupational therapists develop assessments and implement treatment activities that require hand use, they often specify characteristics of the seated positioning to be used. Benbow (1995), who has developed many treatment strategies to improve hand function, stated that "properly fitted furniture is essential if children are to learn handwriting" (p. 278). She recommends that children's knees and hips should be flexed at 90° and feet should be flat on the floor [and] the writing or activity surface should be 2" above the student's flexed elbows (Benbow).

Exner includes instructions in the IMT manual for the child's positioning during test administration, stating that "the child should be seated in a chair with feet well-supported. A table should be positioned so that it is approximately at or just slightly above the child's elbow height" (Exner, 1997, p. 10). However, no studies have been conducted to determine if the positioning guidelines Benbow gives for handwriting or Exner gives for the IMT have any impact on children's performance of hand skills. Given that furniture fitted to a particular child may not always be readily available, research is needed to examine whether the position of the child is a critical aspect to consider when administering the IMT and other tests with hand-skill requirements.

Sents and Marks (1989) identified the need for studies to look at the impact of seated positioning on children's performance on assessments. They conducted a study of 14 nondisabled preschool children to examine whether the positioning of a child affected the child's IQ test scores. Seven children were given an intelligence test first when seated in optimal positioning: back supported, knees in 90° flexion, feet flat on the floor, elbow flexion to 90°; and forearms supported on the table. The other 7 students were given less than optimal seating: feet and back were not supported, knees were not in 90° flexion, and table height was above the height provided to children in the group with proper positioning. Seven to 9 days later the test was given again to all 14 children but with the positioning reversed. The findings were statistically significant ($p < .005$); all children in the study had higher IQ test scores (approximately 5 to 7 points higher) when they were tested in optimal seating. Thus, Sents and Marks' study suggests the positive effects of optimal positioning on one standardized assessment with a very small sample of young children. This is the only study located that addressed the issue of a child's positioning during test administration. As Sents and Marks suggest, additional studies are needed to determine the validity of these results and to determine if children perform better on other tests when tested in furniture that is the appropriate size for them. Such information would be important in determining whether or not attention to furniture fit by the examiner during testing is a critical aspect of assuring optimal test results.

## Purpose of the Study

The purpose of this study was to examine the effect of optimal seated positioning in individually fitted furniture versus suboptimal seated positioning in standard classroom furniture on IMT performance in typical early-elementary school-age children. The study's hypothesis was that in a sample of typically developing 6- and 7-year-old children there would be a significant difference in IMT scores between children tested in an optimal seated position and children tested in a suboptimal seated position. In addition, the study proposed to investigate the effects of different types of positioning for 6-year-olds as compared to the effects for 7-year-olds.

## Method

### Study Design

This study used a two group experimental design with stratified random assignment of the children into groups. Children in one group completed the section of the IMT that addresses quality of skills (the IMT-Q) while seated in furniture that was fitted to them, which resulted in "optimal positioning." Children in the other group completed the test while seated in their standard classroom furniture, which resulted in less than optimal ("suboptimal") positioning, as it was too large for the children. Interrater checks between examiners were conducted throughout the testing phase on 15% of the tests administered by having both examiners score simultaneously during testing.

### Participants

The children for this study were recruited from an elementary school in a public school system in Maryland. This school has a diverse population in terms of socioeconomic status and race. Parent consent forms and questionnaires were sent home with all 1st- and 2nd-grade children at the school. There were three 1st-grade classrooms and three 2nd-grade classrooms with a total of approximately 150 children.

Seventy-six parental consent forms indicating permission for testing were returned. Fifty-eight children between the ages of 72 and 95 months of age met the study criteria that included the following, based upon parental report: receptive language abilities within normal limits in order to understand test directions; no diagnosis of a neurological problem, mental retardation, attention deficit hyperactivity disorder, or cognitive delays; no uncorrected visual and hearing impairments that would impede test performance; and no concerns about the child's fine motor skills. No teacher reports indicated concern about the developmental status of any of these children. Additionally, all children included in the study scored at or above the 16th percentile on the Developmental Test of Visual Motor Integration (VMI) (Beery, 1997), which indicates performance generally within normal limits. Only 6-year-old 1st graders and 7-year-old 2nd graders were included.

To facilitate testing in a timely manner, all children who met the study criteria and attended the before- and after-school care program at the school were included in the study. The remaining participants were selected by stratified random sampling in order for the total sample to have equal numbers of boys ($n = 20$) and girls ($n = 20$), 6- and 7-year-olds ($n = 20$ each), and to allow for equal numbers of right- ($n = 32$) and left-handed ($n = 8$) children in each group.

The mean age of the children in the optimal positioning group was 82.85 months ($SD = 7.21$); the mean age in the suboptimal positioning group was 82.95 months ($SD = 7.64$). Thirty of the 40 children were White (16 in the optimal positioning group, 14 in the suboptimal positioning group). Three Black children were in each group; four children were of other races or ethnic groups, or race was unreported.

### Instrument

Draft #11 of the IMT-Q was used in this study. Administration of the test takes approximately 40–45 minutes. The examiner gives the child verbal directions regarding the activity performance one time per item (Exner, 1997).

Scoring on the test is as follows. For each test item, a rating of the quality of the manipulation skill observed is recorded on a 0–3 scale, as well as any of six identified substitution pattern(s) used by the child. The number of times the child drops the object per item is also recorded. Each item is administered twice, and the better of the two scores recorded for each item is used in calculation of total scores. A "0" is earned if no manipulation within the hand occurs. A score of "1" represents emerging skill use, with initiation but lack of completion of the in-hand manipulation skill. A score of "2" represents almost complete skill use or slower skill execution or more proximal finger contact. A score of "3" is given when the child manipulates the object within the hand smoothly, quickly, and completely, and uses the distal finger pads (Exner, 1995). After administration of the test, the number of points earned for each of the 10 categories on the test is totaled as well as for the total group of items without object stabilization during manipulation, the group of items with stabilization of one or more objects during manipulation, and the total test.

## Procedures

The study was approved by the Institutional Review Board at Towson University.

### Training Procedures

In fall 1998, the second author trained the principle investigator and another occupational therapy graduate student in test administration procedures. Then, each student administered the test to at least five persons of varying ages. Once they were comfortable with the administration procedures, the second author taught the scoring procedures. Once again, the graduate students administered and scored

the test on at least five persons of varying ages. Following this process, the students established interrater agreement in scoring. Finally, the second author observed the students administering the IMT-Q to each other and refined their competency in test administration.

## Study Procedures

The children in the study were assigned to one of two groups, using stratified random assignment based on age, gender, hand preference, and race or ethnic group. Optimal positioning consisted of the child being provided with a chair and table matched to his or her body size. The optimal heights of the table and chair were estimated by having each child sit in one of three different-sized chairs at an adjustable table. The child was asked if he or she felt comfortable in the chair, and each examiner made sure that the child's feet were flat on the floor, knees were flexed at 90º, and the child was seated with his or her back against the backrest. Then the desk was adjusted to be just at or slightly above (no more than 1") the child's bent elbows.

Suboptimal positioning consisted of the school's standard classroom furniture for 1st- and 2nd-grade children; it was too large for the children. This positioning resulted in each child being seated at a chair that did not allow the child to rest his or her feet flat on the floor while also having 90º of flexion at the knees or appropriate back support or both. The desk was not specifically fitted to each child, thus the height was more than 1" above the child's bent elbows, which tended to cause the child to lean on the table.

At the beginning of the testing sessions, written assent was obtained from each child to ensure his or her voluntary participation in the study. The children in both groups were given the VMI test followed by the IMT-Q. All children were in optimal positioning during administration of the VMI. The children in the optimal positioning group remained in this furniture for IMT-Q administration. The children in the suboptimal group were asked to move to a desk and chair that were less than optimal for their height (their standard classroom furniture). Testing lasted about 45 minutes to 1 hour for each child, and most children were tested in only one session. Approximately half of the 40 subjects were tested by the first author, and the other half were tested by another graduate student. Additionally, each examiner tested approximately half of the children in the optimal positioning group and half the children in the suboptimal positioning group. Six interrater checks between the two examiners were performed during the testing phase to assess scoring consistency.

Each study participant was assigned a study number to insure confidentiality of results. All data were stored in a locked file cabinet. The facility, parents, and teachers were thanked and results of the study were given to the parents, school principal, and teachers.

## Data Analysis

All of the tests were scored, and the information was entered on coding sheets. Then all data were entered into the SPSS (SPSS, Inc.) for Windows data analysis program. Means, standard deviations, ranges, and other descriptive statistics were calculated by type of positioning during testing for the IMT-Q total test scores, the group of items that include no stabilization of other objects in the hand during manipulation, and the group of items that include simultaneous stabilization with manipulation.

To test the hypothesis that IMT-Q scores for the children positioned optimally would be significantly different than IMT-Q scores for the children who were positioned suboptimally, an independent groups $t$ test was calculated. An independent group's $t$ test also was used to examine the effects of positioning on the group of IMT-Q test items that require stabilization and those that do not. Means and standard deviations were calculated for the two positioning groups based on age as well as for the age and gender groups.

# Results

## Interrater Agreement During the Training and Testing Periods for the IMT-Q

Interrater agreement during the training phase was 95% for the total score on the IMT-Q. The percentage of agreement during the testing period was 99.4% for the total IMT-Q. The percentage agreement for the group of items without stabilization and the group of items with stabilization were 98% and 99%, respectively.

## Comparison of IMT-Q Scores for Children by Positioning

Table 2 presents descriptive statistics and independent $t$-test results for the IMT-Q total scores and with and without stabilization scale scores for the children in the two positioning groups. A statistically significant difference was found between the two groups for the total test scores ($t$ = -2.77, $df$ = 38, $p$ < .01). The mean for children who were positioned optimally was slightly more than 10 points higher for the total IMT-Q test than the mean for the children who were positioned suboptimally. The mean for the children in the standard classroom furniture (suboptimal positioning) was 81.8% of the total possible score, while the mean for the group in optimal positioning was 88.1% of the maximum possible score.

**Table 2. Independent *t* Tests for Children's IMT-Q Scores Obtained in Optimal vs. Suboptimal Positioning**

| Test Category | Min/Max Score | Mean | SD | t (df = 38) | p |
|---|---|---|---|---|---|
| IMT-Q Total (max score = 165) | | | | | |
|     Optimal Positioning | 114/162 | 145.35 | 12.67 | | |
| | | | | -2.77 | .005 |
|     Suboptimal Positioning | 112/151 | 134.95 | 11.00 | | |
| Without Stabilization Scales* (max score = 81 ) | | | | | |
|     Optimal Positioning | 56/81 | 73.35 | 6.48 | | |
| | | | | -1.38 | .083 |
|     Suboptimal Positioning | 63/78 | 70.85 | 4.84 | | |
| With Stabilization Scales** (max score = 84) | | | | | |
|     Optimal Positioning | 52/82 | 72.00 | 7.86 | | |
| | | | | -3.29 | .001 |
|     Suboptimal Positioning | 47/75 | 64.10 | 7.34 | | |

*Without Stabilization Scales—sum of in-hand manipulation skills without stabilization
**With Stabilization Scales–sum of in-hand manipulation skills with stabilization
*N* = 40; Optimal positioning group, *n* = 20; Suboptimal positioning group, *n* = 20

The majority of the difference in the total test scores is attributed to the items that require object stabilization during manipulation. A statistically significant difference was found between the two groups for the scales that involved stabilization of objects during manipulation (*t* = -3.29, *df* = 38, *p* = .001), but not for the group of scales that did not involve stabilization (*t* = -1.38, *df* = 38, *p* = .083). The difference in means for the two positioning groups was approximately 2.5 points for the without stabilization scales, but approximately 8 points for the with stabilization scales. For items with stabilization, the mean for the group positioned optimally was 85.7% of the possible score, in contrast to the group tested in standard classroom furniture whose mean was 76.3% of the possible score.

## Comparison of IMT-Q Scores by Positioning and Age

Table 3 illustrates the total IMT-Q mean scores and scale mean scores by age group. Six-year-old children who were positioned optimally had a mean score slightly more than 11 points higher on the total test than the 6-year-old children who were positioned suboptimally. The mean for 7-year-old children positioned optimally was almost 10 points higher on the total test than children positioned suboptimally. For the items involving object stabilization, 6-year-olds who were positioned optimally had a mean score slightly more than nine points higher, and the 7-year-olds who were positioned optimally had a mean score almost seven points higher than their age group peers who were positioned less than optimally. Overall, the mean scores for 6-year-olds who were positioned optimally were similar to the mean score for 7-year-olds who were positioned suboptimally.

## Comparison of IMT-Q Scores by Position, Age, and Gender

Table 4 presents descriptive statistics on IMT-Q total scores by age, gender, and positioning during testing. Caution

**Table 3. Descriptive Statistics of Optimal Positioning vs. Suboptimal Positioning on IMT-Q Total Scores and Scale Scores by Age**

| Scale | Minimum/Maximum (max. score = 165) | Mean | SD |
|---|---|---|---|
| IMT-Q Total Scores | | | |
|   6-Year-Olds | | | |
|     Optimal | 114/153 | 139.20 | 12.96 |
|     Suboptimal | 112/145 | 128.00 | 10.36 |
|   7-Year-Olds | | | |
|     Optimal | 134/162 | 151.50 | 9.32 |
|     Suboptimal | 132/151 | 141.90 | 6.37 |
| Without Stabilization Scores | | | |
|   6-Year-Olds | | | |
|     Optimal | 56/78 | 70.30 | 7.20 |
|     Suboptimal | 63/75 | 68.30 | 4.64 |
|   7-Year-Olds | | | |
|     Optimal | 67/81 | 76.40 | 4.03 |
|     Suboptimal | 68/78 | 73.40 | 3.66 |
| With Stabilization Scores | | | |
|   6-Year-Olds | | | |
|     Optimal | 52/81 | 68.90 | 8.65 |
|     Suboptimal | 47/71 | 59.70 | 7.35 |
|   7-Year-Olds | | | |
|     Optimal | 67/82 | 75.10 | 5.86 |
|     Suboptimal | 62/75 | 68.50 | 4.09 |

**Table 4. Descriptive Statistics for IMT-Q Total Scores in Optimal vs. Suboptimal Positioning by Age and Gender**

| | 6-Year-Olds | | 7-Year-Olds | |
|---|---|---|---|---|
| Positioning | Boys Mean *(SD)* | Girls Mean *(SD)* | Boys Mean *(SD)* | Girls Mean *(SD)* |
| Optimal | 134.60 (16.24) | 143.80 (7.82) | 157.80 (5.81) | 145.20 (7.92) |
| Suboptimal | 125.60 (5.94) | 130.40 (13.85) | 138.80 (2.39) | 145.00 (7.84) |

*n* = 5 per group; *N* = 40

must be used in reviewing these data due to the small number of participants in each group (*n* = 5). The 6- and 7-year-old boys who were positioned optimally scored 9 and 19 points higher, respectively, than their age group peers who were positioned suboptimally. Six-year-old girls who were positioned optimally scored 13 points higher than 6-year-old girls positioned suboptimally. This difference was not

reflected in scores of the 7-year-old girls. Six-year-old boys who were positioned optimally had a mean score similar to 7-year-old boys who were positioned suboptimally.

## Discussion

The study's hypothesis was supported by the results of the independent t test in which a statistically significant difference was found between the IMT-Q means for the two groups. The results lend support to findings by Sents and Mark (1989) in which a statistically significant difference between means on an IQ test was found with two groups of preschool children when one group was positioned optimally and one group was positioned suboptimally. Such IQ tests for preschool children use object manipulation within many items. The results from their study and our study suggest that the type of seated positioning used during testing of young, typical children may affect the children's test scores. The difference in test scores found in this study could result in a child appearing to have difficulties with object manipulation that may not be as evident if a child were tested in properly fitting furniture.

When age of the children was considered in addition to their positioning, descriptive statistics suggest that both 6- and 7-year-olds who were positioned optimally had better scores than children positioned suboptimally. Second-grade children, especially boys, who are seated in furniture that does not fit them may demonstrate object manipulation skills similar to those skills that can be demonstrated by well-positioned 1st-grade children. Gender may affect performance of the skills, but further study is needed in this area.

Additionally, more difficult object manipulation skills (i.e., those that require stabilization of objects in the hand during manipulation) appear to be more affected by the quality of the child's positioning than are the easier skills (i.e., those that did not require object stabilization during manipulation). Therefore, on the scales with stabilization, seating quality appeared to be more important for the children, perhaps because proficiency in use of these skills was developing. In contrast, most children had mastered easier skills included in the scales without stabilization, and positioning did not seem to influence their scores. Perhaps when children are challenged in their postural control they are less able to execute complex fine motor skills well. If so, this has important implications for children's performances during testing as well as during learning of new tasks involving complex hand skills, such as handwriting.

The better performance of children in optimal positioning is congruent with both biomechanical and neurodevelopmental perspectives regarding proximal stability

and distal control (Benbow, 1995; Case-Smith et al., 1989; Colangelo, 1993). In optimal positioning the child has greater postural stability and thus has a more effective base upon which to build distal mobility for object manipulation. In fact, the graduate students who tested the children noted that those children who were optimally positioned seemed to move little during testing. Those who were in the standard classroom furniture (the "too large" furniture) moved frequently and appeared to seek a variety of more stable alternatives (i.e., different seating positions or leaning on the table or both). This observation suggests that if a child does not find sufficient support in seating, he or she will seek alternative methods of obtaining that stability when confronted with challenging fine motor tasks.

However, this explanation does not necessarily provide the only rationale for less-skilled performance of the children in furniture that did not fit them well. Because these children moved more in an attempt to find more stable or more comfortable seating or both, they may have been less able to focus on performance of the complex manipulative tasks presented. Thus, in addition to having their postural base affected, the children's attention may have been negatively affected. Obviously attention to task is a critical factor in performance of a fine motor skill.

## Limitations

This study was conducted with a relatively small sample of typically developing children while performing tasks that involved object manipulation, thus the findings cannot be generalized to children who are not typically developing or to other types of activities. Children who have motor control or attention difficulties or both may be differently or more significantly affected by their seated positioning during object manipulation tasks.

In addition, due to the nature of the study and the need for testing by occupational therapists or advanced-level occupational therapy students, it was not feasible to have data collectors who were blind to the study's purpose. Thus, the potential for experimenter bias should be considered. However, measures such as interrater checks were used to insure that the graduate students who administered the tests used consistent administration procedures and scoring criteria. To help minimize experimenter bias, each examiner tested half of both groups of children.

## Recommendations

Given this study's findings and those by Sents and Marks (1989) indicating that positioning can influence test scores of typically developing young children when the test

involves hand skills, information regarding appropriate positioning for testing may be important for all professionals who test children in seated positions. This may be particularly important if children are expected to use hand skills during test performance. However, additional studies are needed to validate these findings and to determine if similar results would occur in testing of older children, children with motor disabilities, and children with attention problems. Other studies examining the impact of positioning on fine motor assessments of children would lend validity to administration instructions provided with standardized tests.

Additionally, further study of the influence of seated positioning quality on children's performance on other fine motor skills and functional skills are needed. Studies could be conducted that examine children's quality and speed of fine motor classroom task performance when children are in furniture considered optimal versus that considered less than optimal. Additionally, studies examining the influence of positioning on children's skills that are already mastered versus skills that are emerging would help to clarify and add validity to this study's results. Certainly given that McHale and Cermak (1992) noted that children spend such a large portion of their school day engaged in activities that require skilled hand use, the impact of environmental factors, including furniture, on children's success needs specific attention.

Other study designs would be helpful in verifying this study's findings. Studies with larger sample sizes would allow for more complex analysis of the data, with consideration for interaction of other variables with positioning, such as age, gender, and level of skill in the area tested. Also, studies that use test–retest study designs would add more information about the impact of furniture on performance. Finally, studies in which participants are videotaped and the videotapes are scored by examiners who are blind to the study purpose may be feasible for some assessments.

## Conclusion

In this study, typically developing 1st- and 2nd-grade children who were seated in furniture that fit them well performed significantly better on the IMT-Q than those children who were seated in furniture that was too large. Thus, the quality of seated positioning for a typically developing child may significantly influence his or her score on a standardized test that involves object manipulation. Emerging in-hand manipulation skills may be more affected by the quality of seated positioning than skills that have been mastered. This study's findings are similar to those of Sents and Marks (1989) regarding the effects of positioning on young,

typical children's performance on an intelligence test. Such findings raise concern that a child may perform more poorly on a test involving hand skills or hand use if seated in furniture that does not provide appropriate support.

Additionally, the results of this study appear to provide support for the principle that proximal control (via positioning) is an important factor for efficient distal control. Seated position quality may affect object manipulation skills in young children as a result of biomechanical or attentional factors or a combination of these factors. The key findings of this study suggest the importance of including positioning instructions in test manuals and the need for professionals to consider the furniture a young child uses when testing his or her fine motor abilities and other skills measured by activities involving hand use.▲

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