A study consisting of three components is reported. During Phase One an extensive literature search led to a compiled set of norms for reflexive and voluntary prehensile development. Phase Two included the clinical use and revision of the resultant Erhardt Developmental Prehension Assessment (EDPA). Phase Three involved the testing of the EDPA for interrater reliability, which resulted in highly significant intraclass correlations. Single test item correlations were also analyzed to identify items needing clarification or alteration in preparation for final revision of the instrument. A sample application in the clinical field is illustrated by segments of an EDPA used to develop an Individualized Educational Plan, required by Federal Law 94-142 (Education of All Handicapped Children).

Rhoda Priest Erhardt, M.A., OTR, is in private practice in Fargo, North Dakota; a pediatric consultant to school districts, special education cooperatives, child evaluation centers, developmental activity centers, and hospitals in North Dakota and Minnesota; and an instructor in the Division of Continuing Education at Moorhead State University, Moorhead, Minnesota.

Patricia Ann Beatty, Ph.D., is a Professor of Psychology at North Dakota State University, Fargo, North Dakota.

Doris Massey Hertsgaard, Ph.D., is an Associate Professor of Mathematical Sciences at North Dakota State University, Fargo, North Dakota.

Occupational therapists traditionally have been involved with the evaluation and treatment of hand dysfunction. The effectiveness of programs for multihandicapped children depends on an assessment methodology that is quantifiable, allows tracking of development over time, and is sensitive to the intervention methods. Lewko's review of current practices in evaluating motor behavior of disabled children reported general dissatisfaction with available tests (1). Reasons for the dissatisfaction included lack of objectivity, insufficient items, failure to assess quality of performance, inappropriateness of design for severely involved and very young children, and limited use for structuring treatment programs. Most standardized tests measure strength (2-4) or timed coordination skills (5, 6) in children six years of age and older, or functional...
performance in activities of daily living for adults (7, 8). Global development scales such as the Bayley Scale of Infant Development and the Denver Developmental Screening Test, although useful in assigning a developmental level of children, are not responsive enough to provide adequate guidance to the therapist concerning progress toward program goals. The greatest limitations of these scales relate to the size of steps between the behavioral sequences leading to emerging skills, the rate of skill acquisition, and the influence one skill by the acquisition of others (9).

Therapists working with children who have cerebral palsy and other neurologically based motor impairments need prehension tests that can be used for severely involved children with extremely limited skills or abnormal hand patterns, as well as children with mild or moderate problems.

A neurodevelopmental theory of prehension, consistent with the Bobath approach (10-12), was presented by Erhardt in 1974 (13) and served as a framework for the evolution of the Erhardt Developmental Prehension Assessment (EDPA©). The literature suggests that: 1. disabled children, as well as normal ones, develop within the framework of predictable progressive stages; 2. early reflexes and primitive prehensile patterns provide the foundation for more voluntary refined movements; and 3. each step in the sequence of motor development is dependent on integration of the preceding steps (14-23).

Thus, a single test that is consistent with the principles of motor development and control should include levels of reflex development as well as voluntary activity, which may be limited in severely handicapped children. In addition, the test should contain items finely graded enough to be sensitive to the slow development of the multihandicapped. Each item must be easily and reliably observed and recorded, and must be related clinically and programmatically to intervention. Frequent reevaluation resulting in continuous monitoring of behavioral development can provide data for therapeutic modifications, as well as demonstrate program accountability (9).

Phase One
In the first phase of the study, nine selected sources of developmental norms of prehension were compiled and compared (14, 16-19, 23-27). Items and time sequences were chosen that had a 50 percent or greater agreement. Each item must be easily and reliably observed and recorded, and must be related clinically and programmatically to intervention. Frequent reevaluation resulting in continuous monitoring of behavioral development can provide data for therapeutic modifications, as well as demonstrate program accountability (9).

Phase One
In the first phase of the study, nine selected sources of developmental norms of prehension were compiled and compared (14, 16-19, 23-27). Items and time sequences were chosen that had a 50 percent or greater agreement. Test behaviors normally developing at each age level were described at 4-week intervals, from neonate to 15 months, under headings of Approach, Grasp, and Release. Selected items were illustrated for clarity. Structure and scoring of the assessment were modeled after the Gesell Developmental Schedules (16). The scoring system differentiated between a well-established pattern (+), incipient pattern not fully integrated (±), pattern not yet achieved (-), and temporary pattern to be replaced by a more mature pattern (++). Mature permanent patterns were listed when first appearing, marked with an asterisk (*), and not repeated at higher levels, although assumed present. To facilitate determination of developmental levels, immature patterns, repeated at successive age levels, were provided with scoring brackets when first emerging only. Opera-
Table 1
Interrater Reliability of the EDPA©

<table>
<thead>
<tr>
<th>Subject</th>
<th>Sex</th>
<th>Age</th>
<th>Diagnosis</th>
<th>N</th>
<th>Percent of Agreement</th>
<th>Intraclass Correlation</th>
</tr>
</thead>
<tbody>
<tr>
<td>KM</td>
<td>F</td>
<td>2 yr. 7 mo</td>
<td>Spastic quadriplegia with athetosis and cortical blindness</td>
<td>40</td>
<td>94.5</td>
<td>92.8 .85</td>
</tr>
<tr>
<td>CW</td>
<td>M</td>
<td>6 yr</td>
<td>Athetoid quadriplegia</td>
<td>90</td>
<td>72.9</td>
<td>75.7 .47</td>
</tr>
<tr>
<td>PM</td>
<td>M</td>
<td>3 yr. 10 mo</td>
<td>Athetoid quadriplegia with spasticity</td>
<td>106</td>
<td>71.6</td>
<td>70.8 .42</td>
</tr>
<tr>
<td>JD</td>
<td>F</td>
<td>10 yr. 9 mo</td>
<td>Spastic quadriplegia</td>
<td>70</td>
<td>89.3</td>
<td>86.8 .74</td>
</tr>
</tbody>
</table>

N = number of items observed and scored
Note: KM and CW were viewed by half (8) of the 16 raters; PM and JD were viewed by the other half (8).

Phase Two
The second phase of the study involved extensive clinical use and several revisions of the EDPA by the occupational therapy staff of the Easter Seal Mobile Therapy Unit in Fargo, North Dakota. The senior author later used the EDPA in private practice as a consultant to school systems, special education cooperatives, child evaluation centers, and developmental activity centers for handicapped infants and preschool children. Although the EDPA was applicable for charting prehensile development of the normal infant, from the neonate period to 15 months, it was specifically designed to describe the behaviors of the delayed or abnormal child or both. Since essential components of prehension are normally developed and functional at approximately 15 months(22), further refinements and increased hand skills after that age are primarily the result of learned experience. Therefore, the 15-month level can be considered the maturity of prehension, and can be used as an approximate norm for testing older children. The separate section describing pencil grasp and drawing skills proved particularly useful in determining school children's level of function in preparation for developing Individualized Educational Plans, required by Federal Law 94-142 (Education of All Handicapped Children).

Phase Three
Phase Three was concerned with determining whether the EDPA was a reliable test of prehension for children with developmental delays, cerebral palsy, and other motor impairments.

Subjects. The 16 raters were registered occupational therapists who participated in a 2-day workshop that provided training for administering and scoring the EDPA. None of the raters had extensive experience with this assessment. Their years of pediatric experience ranged from 3 months to 10 years.

Procedure. The EDPA and other informational materials(26, 27) were
mailed to all participants one week before the workshop. At the workshop, rater training included the following:

1. Presentation of the theoretical basis for the EDPA: definitions and comparisons of prehension theories, stages in perhensile development, and reflexes affecting hand function.

2. Explanation of general standardization procedures, statistical analysis, and specific procedures to be followed in the study.

3. Observation of a videotape showing the instructor demonstrating materials, administering each test item, and recording scores.

4. Observation of videotape segments showing the actual administration and scoring of the EDPA to a child who would not be included in the study.

5. Practice in administering the EDPA to a workshop participant, using designated materials followed by questions and discussion.

Method. Two male and two female children, ranging in age from 2 to 10 years, with diagnoses of various types of cerebral palsy (spastic, athetoid, and mixed) had been videotaped while being tested by the instructor (test author) prior to the workshop. The children were selected because they represented various levels of development as well as severity of handicap (Table 1). All four had originally been given the entire EDPA, which averaged one hour for administration and included scoring both left and right hands for all 100 test items.

Because of developmental ceilings reached (KM, CW), repetition of replaced temporary patterns (CW, PM, JD), and irrelevancy of pencil grasp in the nondominant hand (CW, JD), certain segments of each child’s EDPA were eliminated from the study. The children’s wide range

![Figure 1](https://example.com/figure1.png)

**Segments of the Erhardt Developmental Prehension Assessment (EDPA©)**

<table>
<thead>
<tr>
<th>Patient JD</th>
<th>Examiner Erhardt</th>
<th>Test Date 7-27-79</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birthdate 10-18-68</td>
<td>Chronological Age 10-9</td>
<td>Diagnosis Spastic Quadriplegic</td>
</tr>
</tbody>
</table>

**Scoring**

- + well established pattern
- - pattern not achieved
- + incipient pattern not fully integrated
- + + - programming needed

<table>
<thead>
<tr>
<th>36 w (8.2 m)</th>
<th>Approach</th>
<th>L</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct approach</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Neutral wrist</td>
<td>*</td>
<td>*</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grasp</th>
<th>3-4 years</th>
<th>4-6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Instinctive Grasp Reaction, trap reaction stage; stimulus withdrawn from the palm results in orienting, groping, &amp; final grasping</td>
<td>[+] [+]</td>
<td>[-] [-]</td>
</tr>
<tr>
<td>Radial-digital Grasp; cube held with thumb opposed to ends of fingers, space visible between cube &amp; palm*</td>
<td>[*] [+]</td>
<td>[+][+]</td>
</tr>
<tr>
<td>Increased use of radial side of hand &amp; forefinger, with all fingers extended</td>
<td>[+] [+]</td>
<td>[-] [-]</td>
</tr>
<tr>
<td>Scissors Grasp of pellet, held between thumb &amp; side of curled index finger</td>
<td>[++] [++]</td>
<td>[-] [-]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Release</th>
<th>3-4 years</th>
<th>4-6 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>Voluntary release of cube above a surface but without control</td>
<td>[+][+]</td>
<td>[+][+]</td>
</tr>
</tbody>
</table>
of abilities, however, allowed all 100 EDPA items to be viewed, scored, and analyzed for interrater reliability. To avoid viewer fatigue and because of workshop time restraints, the 16 raters were divided into 2 groups of 8 for viewing videotapes of 2 of the 4 children tested by the instructor. Videotapes of KM and CW were viewed and scored by one group of eight raters; the remaining group of eight viewed and scored PM and JD.

Results. Phases One and Two resulted in the assessment format, which was tested in Phase Three for interrater reliability. Each rater judged whether each of a series of given prehensile skills was present (+) or absent (-) for two of the four children. A comparison was made of the agreement of these judgments with the scoring of the instructor (test author).

Intraclass correlations (28) for each child were found using all pairs of judgments for that child, including those of the test author, that is, all combinations of two of the nine raters on each skill scored for that child. These ranged from .418 to .853, and all correlations were significant at the .001 level.

Table 1 presents the major findings in terms of interrater agreements, as well as interrater reliability. A very high degree of agreement was present among the various raters for two of the subjects, KM and JD. Judgments among raters for the other two subjects, PM and CW, did not have as high a degree of agreement, although intraclass correlations were still highly significant.

A test item analysis was carried out. The percentage of the eight raters agreeing with the test author for each item for each hand of each child was calculated to estimate item score objectivity in consideration of final revision of the EDPA. A given item may have been scored for a total of one, two, or three children depending on their range of abilities. The mean percentage agreements with the test author ranged from a low of 64.78 percent for the left hand of PM, to a high of 96.20 percent for the right hand of KW. Of the total 306 judgments, which included all 100 test items, all 8 of the raters agreed with the test author 142 times. On an additional 44 observations, 7 of the 8 raters (87.5%) agreed with the test author. Six of the 8 raters agreed with the test author on an additional 38 observations. That is, on 224 of the 306 test items (73%), 6 or more of the 8 raters agreed with the test author. Generally, the item by item analysis indicates a highly reliable test. Scoring of most individual items and scoring of the overall test yielded repeatable results.

Discussion. Statistical results of the single test item correlations were analyzed to differentiate high reliability items from those with low reliability. Review of the videotapes revealed the following deficiencies: 1. obscured or partially obscured view of hand movements, 2. observation of movement too brief, and 3. repetition of movement needed. Items with low correlation were also critically examined for imprecise definitions, excessive number of components, and problems of subjective judgment. This information will be used to clarify or com-
pletely alter items with low reliability for the final revision of the EDPA. Although the interrater reliability procedure will be helpful in developing the instrument as an aid to individual treatment planning, it should not be confused with test-retest reliability. Since the EDPA is a compilation of test items from published evaluation scales and child development literature, it cannot be considered a standardized assessment tool with established validity and reliability.

Sample Application
The potential clinical application of the EDPA is illustrated by its use for development and implementation of Individualized Educational Plans (IEPs), required by Public Law 94-142 for all handicapped children. Because the evaluation concept is one that measures competencies as well as deficits, the therapist can determine prehension levels (PA), and reevaluate to document effectiveness and assure accountability. The large number of items, small steps between skills, and comprehensive nature of the test behaviors enable the therapist to write measurable goals and objectives directly related to therapeutic as well as educational needs. The process of analyzing EDPA results, selecting facilitation techniques, and phrasing the occupational therapy program in IEP terms is illustrated in Figure 1 and Table 2, which present goals, objectives, and procedures derived from EDPA segments. The subject, a spastic quadriplegic with left hand dominance, was described when she was 5 years old by Erhardt (13), who had followed her for four years in the home. Consultation was provided periodically to school personnel (aides, teachers, speech therapists, and occupational therapists) from age five to age ten, when she was one of the four subjects participating in the interrater reliability study.

Summary
The Erhardt Developmental Prehension Assessment (EDPA) was compiled on the basis of reported developmental norms, revised after extensive clinical use, and tested for interrater reliability. Its use as a measure of hand function in handicapped children for implementation of Individualized Educational Plans is illustrated.

Acknowledgments
The authors thank Dr. Richard Olafson, David Roberts, and Gloria Dosland for their assistance. A special thanks to all therapists, children, and their parents who were study participants. This paper is based in part on a workshop given at the University of North Dakota Medical Education Center, Fargo, North Dakota, September 1979.

REFERENCES