ABILHAND-Kids

A measure of manual ability in children with cerebral palsy

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Abstract—Objective: To develop a clinical tool for measuring manual ability (ABILHAND-Kids) in children with cerebral palsy (CP) using the Rasch measurement model. Methods: The authors developed a 74-item questionnaire based on existing scales and experts’ advice. The questionnaire was submitted to 113 children with CP (59% boys; mean age, 10 years) without major intellectual deficits (IQ > 60) and to their parents, and resubmitted to both groups after 1 month. The children’s and parents’ responses were analyzed separately with the WINSTEPS Rasch software to select items presenting an ordered rating scale, sharing the same discrimination, and fitting a unidimensional scale. Results: The final ABILHAND-Kids scale consisted of 21 mostly bimanual items rated by the parents. The parents reported a finer perception of their children’s ability than the children themselves, leading to a wider range of measurement, a higher reliability (R = 0.94), and a good reproducibility over time (R = 0.91). The item difficulty hierarchy was consistent between the parents and the experts. The ABILHAND-Kids measures are significantly related to school education, type of CP, and gross motor function. Conclusions: ABILHAND-Kids is a functional scale specifically developed to measure manual ability in children with CP providing guidelines for goal setting in treatment planning. Its range and measurement precision are appropriate for clinical practice.

Cerebral palsy (CP) is the most common cause of physical disability in children. While the rates of perinatal and infant mortality have declined toward the end of the last century, the rate of CP has remained at 2 to 2.5 per 1,000 live births. Medical and technological advances have enabled a cohort of children with severe CP impairments to survive. Despite the nonprogressive nature of their motor impairment syndromes, their clinical picture may change over time. A variety of treatments are intended to improve the child’s functioning in their relevant environments, usually at home or school. However, the effectiveness of these treatments is debated. There is a need to quantify the efficacy of a treatment and to follow a child’s status over time. The first step in this process is to develop clinically relevant, valid, and reliable outcome measures.

Although impaired arm and hand function are the main problems in about half the children with CP, there is a lack of appropriate instruments for measuring the ability of the children to use their hands in daily activities since most scales are focused on lower limb function. Moreover, the existing pediatric scales focused on fine motor functions (e.g., Pediatric Evaluation of Disability Inventory, Activities Scale for Kids) are not validated for children with CP. It is important to have evaluation instruments that are specifically applicable to the population being studied and the purpose of this study is to develop the ABILHAND-Kids questionnaire, a measure of manual ability in children with CP.

Manual ability is a behavior. It can be defined as “the capacity to manage daily activities requiring the use of the upper limbs, whatever the strategies involved.” Manual ability is based upon upper limb function, but it also involves environmental (e.g., assisting devices, school education) or personal (e.g., motivational, cognitive and emotional status, compensatory behaviors) contextual factors. Therefore, manual ability cannot be observed directly, but it can be inferred from a patient’s perception of the difficulty of performing manual activities. Adult patients who are most familiar with their own functional limitations are commonly considered as the gold standard to report their health status. The use of parents as valid proxy reporters is advocated not only for very young children but also for school children and adolescents, even though children at these ages have the ability to adequately communicate their perceptions. The ABILHAND-Kids questionnaire was submitted to both children and their parents in order to compare the reliability of the reported perceptions.

Once the subjects’ perceptions were collected, a linear measure of manual ability was obtained according to probabilistic measurement models, the most promising being the Rasch model. Provided that the behavioral data fit the requirements of the model, manual ability is measured as the log-odds of
reported successful achievement in manual activities and is located on a linear scale. In this study, the ABILHAND-Kids questionnaire was developed to assess manual ability as perceived by children with CP or their parents. Its reproducibility was tested after a delay of approximately 1 month.

Subjects and methods. Subjects. The study was authorized by the ethics committee of the Université catholique de Louvain, Faculty of Medicine in Brussels, Belgium. The definition adopted for selecting children with cerebral palsy was "all non-progressive but often changing motor impairment syndromes secondary to lesions or anomalies of the brain arising in the early stages of its development."

Subjects older than 6 years were recruited to focus on children with mature manipulative skills in activities of daily life. Age, sex, handedness, level of school education, type of CP, and the Gross Motor Function Classification System (GMFCS) were included as independent demographic and clinical indices in the validation analysis. The children, recruited through seven centers specialized in CP, exhibited a wide range in each index. Moreover, given that ABILHAND-Kids was designed as an interview-based questionnaire, children with a major intellectual deficit (IQ ≤ 60) were excluded. As a result, 113 children with CP (67 boys and 46 girls; mean age, 10 years) were assessed by the same examiner. The test-retest reliability was investigated by submitting the questionnaire a second time, after a delay of approximately 1 month.

Procedure. The French version of the questionnaire was presented separately to children with CP and their parents. The 74 items were randomly presented. Each item was presented verbally to the child by the examiner, while the parents filled in the questionnaire themselves in another room. Fourteen percent of the children attended boarding school so their activities were not observed daily by their parents. In these cases, the questionnaire was completed by the occupational therapists on behalf of the children and their parents was added to the questionnaire because the suggestions were not exclusively related to the upper limbs (e.g., swimming, bicycling) and thus could involve factors other than just manual ability.

Instrument. The experimental version of ABILHAND-Kids explored unimanual and bimanual activities completed without technical or human assistance. For each question, the children and their parents were asked to provide their perceived difficulty irrespective of the limb(s) actually used to perform the activity on a three-level scale: impossible (0), difficult (1), or easy (2). Activities not attempted in the last 3 months were not scored and were encoded as missing responses (4% of the data for the children and 5% for their parents).

Data analysis. Children's and parent's responses were analyzed separately with the WINSTEPS Rasch analysis computer program. The Rasch model verified that successive response categories for each item represented increasing levels of ability and that thresholds between successive response categories are located in the anticipated order. It required that the probability of endorsing any response category to an item depended solely on the patient's ability, the item difficulty, and the threshold difficulties. Patient measures, item, and threshold difficulties were then located on a single real-number line representing the measurement scale. The Rasch model can also be used to verify that all items line up on a unidimensional scale. Given the location of the parameters on the linear scale, the model recalculates the response expected for each subject to each item. The similarity between the observed and expected responses to any item is reported by the software through two fit statistics: 1) the outlier-sensitive fit statistic (OUTFIT) and 2) the information-weighted fit statistic (INFIT). The INFIT is more sensitive to unexpected responses from patients with an ability level near the item difficulty. The OUTFIT is more sensitive to unexpected responses from patients with a higher ability level even from the item difficulty. Another statistic, the point measure correlation coefficient (RPM), indicates the coherence of each item with the rest of the questionnaire. It is computed as the correlation coefficient between all patients' responses to an item and their measures on the overall questionnaire except for that particular item. Positive RPM values are expected when each item is coherent with the other questionnaire items.

Table 1 Sample description (n = 113)

<table>
<thead>
<tr>
<th>Age, y, mean (range)</th>
<th>10 (6–15)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td></td>
</tr>
<tr>
<td>Male</td>
<td>67</td>
</tr>
<tr>
<td>Female</td>
<td>46</td>
</tr>
<tr>
<td>Handedness</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>55</td>
</tr>
<tr>
<td>Left</td>
<td>57</td>
</tr>
<tr>
<td>Ambidextrous</td>
<td>1</td>
</tr>
<tr>
<td>School education</td>
<td></td>
</tr>
<tr>
<td>Mainstream</td>
<td>47</td>
</tr>
<tr>
<td>Type 1: mild mental retardation</td>
<td>1</td>
</tr>
<tr>
<td>Type 4: physical handicap</td>
<td>58</td>
</tr>
<tr>
<td>Type 8: learning disabilities</td>
<td>6</td>
</tr>
<tr>
<td>Home</td>
<td>1</td>
</tr>
<tr>
<td>Type of CP</td>
<td></td>
</tr>
<tr>
<td>Tetraplegia/paresis</td>
<td>35</td>
</tr>
<tr>
<td>Diplegia</td>
<td>24</td>
</tr>
<tr>
<td>Hemiplegia/paresis</td>
<td></td>
</tr>
<tr>
<td>Right</td>
<td>26</td>
</tr>
<tr>
<td>Left</td>
<td>28</td>
</tr>
<tr>
<td>GMFCS</td>
<td></td>
</tr>
<tr>
<td>Level I: most independent motor function</td>
<td>50</td>
</tr>
<tr>
<td>Level II</td>
<td>26</td>
</tr>
<tr>
<td>Level III</td>
<td>12</td>
</tr>
<tr>
<td>Level IV</td>
<td>21</td>
</tr>
<tr>
<td>Level V: least independent motor function</td>
<td>4</td>
</tr>
</tbody>
</table>

CP = cerebral palsy; GMFCS = Gross Motor Function Classification System.
Item selection. Starting from the 74 experimental items, indexes reported from successive analyses were used to select the items that constituted the final ABILHAND-Kids scale. Any item that did not meet any of the following criteria was eliminated.

An ordered rating scale. The subjects were asked to report their perceptions on a three-level scale: impossible (0), difficult (1), or easy (2). If the anticipated order of response categories was verified, subjects with a higher ability ought to select a higher response to any given item and subjects selecting a higher response for a given item ought to present a higher ability. When these conditions were not met, the order of thresholds between successive response categories was skewed, indicating that the rating scale was not used as anticipated for the particular item. Only items having thresholds in the anticipated order were retained.

All items share the same discrimination. Though all items were answered according to the same three-level rating, the threshold locations (relative to the item location) could vary across items. In this case, the items are perceived with a different discrimination. The difference in discrimination from one item to another complicates the clinical interpretation of scores since a given response has a different relative weight across all items. Therefore, items presenting a discrimination significantly different from the average (Z-test) were removed.

All items fit a unidimensional scale. Fit statistics (INFIIT and OUTFIT) were used to detect items that did not satisfy the model requirement of unidimensionality. The acceptable range of fit statistics for a sample of 113 subjects is between 0.80 and 1.20 for the INFIIT and between 0.40 and 1.60 for the OUTFIT.34 Items presenting an INFIIT lower than 0.80 or an OUTFIT lower than 0.40 are not considered to be a major threat to unidimensionality.35 All items presenting an INFIIT higher than 1.20 or an OUTFIT higher than 1.60 were removed.

Scale validation. To validate the difficulty hierarchy of the selected activities, four occupational therapists were independently asked to classify each as either 1) unimanual or 2) bimanual. Bimanual activities were further classified as either (2A) normally done with two hands but also manageable in several unimanual steps when using an adaptive strategy; (2B) requiring one hand to stabilize an object—not involving any finger—and the other hand to complete the activity; or (2C) requiring digital activity from both hands. In addition, the patient measures were validated according to the relationship between ABILHAND-Kids measures and different demographic (age, sex, handedness, school education) or clinical (type of CP, GMPCS9) indices. A Pearson correlation coefficient was computed for continuous indices, a t-test for two groups of nominal indices, and a one-way analysis of variance for more than two groups of nominal indices. Finally, the item difficulty hierarchy between the parents and the 27 experts was compared through a differential item functioning (DIF) test.36

Scale reliability. A person separation reliability coefficient was determined as the ratio between the true measure variance (as expressed by the SD corrected for measurement error) and the observed (true + error) measure variance in the sample.37 This index is analogous to the traditional internal consistency coefficient, Cronbach’s alpha. Moreover, test-retest reliability of the parents’ responses was determined by the Pearson correlation coefficient. The invariance in the item difficulty hierarchy across the first and the second assessment was also tested through a DIF test.

Results. Children’s versus parents’ perceptions. The children’s and parents’ responses to the questionnaire were analyzed separately. The analysis of the children’s responses resulted in a 13-item questionnaire because most of the items (n = 54) showed a disordered rating scale. Moreover, five items did not fit a unidimensional scale and two items did not share the common discrimination. The analysis of the parents’ responses resulted in a 21-item questionnaire because most of the items (n = 36) did not share the common discrimination. Moreover, 15 items did not fit a unidimensional scale and 2 items showed disordered thresholds. The analysis showed that the retained items were different in both groups and also that the manual ability was better discriminated by the children’s parents as compared to the children themselves.

The parents’ measures and the item thresholds distributions for both the parents’ and the children’s scales are presented in figure 1. The manual ability scales are calibrated in logits (i.e., log-odds units), a probability unit that expresses the natural logarithm of the odds of success (i.e., the pass/fail probability ratio). At any given ability level, a 1-logit difference between two children indicates that their odds of successful achievement of any activity are 2.7:1 (i.e., e1:1), 2 logits have 7.4:1 odds, and 3 logits have > 20:1 odds. The items are well targeted on the subjects in both scales. While both scales are able to successfully discriminate the manual ability of the subjects, the parents’ scale covers a wider range than the children’s scale, indicating a finer perception of item difficulties. Subjects measures are estimated over a range of 10.38 logits by the parents (leading to an odds ratio of over 32,000:1, i.e., e10.38:1, between the most able and the least able child) while they cover only 7.54 logits according to the children’s perceptions (leading to an odds ratio less than 2,000:1). Consequently, the subject measures can be discriminated with a greater than a 16 times higher resolution when using the parents’ perceptions rather than the children’s. Both scales present comparable floor and ceiling effects.

The children’s lack of discrimination is emphasized even further when investigating the probability of each possible response (“impossible,” “difficult,” or “easy”) to an item as a function of the child’s ability. For any given item, a higher (i.e., easier) response is associated with a higher level of ability. However, the increase in manual ability required to answer “easy” rather than “impossible” is 2.66 times higher for the parents (3.24 logits) than for the children (1.22 logits). This indicates that the children’s perception is more dichotomous; activities are perceived as either “impossible” or “easy” with very rare intermediate responses. However, the parents report a finer perception on their children’s manual ability. They allow a better separation of the subjects according to their manual ability and allow a more precise measurement as reported by the person separation reliability of 0.94 for the parents and of 0.87 for the children.

The final version of the ABILHAND-Kids questionnaire
was therefore exclusively built on the parents’ perceptions because of the higher discrimination of the three-level rating scale, the wider range of measurement, and the higher person separation reliability.

**Metric properties of ABILHAND-Kids.** The calibration of the final 21-item ABILHAND-Kids scale is presented in table 2. The items are sorted, from top to bottom, in order of decreasing difficulty (range: 3.00 to \(3.23\) logits). Higher logit values indicate more difficult activities. Table 2 also reports the standard error (SE) associated with each item difficulty (mean: \(0.23\) logits; range: \(0.21\) to \(0.35\) logits). The mean square fit statistics indicate that all 21 items contribute to the definition of a unidimensional measure of manual ability. Moreover, all RPM are positive (all values \(> 0.55\)) indicating that each item is coherent with the rest of the questionnaire and contributes to the measurement of the manual ability.

**Description of ABILHAND-Kids.** The definition and use of the ABILHAND-Kids scale is depicted in figure 2. The top panel shows the distribution of manual ability measures of the children as perceived by the parents. The manual ability measures of the children with CP are obtained by converting the ordinal total scores into linear measures. The bottom panel illustrates the ogival relationship between the finite total raw scores and the infinite manual ability measures. This relationship is approximately linear between total scores of 11 and 30. Outside this central range, however, a unitary progression in total score accounts for an increasing amount of manual ability measure. In the central range, the change in manual ability measure corresponding to a unitary increment in total score from 19 to 20 scores is equal to \(0.17\) logits. Outside this central range, it increases to \(0.86\) logits for the same increment in total score from 1 to 2. This fivefold difference denotes the non-linearity of the total score.

The middle panel shows the expected response to a given item as a function of the underlying manual ability measure. By comparing the ability of a given child to the difficulty of each item, it is possible to determine the expected score of the child to the item. According to the parents’ perception, a child with an ability of \(0\) logits would be expected to perform without difficulty the two easiest activities, to perform with some difficulties the average activities, and to fail to perform the three most difficult activities. In summary, according to the distribution of subject measures, 52% of the children in our sample should successfully perform all the listed activities easily or with some difficulty. Twelve percent of the children should perform all activities easily and 4% should not be able to perform any of the 21 ABILHAND-Kids items. Therefore, the range of difficulties of

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**Table 2 ABILHAND-Kids calibration for children with cerebral palsy**

<table>
<thead>
<tr>
<th>Item</th>
<th>Difficulty, logits</th>
<th>SE, logits</th>
<th>INFIT, mean square</th>
<th>OUTFIT, mean square</th>
<th>RPM</th>
<th>Hands involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. Buttoning up trousers</td>
<td>3.00</td>
<td>0.22</td>
<td>0.88</td>
<td>1.55</td>
<td>0.58</td>
<td>2B</td>
</tr>
<tr>
<td>b. Buttoning up a shirt/sweater</td>
<td>2.67</td>
<td>0.22</td>
<td>0.77</td>
<td>0.65</td>
<td>0.58</td>
<td>2A</td>
</tr>
<tr>
<td>c. Opening a jar of jam</td>
<td>1.82</td>
<td>0.22</td>
<td>1.09</td>
<td>0.97</td>
<td>0.55</td>
<td>2B</td>
</tr>
<tr>
<td>d. Zipping up a jacket</td>
<td>1.34</td>
<td>0.21</td>
<td>1.00</td>
<td>0.98</td>
<td>0.57</td>
<td>2B</td>
</tr>
<tr>
<td>e. Rolling up a sleeve of a sweater</td>
<td>1.12</td>
<td>0.21</td>
<td>1.14</td>
<td>1.42</td>
<td>0.57</td>
<td>2A</td>
</tr>
<tr>
<td>f. Sharpening a pencil</td>
<td>0.98</td>
<td>0.22</td>
<td>1.05</td>
<td>0.98</td>
<td>0.58</td>
<td>2C</td>
</tr>
<tr>
<td>g. Putting on a backpack/schoolbag</td>
<td>0.58</td>
<td>0.22</td>
<td>1.12</td>
<td>0.97</td>
<td>0.56</td>
<td>2A</td>
</tr>
<tr>
<td>h. Zipping up trousers</td>
<td>0.52</td>
<td>0.21</td>
<td>1.13</td>
<td>1.14</td>
<td>0.57</td>
<td>2A</td>
</tr>
<tr>
<td>i. Fastening the snap of a jacket</td>
<td>0.33</td>
<td>0.21</td>
<td>1.13</td>
<td>1.03</td>
<td>0.57</td>
<td>2A</td>
</tr>
<tr>
<td>j. Squeezing toothpaste onto a toothbrush</td>
<td>0.29</td>
<td>0.22</td>
<td>1.00</td>
<td>1.44</td>
<td>0.59</td>
<td>2A</td>
</tr>
<tr>
<td>k. Unscrewing a bottle cap</td>
<td>0.08</td>
<td>0.22</td>
<td>1.07</td>
<td>1.33</td>
<td>0.57</td>
<td>2B</td>
</tr>
<tr>
<td>l. Opening a bag of chips</td>
<td>−0.09</td>
<td>0.22</td>
<td>1.18</td>
<td>1.21</td>
<td>0.59</td>
<td>2C</td>
</tr>
<tr>
<td>m. Opening the cap of a toothpaste tube</td>
<td>−0.41</td>
<td>0.23</td>
<td>0.80</td>
<td>0.62</td>
<td>0.61</td>
<td>2A</td>
</tr>
<tr>
<td>n. Washing the upper body</td>
<td>−0.61</td>
<td>0.22</td>
<td>1.13</td>
<td>1.06</td>
<td>0.60</td>
<td>1</td>
</tr>
<tr>
<td>o. Filling a glass with water</td>
<td>−0.62</td>
<td>0.23</td>
<td>1.08</td>
<td>1.17</td>
<td>0.58</td>
<td>2A</td>
</tr>
<tr>
<td>p. Opening a bread box</td>
<td>−1.01</td>
<td>0.24</td>
<td>0.89</td>
<td>0.68</td>
<td>0.62</td>
<td>2A</td>
</tr>
<tr>
<td>q. Taking off a T-shirt</td>
<td>−1.38</td>
<td>0.24</td>
<td>0.91</td>
<td>0.83</td>
<td>0.61</td>
<td>2A</td>
</tr>
<tr>
<td>r. Putting on a hat</td>
<td>−1.38</td>
<td>0.26</td>
<td>0.83</td>
<td>0.70</td>
<td>0.63</td>
<td>2A</td>
</tr>
<tr>
<td>s. Taking a coin out of a pocket</td>
<td>−1.63</td>
<td>0.26</td>
<td>0.66</td>
<td>0.45</td>
<td>0.64</td>
<td>1</td>
</tr>
<tr>
<td>t. Unwrapping a chocolate bar</td>
<td>−2.38</td>
<td>0.28</td>
<td>0.94</td>
<td>1.12</td>
<td>0.65</td>
<td>2A</td>
</tr>
<tr>
<td>u. Switching on a bedside lamp</td>
<td>−3.23</td>
<td>0.35</td>
<td>0.84</td>
<td>0.51</td>
<td>0.70</td>
<td>1</td>
</tr>
</tbody>
</table>

**Mean** | 0.00 | 0.23 | 0.98 | 0.99 |
| **SD** | 1.52 | 0.03 | 0.14 | 0.30 |

*1 indicates unimanual activities; 2 indicates bimanual activities manageable in several unimanual steps (2A), requiring stabilization with one hand and digital activity with the other (2B), requiring digital activity from both hands (2C).
The ABILHAND-Kids items fits the distribution of children’s abilities.

Scale validation. The opinions of the four occupational therapists concerning the number of hands involved in each activity were consistent. The most frequently reported opinion is presented for each item in the last column in table 2. Most of the ABILHAND-Kids items are bimanual activities (2A-2B-2C, 86%), most of which can be managed in several unimanual steps when using an adaptive strategy (2A, 67%). The activities requiring more bimanual involvement tend to be more difficult.

No significant differences in ABILHAND-Kids measures were observed across age, sex, or handedness. A difference in ABILHAND-Kids measures was observed as a function of school education (t = 4.136, p < 0.001), type of CP (F = 9.621, p < 0.001), and the GMFCS (R = −0.640, p < 0.001). A post hoc analysis of the indices indicating that the perceptions of the parents and the experts appear to be similar for the item hierarchy. There are four minor exceptions: “Zipping-up trousers” (h) and “Putting on a hat” (r) are estimated to be more difficult by the parents than by the experts, while “Unwrapping a chocolate bar” (t) and “Switching on a bedside lamp” (u) are estimated to be more difficult by the experts than by the parents.

Test-retest reliability. The test-retest reliability (delay: 25 ± 13 days) of the subject measures is presented in figure 4. Children’s measures perceived by the parents at the first and the second assessment are correlated (R = 0.91, p < 0.001). Most of the measures lie within the 95% CI of the identity line indicating that the parents tend to estimate consistently their child’s ability over time. Moreover, the difficulty hierarchy of all 21 ABILHAND-Kids items is maintained between the first and the second assessment, indicating that the ABILHAND-Kids scale is invariant across time.

Discussion. We sought to develop a measure of manual ability in children with CP using the Rasch model. We also compared children’s and parents’ perceptions. The ABILHAND-Kids questionnaire was constructed from the parents’ perception in order to cover a wider measurement range of manual ability than was possible using the children’s perception. The 21 items retained for the final ABILHAND-Kids measures show an ordered rating scale, share the same discrimination, and fit a unidimensional scale.

The children’s manual ability is better discriminated by the parents than by the children themselves. The activities are perceived by the children as either “impossible” or “easy” with very rare intermediate responses. The more dichotomous perception of the children is consistent with the Piagetian theory where young children typically engage in dichotomous thinking and may therefore focus only on the
two extremes of Likert-type rating scales. The poly-
chotomous parents' perception appears to be a more
accurate source of information about manual ability
than the dichotomous children's perception. How-
ever, the difference in discrimination between par-
ents and children must be considered with caution,
given the different modes of observation used in the
two groups. A face-to-face interview was used for
the children and a written self-report for parents. A
written self-report appears to be more appropriate
for a clinical routine than a face-to-face interview
where the interviewer is rarely the same. Moreover,
face-to-face interviews may be influenced by the per-
sonality and the style of the interviewer, and the
relationship with the subject. The ABILHAND-
Kids questionnaire was exclusively built on the par-
ents' perception to reduce the error of measurement
of manual ability as indicated by the higher person
separation reliability observed in our sample (R =
0.94). In addition, the use of the parents' perception
on behalf of the children's should allow, in the fu-
ture, measurements of manual ability in all children
with CP, including very young and severely impaired
children and those with mental, psychological, emo-
tional, attentional, or communicative disorders. The
difficulty of just four items differs slightly between
the parents and the experts. However, the differen-
tial item functioning of the four items is not high
enough to compromise the clinical application of the
scale. Parents might be better able than experts to
judge which of the tasks are more difficult since they
can observe their child's manual ability on a regular
basis, capturing a sort of weighted average of the
performance over long periods of time. Thus, two
different modes of perception were used in the
present study. Parents were asked to provide the
observed difficulty of each activity for their child,
while the experts were asked to provide the esti-
mated difficulty of each activity for a "typical" CP
child with moderate disorder. Nevertheless, further
research will be needed to verify that parents' and
experts' perceptions are really different for the four
items, and to make any assumption about the rea-
sons of these different points of view.

The 21 activities retained for ABILHAND-Kids in-
volve both hands. Most of the unimanual activities
included in the experimental version of the question-
aire were rarely perceived by the parents as "diffi-
cult," and consequently these activities were
removed in the final version because the equal dis-

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unit increment in total score, is equal to 0.19 logits in the central range of the scale (range: –1.85 to 1.65 logits). This indicates that in the central range, the resolution of ABILHAND-Kids is sufficient to differentiate the ability of two subjects if one has 50% probability to succeed in performing a given item and the other 45%. The overall precision of the scale is summarized by a good person separation reliability in this sample (R = 0.94). The observed invariance in the item hierarchy after a delay of approximately 1 month indicates that the ABILHAND-Kids manual ability measures are reproducible over time. The metric properties of ABILHAND-Kids give to the scale the potential to measure any sensible change in manual ability induced, for example, by surgery, rehabilitation, biomedical treatment, or the use of assisting devices. However, the responsiveness and the predictiveness of ABILHAND-Kids need to be investigated further in a longitudinal study.

The analysis of the relationship between ABILHAND-Kids measures and demographic or clinical indices appears not only as a form of validation of the scale but also as a clinical end point. Although ABILHAND-Kids measures are not related to age, sex, or handedness, a significant relationship was found with school education, type of CP, and GMFCS. Children with more severe forms of CP are high-intensity users of physiotherapy services and are more likely to be placed in special schools which can better cope with treatment requirements. The significant relationship between ABILHAND-Kids measures and the type of CP confirms the previous reports that children with hemiplegia/paresis and diplegia are less disabled in their fine and gross motor functions than children with tetraplegia/paresis. Finally, ABILHAND-Kids measures are significantly related to the levels of GMFCS; a higher manual ability relates to a higher gross motor function. A similar relationship between bimanual fine motor function and the levels of GMFCS was previously found. However, in this study, the relationship to gross motor function is not perfect, indicating that fine and gross motor functions are two distinct but complementary variables. The relationship between ABILHAND-Kids measures and some demographic and clinical indices that relate to the severity of the pathology (i.e., school education, type of CP, GMFCS) is age-independent. This suggests that the questionnaire is sensitive to the pathologic disruption of manual ability rather than to a maturation of manual ability, at least in CP children older than 6 years.

The Rasch model was used to construct and validate ABILHAND-Kids. It provides the calibration of the ABILHAND-Kids activities that can be sorted according to their estimated difficulty (see figure 2). The hierarchical nature of the scale identifies a child’s spontaneous pattern of recovery given the current manual ability measurement. It can be used for goal setting in treatment planning. Furthermore, the Rasch model has the ability to detect discrepancies between the observed score to each item and the expected score, given the overall measure of the subject. More than a simple data quality control, it can be used to identify an idiosyncratic use of the questionnaire or diagnose behavioral peculiarities such as a misuse of adaptive strategies.

Finally, the Rasch model can be used to test the invariance of the manual ability variable defined by ABILHAND-Kids through differential item functioning tests. The current metric properties of ABILHAND-Kids make an encouraging starting point for further investigation of its invariance across demographic or clinical patient subgroups, and for its application across various pediatric diagnostic groups and cultures. If the invariance in the item hierarchy is also verified across treatment, then ABILHAND-Kids will also provide a responsive outcome measure to monitor patient status across time and recovery.

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