Introduction to the Pediatric Evaluation of Disability Inventory Computerized Adaptive Test (PEDI-CAT) for Children with Cerebral Palsy

A New Option for Measuring Function in Daily Activities, Mobility, Social/Cognitive and Responsibility

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Disclosures

• Financial: Benjamin Shore has no financial disclosures to report.
• Non-financial: He has no non-financial disclosures to report.

• Financial: Jessica Kramer has no financial disclosures to report.
• Non-financial: She has a professional non-financial relationship with CRECare; she is the senior author of the PEDI-PRO and a contributing author of the PEDI-CAT/PEDI-CAT (ASD).
Disclosure Information
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Speaker Name: Maria Fragala-Pinkham

Disclosure of Relevant Financial Relationships
I have the following financial relationships to disclose:
I am one of the senior authors of the PEDI-CAT.

Consultant for: provide consultation to CRECare related to PEDI-CAT
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Stockholder in: None
Honoraria from: None
Employee of: Franciscan Hospital for Children

Disclosure of Off-Label and/or investigative uses:
I will discuss investigational use/future research related to development of the PEDI-CAT in my presentation
Objectives

• Describe the transition from the Pediatric Evaluation of Disability Inventory (PEDI) to the Pediatric Evaluation of Disability Inventory Computer Adaptive Test (PEDI-CAT).
• Identify the PEDI-CAT test applications including intended populations, domains, test items, response scales, administration procedures, and scoring.
• Discuss applicability of the PEDI-CAT to measure abilities in youth with disabilities including psychometric properties specifically for youth with CP (GMFCS Levels I-V).
• Discuss future development and preliminary findings of the PEDI-CAT: ASD option as well as other disability specific PEDI-CAT options and the new PEDI self report (PEDI-PRO).
Pediatric Evaluation of Disability Inventory (PEDI) Stephen M. Haley PT, PhD, Wendy J. Coster PhD, OTR/L, Larry H. Ludlow PhD, Jane Haltiwanger PhD, Peter Andrellos PhD

- Published in 1992
- First pediatric measure to assess function rather than development
- Translated into multiple languages and validated for multiple cultures
- Applications:
  1) Document functional delay
  2) Document changes in functional abilities over time in response to therapeutic intervention
**PEDI: The Positives**

- Document functional delay or changes in functional abilities after therapeutic interventions
- Program evaluation to document functional status in groups of children and changes over time
- Document functional skill acquisition in clinical populations and the importance of recognizing cultural differences
- Minimal training, low cost to administer
PEDI: The Criticisms

- Lengthy administration time (60min)
- Skills are at the lower end of the continuum
- Items focused primarily on home-based activities, which creates difficulties for therapists to answer questions without parent input
- Original standardization sample had some sampling error due to a lack of geographical representation and small numbers in each age group, which can affect the validity of interpretations made using norm-referenced scores
From PEDI → PEDI-CAT

- 2003 - transition to computer adaptive testing began
- Pompe PEDI (expanded self-care and mobility domains adding items on both ends of the easy to hard continuum – normed to age 15 years)
- PEDI-MCAT (M=multi-dimensional; Pompe PEDI but use of both self-care and mobility simultaneously for item administration)
- Today’s final PEDI-CAT - released October, 2012
Pediatric Evaluation of Disability Inventory-Computer Adaptive Test

- For children and youth ages 0 - 20 years
- Can be used across all diagnoses, conditions and settings
- Focuses on activities and participation in life tasks
- Can be completed by a parent independently
- Brief yet precise
What is Computer Adaptive Testing (CAT)?

- Administered only on the computer
  - No ‘paper and pencil’ version available!
- Uses artificial intelligence to select only most relevant items from a ‘pool’ of validated items
- Each item in the ‘pool’ represents a different amount of ‘difficulty,’ from most easy to most difficult to perform
What is CAT? Item Banks

High

- I can try on clothes in a store dressing room
- I can tighten screws and bolts on a wheelchair
- I can take off jeans

Moderate

- I can put on sweatpants
- I can clean my upper body
- I can use a fork (one hand)

Low

- I can wash my face
- I can take off my hat
- I can rub my eyes
What is Computer Adaptive Testing (CAT)?

- Set of calibrated items that describe one domain (item banks)
- *Not every item needs to be answered to get a score*
- For each domain, all respondents begin with the same question in the middle of the scoring range
- Depending on the initial response will dictate if a **harder or easier** item will be administered next
How does item selection occur?

Response to the starting question

Starting Question: Stands alone for a few minutes

- 4 (Easy)
- 3 (A Little Hard)
- 1 (Unable) or 2 (Hard)

High
- Select a “High” question

Medium
- Select a “Medium” question

Low
- Select a “Low” question
What is Computer Adaptive Testing?

- With each new response, the score & CI are re-estimated
- CAT software then determines whether the pre-set stopping rule has been satisfied (level of precision or a number of items)
- If satisfied= Domain ends & score is provided
- If not satisfied= New items administered until the stopping rule is satisfied
Computer Adaptive Testing

- CATs used as measure in community reintegration, behavioral health, quality of life, headaches, behavioral health and more.....

- PEDICAT
  - Accurate & Precise
  - Increased efficiency
  - Reduced respondent burden

- PEDI-CAT is available for iPads & PCs
- Each download includes English & Spanish versions
PEDI-CAT

Intended Population:
- Children and youth (birth *through* 20 years of age) with physical and/or behavioral conditions

Applications:
- Identification of functional delay
- Examination of improvement for an individual child after intervention
- Evaluation and monitoring of group progress in program evaluation and research
PEDI-CAT Features

• Age, gender and mobility device filters prevent irrelevant items from being presented
• Items worded using everyday language & clear examples
• Can be completed by the child’s caregiver(s) or by the child’s therapist/clinician
• Equations available to link previous PEDI Functional Skills Self-care, Mobility and Social Function scores to the PEDI-CAT so that clinicians may continue to track a child’s changes over time
Administration of the PEDI-CAT

- No special environment, materials or activities necessary
- Focuses on **typical performance at the present time**
- Can be used on multiple occasions for the same child (e.g. initial, interim, discharge and follow-up)
- No minimum time must pass between assessments
- Recommendation: review of the PEDI-CAT Manual prior to administration to familiarize self with administration procedures, instrument content, item intent, response scales and score interpretation
Domains of the PEDI-CAT

4 Domains:
- Daily Activities
- Mobility
- Social/Cognitive
- Responsibility

- Each domain is self-contained and can be used separately or with other domains
- Illustrations of Daily Activities and Mobility items are included to facilitate understanding of the item intent

Examples:
- Walks with walking aid (e.g. cane, crutches, walker) several hours at family or school outing such as zoo, amusement park or fair

  ○ **Unable**: Can't do, doesn't know how or is too young.
  ○ **Hard**: Does with a lot of help, extra time, or effort.
  ○ **A little hard**: Does with a little help, extra time or effort.
  ○ **Easy**: Does with no help, extra time or effort, or child's skills are past this level.
  ○ I don't know.
The ICF as a conceptual framework
PEDI-CAT Domains

- 3 domains aligned with ICF Activity dimension, i.e. the execution of discrete tasks
  - Daily Activities
  - Social/ Cognitive
  - Mobility
- One domain aligned with ICF participation dimension, i.e. involvement in a life situation
  - Responsibility
PEDI-CAT = Response Scales

For Daily Activities, Mobility and Social/Cognitive:

- Unable
- A Little Hard
- Hard
- Easy
- I don’t know For Responsibility:

5-point Responsibility Scale:

- Range from:
- Adult/caregiver has **full** responsibility & child does not take responsibility
- Child takes **full** responsibility without any direction, supervision or guidance from an adult/caregiver
Daily Activities

68 items in Item Pool

- 4 Content Areas:
  - Getting Dressed
  - Keeping Clean
  - Home Tasks
  - Eating & Mealtime

Sample Item:
Ties Shoelaces (Getting Dressed content area)
Mobility

75 items in Item Pool

• 5 Content areas:
  • *Basic Movement & Transfers*
  • *Standing & Walking*
  • *Steps & Inclines*
  • *Running & Playing*

• Additional 22 items for children who use mobility devices (walking aids (canes, crutches, walkers) &/or wheelchairs)

Sample Item:
*Gets on and off a public bus or school bus* (Steps & Inclines content area)
Social/Cognitive

60 items in Item Pool (*No Pictures*)

- 4 Content areas:
  - *Interaction*
  - *Communication*
  - *Everyday Cognition*
  - *Self Management*

**Sample Items:**

*Communicates ideas in a 2-3 page written assignment or report* (*Everyday Cognition*)

*Uses single words, gestures or signs to show what he/she wants* (*Communication*)
Responsibility

51 items in Item Pool (4 Content areas)

- Organization & Planning
- Taking Care of Daily Needs
- Health Management
- Staying Safe

- Items require children to use several functional skills in combination to carry out life tasks

Sample Item: *Keeping track of time throughout the day*

- Includes: Arriving on time to scheduled activities or appointments; Coming back home at planned time; Ending an activity on time to stay on schedule
Versions of the PEDI-CAT

**Speedy (<15 items)**
- Fastest way to get an accurate and precise score
  - 10-15 minutes for all 4 domains

**Content-Balanced (up to 30 items)**
- Program will choose items from all content areas within a domain
- Example—for Daily Activities will get items from all 4 content areas: *Getting Dressed, Keeping Clean, Home Tasks, and Eating & Mealtime*
  - 20-30 minutes for all 4 domains
**Type of PEDICAT to be completed:**

<table>
<thead>
<tr>
<th></th>
<th>None</th>
<th>Speedy</th>
<th>Content Balanced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Social/Cognitive</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Responsibility</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Identification Number: AACFDM

Next
PEDI-CAT Scoring

**Normative scores**
- Provided as age percentiles and T-scores
- Based on a child’s chronological age
- Intended for use by clinicians so that they may interpret a particular child’s functioning relative to other children of comparable age
Test Scores-Normative Standard

Age Percentile = indicates percent of the total frequency scored below that score

T Score = Mean of 50 SD of 10
PEDI-CAT Scoring

**Scaled scores**
- 20-80 metric
- Provide a way to look at a child’s current functional skills and progress in these skills over time
- Helpful in documenting improvements in functional skills for children not expected to exhibit or regain normative levels of functioning

**Item Maps** - generated with Content-Balanced PEDI-CAT and Speedy; represent location of item ratings along the continuum of difficulty measured in that domain
PEDI-CAT Score Report
# PEDI-CAT Assessment Report

**Identification Number:** Test_ZL  
**Date of Birth:** 1/23/2010  
**Gender:** FEMALE

---

<table>
<thead>
<tr>
<th>Domain</th>
<th>Score</th>
<th>SE</th>
<th>T-Score</th>
<th>Percentile</th>
<th># items</th>
<th>Proxy</th>
<th>Device*</th>
<th>Wheelchair**</th>
<th>Date</th>
<th>Type***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities</td>
<td>51</td>
<td>0.78</td>
<td>42</td>
<td>5–25</td>
<td>15</td>
<td>0.92</td>
<td>0</td>
<td>0</td>
<td>11/15/2013</td>
<td>1</td>
</tr>
<tr>
<td>Mobility</td>
<td>59</td>
<td>1.02</td>
<td>21</td>
<td>45</td>
<td>5</td>
<td>0.77</td>
<td>0</td>
<td>0</td>
<td>11/15/2013</td>
<td>1</td>
</tr>
</tbody>
</table>

* 0: Does not use any device; 1: Walker; 2: Crutches; 3: Cane  
** 0: Does not use any wheelchair; 1: Manual Wheelchair (doesn't propel); 2: Manual Wheelchair (does propel); 3: Power Wheelchair  
*** 1: Speedy; 2: Content-Balanced

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<table>
<thead>
<tr>
<th>Domain</th>
<th>Item Content</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities</td>
<td>Pulls open a sealed bag of snack food</td>
<td>Unable</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Puts on a t-shirt</td>
<td>A little hard</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Puts on and fastens pants</td>
<td>A little hard</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Tucks in shirt or blouse</td>
<td>A little hard</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Fastens belt buckle</td>
<td>Unable</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Pours liquid from a large carton into a glass</td>
<td>Unable</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Puts on winter, sport, or work gloves</td>
<td>Hard</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Puts on socks</td>
<td>A little hard</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Puts on and buttons a front-buttoning shirt</td>
<td>Hard</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Uses a knife to butter bread and spread jam</td>
<td>Unable</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Connects and zips zippers that are not fastened at the bottom</td>
<td>Hard</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>Inserts a straw into a juice box</td>
<td>Hard</td>
</tr>
</tbody>
</table>

---
# PEDICAT Score Report

## Understanding the PEDICAT score report

<table>
<thead>
<tr>
<th>Domain</th>
<th>Assessment Date</th>
<th>Scaled Score</th>
<th>SE</th>
<th>T-Score</th>
<th>Age Pctile</th>
<th>Fit</th>
<th># of items</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities</td>
<td>9/9/2015</td>
<td>58</td>
<td>0.67</td>
<td>33</td>
<td>5~25</td>
<td>-1.78</td>
<td>31</td>
<td>Content-Balanced</td>
</tr>
<tr>
<td>Mobility</td>
<td>9/9/2015</td>
<td>64</td>
<td>0.81</td>
<td>17</td>
<td>&lt;5</td>
<td>-0.67</td>
<td>14</td>
<td>Speedy</td>
</tr>
<tr>
<td>Social/Cognitive</td>
<td>9/9/2015</td>
<td>69</td>
<td>0.81</td>
<td>39</td>
<td>5~25</td>
<td>0.63</td>
<td>12</td>
<td>Speedy</td>
</tr>
<tr>
<td>Responsibility</td>
<td>9/9/2015</td>
<td>51</td>
<td>1.10</td>
<td>41</td>
<td>5~25</td>
<td>0.82</td>
<td>12</td>
<td>Speedy</td>
</tr>
</tbody>
</table>
Case Example
PEDI-CAT
Demonstration: Speedy
PEDI-CAT
Demonstration: Content-Balanced
PEDI-CAT Research

- Accuracy and Precision of Scoring (Haley et al. 2010)
- Efficiency & Feasibility (Dumas et al. 2012)
- Reliability
  - Test-retest (Dumas et al. 2012)
  - Item-specific Reliability (Dumas et al. 2012)
- Validity
  - Discriminant Validity (Dumas et al. 2012)
  - Discriminant Validity (PEDI-CAT Mobility) for children who use a walking aid or wheelchair (Dumas et al. 2012)
- Concurrent Validity:
  - AIMS (Dumas and Fragala-Pinkham, 2015)
  - PEDI-CAT (Mobility) and PEDI FS Mobility (Dumas & Fragala-Pinkham, 2012)
Validity & Reliability of PEDI-CAT in CP

- Prospect cross sectional cohort of children with CP
- Study aims:
  1. Evaluate discriminant validity (Sensitivity) of the PEDI-CAT according to GMFCS
  2. Evaluate convergent validity of the PEDI-CAT with PedsQL (CP module), CP CHILD and FMS
  3. Perform a validation analysis of the crosswalk that links the new PEDI-CAT scores with original PEDI scores.
  4. Measure test, re-test reliability of the PEDI-CAT.
Demographics

- 101 Children presenting to BCH (June 2013- May 2014)
- 54 boys (53%)
- Mean age was 11.9 (SD±3.7 years)
### PEDI-CAT Domain Scores

- **Mean PEDI-CAT domain scores**
- **No Floor & Ceiling effects**

<table>
<thead>
<tr>
<th>Domain</th>
<th>Mean ± SD</th>
<th>Range</th>
<th>Ceiling (%)</th>
<th>Floor (%)</th>
<th>Missing (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities</td>
<td>50.2 ± 9.78</td>
<td>29.7 - 70.2</td>
<td>(0%)</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Mobility</td>
<td>55.4 ± 11.46</td>
<td>26.8 - 76.3</td>
<td>(0%)</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Social/Cognitive</td>
<td>63.4 ± 9.73</td>
<td>28.0 - 76.7</td>
<td>(0%)</td>
<td>o</td>
<td>o</td>
</tr>
<tr>
<td>Responsibility</td>
<td>44.3 ± 11.47</td>
<td>24.5 - 65.2</td>
<td>(0%)</td>
<td>o</td>
<td>o</td>
</tr>
</tbody>
</table>
Aim 1: Sensitivity

- All 4 domains of PEDI-CAT were able to differentiate across GMFCS (p<0.001)

<table>
<thead>
<tr>
<th>GMFCS LEVEL</th>
<th>PEDI-CAT Mobility</th>
<th>PEDI-CAT Daily Activities</th>
<th>PEDI-CAT Social/Cognitive</th>
<th>PEDI-CAT Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>67.0±3.79</td>
<td>58.1± 3.01</td>
<td>68.9± 3.04</td>
<td>51.4± 4.66</td>
</tr>
<tr>
<td>II</td>
<td>62.6±4.19</td>
<td>54.6± 6.46</td>
<td>65.8± 5.66</td>
<td>47.7± 8.83</td>
</tr>
<tr>
<td>III</td>
<td>58.2±5.32</td>
<td>56.2± 4.35</td>
<td>68.8± 4.88</td>
<td>51.5± 7.04</td>
</tr>
<tr>
<td>IV</td>
<td>49.9±7.67</td>
<td>47.9± 5.22</td>
<td>64.6± 7.70</td>
<td>43.1± 10.64</td>
</tr>
<tr>
<td>V</td>
<td>39.4±5.94</td>
<td>35.0± 4.78</td>
<td>49.7± 9.91</td>
<td>28.9± 7.41</td>
</tr>
</tbody>
</table>

Anova (p<0.001)
**PEDI-CAT Mobility**

- PEDI-CAT Mobility was able to differentiate between all levels of GMFCS
  - Except between GMFCS I & II (P=0.09) and II & III (P=0.12)

<table>
<thead>
<tr>
<th>GMFCS LEVEL</th>
<th>PEDI-CAT Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>67.0±3.79</td>
</tr>
<tr>
<td>II</td>
<td>62.6±4.19</td>
</tr>
<tr>
<td>III</td>
<td>58.2±5.32</td>
</tr>
<tr>
<td>IV</td>
<td>49.9±7.67</td>
</tr>
<tr>
<td>V</td>
<td>39.4±5.94</td>
</tr>
</tbody>
</table>
**Aim 1: Sensitivity**

- All 4 domains of PEDI-CAT were able to differentiate across MACS level (p<0.001)

<table>
<thead>
<tr>
<th>MACS LEVEL</th>
<th>PEDI-CAT Mobility</th>
<th>PEDI-CAT Daily Activities</th>
<th>PEDI-CAT Social/Cognitive</th>
<th>PEDI-CAT Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>64.4±7.34</td>
<td>57.7±3.59</td>
<td>69.2±3.28</td>
<td>52.1±5.07</td>
</tr>
<tr>
<td>II</td>
<td>62.6±4.97</td>
<td>57.4±2.01</td>
<td>68.7±2.49</td>
<td>51.4±3.15</td>
</tr>
<tr>
<td>III</td>
<td>55.7±8.51</td>
<td>50.1±5.73</td>
<td>64.7±8.91</td>
<td>44.2±11.89</td>
</tr>
<tr>
<td>IV</td>
<td>43.7±9.59</td>
<td>44.4±2.76</td>
<td>61.9±4.03</td>
<td>34.4±9.39</td>
</tr>
<tr>
<td>V</td>
<td>36.7±4.40</td>
<td>34.3±3.84</td>
<td>50.6±10.46</td>
<td>29.8±9.62</td>
</tr>
</tbody>
</table>

Anova (p<0.001)
PEDI-CAT *Daily-Activities*

- PEDI-CAT *Daily Activities* was able to differentiate across all levels of MACS
- Except between Level I & II (P=1.00)

<table>
<thead>
<tr>
<th>MACS LEVEL</th>
<th>PEDI-CAT Daily Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>57.7±3.59</td>
</tr>
<tr>
<td>II</td>
<td>57.4±2.01</td>
</tr>
<tr>
<td>III</td>
<td>50.1±5.73</td>
</tr>
<tr>
<td>IV</td>
<td>44.4±2.76</td>
</tr>
<tr>
<td>V</td>
<td>34.3±3.84</td>
</tr>
</tbody>
</table>
### PEDI-CAT Correlations

- Spearman correlation b/w GMFCS & MACS

<table>
<thead>
<tr>
<th>Domain</th>
<th>GMFCS Correlation (r)</th>
<th>GMFCS P-value</th>
<th>MACS Correlation (r)</th>
<th>MACS P-Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mobility</td>
<td>-0.89</td>
<td>&lt;0.001</td>
<td>-0.76</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Daily Activities</td>
<td>-0.78</td>
<td>&lt;0.001</td>
<td>-0.83</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Social/Cognitive</td>
<td>-0.55</td>
<td>&lt;0.001</td>
<td>-0.61</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>Responsibility</td>
<td>-0.56</td>
<td>&lt;0.001</td>
<td>-0.60</td>
<td>&lt;0.001</td>
</tr>
</tbody>
</table>
Aim 2: Convergent Validity

- Tested against
  - PedsQL (GMFCS I-III)
  - CPCHILD (GMFCS IV & V)
  - Functional Mobility Scale

- 4 Domains of PEDI-CAT tested individually against individual domains of PedsQL & CPCHILD
### Aim 2: PEDI-CAT vs PedsQL

- Daily activities domain had highest correlation with *daily activities* \( (r=0.85, \ p<0.001) \) & *eating activities* \( (r=0.76, \ p<0.001) \)

<table>
<thead>
<tr>
<th>Peds QL</th>
<th>Mobility</th>
<th>Daily Activities</th>
<th>Social Function</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities</td>
<td>0.61*</td>
<td>0.85*</td>
<td>0.70*</td>
<td>0.66*</td>
</tr>
<tr>
<td>School Activities</td>
<td>0.38*</td>
<td>0.62*</td>
<td>0.51*</td>
<td>0.47*</td>
</tr>
<tr>
<td>Eating Activities</td>
<td>0.41*</td>
<td>0.76*</td>
<td>0.57*</td>
<td>0.49*</td>
</tr>
<tr>
<td>Movement &amp; Balance</td>
<td>0.45*</td>
<td>0.33^</td>
<td>0.23</td>
<td>0.25</td>
</tr>
<tr>
<td>Fatigue</td>
<td>0.43*</td>
<td>0.28^</td>
<td>0.19</td>
<td>0.19</td>
</tr>
<tr>
<td>Communication</td>
<td>0.24</td>
<td>0.49*</td>
<td>0.42*</td>
<td>0.24</td>
</tr>
<tr>
<td>Pain &amp; Hurt</td>
<td>0.14</td>
<td>0.01</td>
<td>0.15</td>
<td>0.08</td>
</tr>
</tbody>
</table>
### Aim 2: PEDI-CAT vs FMS

- Mobility domain demonstrated highest correlation with FMS levels

<table>
<thead>
<tr>
<th>FMS</th>
<th>Mobility</th>
<th>Daily Activities</th>
<th>Social Function</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>5m</td>
<td>0.85*</td>
<td>0.69*</td>
<td>0.43*</td>
<td>0.46*</td>
</tr>
<tr>
<td>50m</td>
<td>0.84*</td>
<td>0.69*</td>
<td>0.41*</td>
<td>0.43*</td>
</tr>
<tr>
<td>500m</td>
<td>0.76*</td>
<td>0.58*</td>
<td>0.35*</td>
<td>0.41*</td>
</tr>
</tbody>
</table>
Aim 2: PEDI-CAT vs CPCHILD

- Strongest correlations were found between Mobility & Positioning, Daily Activities & Health and Social Function & Health

<table>
<thead>
<tr>
<th>CPCHILD</th>
<th>Mobility</th>
<th>Daily Activities</th>
<th>Social Function</th>
<th>Responsibility</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal Care</td>
<td>0.43*</td>
<td>0.44*</td>
<td>0.38^</td>
<td>0.29</td>
</tr>
<tr>
<td>Positioning</td>
<td><strong>0.61</strong>*</td>
<td>0.58*</td>
<td>0.46*</td>
<td><strong>0.36^</strong></td>
</tr>
<tr>
<td>Comfort</td>
<td>0.34^</td>
<td>0.40^</td>
<td>0.31</td>
<td>0.16</td>
</tr>
<tr>
<td>Communication</td>
<td>0.38^</td>
<td>0.54*</td>
<td>0.64*</td>
<td>0.37^</td>
</tr>
<tr>
<td>Health</td>
<td>0.40^</td>
<td><strong>0.60^</strong></td>
<td><strong>0.60^</strong></td>
<td><strong>0.53^</strong></td>
</tr>
<tr>
<td>Quality of Life</td>
<td>0.13</td>
<td>0.12</td>
<td>0.10</td>
<td>-0.07</td>
</tr>
<tr>
<td><strong>Total Score</strong></td>
<td><strong>0.53</strong>*</td>
<td><strong>0.61</strong>*</td>
<td><strong>0.56^</strong></td>
<td><strong>0.40^</strong></td>
</tr>
</tbody>
</table>
Aim 3: Validity of PEDI vs PEDI-CAT

- Pearsons correlations with 95% CI demonstrated excellent concurrent validity across all PEDI domains
  - Mobility ICC = 0.91
  - Daily Activities ICC = 0.95
  - Social/Cognitive ICC = 0.84

Time to complete PEDICAT (10 minutes) vs. PEDI (30 min)
Aim 4: Retest Reliability

- A 20 patient subset completed the PEDI-CAT @ 2 separate time points (avg 25 days, range 6-44 days)

- Test retest reliability was excellent across all domains

- ICC = 0.96-0.99 (p<0.001)
PEDI-CAT (ASD)
PEDI-CAT (ASD)

- PEDI-CAT Autism Spectrum Disorder module
- Modified to reflect the unique needs and strengths of children and youth with Autism (Kramer J, et al, 2012)
  - Additional Social/Cognitive and Daily Activity Items
  - Additional directions to enhance rating consistency
  - Social/Cognitive scaled scores reflect unique developmental patterns of youth with ASD, but remain comparable to PEDI-CAT
# PEDI-CAT (ASD): Items

<table>
<thead>
<tr>
<th>Item Pool Revisions for PEDI-CAT-ASD</th>
<th>Social/Cognitive Domain</th>
<th>Daily Activities Domain</th>
<th>Responsibility Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>New items</td>
<td>4</td>
<td>0</td>
<td>6</td>
</tr>
<tr>
<td>Reinstated items</td>
<td>5</td>
<td>8</td>
<td>1</td>
</tr>
<tr>
<td>Revised items</td>
<td>4</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Additional directions</td>
<td>15</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>TOTAL ITEMS</td>
<td>67</td>
<td>76</td>
<td>58</td>
</tr>
</tbody>
</table>

- Only four items across the three domains had poor fit (Coster W, et al, 2015)
PEDI-CAT (ASD): Directions

- Expanded rating scale directions through a pop up “help” button.
- Specific guidance regarding performance variability to help parents make consistent rating decisions.

- **Unable:** Child can’t do, doesn’t know how, or is too tired.
- **Hard:** Child does with a lot of help, extra time, or effort.
- **A Little Hard:** Child does with a little help, extra time, or effort.
- **Easy:** Child does with no help, extra time, or effort, or child’s skills are past this level.
- **I don’t know**
PEDI-CAT (ASD): Directions

- Added FAQs and item specific directions, or “Helpful hints”:
  - Encourages parents to systematically consider all relevant, available knowledge of their child’s abilities to ensure their evaluation is as objective as possible.

Uses words, gestures, or signs that non-family members generally understand to ask for something

*Helpful Hints:* Remember, if your child no longer demonstrates a particular skill because he/she is now beyond this level, choose "easy" as your response. When responding to these items, consider your child’s performance using their primary mode of communication. This could include augmentative communication devices (AAC), sign language, or use of the Picture Exchange Communication System (PECS).
PEDI-CAT (ASD): Reliability & Criterion Validity

- Excellent score reliability over two testing occasions.
- Moderate to strong significant relationship with PEDI-CAT (ASD) and Vineland scales.
- Parents felt they were asked fewer irrelevant questions on the PEDI-CAT (ASD).

- Kramer J, et al, in press
Comparing PEDI-CAT ASD & PEDI-CAT

- Compared to the **relative difficulty** of items with the original PEDI-CAT validation sample (Coster W, et al, 2015):

<table>
<thead>
<tr>
<th>Domain</th>
<th>Total # of Items</th>
<th># Items Significantly Different</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities</td>
<td>76</td>
<td>4</td>
</tr>
<tr>
<td>Social/ Cognitive</td>
<td>68</td>
<td>32</td>
</tr>
<tr>
<td>Responsibility</td>
<td>58</td>
<td>4</td>
</tr>
</tbody>
</table>
Comparing PEDI-CAT ASD & PEDI-CAT

- Items More Difficult for Youth with Autism (Kramer J, et al, in press)
  - Carries on a conversation with a familiar person by listening and responding appropriately
  - Greets new people appropriately when introduced
  - Follows gaze of another person to look at the same place or object
  - Engages in simple social games (peek-a-boo or pat-a-cake)
  - Interacts briefly with a peer during play
  - Asks one or more peers to play using words or gestures
  - Takes turns sharing a favorite toy with peers
  - Plays with one or more children of the same age for several hours on their own
  - Tries to make toys work by pressing, pushing, or squeezing
  - Follows directions given by adult leader of a small group
  - Attends to and follows direction given by a coach or teacher while in a large group
Comparing PEDI-CAT ASD & PEDI-CAT

- **Items less difficult for youth with Autism** (Kramer J, et al, in press)
  - Writes short notes or sends text messages or email
  - Provides own address and telephone number when asked
  - Recognizes his/her printed name
  - Prints first and last name legibly
  - Writes a legible 3-4 item list
  - Recognizes numbers such as on a clock or phone
  - Counts out the correct coins to pay for an item that costs $1 or less
  - Understands signs in the community
  - Counts out the correct amount of bills and/or coins to pay for an item costing $20-$40
  - Uses a map to plan a route to a new place
  - Finds a phone number or address using the phone book or computer
  - Follows written directions of 2-3 steps
  - Follows complex written instructions
  - Uses a watch or clock to be ready for an activity
  - Uses a calendar or datebook to record and keep track of appointments, assignment or events
  - Accepts advice or feedback without losing temper
PEDI-CAT-ASD Scoring

- **Normative** scores (T-scores, percentiles) that are exactly the same as the PEDI-CAT-ASD.

<table>
<thead>
<tr>
<th>Scales</th>
<th>Score</th>
<th>SE</th>
<th>T-Score</th>
<th>Percentile</th>
<th>Fit</th>
<th># items</th>
<th>Proxy</th>
<th>Device*</th>
<th>Wheelchair**</th>
<th>Date</th>
<th>Type***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities/ASD</td>
<td>55</td>
<td>0.82</td>
<td>&lt;10</td>
<td>&lt;5</td>
<td>-0.76</td>
<td>15</td>
<td>PARENT</td>
<td>0</td>
<td>0</td>
<td>4/6/2013</td>
<td>1</td>
</tr>
<tr>
<td>Social/Cognitive/ASD</td>
<td>59</td>
<td>0.85</td>
<td>&lt;10</td>
<td>&lt;5</td>
<td>1.23</td>
<td>15</td>
<td>PARENT</td>
<td>0</td>
<td>0</td>
<td>4/6/2013</td>
<td>1</td>
</tr>
<tr>
<td>Responsibility/ASD</td>
<td>44</td>
<td>1.57</td>
<td>&lt;10</td>
<td>&lt;5</td>
<td>-1.29</td>
<td>15</td>
<td>PARENT</td>
<td>0</td>
<td>0</td>
<td>4/6/2013</td>
<td>1</td>
</tr>
</tbody>
</table>

*: 0: Does not use any device; 1: Walker, 2: Crutches; 3: Cane

**: Wheelchair: 0: Does not use any wheelchair; 1: Manual Wheelchair (doesn't propel); 2: Manual Wheelchair (does propel); 3: Power Wheelchair

***: 1: Speedy; 2: Content-Balanced

<table>
<thead>
<tr>
<th>Scales</th>
<th>Item Content</th>
<th>Response</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities/ASD</td>
<td>Pulls open a sealed bag of snack food</td>
<td>Easy</td>
</tr>
<tr>
<td>Daily Activities/ASD</td>
<td>Inserts laces into sneakers or boots</td>
<td>Hard</td>
</tr>
<tr>
<td>Daily Activities/ASD</td>
<td>Puts on and fastens pants</td>
<td>A little hard</td>
</tr>
<tr>
<td>Daily Activities/ASD</td>
<td>Tucks in shirt or blouse</td>
<td>A little hard</td>
</tr>
</tbody>
</table>
PEDI-CAT-ASD Scoring

• **Social/Cognitive scaled** score is adjusted to better reflect the way that children and youth with ASDs perform functional activities.

• Score remains comparable to scores produced using the PEDI-CAT

<table>
<thead>
<tr>
<th>Scales</th>
<th>Score</th>
<th>SE</th>
<th>T-Score</th>
<th>Percentile</th>
<th>Fit</th>
<th># items</th>
<th>Proxy</th>
<th>Device*</th>
<th>Wheelchair**</th>
<th>Date</th>
<th>Type***</th>
</tr>
</thead>
<tbody>
<tr>
<td>Daily Activities/ASD</td>
<td>55</td>
<td>0.82</td>
<td>&lt;10</td>
<td>&lt;5</td>
<td>-0.76</td>
<td>15</td>
<td>PARENT</td>
<td>0</td>
<td>0</td>
<td>4/6/2013</td>
<td>1</td>
</tr>
<tr>
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<td>59</td>
<td>0.85</td>
<td>&lt;10</td>
<td>&lt;5</td>
<td>1.23</td>
<td>15</td>
<td>PARENT</td>
<td>0</td>
<td>0</td>
<td>4/6/2013</td>
<td>1</td>
</tr>
<tr>
<td>Responsibility/ASD</td>
<td>44</td>
<td>1.57</td>
<td>&lt;10</td>
<td>&lt;5</td>
<td>-1.29</td>
<td>15</td>
<td>PARENT</td>
<td>0</td>
<td>0</td>
<td>4/6/2013</td>
<td>1</td>
</tr>
</tbody>
</table>

*: 0: Does not use any device; 1: Walker; 2: Crutches; 3: Cane

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***: 1: Speedy; 2: Content-Balanced
PEDI-CAT  Emerging Research
Future research directions

- Self report
  - PEDI-PRO (Patient Reported Outcome- Dr. Kramer, BU)

- Diagnostic Specific
  - Spinal Muscular Atrophy module (Dr. Darras/SMA team – Boston Children’s Hospital; PNCR network)

- Setting Specific
  - Hospital-items (Franciscan Hospital for Children – Dumas, 2010)
Proxy respondents, such as parents or professionals, do not identify the same needs as youth, particularly as youth age and transition to adult service systems.

Representation of youth with DD in research is significant concern given growing population and significant healthcare expenditures:

- Prevalence increased among youth ages 3-17 years increased from 12.8% in 1999 to 15.04% in 2008 (Boyle et al., 2011).
- Children with disabilities comprise 7.3% of the 0-17 population, yet account for 22.7% of total health care expenditures (Newacheck et al., 2004).
PEDI-PRO

- User interface (features in the software) support the cognitive processes required for reliable self reports:
  - Recall
  - Long and short term memory
  - Attention
Stay calm when I don’t get what I want.
Functional domain questions were developed in partnership with a panel of youth with DD (n = 8)

<table>
<thead>
<tr>
<th>Functional Domain</th>
<th>Items Revised from Parent Item Pools</th>
<th>New Items</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social/Cognitive</td>
<td>45</td>
<td>19</td>
<td>64</td>
</tr>
<tr>
<td>Example:</td>
<td>Teach a friend how to play my favorite game.</td>
<td>Use a self-checkout machine.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Daily Activities</td>
<td>58</td>
<td>13</td>
<td>71</td>
</tr>
<tr>
<td>Example:</td>
<td>Cut my toenails.</td>
<td>Swipe a debit or credit card.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mobility</td>
<td>40</td>
<td>4</td>
<td>44</td>
</tr>
<tr>
<td>Example:</td>
<td>Reach across the table for salt, butter, or ketchup.</td>
<td>Slide into a booth so someone can sit next to me.</td>
<td></td>
</tr>
</tbody>
</table>
To complete the PEDI-PRO, youth will select from 11 familiar everyday life situations.

Each everyday life situation is linked with relevant questions from each functional domain.

When questions included situation specific wording and pictures, 70% of youth’s open-ended responses explicitly referenced the situation.
PEDI-PRO Pilot work

- Youth with DD (n = 17) interpret the assessment questions in the intended manner 61-69% of the time, and rarely (6-11%) think of only extraneous content when responding to questions.

- Youth with DD (n = 17) select self-report ratings that match their self-described abilities for both positive ($M = 100\%$) and negative ($M = 89.1\%$) rating categories.
PEDI-CAT

SMA specific option
PEDI-CAT in children with SMA

Decreased Functional Skills
(% with Normative Scores ≥2 SD Below the Mean)

- Type III
- Type II
- Type I

Daily Activities
Mobility
PEDI-CAT in SMA (scaled scores)
SMA: Mobility Subscale Test Information Function
### Mobility Item Maps Types II/III

#### Type-II

<table>
<thead>
<tr>
<th>Mobility</th>
<th>Subscale</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>+ MB027 II MB032 II MB033 II MB034 II MB035 II</td>
</tr>
<tr>
<td></td>
<td>MB036 II MB038 II MB041 II MB042 II MB044 II</td>
</tr>
<tr>
<td></td>
<td>MB045 II MB046 II MB047 II MB048 II MB049 II</td>
</tr>
<tr>
<td></td>
<td>MB050 II MB051 II MB053 II MB054 II MB055 II</td>
</tr>
<tr>
<td></td>
<td>MB056 II MB057 II MB058 II MB059 II MB060 II</td>
</tr>
<tr>
<td></td>
<td>MB061 II MB062 II MB064 II MB065 II MB066 II</td>
</tr>
<tr>
<td></td>
<td>MB067 II MB068 II MB069 II MB070 II MB071 II</td>
</tr>
<tr>
<td></td>
<td>MB072 II MB074 II MB075 II MB076 II MB077 II</td>
</tr>
<tr>
<td></td>
<td>MB078 II MB079 II MB083 II MB084 II MB085 II</td>
</tr>
<tr>
<td></td>
<td>MB086 II MB087 II MB088 II MB092 II MB093 II</td>
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<tr>
<td></td>
<td>MB094 II MB095 II MB096 II MB097 II MB101 II</td>
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<tr>
<td></td>
<td>MB102 II MB103 II MB104 D I MB105 II MB106 II</td>
</tr>
<tr>
<td></td>
<td>MB107 II MB108 II MB109 II MB110 II MB111 II</td>
</tr>
<tr>
<td></td>
<td>MB112 II MB113 II MB114 D I MB115 D I MB116 D I</td>
</tr>
<tr>
<td></td>
<td>MB117 II MB118 D I MB119 D I MB120 II MB121 D I</td>
</tr>
<tr>
<td></td>
<td>MB122 II MB123 D I MB124 D I MB125 D I MB126 D I</td>
</tr>
<tr>
<td></td>
<td>MB127 II MB128 D I MB129 D I MB130 D I MB131 D I</td>
</tr>
<tr>
<td></td>
<td>MB132 D I MB133 D I MB134 D I MB135 D I MB136 D I</td>
</tr>
</tbody>
</table>

#### Type-III

<table>
<thead>
<tr>
<th>Mobility</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>2</td>
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<td></td>
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<tr>
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<td></td>
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<tr>
<td>0</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>-1</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>-2</td>
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<tr>
<td></td>
</tr>
<tr>
<td>-3</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>-4</td>
</tr>
</tbody>
</table>

### Legend

- **+**: Item included in the subscale.
- **-**: Item excluded from the subscale.
- **T**: Item is a terminal item.
- **X**: Item is an indicator item.
PEDI-CAT
Hospital-setting
Hospital specific Items

- Responsiveness of PEDI-CAT (Mobility, Daily Activities, Social/Cognitive) in pediatric post-acute care hospital
- Significant differences for all domains when mean admission and discharge scores compared
- Missing content specific to hospital setting

Examples:
- Walks 100 feet (30m) in hospital corridor or similar space with no walking aid (cane, crutches, walker)
- Cruises in crib or along bench
• Other Cases
• iPad demo
• Questions
www.pedicat.com

- FAQ
- How-to videos
- Contact and Ordering Information