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Examining differential responses of youth with and without autism on a measure of everyday activity performance

Jessica M. Kramer¹, Kendra Liljenquist¹, Pengsheng Ni², and Wendy J. Coster¹

¹Ph.D. Program in Rehabilitation Sciences, Department of Occupational Therapy, Boston University, Boston, MA 02215, USA

²Health and Disability Research Institute, Health Policy and Management, Boston University, Boston, MA, USA

Abstract

Purpose—This study further investigated items with differential item function (DIF) in the Social/Cognitive domain of a measure of everyday activity performance, the Pediatric Evaluation of Disability Inventory-Computer Adapted Test version for Autism “PEDI-CAT (ASD),” to understand possible sources of response variation in a heterogeneous sample of youth with autism compared to the national standardization sample.

Methods—Cross-sectional design. A convenience sample of parents who identified they had a child between 3 and 21 years ($M = 11.9$ years, $SD = 4.67$ years) with autism ($n = 365$) completed an online survey that included the PEDI-CAT (ASD) and descriptive measures. For 28 items previously identified as having DIF, the PEDI-CAT (ASD) expected item score curves for the autism sample were compared to the original PEDI-CAT standardization sample. The weighted area between expected score curves (wABC) was also calculated; values >0.24 indicate significant DIF.

Results—All items had wABC that exceeded the criterion. Compared with peers without disabilities at the same ability level, 11 items were significantly more difficult for the youth with autism and 16 items were significantly easier. One item demonstrated non-uniform DIF.

Conclusion—Differential responses could indicate that: (1) children with autism have a different developmental pattern of skill acquisition for everyday activities in the Social/Cognitive domain, or (2) parents of children with autism utilize a unique appraisal process when assessing their children’s functional performance of everyday activities. Further research is required to better understand the factors leading to differential responses on the targeted items. The study illustrates the value of in-depth analysis of DIF to gain insight into the impact of a clinical condition on functional performance.

Jessica M. Kramer kramerj@bu.edu.

Conflict of interest Pengsheng Ni has acted as a paid consultant to CRE Care, distributor of the PEDI-CAT, and has received funding for research carried out in this work. All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Keywords

Item response theory; Autistic disorder; Differential item function (DIF)

Introduction

In recent years the field of pediatric rehabilitation has seen the development of a number of high-quality, universal outcome measures of health-related quality of life designed to apply across diagnostic groups [1–3]. A key assumption underlying this universal approach is that the measurement construct will remain invariant across different populations, thus allowing comparison of the needs and outcomes of diverse groups using the same instrument [4–6]. However, some recent studies have reported that such measures may perform differently when used with specific clinical populations, particularly when the content of a scale is closely related to a primary area of impairment or functional limitation in the clinical group [7–9]. Methods derived from item response theory (IRT) have been used to investigate differences in measurement performance in clinical groups, to explore potential reasons for those differences, and identify implications for measurement development and assessment validity [10, 11]. The present study applied these methods to more closely examine measurement invariance in items from the Social/Cognitive domain of the Pediatric Evaluation of Disability Inventory-Computer Adapted Test (PEDI-CAT) in children and youth with autism. The PEDI-CAT is a universal measure designed to assess a child's ability to engage in functional activities of everyday life. Given the increased prevalence of autism in children ages 3–17 in the past decade, there is a pressing need for high-quality measures that can be used to validly describe and track functional outcomes and health-related quality of life across time for this clinical population [12–14].

Item Response Theory methods have been recognized as the approach of choice for developing new instruments in rehabilitation [10]. IRT is based on the assumption that items representing the same single (unidimensional) underlying construct can be ordered in a developmental fashion from less to more difficult and that progression along this continuum is explained by an increase in ability in the underlying construct. To ensure the validity of measurement results across clinical populations, the underlying construct should remain invariant and items should retain the same relation to the underlying construct across clinical groups.

The process of empirically validating unidimensionality requires a series of analyses [15]. At the test level, confirmatory factor analysis (CFA) fit indices indicate whether items coalesce to measure only one construct. At the item level, IRT fit indices indicate the extent to which individuals respond to and interpret items along the continuum in a predictable manner. Respondents with less ability are less likely to endorse the more difficult items along the continuum, and respondents with greater ability are more likely to endorse the more difficult items. When measuring complex constructs such as activity performance, multiple factors may influence the likelihood that a respondent endorses a particular item. However, in a well-designed scale, one primary underlying factor should account for an individual's response [15]. When more than one underlying factor influences a response to

an item, and the relationship between those underlying factors and the respondent(s) is not consistent, unidimensionality will not be supported.

For clinical groups an important question is whether some factor related to the clinical condition influences the relative difficulty of the items on a particular instrument. Differential item functioning (DIF) occurs when the relative location of an item along the continuum is inconsistent, or results in response variation, for unique subgroups of respondents [16]. For example, the unique symptomology of children with autism may result in a different relationship between the general level of underlying ability and the ability to perform a particular item (everyday activity). If differences in responses were due to a factor completely irrelevant to the construct, then its effects would be random across persons and the item would have poor fit. However, if there is a predictable relationship between the construct being measured and a particular clinical profile, those respondents as a group may interpret the items consistently but differently from the instruments' original standardization population, which would give rise to DIF. When this occurs, an in-depth investigation of DIF provides an opportunity to learn about the unique performance patterns associated with a particular clinical condition [8].

Recent psychometric testing [7] of the PEDI-CAT (ASD), a slightly modified version of the original PEDI-CAT, with youth with autism showed acceptable values from CFA, which confirmed the validity of the three-domain structure for this group. Further, almost all items on the PEDI-CAT (ASD) had acceptable fit, indicating that items continue to fit along a unidimensional continuum for this population. However, analyses also identified significant DIF in about half of the Social/Cognitive items between youth with autism and youth without disabilities [7]. A specific pattern of social and cognitive impairments is diagnostic of autism; thus, it is not completely unexpected that differences were found in this domain. The extent of DIF suggests that the unique constellation of deficits and strengths associated with autism may affect how parents assess their child's functional performance of everyday activities requiring Social/Cognitive skills. The present study undertook further analysis of items previously identified with DIF with two major aims: (1) to use the item-level information obtained from IRT to understand possible sources of response variation that may identify unique performance patterns for youth with autism; (2) to identify areas for further research into the functional difficulties of children and youth with autism.

Methods

Participants

A convenience sample of parents of children and youth ages 3–21 was recruited through local and national service and advocacy groups for children with autism. The PEDI-CAT (ASD) item pools were designed to measure skills acquired across this broad age range. Eligibility was determined via email or phone screening [17]. Most respondents ($n = 365$) were mothers (93.7 %) reporting about their male children (83.3 %), with a mean age of 11.9 years, $SD = 4.67$ years. Diagnoses, as reported by parents, included autism (52.1 %), Asperger's (25.5 %), and pervasive developmental disorder (22.2 %). Twenty-one percent (21.9 %) also reported a current or past diagnosis of intellectual disability. The severity of autism symptomology exhibited by the sample varied, as assessed with the Social

Communication Questionnaire (SCQ) [18]; higher scores indicate more severe behaviors. Table 1 contains additional information about this sample.

Procedures

This was a cross-sectional study. The University Human Subjects Review Board provided permission for all research activities, and informed consent was obtained from all study participants. Eligible parents received a link and password to access a secure Web site. Parents provided informed consent online before completing a demographic questionnaire and SCQ Current. Parents then answered all PEDI-CAT items in the Social/Cognitive (68 items), Daily Activities (76 items), and Responsibility (58 items) domains. After completing the PEDI-CAT items, parents had the option of completing the SCQ Lifetime. Parents could return to the online survey within a 14-day period. Data were downloaded from the secure Web site into SPSS and cleaned. This study only used responses from the Social/Cognitive domain.

Instruments

The PEDI-CAT was standardized with a stratified nationally representative (US) sample of 2205 children and youth without disabilities and 703 children and youth with heterogeneous disabilities ages 0–21, including 108 with autism [1]. We conducted an extensive qualitative evaluation of the appropriateness of the content and rating scales of the PEDI-CAT for children and youth with autism prior to conducting further evaluation of the PEDI-CAT for this unique population. Based on these findings, we expanded the item pools and modified some instructions to give directions for rating certain behavior patterns common in autism [19]. For clarity, we refer to this slightly modified version of the instrument as the PEDI-CAT (ASD).

The PEDI-CAT (ASD) measures the performance aspect of the ICF construct of “activity,” i.e., how the child or youth performs the activities in his or her usual daily environment. Social/Cognitive items address communication, interaction, safety, behavior, play, attention, and problem solving. Parents answer items using a four-point Likert scale measuring the extent to which the child has difficulty performing each activity: “Unable,” “Hard,” “A little hard,” and “Easy.” Parents are directed to select a rating based on their child’s typical performance while using usual supports such as alternative communication devices.

Our previous analysis indicated that the PEDI-CAT domains maintain strong psychometric properties when used with children and youth with autism [7]. However, as noted earlier, about half the items in the Social/Cognitive domain were found to have significant DIF using a logistic regression approach [7]. To ensure that clinicians and researchers could meaningfully compare scores generated by the original and the ASD version of the PEDI-CAT, we linked the two versions with a non-equivalent group with anchor test design [20]. Linking coefficients were calculated based on items common to both versions of the PEDI-CAT that did not have DIF. These coefficients were then used to link the ASD Social/Cognitive items and ensure the item estimates, and resulting scaled scores remain on the same metric as the PEDI-CAT [7].

Analysis

For the 28 Social/Cognitive items common to both versions of the PEDI-CAT and previously identified with DIF, we used two sets of IRT item estimates for this analysis: (1) the item estimates used in the original PEDI-CAT obtained from a nationally representative sample of youth with and without disabilities [1], and (2) the equated PEDI-CAT (ASD) item estimates obtained from the sample of 365 respondents (as described above, and [7]). The graded response model was used to obtain both sets of estimates via PARSCALE. We compared the expected item score curves for the PEDI-CAT (ASD) estimates to the expected item score curves for the original PEDI-CAT estimates because these estimates are on the same metric. The item score curve depicts the expected relationship between the ability of each respondent, theta (θ), and the response to a specific item (see Fig. 1). The weighted area between expected score curves (wABC) can be calculated to obtain a numerical representation of the difference between the two curves [21].

The wABC was calculated by weighting the autism sample distribution, with an adjustment for the mean shift in the normal distribution [21]. For the ASD sample, the mean and standard deviation of the score distribution is -0.756 and 0.492 . To approximate the weights of the sample distribution, the Gaussian rectangular quadrature was used with 41 nodes from -4 to 4 , each increasing 0.2 points, with the corresponding normal distribution density. This approach mimics the distribution of the ASD sample, and places more weight for scores near the mean. For a four category rating scale, we applied the criterion that a wABC value of >0.24 would indicate DIF [21].

We also used Excel to superimpose item characteristic curves (ICC) generated from the standardization sample and autism sample to determine the impact of group membership (autism or original standardization sample) on the expected responses to a given item. Items were considered “easier” for the group in which the same ability level was associated with a higher expected rating response compared with the alternative group (see Fig. 1).¹ We then examined the findings for patterns.

Results

All 28 items originally identified as DIF using a logistic regression approach also had $wABC > 0.24$, indicating that there was a significant difference in the expected scores for the autism sample compared with youth without disabilities in the same ability range.

Eleven items were significantly more difficult for the autism sample to perform. That is, at the same level of overall ability, caregiver respondents of youth with autism were expected to give a rating response that was lower than the caregivers of youth in the original standardization sample (see Table 2; Fig. 1). Three items were from everyday cognition, and the remaining eight items were from the interaction content area.

Sixteen items were significantly easier for the autism sample to perform (see Table 2; Fig. 1). That is, at the same level of overall ability, caregiver respondents of youth with autism

¹The y-axis on Figs. 1 and 2 depicts rating scale thresholds for the four-point PEDI-CAT 284 rating scale.

were expected to give a rating response that was higher than the caregivers of youth in the original standardization sample (see Table 2; Fig. 1). The communication and self-management content areas had two and one items, respectively, significantly easier for the autism sample, and 13 items represented everyday cognition content.

One item, “Transitions from one familiar activity to another such as playground to classroom, bath time to bed time,” had a non-uniform pattern of DIF (Fig. 2). This item was less difficult for youth with autism compared with the original sample for approximate ability levels <-1 and more difficult for youth with autism compared with the original sample for approximate ability levels >-1 .

Discussion

This study illustrates how IRT-based analytical approaches can be used to systematically investigate differential response patterns to a universal measure by a clinical group. The findings from this study provide additional understanding about the direction of the differential responses and suggest two possible reasons for the unique patterns found in this clinical population: (1) Children and youth with autism have a different developmental pattern of skill acquisition for everyday activities in the Social/Cognitive domain due to the unique constellation of strengths and deficits associated with the clinical profile, or (2) parents of children with autism interpret their children’s behavior differently than parents of children without disabilities because of the unique clinical profile.

The patterns of differential responses identified in this study can be mapped onto known characteristics of youth with autism. For example, items that were significantly more difficult for youth with autism such as “Carries on a conversation with a familiar person by listening and responding appropriately” represent behaviors that are associated with autism symptomology such as difficulty taking others’ perspectives [22]. Many of the items that were easier for youth with autism require concrete thinking, memorization of facts, visual perceptual skills, adherence to rules, and familiarity with routines and schedules, all skills and behaviors commonly reported in this population [23, 24]. Communication items such as “Provides own address and telephone number when asked” may be possible to perform at an acceptable level by youth with autism through memorizing and using social scripts, which may explain why such items were significantly easier for youth with autism after adjusting for the ability level of the sample. Other items involve activities that may be performed successfully using memorization such as counting money. Thus, it is possible that the profile of strengths and difficulties identified using this DIF approach represents a unique developmental trajectory for youth with autism.

Some items that were significantly easier for youth with autism do not match expected clinical profiles, such as the item “Follows complex written instructions.” The analytical technique used in this study adjusted the expected item response curves based on the performance of the ASD sample, which was older and had a mean ability level below 0. The older age of the ASD sample, which translates into more time learning such skills, may explain why in this study some advanced activities were performed in a more functional manner at a lower ability level.

An alternative explanation of the findings is that parents of children and youth with autism may assess their children's behavior differently than parents of children without disabilities. All respondents to self-report measures bring their own interpretations to the assessment process. On the PEDI-CAT (ASD) each parent must interpret the question, evaluate his or her child's performance, and then match that evaluation to a response scale. Differential response patterns could indicate that parents of children with autism use a unique frame of reference at some or all points of this self-report process. Contemporary literature on response shift [25, 26] proposes that new life experiences, such as those related to disability, become a catalyst for changes in self-perception, which are then reflected in self-reported responses. It is possible that parents of children with autism shift their appraisal of their children's performance of everyday activities as they learn strategies that maximize their child's performance, adjust performance expectations, and reframe their child's symptomology from deficits into strengths [27, 28].

One possible example of parents' shift in the frame of reference used to select a response may be the finding that the relative difficulty of the item "Transitions from one familiar activity to another..." (Figure 2) varied based on youth ability. Parents of youth with more severe impairments may more consistently utilize strategies such as timers or highly structured routines, and such strategies may support their child to transition successfully. This could lead parents to choose higher ratings even when youth demonstrate a lower overall level of performance. Conversely, parents of children with fewer autism-related impairments may have higher expectations for their children's behavior and may select lower ratings when youth have moderate to minimal performance difficulties. When the frame of reference used to select self-report responses differs among or within clinical groups, interpretation of the meaning of assessment results may need to be reconsidered. Cognitive interviews conducted during the development of the PEDI-CAT (ASD) did not suggest that parents utilized an alternative reference point when answering questions [19]. However, explicitly asking parents to explain how they select responses to the specific questions identified in this study may provide new insights on the frame of reference parents use when selecting responses to items.

Since many measures of functional performance are based on parent report, our findings indicate the importance of additional research into the cognitive processes and frames of reference that parents of children and youth with autism employ when reporting on their children's behavior. A related question is whether these frameworks are similar or different from those used by parents of children with other types of disabilities and children without disabilities. Further understanding of this question is important to further clarify when it is appropriate to compare the performance or health-related quality of life of these different groups of youth. Such findings also highlight the need to develop patient reported outcome measures that youth with autism can use to report their performance of everyday activities in a valid and reliable manner [14].

Study limitations

Results of the present study should be considered in relation to several limitations. The sample, although relatively large, was one of convenience, and findings may not be

representative of all children with autism. Recruitment through parent and service groups may have led to a selection bias. Additionally, autism was confirmed by parent report only, and the sample included youth with current SCQ scores above a published score (15) associated with a formal diagnosis. However, the purpose of the study was to examine response patterns in a heterogeneous sample of youth with a range of autism symptoms to determine whether consistent patterns might be identified.

Conclusion

This study provided an illustration of how IRT-based analytical approaches can be used to systematically investigate differential response patterns to an assessment to gain insight into the impact of clinical condition on the performance of everyday activities. The identified patterns of differential responses are consistent with known clinical differences in youth with autism and suggest important areas for future investigation. Further research is needed to determine whether findings reflect developmental patterns specific to youth with autism or a self-report frame of reference that is unique for parents of youth with autism.

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Fig. 1.
Examples of PEDI-CAT Social/Cognitive items with and without significant differences between youth with autism (ASD) and original standardization sample. * significant difference between plotted expected item score curves as given by $wABC > 0.24$

Fig. 2.

Non-uniform DIF for item “Transitions from one familiar activity to another such as playground to classroom, bath time to bed time” *. * at an overall ability of -2 (*large dashed line*), youth with autism (ASD) were expected to give a response higher than original standardization sample. At an overall ability of -1 (*short dashed line*), youth with autism were expected to give a response lower than original standardization sample

Table 1Sample demographics (*n* = 365)

Demographics	<i>n</i> (%)
Race	
Caucasian	312 (85.5)
Multiracial	26 (7.1)
African-American/black	5 (1.4)
Asian	7 (1.9)
Other	14 (4.1)
Ethnicity	
Hispanic/latino (a)	35 (9.6)
Not hispanic	330 (90.4)
Family income ^a	
Less than \$30,000	46 (12.6)
\$30,000–\$60,000	89 (24.4)
\$60,000–\$100,000	95 (26)
Above \$100,000	102 (27.9)
Communication style	
Sentences	272 (74.5)
Single words	43 (11.8)
Sign language, gestures, augmentative, or facilitated communication	50 (13.7)
SCQ current score	
0–14	116 (31.8)
15–21	131 (35.9)
Greater than 22	118 (32.3)
SCQ lifetime score ^b	
0–14	31 (10.3)
15–21	72 (24)
Greater than 22	197 (65.7)

^a33 respondents (9 %) preferred not to report their income

^bOptional: 300 respondents completed the SCQ lifetime

Table 2

Items with significant differences between youth with autism and original standardization sample

Items more difficult for youth with autism			Items less difficult for youth with autism		
Item stem ^a	Content area	wABC value	Item stem ^a	Content area	wABC value
Carries on a conversation with a familiar person by listening and responding appropriately	Interaction	0.72	Writes short notes or sends text messages or email	Communication	0.82
Greets new people appropriately when introduced	Interaction	0.48	Provides own address and telephone number when asked	Communication	1.43
Follows gaze of another person to look at the same place or object	Interaction	0.84	Recognizes his/her printed name	Everyday cognition	0.77
Engages in simple social games (peekaboo or pat-a-cake)	Interaction	0.39	Prints first and last name legibly	Everyday cognition	1.11
Interacts briefly with a peer during play	Interaction	0.58	Writes a legible 3–4 item list	Everyday cognition	1.01
Asks one or more peers to play using words or gestures	Interaction	0.89	Recognizes numbers such as on a clock or phone	Everyday cognition	0.76
Takes turns sharing a favorite toy with peers	Interaction	0.52	Counts out the correct coins to pay for an item that costs \$1 or less	Everyday cognition	0.89
Plays with one or more children of the same age for several hours on their own	Interaction	1.28	Understands signs in the community	Everyday cognition	0.97
Tries to make toys work by pressing, pushing, or squeezing	Everyday cognition	0.88	Counts out the correct amount of bills and/or coins to pay for an item costing \$20–\$40	Everyday cognition	0.68
Follows directions given by adult leader of a small group	Everyday cognition	0.40	Uses a map to plan a route to a new place	Everyday cognition	0.58
Attends to and follows direction given by a coach or teacher while in a large group	Everyday cognition	0.29	Finds a phone number or address using the phone book or computer	Everyday cognition	0.58
			Follows written directions of 2–3 steps	Everyday cognition	0.68
			Follows complex written instructions	Everyday cognition	0.32
			Uses a watch or clock to be ready for an activity	Everyday cognition	0.70
			Uses a calendar or datebook to record and keep track of appointments, assignment or events	Everyday cognition	0.49
			Accepts advice or feedback without losing temper	Self-management	0.44

^a Item stem only; item has been abbreviated