AutismCRC

Reliability, Validity and Usability of Assessment of Functioning Tools for Autism Spectrum Disorder and Neurodevelopmental Conditions in the Australian Context

Final Report

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The Cooperative Research Centre for Living with Autism (Autism CRC)

The Cooperative Research Centre for Living with Autism (Autism CRC) is the world’s first national, cooperative research effort focused on autism. Taking a whole-of-life approach to autism focusing on diagnosis, education and adult life, Autism CRC researchers are working with end-users to provide evidence-based outcomes which can be translated into practical solutions for governments, service providers, education and health professionals, families and people on the autism spectrum.

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Background and Rationale

The National Disability Insurance Scheme (NDIS), implemented by the National Disability Insurance Agency (NDIA), is a major reform of the Australian disability sector that provides individuals with individualised funding for reasonable and necessary supports based on their level of functioning (Commonwealth of Australia, 2013). A significant proportion of young people accessing the NDIS have a neurodevelopmental condition (NDC), that is, a neurodevelopmental disorder, as defined in the DSM-5 (American Psychiatric Association, 2013) and ICD-11 (World Health Organisation, 2018) or developmental delay, as defined in the NDIS legislation (Commonwealth of Australia, 2013). The most common of these is autism spectrum disorder (ASD), with 47% of all children participating in the scheme having an ASD diagnosis (Commonwealth of Australia, 2017). Thus, there is an important need to determine the best ways to identify and address the support needs of this population within the NDIS framework.

To receive a diagnosis of ASD, individuals must show specified difficulties with social communication and interaction, along with restricted and repetitive behaviours (American Psychiatric Association, 2013; World Health Organization, 2018). For the purpose of this research project, individuals who received a diagnosis of autistic disorder, Asperger's disorder or pervasive developmental disorder not otherwise specified under previous diagnostic criteria are included within the label of ASD (American Psychiatric Association, 1994; World Health Organization, 1992). An ASD diagnosis alone does not describe the individual's functioning and support needs, which can vary markedly from minimal to significant and lifelong support needs. The recently published National Guideline for the Assessment and Diagnosis of ASD in Australia (hereafter, 'National Guideline'; Whitehouse, Evans, Eapen, & Wray, 2018) describes a recommended process for a comprehensive assessment of functioning and support needs. The National Guideline provides recommendations in relation to guiding principles for an assessment, assessor qualifications and expertise, assessment settings, topics to be covered, methods for collecting information, decision making, sharing findings and adapting assessments according to important considerations (e.g. age, gender, intellectual and communication capacity, culturally and linguistically diverse backgrounds, complex psychosocial factors and regional or remote location). A critical element of the National Guideline is the recommendation that an understanding of the indvidual's support needs, rather than the presence or absence of a diagnosis, that is critical in determining eligibility and prioritisation of access to intervention and support services.

It is widely recognised in clinical practice and research relating to NDCs that there is no one 'gold standard' assessment for gauging the full range of functioning, and existing tools are not based on a strong conceptual underpinning (Price, Morris, & Costello, 2018; Whitehouse et al., 2018). Currently, the NDIA uses the Pediatric Evaluation of Disability Inventory-Computer Adaptive Test (PEDI-CAT; Haley et al., 2012) to evaluate the functional abilities of young people with neurodevelopmental and other disorders and, consequently, this tool contributes to the NDIS planning process (Commonwealth of Australia, 2017). Concerns have been raised within scientific literature, and through Australian community consultations, that this tool may not adequately describe functioning in young people on the autism spectrum (Joint Standing Committee on the National Disability Insurance Scheme, 2017), and it is possible these concerns may also be relevant to young people with other NDCs. The PEDI-CAT provides a measure of adaptive behaviour, covering social, practical and conceptual domains (Price et al., 2018). A modified version of the PEDI-CAT for young people on the autism spectrum has been developed, termed the PEDI-CAT (ASD) (Haley et al., 2017, 2019). The PEDI-CAT (ASD) includes 25 additional items (Daily Activities domain = 8, Social/Cognitive domain = 9 and Responsibility domains = 8) and 11 revised items (all in the Social/Cognitive domain) to create an assessment tool more specific to the autism population (Haley et al., 2017, 2019). Two studies have demonstrated the effectiveness of the PEDI-CAT (ASD) in the assessment of functioning in individuals diagnosed with ASD in the US (Kramer, Coster, Kao, Snow, & Orsmond, 2012; Kramer, Liljenquist, & Coster, 2016). The developers of the PEDI-CAT (ASD) have also suggested that this modified version may also better suit the needs of individuals with other NDCs (Hayley et al., 2017, 2019), although there are currently no published data to support this assertion. It is therefore critical to evaluate the psychometric properties of the tool with an Australian population of young people with ASD and other NDCs, to provide data that supports NDIA's decision making.

It is essential to have the best available evidence to support decisions regarding the most accurate and efficient assessment of functioning tool for young people with NDCs to ensure they receive the relevant supports required to maximise their independence and facilitate community participation. Furthermore, the assessment process must be applied consistently across Australia to ensure a sustainable scheme and equitable distribution of resources.

Purpose and Aims

The project purpose was to provide empirical data regarding the psychometric properties and usability of assessment of functioning tools for children with ASD or other NDCs, within an Australian setting. Findings may inform the tools used in the intake and planning process for individuals under 21 years of age diagnosed with ASD seeking to enter the NDIS. This report focuses on the evaluation of the PEDI-CAT (ASD), with supporting information on the evaluation of the Vineland Adaptive Behavior Scales – 3rd Edition (Vineland-3). To achieve the research purpose, a set of project aims and objectives were developed. The aims are described below, with the objectives stemming from these aims described within the 'Findings' Section.

Aim 1: To determine if the PEDI-CAT (ASD) has adequate reliability as a measure of functioning in individuals aged 20 years or younger with a diagnosis of ASD (Method 1).

Aim 2: To determine if the PEDI-CAT (ASD) has adequate validity as a measure of functioning in individuals aged 20 years or younger with a diagnosis of ASD (Method 1).

Aim 3: To determine if the PEDI-CAT (ASD) has adequate usability as a measure of functioning in individuals aged 20 years or younger with a diagnosis of ASD (Method 1 and 2).

The main report provides data relevant to each of these aims. The appendices includes data collected throughout this project that address additional research aims, including: (1) Evaluation of the psychometric properties and usability of the Vineland-3 (Appendix D); (2) Psychometric properties and usability of the PEDI-CAT (ASD) and Vineland-3 for the ASD sub-sample only (Appendix E); (3) Psychometric properties and usability of the PEDI-CAT (ASD) and Vineland-3 for non-ASD disability sub-samples (Appendix F); and (4) Psychometric properties and usability of the PEDI-CAT (ASD) and Vineland-3 for age-specific sub-samples (Appendix G).

Methods

To meet the project purpose and aims, data were collected in relation to the PEDI-CAT (ASD) and Vineland-3 using two data collection methods (clinical assessments and clinician workshops). This project was given ethical approval by Bellberry Human Research Ethics Committee (HREC approval 2018-10-852). All aspects of this research were conducted in accordance with the

Australian Code for the Responsible Conduct of Research (National Health and Medical Research Council, 2018).

Assessment Tools

Pediatric Evaluation of Disability Inventory-Computer Adaptive Test (PEDI-CAT)

The PEDI-CAT (Haley et al., 2012) is a computer-based assessment tool that uses parent/caregiver report to assess the functioning and performance of children and youths (aged 20 years or younger) with physical, cognitive, and/or behavioural conditions. Functioning is assessed using a question bank of 276 items across four domains: (1) Daily Activities, (2) Mobility, (3) Social/Cognitive, and (4) Responsibility. Each domain consists of a series of items that are scored according to how well the individual can perform each activity (i.e., the first three domains are scored as 'unable' to perform, 'hard' if they require substantial assistance, 'a little hard' if they require some assistance, 'easy' if they require no assistance, whilst the Responsibility domain is scored on a scale ranging from the 'adult/caregiver has full responsibility if the child does not take any responsibility' to the 'child takes full responsibility without any direction, supervision or guidance from an adult/caregiver'). The Content-Balanced, or comprehensive, version of the PEDI-CAT comprises approximately 30 items per domain, with algorithms used to determine the minimum number of items required to generate a score. If 'I don't know' is selected, additional questions from the same content area/subdomain will be administered to attain this minimum (if there are sufficient items in the item bank). All participants commence each domain with a consistent item in the middle range of difficulty, and subsequent items are determined on the basis of the participant's response (i.e. an easier or more difficult item will be presented). Hence, if all four domains are administered, each participant will only complete a sub-set of approximately 120 items from the total item bank of 276 questions, and these items will vary between individuals (Haley et al., 2012).

A new version, the PEDI-CAT (ASD), was released by the publishers in early 2018 and designed specifically for individuals on the autism spectrum (Haley et al., 2017, 2019). The validity, reliability and usability of the tool has previously been established on US samples (Kramer et al., 2012, 2016). The specific changes that were introduced include (Haley et al., 2017, 2019):

- 8 new items across the Daily Activities domain:
    1. Drinks from bottle or spout cup (held by self or someone else)
    2. Puts on sunglasses or glasses
    3. Squeezes plastic bottles to obtain ketchup, syrup, etc.
    4. Pulls open the tab on a soft drink can
    5. Puts on deodorant
    6. Unscrews the lid on a tight or new jar
    7. Shaves legs and underarms using either electric or safety razor
    8. Puts on and ties a tie
- 8 new items across the Social/Cognitive domain:
    1. Uses words, gestures, or signs that non-family members generally understand to ask for something
    2. Accepts changes in routine without losing temper and crying
    3. Goes along with peers' ideas for play
    4. Handles stimulating situations such as a shopping mall or party for 1-2 hours without losing control
    5. Tells others when she/he does not understand what they are saying, and asks for clarification
    6. Lets others know that he/she is in pain or does not feel well
    7. Respects others' personal space during interactions
    8. Uses words, gestures or signs to express feelings such as happy or mad
- 8 new and/or revised items across the Responsibility domain:
    1. Washing hands after using the bathroom
    2. Following a recipe or cooking instructions that includes 3-4 ingredients and steps such as macaroni and cheese or brownies
    3. Staying near parents or other caregiver when not given permission to go off on his/her own
    4. Keeping track of personal belongings throughout the day
    5. Keeping oneself and surrounding area neat when eating
    6. Keeping track of and completing homework assignments
    7. Recognizing and responding appropriately if others try to take advantage of him/her
    8. Maintaining the security of his/her home
- 11 revised Social/Cognitive domain items:
    1. Uses several words or signs together such as “go home now” and “daddy go”
    2. Uses words or signs to ask questions such as “Where’s mommy?” or “What’s that?”
    3. Carries on a conversation with a familiar person by listening and responding appropriately
    4. Greets new people appropriately when introduced
    5. Engages in simple social games with another person (such as tickling, making faces, peek-a-boo)
    6. Interacts briefly with a peer during play
    7. Communicates ideas in a 2-3 page written assignment or report
    8. When upset, responds without punching, hitting, or biting
    9. Uses unique sounds or body language that caregiver understands to indicate a general need or want; others may not understand
    10. Provides own address and telephone number when asked
    11. Transitions from one familiar activity to another such as playground to classroom, bath time to bed time

- Modified instructions to clarify some Social/Cognitive and Responsibility items by further defining the task, behaviour, context or allowable methods to complete the item (including communication devices)
- Adjustment to scoring and item maps related to non-normative scores.

Administration instructions state that the PEDI-CAT (Original and ASD) are to be interpreted by a professional from an education, early childhood education, paediatrics and/or rehabilitation background (Haley et al., 2017, 2019). The educator/clinician is also required to have knowledge related to assessments of functioning, including the ability to score, interpret and explain items and scores. The manual states that the PEDI-CAT (Original and ASD) take approximately 12-17 minutes to complete and the item bank is provided in Appendix A. Based on testing within this project, the PEDI-CAT (ASD) took a mean of 24-29 minutes (administration time was greatest for Assessment 1).

The PEDI-CAT (Original and ASD) t-scores for each domain were used for all data analyses, as this provides a comparison to a single normative sample (*n* = 2,205) of parents/caregivers reporting on typically developing young people at annual age strata (Haley et al., 2012, 2017, 2019). A research composite score was generated by calculating the mean of the Daily Activities, Social/Cognitive and Responsibility domain scores (please note this score, which we have termed the 'research composite', was generated for comparison purposes only, and is not an algorithm endorsed by the publishers for clinical use). The Mobility domain was excluded to enable comparison with the Vineland-3 adaptive behaviour composite which does not include the optional Motor Skills domain. Research composite and domain scores have a mean of 50 and standard deviation (*SD*) of 10. The research composite and domain scores were converted into categories according to the PEDI-CAT manual ('manual categories'), where 'normal' range is considered to be the mean ± two *SD* (Haley et al., 2012, 2017, 2019):

- Above Normal: 2-3 *SD* above mean
- Normal High: 1-2 *SD* above mean
- Normal: Between 1 *SD* above and 1 *SD* below
- Normal Low: 1-2 *SD* below mean
- Below Normal: 2-3 *SD* below mean.

In addition, the research composite and domain scores were converted into categories according to guidance from the NDIA regarding thresholds of interest to provide more precise indications of functioning ('NDIA categories'):

- Above 1.49 *SD* below the mean
- 1.50-1.99 *SD* below the mean
- 2.00-2.49 *SD* below the mean
- 2.50-2.99 *SD* below the mean
- 3.00 *SD* below the mean or less.

Vineland Adaptive Behavior Scales, Third Edition (Vineland-3)

Vineland-3 (Sparrow et al., 2016) is a measure of adaptive behaviour of individuals with intellectual, developmental and other disabilities (birth to 90+ years). It is comprised of three core domains (Communication, Daily Living Skills, and Socialization), and two optional domains (Motor Skills and Maladaptive Behavior). For the current research project, the Vineland-3 was administered online using the Comprehensive versions which consist of a total item pool of 381 core items and 121 optional items (Appendix B). To make administration more efficient, the items presented are restricted to an examinee's developmental level, determined using start points and basal and ceiling rules (except for the Maladaptive Behaviors domain for which all items must be answered). The start point is chosen according to the developmental age of the examinee. As the items are sequenced in order of increasing difficulty, those below the specified basal rule are assumed to be mastered, while items above the ceiling are considered to be beyond the examinee's ability. Item responses are scored based on how often the individual exhibits each behaviour (i.e., 'usually/regularly' = 2, 'sometimes' = 1, or 'does not' present behaviour = 0).

The publisher's website states that the Vineland-3 must be administered by an allied health or special education professional (Level B user level), such as those with a degree in speech pathology, occupational therapy, physiotherapy, special education, medical and behavioural science (Pearson Clinical Assessment, 2020). The *Parent/Caregiver Form* was completed independently by caregivers with the results interpreted by an appropriately skilled occupational therapist. The *Interview Form* was completed by a trained occupational therapist based on an interview with a caregiver knowledgeable on the adaptive behaviour of the individual. The Vineland-3 *Parent/Caregiver Form* is estimated to take between 10 and 31 minutes to complete and the *Interview Form* between 20 and 47 minutes, depending on the age and domains administered (Sparrow et al., 2016). Based on testing within this project, the Vineland-3 *Parent/Caregiver Form* took on average 51-57 minutes (administration time was longer in Assessment 1) and the *Interview Form* an average of 90 minutes to complete.

The Vineland-3 composite and domain standard scores, and maladaptive v-scale scores, were used for all relevant data analyses. The composite score is calculated from the core domains: Communication, Daily Living Skills and Socialization. Composite and domain standard scores have a mean of 100 and *SD* of 15, whereas v-scale scores have a mean of 15 and *SD* of 3. The composite and domain standard scores were converted into categories according to guidance in the manual ('manual categories'), where normal is considered to be the mean ± two *SD* (Sparrow et al., 2016):

- High: 2-3 *SD* above mean
- Moderately High: 1-2 *SD* above mean
- Adequate: Between 1 *SD* above and 1 *SD* below
- Moderately Low: 1-2 *SD* below mean
- Low: 2-3 *SD* below mean.

In addition, the composite and domain scores were converted into categories according to guidance from the NDIA regarding thresholds of interest to provide more precise indications of functioning ('NDIA categories'):

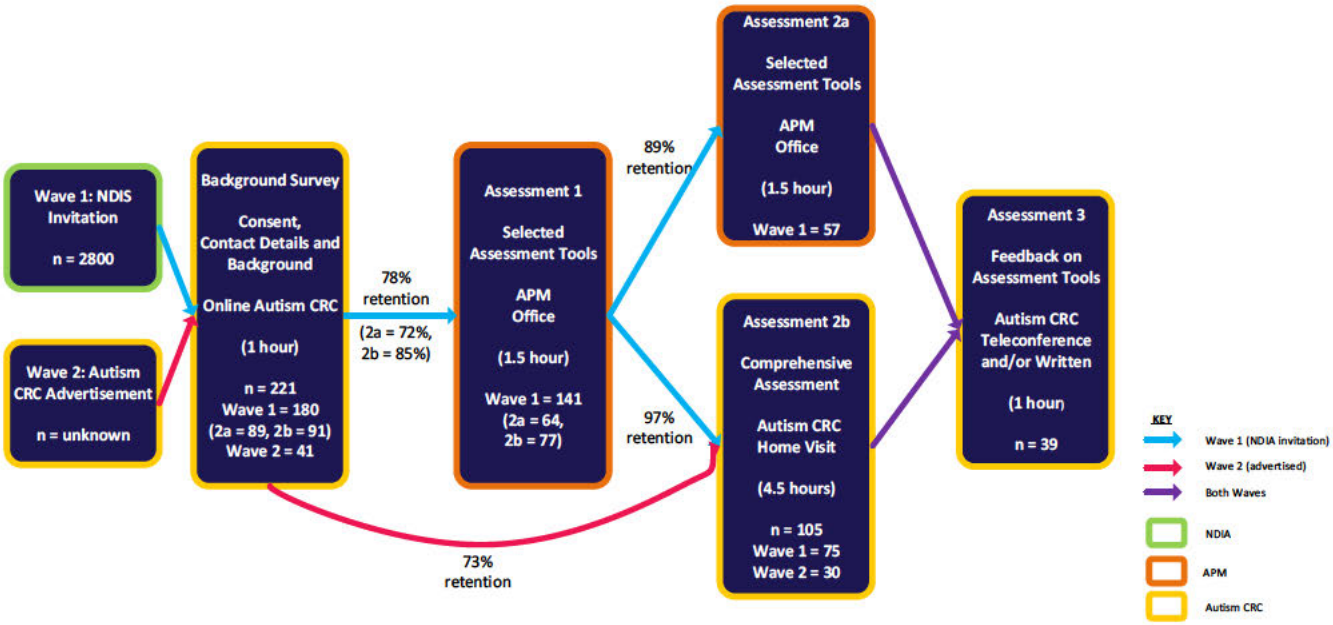
- Above 1.49 *SD* below the mean
- 1.50-1.99 *SD* below the mean
- 2.00-2.49 *SD* below the mean
- 2.50-2.99 *SD* below the mean
- 3.00 *SD* below the mean or less.

Method 1 – Clinical Assessments

Data Collection Procedures

The research activities and processes for the clinical assessments are illustrated in Figure 1 and described below:

Figure 1. Diagram explaining sequence of clinical assessment activities



Recruitment

Study participants were recruited in two waves. Wave 1 involved the assistance of the NDIA who forwarded an invitation letter via post or email to 2800 caregivers of individuals under 21 years of age with an NDC, on an NDIS plan and living in metropolitan or regional areas of Queensland, New South Wales, Victoria or Western Australia. These states were selected as they provided a good geographic spread across Australia and facilitated the recruitment of the sample size required within the timeframe of the project. The letter detailed the research project and directed potential participants to online links where they could choose to opt-in or opt-out of the research project. Recruitment Wave 2 was undertaken as the project progressed, to recruit additional participants for the purpose of achieving the sample size required for Assessment 3 and targetting underrepresented groups. In this situation, families in Western Australia (where the research project was based) were invited to complete Assessment 2b and 3 only and recruited via research investigators' professional networks and websites/social media presence, along with the Autism CRC, Curtin University and Telethon Kids Institute databases. This promotion involved sharing a brief description of the research project and eligibility requirements, researcher contacts and an online link to commence the opt-in process.

The opt-in process is described below. If the caregiver chose to opt-out via the NDIA hosted link (*n* = 70), they were not contacted further regarding the research project. Contact details of potential

participants who did not opt-out of the study by the specified date were forwarded to Autism CRC for follow-up by administration officers and other members of the research team employed through Telethon Kids Institute (*n* = 2730). Up to three contact attempts were made using a variety of methods across different times and days. If a caregiver expressed interest in participating in the research project, they were given the option of completing the opt-in process and Background Survey via the opt-in link or telephone (with an interpreter if required).

Opt-In process and Background Survey

The opt-in link and Background Survey were hosted by Telethon Kids Institute on a secure web application, REDCap (Harris et al., 2019; Harris et al., 2009). During the opt-in process, potential participants were screened for eligibility; given the option to request an interpreter; provided with the Participant Information Sheet and the opportunity to consent to participate in the research project; and supply contact and availability details necessary to schedule assessments. They then progressed to the Background Survey.

Randomisation and Scheduling

Participants from Recruitment Wave 1 (NDIA invitation letter) received a schedule of assessments randomly assigned via a computer algorithm based on the young person's age (0-5 years, 6-10 years, 11-16 years, 17-20 years) and geographical location (state). This computer algorithm was located within a Microsoft Excel spreadsheet, with 16 sheets in total to represent each of the potential stratification pathways based on age and location. The computer algorithm assigned a score of 1 (Assessment 2a) or 2 (Assessment 2b) to each row using the formula =RANDBETWEEN(1,2). Participants were added to the next available row upon providing consent and sufficient information to commence the research project. Given that randomisation occurred on a row by row basis, the computer algorithm had the potential to result in an unequal number of participants in each stream.

All of the Wave 1 (NDIA invitation letter) participants were invited to complete Assessment 1 and were randomised to one of two pathways for Assessment 2 (Figure 1), where they either repeated the assessment tools (2a) or completed a comprehensive assessment (2b). Relevant participant details were then securely transferred to Advanced Personnel Management (APM) who were contracted to complete data collection for Assessment 1 and 2a. Autism CRC collected data during Assessment 2b and 3. Each agency was responsible for scheduling their respective assessments. A minimum of two attempts were made to contact caregivers on each of the available methods

(telephone, email, mail). Where contact was unsuccessful, or the family did not respond with sufficient time to schedule an appointment by the completion date, their case was finalised as 'unable to contact'. Participants recruited via Wave 2 (advertising) did not undergo a randomisation process but were, instead, streamed directly into Assessment 2b and 3, with the aim of enhancing recruitment to these assessments.

Assessment 1

Assessment 1 involved administration of the PEDI-CAT (ASD) and Vineland-3 *Parent/Caregiver Form* and was conducted by an APM assessor who was either an allied health professional (Bachelor's degree or higher) or disability personnel (e.g. Certificate IV in Disability or higher). Where possible, the assessment occurred within an APM clinic setting, substituted by a teleconference meeting, remote administration (Vineland-3) or home visit if required.

Assessment 2a

Assessment 2a involved the repeat administration of the PEDI-CAT (ASD) and Vineland-3 *Parent/Caregiver Form* for approximately half of the sample to allow for test-retest reliability to be determined for both assessment tools. It was completed between 11 and 41 days following Assessment 1 (mean = 18 days), with the same APM clinic and assessor, where possible.

Assessment 2b

Assessment 2b was a comprehensive assessment of functioning, as defined in the National Guideline (Whitehouse et al., 2018). It involved a repeat administration of the PEDI-CAT (ASD) to allow for test-retest reliability to be determined, the different *Interview Form* version of the Vineland-3 to allow for alternate forms reliability to be determined, and collection of additional information through surveys, interview and observation to complete a comprehensive assessment of functioning.

Assessment 2b was conducted 7 to 39 days following the completion of Assessment 1 (mean = 22 days) by an Autism CRC assessor, who was a registered occupational therapist with clinical experience working with families of children with NDCs and relevant research experience (degree with Honours, Master's degree and/or, current PhD candidate). Occupational therapists were selected as the key personnel for this assessment given their extensive tertiary-level training in the assessment of functioning. The PEDI-CAT (ASD) occurred in the home setting during a comprehensive assessment of functioning. The Vineland-3 *Interview Form* (audio recorded) was

completed over the telephone within 14 days of the home visit (mean = 5 days). This had the benefit of reducing the length of the home visit, associated fatigue, and challenges of completing the assessment with the young person present (such as distraction and sensitivity of topics). Furthermore, it allowed the Vineland-3 *Interview Form* to be administered by a different assessor to ensure that the scoring was not influenced by information collected during the home visit.

Assessment 3

Assessment 3 involved administration of the original version of the PEDI-CAT and a semi-structured interview to explore the user experience, usability and acceptability of the PEDI-CAT (ASD) and Vineland-3 with caregivers who participated in Assessment 2a and/or 2b. The PEDI-CAT (Original) was prioritised for administration at the beginning of Assessment 3, as the feedback could be completed via alternate means if time did not permit both components to be completed. Assessment 3 occurred with an Autism CRC assessor via a recorded videoconference within an average of 21 days of completing their final assessment. This sequence was selected to optimise retention for Assessment 2a and 2b, and to allow participants to provide feedback on the comprehensive assessment of functioning process if they were streamed to Assessment 2b. The open-ended and limited response interview questions have been included in Appendix C. If caregivers did not want to participate in the full Assessment 3 process, they were invited to provide feedback via an online REDCap survey link following Assessment 2 (30 participants selected this option, and an additional three participants provided feedback via the survey link prior to completing the PEDI-CAT (Original) component of Assessment 3).

Participant Payment and Reimbursement

Caregivers were offered a $50 participant payment for their time and inconvenience participating in Assessment 1, 2a and 3, and a $100 participant payment for Assessment 2b. This was in the form of a gift voucher or donation to their chosen charity, depending on their preference. They were also offered reimbursement for reasonable direct costs incurred (such as public transport and parking).

Participants

Caregivers of a total of 221 young people with an NDC provided consent and sufficient information to enrol in the research project, with 180 during Wave 1 (NDIA invitation letter) and 41 during Wave 2 (advertising). Of those recruited during Wave 1 (NDIA invitation letter), 89 (49%) were randomised to Assessment 2a and 91 (51%) were randomised to Assessment 2b. The families of

172 young people with an NDC proceeded to participate in at least one assessment, with 141 completing Assessment 1 (64 randomised to Assessment 2a and 77 randomised to Assessment 2b, noting that a greater number of participants randomised to Assessment 2a did not complete Assessment 1) and 31 who commenced at Assessment 2b (one Wave 1 participant was unable to attend their Assessment 1 appointment). This resulted in a total of 57 in Assessment 2a, 105 in Assessment 2b and 39 in Assessment 3 (although a 77 participants provided feedback). Families who did not attend any assessments, or completed Assessment 1 but did not progress to Assessment 2a or 2b, either declined to continue with the project, could not be contacted or could not complete the second assessment within specified time frames. Some assessment data were also identified as invalid and excluded during the data checking processes, for example, if the incorrect version of the assessment tool was administered, incorrect date of birth entered at the time of administration or an unacceptable time span between assessments. Characteristics of the young person with an NDC are detailed in Table 1 and Figure 2.

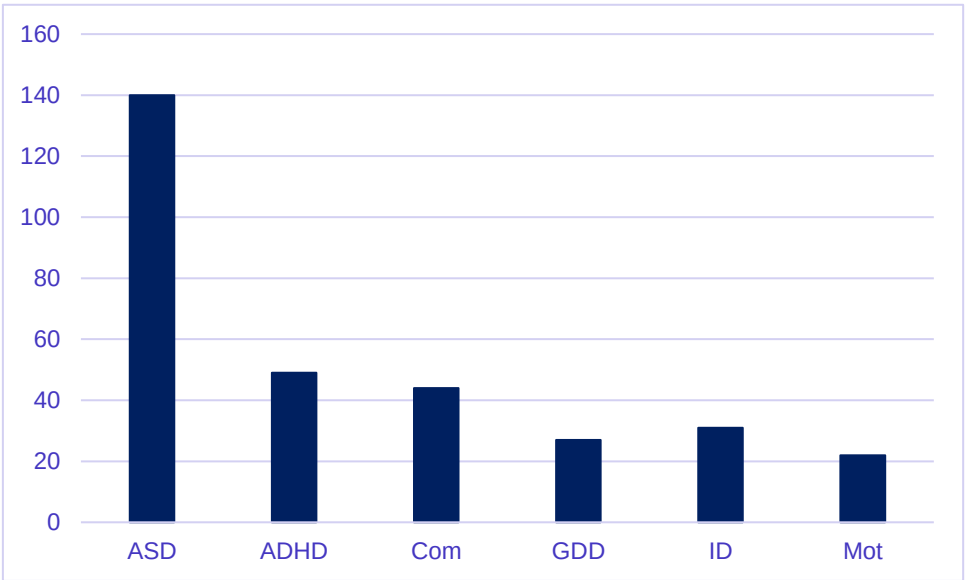
Table 1. Young Person Characteristics Based on Caregiver Report

	Assessment 1 *n* = 141		**Assessment 2a *n* = 57**		**Assessment 2b *n* = 105**		**Assessment 3 *n* = 39**	
	n	% of *n*	*n*	% of *n*	*n*	% of *n*	*n*	% of *n*
Gender								
Male	102	72.3	46	80.7	69	65.7	27	69.2
Female	39	27.7	11	19.3	36	34.3	12	30.8
Identifies with specific cultural group								
Yes	18	12.8	10	17.5	12	11.4	3	7.7
No	117	83.0	44	77.2	91	86.7	38	89.7
Missing	6	4.3	3	5.3	2	1.9	1	2.6
Speaks a language other than English at home								
Yes	8	5.7	3	5.3	8	7.6	3	7.7
No	127	90.1	51	89.5	95	90.5	35	89.7
Missing	6	4.3	3	5.3	2	1.9	1	2.6
Aboriginal or Torres Strait Islander person								
Aboriginal person	4	2.8	2	3.5	3	2.9	1	2.6
Neither	131	92.9	52	91.2	100	95.2	38	97.4
Missing	6	4.3	3	5.3	2	1.9		
Diagnosis of autism								
Yes	119	84.4	48	84.2	82	78.1	23	59.0
No	22	15.6	9	15.8	23	21.9	16	41.0

Diagnosis of intellectual disability								
Yes	31	22.0	11	19.3	27	25.7	12	30.8
No	110	78.0	46	80.7	78	74.3	27	69.2
Reported condition results in fluctuating functioning								
Yes	14	9.9	4	7.0	17	16.2	7	17.9
No	126	89.4	53	93.0	87	82.9	32	82.1
Missing	1	0.7			1	1.0		
Presence of co-occurring condition								
Yes	89	63.1	36	63.2	67	63.8	27	69.2
No	52	36.9	21	36.8	38	36.2	12	30.8
Number of NDC diagnoses								
Mean (*SD*)	2.23 (1.45)		2.28 (1.56)		2.11 (1.33)		1.92 (0.96)	
Range	1 – 8		1 – 8		0 – 8		0 – 5	
Age in years								
Mean (*SD*)	8.80 (3.50)		8.36 (3.38)		10.00 (4.03)		10.08 (4.48)	
Range	3.47 – 18.52		3.47 – 16.57		3.41 – 19.42		3.41 – 18.93	

Note. Some variables may add to up to >100% due to rounding to 1 decimal place.

Figure 2. Number of Young People Reporting each Disability



Note. Young people may be associated with more than one of the following disability types: Autism Spectrum Disorder (ASD); Attention Deficit Hyperactivity Disorder (ADHD); Communication Disorder (Com); Global Developmental Delay (GDD); Intellectual Disability (ID); Motor Disorder (Mot).

In total, 139 young people (80.8%) were reported to have an autism diagnosis. Of these, 122 were reported to have a DSM-5 diagnosis of ASD, while other young people were described as having a DSM-IV diagnosis, such as autistic disorder (*n* = 13), Asperger's syndrome (*n* = 12) or pervasive developmental disorder – not otherwise specified (*n* = 6). For those with a DSM-5 diagnosis, information on severity levels was provided in 111 cases (see Table 2).

Table 2. Young Person Characteristics: DSM-5 Severity Levels for 111 Young People with an ASD Diagnosis

	Assessment 1 ***n* = 95**		**Assessment 2a** ***n* = 39**		**Assessment 2b** ***n* = 66**		**Assessment 3** ***n* = 20**	
	n	%	*n*	%	*n*	%	*n*	%
Social Communication								
Level 1 *(Requiring support)*	36	37.9	13	33.3	24	36.4	6	30.0
Level 2 *(Requiring substantial support)*	40	42.1	18	46.2	33	50.0	13	65.0
Level 3 *(Requiring very substantial support)*	19	20.0	8	20.5	9	13.6	1	5.0
Restricted, Repetitive Behaviours								
Level 1 (Requiring support)	40	42.1	12	30.8	32	48.5	8	40.0
Level 2 *(Requiring substantial support)*	45	47.4	25	64.1	27	40.9	12	60.0
Level 3 *(Requiring very substantial support)*	10	10.5	12	5.1	7	10.6	0	0.0

Information was provided by one caregiver in 144 cases and two caregivers in 28 cases, totaling 200 caregivers involved in the research project. Descriptive information was available for 174 caregivers of 166 young people, detailed in Table 3.

Table 3. Caregiver Characteristics

	Caregiver *n* = 174	**Frequency** %
Relationship[#]		
Biological parent	170	97.7
Adoptive parent	2	1.1
Grandparent	1	0.6
Other	1	0.6
Gender		
Male	16	9.2
Female	158	90.8

Identifies with specific cultural group		
Yes	32	18.4
No	142	81.6
Speaks a language other than English at home		
Yes	36	20.7
No	138	79.3
Aboriginal or Torres Strait Islander person		
Aboriginal person	2	1.1
Neither	172	98.9
Age in years		
Mean (*SD*)	41.81 (7.08)	
Range	26.57 – 67.28	

[#]A step-parent also provided information during the assessments, however demographic details were not available.

The socio-economic status of participants was estimated using the Australian Bureau of Statistics Socio-Economic Indexes for Areas (SEIFA; Australian Bureau of Statistics, 2016), in particular the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD). The IRSAD ranks each area in Australia according to relative advantage and disadvantage, on the basis of a range of census variables (such as income, employment, education, family structure, housing, car ownership, internet connection and disability status). Higher scores indicate greater relative advantage and lack of disadvantage in economic and social conditions. The socio-economic status of families was determined using IRSAD, whereby their postcodes were assigned a decile rank. The median IRSAD decile was 8 (range = 1 – 10), suggesting that the participants mainly lived in areas where the average socio-economic characteristics were associated with high socio-economic advantage and low socio-economic disadvantage. Postcodes also allowed for categorisation of remoteness (Australian Bureau of Statistics, 2016). The majority of participants (89%) resided in Major Cities in Australia, with 7% living in Inner Regional Australia and 4% in Outer Regional Australia.

Data Management

All data were stored and managed through a secure web application, REDCap (Harris et al., 2019; Harris et al., 2009). During the assessments, PEDI-CAT data were collected via the PEDI-CAT program installed on the assessor's password protected laptop and Vineland-3 data were collected through the Q-global online platform. Reports from these assessments were generated and the resulting scores were entered into REDCap. Paper versions of the assessments were used as back-up where internet access was restricted. Audio and video recordings and scanned documents were obtained through a password protected mobile telephone and uploaded to the secure Telethon Kids Institute server in a password protected folder. Paper-based documents were

secured in lockable cabinets. All data were entered into REDCap or onto the Telethon Kids Institute server within 24 hours of the assessment, where possible. Participants were allocated a research identification number to allow the confidential linking of REDCap databases and deidentification of data prior to analysis. Data will be retained for 7 years after project completion or until the young person reaches 25 years of age (whichever is the latter) before being destroyed. This is in accordance with the Western Australian University Sector Disposal Authority (*SD*2011011).

Systematic data checking audits were conducted for data quality assurance. Source data (ID number and date of birth) across all REDCap databases were checked for all cases. PEDI-CAT and Vineland-3 data were checked for all participants to ensure: 1) the appropriate report was generated and uploaded to the correct record, 2) administration details were valid, and 3) assessment scores were accurately entered into REDCap. Discrepancies identified during the auditing process were investigated and edits recorded in REDCap.

Data Analysis

Statistical analyses were conducted using R, an integrated suite of software facilities that provides a language and environment for data manipulation, statistical computing and graphical display (The R Foundation, n.d.). Along with reporting the statistical values, the findings are presented using descriptors associated with the magnitude of the statistical value. These descriptors vary across psychometric properties, and are explained in the following section and below the result tables. The main report includes the findings relevant to the PEDI-CAT (ASD) for the full NDCs sample, with findings related to the Vineland-3 contained within Appendix D. In addition, findings for all analyses are replicated for the sub-sample of young people with an ASD diagnosis (Appendix E) and selected analyses findings for young people by various disability are located in Appendix F and age sub-samples in Appendix G (note that age related results are described in the following groups: 3-5 years, 6-10 years and 11-16 years, as there were no participants aged 0-2 years and too few participants aged 17-20 years).

Internal Consistency

Internal consistency is a type of reliability where the homogeneity of assessment items is established (Portney & Watkins, 2009). McDonald's Omega (ω) was used to calculate the internal consistency coefficients of the items included in the PEDI-CAT (ASD) domains (McDonald, 1999). The McDonald's Omega was chosen over the more frequently used Cronbach's Alpha, as the

PEDI-CAT (ASD) was developed using Item Response Theory and uses software algorithms to select items to be administered from hierarchically structured item pools (Haley et al., 2017, 2019), and did not meet the assumptions necessary for coefficient alpha (Dunn, Baguley, & Brunsden, 2014). The magnitude of the internal consistency coefficient is described according to the following categories (Cicchetti, 1994):

- Below .70 = unacceptable (pink)
- Between .70 to .79 = fair (orange)
- Between .80 to .89 = good (light green)
- Above .90 = excellent (dark green).

Alternate Forms Reliability

Alternate forms reliability is concerned with determining the equivalence of two or more versions of an assessment (Portney & Watkins, 2009). Alternative forms reliability was explored through calculating correlation coefficients (Pearson's *r*, 2-tailed), paired t-tests and limits of agreement to compare research composite and domain scores between the PEDI-CAT (ASD) in Assessment 2 and the PEDI-CAT (Original) in Assessment 3 (Portney & Watkins, 2009). Agreement was also explored through comparing if classifications remained consistent within the same category when administered via the two versions of the PEDI-CAT. The magnitude of the correlation coefficient is described according to the following categories (Portney & Watkins, 2009):

- Below .50 = poor (pink)
- Between .50 to .75 = moderate (orange)
- Above .75 = good (green, this also represents non-significant t-values).

Test-Retest Reliability

Test-retest reliability is a type of reliability associated with the consistency of measurement during repeated administration of an assessment where the testing conditions remain as constant as possible (Portney & Watkins, 2009). Intraclass correlation coefficients (ICC) were calculated to compare PEDI-CAT (ASD) research composite and domain scores between Assessment 1 and each of Assessment 2a and Assessment 2b separately and combined. ICC estimates were based on single-measures (type), absolute-agreement (definition) and a two-way mixed effects model (Koo & Li, 2016). The magnitude of the ICC is described according to the following categories,

where the lower bound confidence interval (CI) is referenced as the beginning range of the reliability (Koo, 2016):

- Below .50 = poor (pink)
- Between .50 to .75 = moderate (orange)
- Between .75 to .90 = good (light green)
- Above .90 = excellent (dark green).

Concurrent Validity

Concurrent validity refers to the extent that two assessments measuring the same concept and administered at relatively the same time are correlated, particularly when one of the assessment tools is considered to be the gold standard (Portney & Watkins, 2009). Concurrent validity was evaluated through calculating correlation coefficients (Pearson's *r*, 2-tailed) between (research) composites and domains of the PEDI-CAT (ASD) (Assessments 1 and 2b) and Vineland-3 (*Parent/Caregiver Form* in Assessment 1 and *Interview Form* in Assessment 2b). The magnitude of the correlation coefficient is described according to the following categories (Portney & Watkins, 2009):

- Below .50 = poor (pink)
- Between .50 to .75 = moderate (orange)
- Above .75 = good (green)

In addition, agreement was also explored for Assessment 1 relationships between the PEDI-CAT (ASD) and Vineland-3 *Parent/Caregiver Form* where, conceptually, a high level of agreement would be expected to determine if classifications of functioning remained consistent within the same category. This involved the creation of contingency tables and calculation of agreement rates.

Applicability

Applicability within this project is defined as the capacity for an assessment tool to determine an individual's impairment level. This was evaluated through calculating the proportion of cases that were below a series of thresholds, as defined by the 'manual' and 'NDIA' categories outlined in the 'Assessment Tools' section.

Caregiver Acceptability

Caregiver qualitative responses were initially coded in Nvivo, then thematically analysed to identify common ideas present in the data (DePoy & Gitlin, 2015). Steps were taken to differentiate comments that related to the assessment process in general from comments about a specific tool. Emerging themes and sub-themes were repeatedly reviewed and modified throughout the analysis process as new information was revealed. Two additional members of the research team were consulted to discuss and confirm the findings.

Method 2 – Clinician Workshops

Data Collection Procedures

Workshops were selected as a data collection method due to their ability to elicit various viewpoints and opinions in a single sitting and the ability for participants to develop ideas based on feedback from others within the group (Lysack, Luborsky & Dillaway, 2006).

Recruitment

Participants in the workshops were individuals with medical or allied health qualifications who had experience in assessing individuals with NDCs. Four face-to-face workshops were held in four major cities (Brisbane, Melbourne, Perth and Sydney) and two online (videoconference) workshops were conducted. A self-directed REDCap survey version of the workshop was also offered, where clinicians could individually complete the questions at their own pace after reviewing embedded written and video information about the assessment tools. This variety of data collection methods were selected to ensure the attendance of as many participants as possible. The workshops were promoted through the Autism CRC mailing lists and the researchers' networks. Before attending a workshop, participants were required to read the Participant Information Sheet, consent to participate in the study and answer a short online survey. The survey included demographic questions including age, gender, profession, education, years of experience and postcode. In addition, questions regarding the participants' familiarity with the relevant assessment tools were asked. A potential participant's eligibility was determined according to their survey answers. The socio-economic status of participants was estimated using the Australian Bureau of Statistics SEIFA (Australian Bureau of Statistics, 2016). SEIFA consists of four indexes:

1. The Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD) – Ranks each area in Australia according to relative advantage and disadvantage, on the basis of a range of census variables (such as income, employment, education, family structure, housing, car ownership, internet connection and disability status). Higher scores indicate greater relative advantage and lack of disadvantage in economic and social conditions.
2. The Index of Relative Socio-Economic Disadvantage (IRSD) – Similar to IRSAD, however it only measures relative disadvantage.
3. The Index of Education and Occupation (IEO) – Reflects the education (level of qualification or further education being undertaken) and occupational level (unemployment or workforce classification according to the Australian and New Zealand Standard Classification of Occupations) of communities. Higher scores indicates relatively higher education and occupation status of people in the area in general.
4. The Index of Economic Resources (IER) – Focuses on the financial aspect of relative socio-economic advantage and disadvantage, summarising variable directly related to income and wealth. Higher scores indicates relatively greater access to economic resources in general.

Session Structure and Content

Workshops commenced with a presentation by the researchers covering the research objectives and an introduction to the PEDI-CAT (Original and ASD) and Vineland-3, including published psychometric properties, domains/sub-domains, administration process and screen captures. Copies of relevant assessment resources (e.g. forms, manual, sample reports) were available for participants to view during the workshops. Workshops were semi-structured and guided by a multidimensional model of clinical utility (Smart, 2006), with each assessment tool evaluated on the four components and 10 aspects of clinical utility (Table 4). While prompt questions were provided, participants were encouraged to elaborate and discuss other topics relevant to the clinical utility of assessment of functioning tools in general as well as the specific tools being evaluated. Notes were taken during the workshops by participants and facilitators (including hand written notes, Google Docs and online REDCap responses), and where participants had consented, the workshop discussions were audio recorded. These audio recordings were transcribed.

Table 4. Multidimensional Model of Clinical Utility Question Guide

Component	Aspect	Prompt questions
Appropriate	Effective	How effective is the [assessment] in the assessment of functioning for individuals on the autism spectrum? What type of information would you use to determine the effectiveness of the [assessment]?
	Relevant	How relevant is the [assessment] to your area of clinical practice? Why?
Accessible	Resource Implications	How cost-effective is it to use the [assessment] in clinical practice (taking into account direct assessment costs and clinician time)?
	Procurement	How easy is it to obtain the resources needed to use the [assessment] in clinical practice?
Practicable	Functional	Does the [assessment] come with the complete materials and information required to use it?
	Suitable	Is the [assessment] suitable to complete in a clinical practice setting?
	Training or Knowledge	What training or knowledge acquisition would be required to use the [assessment] in clinical practice?
Acceptable	To Clinicians	How acceptable do you find the [assessment] when considering your values and ethics?
	To Clients (including families/carers)	How acceptable do you think individuals on the autism spectrum and their families would find the [assessment]?
	To Society (public or stakeholder groups)	How acceptable do you think the general community would find the [assessment]?

Participant Payment and Reimbursement

Clinicians were offered a $50 participant payment for their time and inconvenience participating in the workshop. This was in the form of a gift voucher or donation to their chosen charity, depending on their preference. They were also offered reimbursement for reasonable direct costs incurred (such as public transport and parking).

Participants

In total, 55 clinicians attended the five workshops, with characteristics detailed in Table 5.

Table 5. Clinician Characteristics

	Median (range)	**Clinicians** *n* = 55	**Frequency** %
Gender			
Female		49	89
Male		6	11
Age (years)	44 (23-72)		
Profession			
General practitioner		3	5
Occupational therapist		19	35
Psychologist		14	25
Paediatrician		8	15
Speech pathologist		6	11
Other (psychiatrist, physiotherapist, education professional, "assessment coordinator – ASD" and "autism research – assessments")		5	9
Experience Assessing Individuals on the Autism Spectrum (years)	10 (1-40)		
State			
Australian Capital Territory		1	2
New South Wales		13	24
Northern Territory		1	2
Queensland		5	9
South Australia		1	2
Tasmania		2	4
Victoria		12	22
Western Australia		19	35
SEIFA (IRSD decile)	8th (1st-10th)		
SEIFA (IRSAD decile)	9th (1st-10th)		
SEIFA (IER decile)	6th (1st-10th)		
SEIFA (IEO decile)	9th (1st-10th)		

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Familiarity with PEDI-CAT/PEDI-CAT (ASD)			
Use frequently		3	6
Use occasionally		6	11
Don't use, but am familiar		17	31
Don't use, not familiar		28	52
Familiarity with the Vineland-3 (or earlier versions)			
Use frequently		15	28
Use occasionally		13	24
Don't use, but am familiar		13	24
Don't use, not familiar		13	24

Data Management

Demographic data and consent were collected through the secure online event management software SplashThat, and survey platform REDCap. During the workshops, discussions were recorded through hand-written notes, Google Docs, REDCap surveys and audio files on a password protected mobile telephone. Scanned copies of hand-written notes and audio recordings were uploaded to the secure Telethon Kids Institute server in a password protected folder. Typed summaries and transcripts of the workshops were prepared through reviewing the hand-written notes and audio recordings, and data were deidentified prior to analysis. Data will be retained for 7 years after project completion before being destroyed. This is in accordance with the Western Australian University Sector Disposal Authority (*SD*2011011).

Data Analysis

Clinical Utility

Framework analysis (Ritchie & Spencer, 2002) was used to explore qualitative responses in relation to perceived advantages and disadvantages of the assessment of functioning tools. Notes taken during the workshops were used to create a framework within the Multi-dimensional Model of Clinical Utility (Smart, 2006). Transcripts of audio recordings and notes written by participants using online formats were then reviewed to confirm and expand upon the themes and extract quotes.

Findings

Reliability

Internal Consistency

Objective 1.1: Determine the internal consistency of the PEDI-CAT (ASD).

Internal consistency (Table 6) of the PEDI-CAT (ASD) was established through calculating McDonald's Omega (ω) and CIs using the raw data from 132 PEDI-CAT (ASD) assessments administered during Assessment 1. Results indicate that the PEDI-CAT (ASD) has good to excellent internal consistency.

Table 6. Internal Consistency Results for the PEDI-CAT (ASD) Domains for the Full NDC Sample

Domain	Sample Size	No. Items	McDonald's Omega	Lower CI	Upper CI	Standard Error	Mean#	Standard Deviation#
Daily Activities	132	9	0.91	0.88	0.93	0.01	2.94	1.07
Mobility	132	16	0.89	0.84	0.92	0.02	3.36	0.94
Social/Cognitive	132	12	0.89	0.86	0.92	0.01	2.34	1.03
Responsibility	132	16	0.92	0.89	0.94	0.01	1.64	0.90

Note. Between .80 to .89 = good (light green); Above .90 = excellent (dark green).

Alternate Forms Reliability

Objective 1.2: Determine the alternate forms reliability of the PEDI-CAT (ASD) with the PEDI-CAT (Original).

Alternate forms reliability between the PEDI-CAT (ASD) and the PEDI-CAT (Original) was explored statistically (Table 7) using 39 completed assessments during Assessment 2 and Assessment 3 (mean = 21 days later). All correlation coefficients were statistically significant and classified as 'good', ranging from 0.85 – 0.96. Results from t-tests showed no statistically significant difference in means for the Daily Activities, Mobility or Responsibility domains. However, the mean research composite and Social/Cognitive domain scores were significantly lower when measured with the

PEDI-CAT (Original), indicating that this version specifies a greater level of impairment than the PEDI-CAT (ASD). These two domains also had the greatest mean difference between scores. Limits of agreement showed a relatively wide range of differences between scores, in particular for the Mobility and Social/Cognitive domains where the range exceeded two standard deviations on the norm-referenced scale. Scatter and Bland-Altman plots (Figure 3) visually demonstrate a relationship and the absence of a systematic bias in measurement error between the two versions.

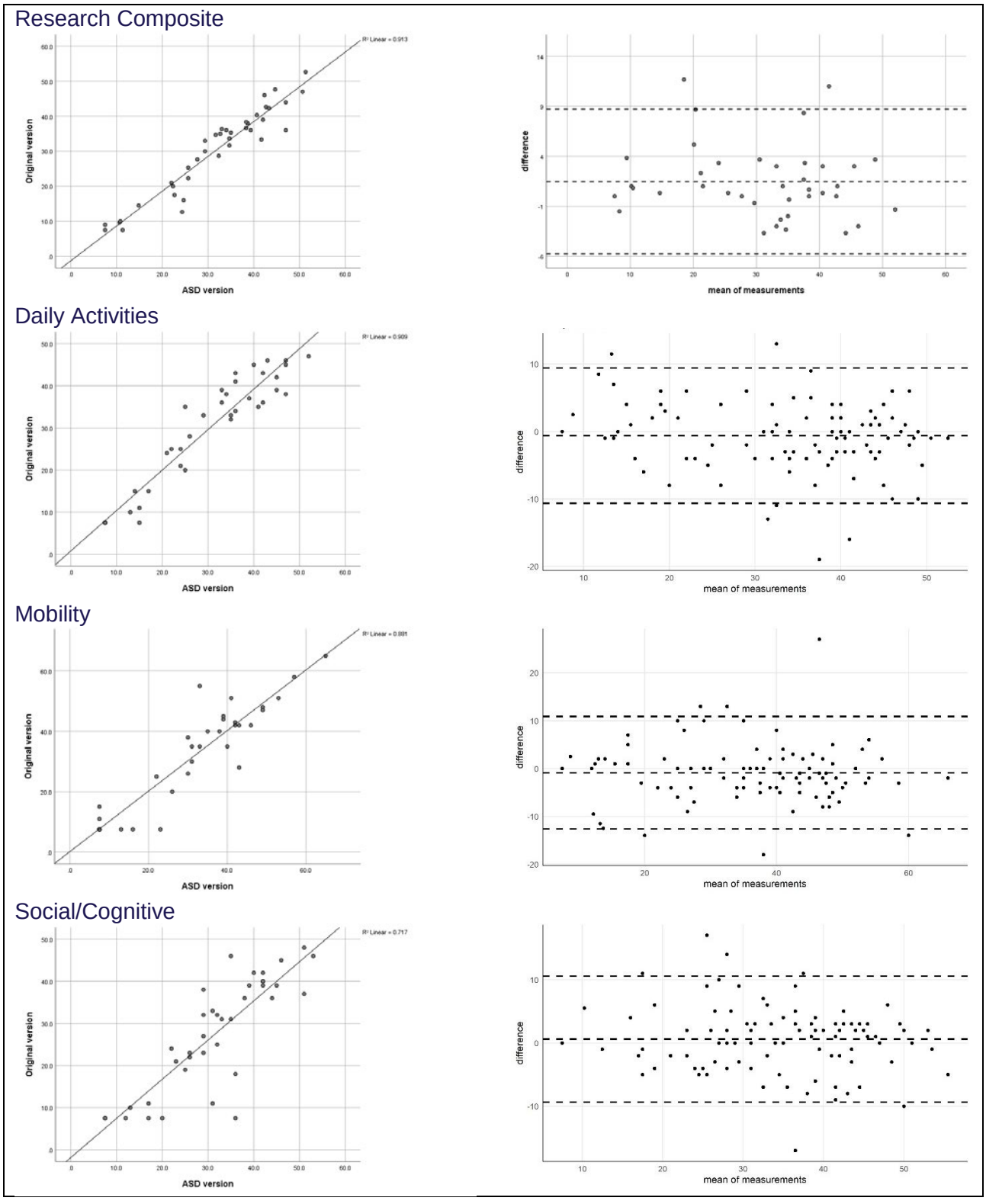
Further analyses investigated whether impairment classifications remained consistent within the same category when administered via the two versions of the PEDI-CAT. These data are presented in Tables 8-17 and levels of agreement are summarised across domains. There was 72-85% agreement in assigning categories according to the manual (Tables 8-12), with 5-13% with a lower level of functioning according to the PEDI-CAT (ASD) and 8-21% with a lower level of functioning according to PEDI-CAT (Original). When the results were compared using the larger number of categories suggested by the NDIA (Tables 13-17), there was 72-79% agreement in assigning categories, with 8-13% with a lower level of functioning according to the PEDI-CAT (ASD) and 8-21% with a lower level of functioning according to PEDI-CAT (Original).

Table 7. Pearson Correlations, Paired T-Tests and Limits of Agreement between the PEDI-CAT (ASD) and PEDI-CAT (Original) for the Full NDC Sample

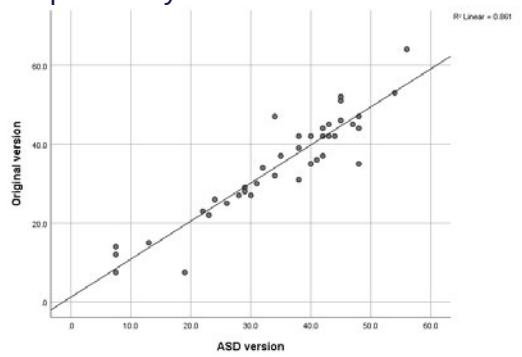
		Pearson Correlations	Dependent T-Tests (Paired Samples)			95% Limits of Agreement (LOA)		
Domain	***n***	***R***	**T-Value**	**Mean ASD**	**Mean Original**	**Mean Difference**	**Lower LOA**	**Upper LOA**
Research Composite	39	0.96**	2.49*	31.60	30.13	1.47	-5.77	8.71
Daily Activities	39	0.95**	0.51	28.79	28.45	0.35	-7.91	8.60
Mobility	39	0.94**	-0.24	28.18	28.42	-0.24	-12.59	12.10
Social/Cognitive	39	0.85**	3.47**	31.17	27.14	4.03	-10.15	18.21
Responsibility	39	0.93**	0.05	34.83	34.79	0.04	-9.49	9.56

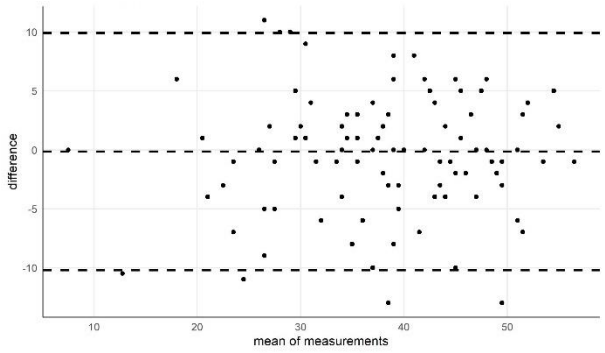
**Correlation is significant at the 0.01 level (2-tailed).
Note. Above .75 , indicates 'good' agreement (green) between the PEDI-CAT and PEDI-CAT (ASD); Non-significant t-values indicate no difference, denoting good agreement between the PEDI-CAT and PEDI-CAT (ASD) (green).

Figure 3. Correlation Scatter Plots (Left) and Bland-Altman Plot with 95% Limits of Agreement (Right) between the PEDI-CAT (ASD) and PEDI-CAT (Original) for the Full NDC Sample



Responsibility





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Tables 8-17. Classification Comparison between the PEDI-CAT (Original) and PEDI-CAT (ASD) for the Full NDC Sample - Various Domains According to the Categories Described in the Manual (Left) and the Categories Used by the NDIA (Right)

Table 8. PEDI-CAT Research Composite – Manual Categories

		Original Version					
		Above Normal	Normal High	Normal	Normal Low	Below Normal	Total
ASD Version	Above Normal	0	0	0	0	0	0
	Normal High	0	0	0	0	0	0
	Normal	0	0	8	3	0	11
	Normal Low	0	0	0	11	1	12
	Below Normal	0	0	0	2	14	16
	Total	0	0	8	16	15	39

Note. 85% = Consistent Categories; 5% = Inconsistent Categories - Lower level of functioning according to ASD version; 10% = Inconsistent Categories - Lower level of functioning according to Original version.

Table 9. PEDI-CAT Daily Activities Domain – Manual Categories

		Original Version					
		Above Normal	Normal High	Normal	Normal Low	Below Normal	Total
ASD Version	Above Normal	0	0	0	0	0	0
	Normal High	0	0	0	0	0	0
	Normal	0	0	6	4	0	10
	Normal Low	0	0	3	7	0	10
	Below Normal	0	0	0	2	17	19
	Total	0	0	9	13	17	39

Note. 77% = Consistent Categories; 13% = Inconsistent Categories - Lower level of functioning according to ASD version; 10% = Inconsistent Categories - Lower level of functioning according to Original version.

Table 13. PEDI-CAT Research Composite – NDIA Categories

		Original Version					
		Above 1.49 *SD* Below	1.50-1.99 *SD* Below	2.00-2.49 *SD* Below	2.50-2.99 *SD* Below	3 *SD* Below or Less	Total
ASD Version	Above 1.49 *SD* Below	14	1	0	0	0	15
	1.50-1.99 *SD* Below	3	4	1	0	0	8
	2.00-2.49 *SD* Below	0	1	3	1	0	5
	2.50-2.99 *SD* Below	0	0	0	1	4	5
	3 *SD* Below or Less	0	0	0	0	6	6
	Total	17	6	4	2	10	39

Note. 72% = Consistent Categories; 10% = Inconsistent Categories - Lower level of functioning according to ASD version; 18% = Inconsistent Categories - Lower level of functioning according to Original version.

Table 14. PEDI-CAT Daily Activities Domain – NDIA Categories

		Original Version					
		Above 1.49 *SD* Below	1.50-1.99 *SD* Below	2.00-2.49 *SD* Below	2.50-2.99 *SD* Below	3 *SD* Below or Less	Total
ASD Version	Above 1.49 *SD* Below	13	2	0	0	0	15
	1.50-1.99 *SD* Below	3	2	0	0	0	5
	2.00-2.49 *SD* Below	0	1	1	0	0	2
	2.50-2.99 *SD* Below	0	1	0	4	1	6
	3 *SD* Below or Less	0	0	0	0	11	11
	Total	16	6	1	4	12	39

Note. 79% = Consistent Categories; 13% = Inconsistent Categories - Lower level of functioning according to ASD version; 8% = Inconsistent Categories - Lower level of functioning according to Original version.

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Table 10. PEDI-CAT Mobility Domain – Manual Categories

		Original Version					
		Above Normal	Normal High	Normal	Normal Low	Below Normal	Total
ASD Version	Above Normal	0	0	0	0	0	0
	Normal High	0	1	0	0	0	1
	Normal	0	0	9	1	1	11
	Normal Low	0	0	5	4	1	10
	Below Normal	0	0	0	0	17	17
	Total	0	1	14	5	19	39

Note. 79% = Consistent Categories; 13% = Inconsistent Categories - Lower level of functioning according to ASD version; 8% = Inconsistent Categories - Lower level of functioning according to Original version.

Table 11. PEDI-CAT Social/Cognitive domain – Manual Categories

		Original Version					
		Above Normal	Normal High	Normal	Normal Low	Below Normal	Total
ASD Version	Above Normal	0	0	0	0	0	0
	Normal High	0	0	0	0	0	0
	Normal	0	0	7	4	0	11
	Normal Low	0	0	1	6	4	11
	Below Normal	0	0	0	2	15	17
	Total	0	0	8	12	19	39

Note. 72% = Consistent Categories; 8% = Inconsistent Categories - Lower level of functioning according to ASD version; 21% = Inconsistent Categories - Lower level of functioning according to Original version.

Table 15. PEDI-CAT Mobility Domain – NDIA Categories

		Original Version					
		Above 1.49 *SD* Below	1.50-1.99 *SD* Below	2.00-2.49 *SD* Below	2.50-2.99 *SD* Below	3 *SD* Below or Less	Total
ASD Version	Above 1.49 *SD* Below	13	1	1	0	0	15
	1.50-1.99 *SD* Below	2	2	1	0	0	5
	2.00-2.49 *SD* Below	1	0	1	0	1	3
	2.50-2.99 *SD* Below	0	0	0	1	1	2
	3 *SD* Below or Less	0	0	0	0	14	14
	Total	16	3	3	1	16	39

Note. 79% = Consistent Categories; 8% = Inconsistent Categories - Lower level of functioning according to ASD version; 13% = Inconsistent Categories - Lower level of functioning according to Original version.

Table 16. PEDI-CAT Social/Cognitive Domain – NDIA Categories

		Original Version					
		Above 1.49 *SD* Below	1.50-1.99 *SD* Below	2.00-2.49 *SD* Below	2.50-2.99 *SD* Below	3 *SD* Below or Less	Total
ASD Version	Above 1.49 *SD* Below	13	0	0	0	2	15
	1.50-1.99 *SD* Below	1	4	0	1	1	7
	2.00-2.49 *SD* Below	1	1	1	3	0	6
	2.50-2.99 *SD* Below	0	0	0	2	1	3
	3 *SD* Below or Less	0	0	0	0	8	8
	Total	15	5	1	6	12	39

Note. 72% = Consistent Categories; 8% = Inconsistent Categories - Lower level of functioning according to ASD version; 21% = Inconsistent Categories - Lower level of functioning according to Original version.

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Table 12. PEDI-CAT Responsibility Domain – Manual Categories

		Original Version					
		Above Normal	Normal High	Normal	Normal Low	Below Normal	Total
ASD Version	Above Normal	0	0	0	0	0	0
	Normal High	0	0	0	0	0	0
	Normal	0	1	13	4	0	18
	Normal Low	0	0	2	6	1	9
	Below Normal	0	0	0	0	12	12
	Total	0	1	15	10	13	39

Note. 79% = Consistent Categories; 8% = Inconsistent Categories - Lower level of functioning according to ASD version; 13% = Inconsistent Categories - Lower level of functioning according to Original version.

Table 17. PEDI-CAT Responsibility Domain – NDIA Categories

		Original Version					
		Above 1.49 *SD* Below	1.50-1.99 *SD* Below	2.00-2.49 *SD* Below	2.50-2.99 *SD* Below	3 *SD* Below or Less	Total
ASD Version	Above 1.49 *SD* Below	18	3	0	0	0	21
	1.50-1.99 *SD* Below	2	2	1	0	0	5
	2.00-2.49 *SD* Below	0	0	4	1	0	5
	2.50-2.99 *SD* Below	0	0	1	2	0	3
	3 *SD* Below or Less	0	0	0	0	5	5
	Total	20	5	6	3	5	39

Note. 79% = Consistent Categories; 8% = Inconsistent Categories - Lower level of functioning according to ASD version; 13% = Inconsistent Categories - Lower level of functioning according to Original version.

Test-Retest Reliability

Objective 1.3: Determine the test-retest reliability of the PEDI-CAT (ASD).

For the PEDI-CAT (ASD), ICCs were calculated using 45 completed assessments for comparison with Assessment 2a (mean = 19 days later) and 62 completed assessments for comparison with Assessment 2b (mean = 22 days later), resulting in a combined sample of 107 who completed the assessment twice (mean = 20 days apart). Results showed ICC values ranging from .89 to .95, and lower bound CIs commencing at .83, indicating good to excellent test-retest reliability for the included research composite and domain scores (Table 18).

Table 18. Test-Retest Reliability (ICC) for PEDI-CAT (ASD) between Assessment 1 and 2 for the Full NDC Sample

Domain	Pathway	ICC	*n*	Lower Bound	Upper Bound	F Value
Research Composite	2a	0.95 **	45	0.92	0.97	40.47
	2b	0.92 **	62	0.88	0.95	24.59
	Combined	0.94 **	107	0.91	0.96	30.52
Daily Activities	2a	0.95 **	45	0.92	0.97	41.99
	2b	0.90 **	62	0.85	0.94	19.88
	Combined	0.93 **	107	0.89	0.95	26.24
Mobility	2a	0.92 **	45	0.86	0.96	23.82
	2b	0.93 **	62	0.88	0.95	26.12
	Combined	0.92 **	107	0.89	0.95	25.04
Social/Cognitive	2a	0.93 **	45	0.88	0.96	28.37
	2b	0.90 **	62	0.84	0.94	20.76
	Combined	0.92 **	107	0.88	0.94	22.92
Responsibility	2a	0.91 **	45	0.85	0.95	21.72
	2b	0.89 **	62	0.83	0.93	17.11
	Combined	0.90 **	107	0.86	0.93	19.83

**Correlation is significant at the 0.01 level (2-tailed).
Note. Between .75 to .90 = good (light green); Above .90 = excellent (dark green).

Validity

Concurrent Validity

Objective 2.1: Determine the concurrent validity of the PEDI-CAT (ASD), as measured against the Vineland-3 *Parent/Caregiver Form* and Vineland-3 *Interview Form*.

When comparing the PEDI-CAT (ASD) to the Vineland-3 *Parent/Caregiver Form* based on 129 cases from Assessment 1, all but the five correlation coefficients involving the Maladaptive Behavior (Externalizing) domain were statistically significant (Table 19). There were five relationships where the strength was considered good, mostly involving the PEDI-CAT (ASD) research composite or Responsibility domain. Just over half of the relationships were moderate in strength, and approximately one-quarter were considered poorly correlated. When examined using data from 81 Assessment 2b cases where the Vineland-3 *Interview Form* was administered, there are five fewer significant relationships (all involving the Maladaptive Behavior (Internalizing) domain). The correlation coefficients for the Vineland-3 *Interview Form* tend to be weaker, with only two considered good and over two-thirds moderate and a similar proportion of poor correlations (Table 20).

While it is not possible to map the domains of the PEDI-CAT (ASD) directly onto those measured by the Vineland-3, we were able to provide some conceptual alignment between the two assessments (these relationships are bolded in the correlation matrices). These analyses revealed only a moderate level of agreement at the category level. When the results were compared using the categories outlined in the manual (Tables 21-25), there was 42-52% agreement in assigning consistent categories, with 6-21% with a lower level of functioning according to the PEDI-CAT (ASD) and 34-42% with a lower level of functioning according to the Vineland-3 *Parent/Caregiver Form*. When the results were compared using the larger number of categories suggested by the NDIA (Tables 26-30), there was 40-57% agreement in assigning consistent categories, with 16-32% with a lower level of functioning according to the PEDI-CAT (ASD) and 23-33% with a lower level of functioning according to the Vineland-3 *Parent/Caregiver Form*.

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Table 19. Assessment 1 Correlations between PEDI-CAT (ASD) and Vineland-3 (*Parent/Caregiver Form*) for the Full NDC sample

	Vineland-3 (*Parent/Caregiver Form*) Domain						
PEDI-CAT (ASD) Domain	Adaptive Behavior Composite	Communication	Daily Living Skills	Socialization	Motor Skills	Maladaptive Behavior (Internalizing)	Maladaptive Behavior (Externalizing)
Research Composite	**0.76****	0.64**	0.75**	0.72**	0.60**	-0.29**	-0.15
Daily Activities	0.59**	0.47**	**0.61****	0.55**	0.52**	-0.28**	-0.17
Mobility	0.53**	0.39**	0.52**	0.55**	**0.54****	-0.28**	-0.17
Social/Cognitive	0.75**	**0.68****	0.69**	**0.73****	0.63**	-0.24**	-0.10
Responsibility	0.76**	0.61**	**0.78****	0.71**	0.47**	-0.28**	-0.13

**Correlation is significant at the 0.01 level (2-tailed).
Note. Below .50 = poor (pink); Between .50 to .75 = moderate (orange); Above .75 = good (green).
n = 88 for relationships involving the Vineland-3 motor domain; *n* = 123 for relationships involving the Vineland-3 maladaptive scales; *n* = 129 for all other relationships.
Bold font indicates domains with conceptual alignment, where higher correlations were expected.

Table 20. Assessment 2b Correlations between PEDI-CAT (ASD) and Vineland-3 (*Interview Form*) for the Full NDC Sample

	Vineland-3 (*Interview Form*) Domain						
PEDI-CAT (ASD) Domain	Adaptive Behavior Composite	Communication	Daily Living Skills	Socialization	Motor Skills	Maladaptive Behavior (Internalizing)	Maladaptive Behavior (Externalizing)
Research Composite	**.78****	.74**	.71**	.60**	.53**	0.13	0.13
Daily Activities	.64**	.60**	**.64****	.43**	.58**	0.15	0.14
Mobility	.52**	.45**	.51**	.39**	**.44****	0.02	0.04
Social/Cognitive	.73**	**.71****	.60**	**.61****	.48**	0.16	0.10
Responsibility	.79**	.72**	**.72****	.62**	.37*	0.04	0.12

**Correlation is significant at the 0.01 level (2-tailed); * Correlation is significant at the 0.05 level (2-tailed).
Note. Below .50 = poor (pink); Between .50 to .75 = moderate (orange); Above .75 = good (green).
n = 43 for relationships involving the Vineland-3 motor domain; *n* = 80 for relationships involving the Vineland-3 maladaptive scales; *n* = 81 for all other relationships.
Bold font indicates domains with conceptual alignment, where higher correlations were expected.

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While it is not possible to map the domains of the PEDI-CAT (ASD) directly onto those measured by the Vineland-3, there is a degree of conceptual alignment with the subscales between assessments. The scales showing some conceptual alignment between tests are presented in Tables 31-35. These analyses revealed only a moderate level of agreement at the category level. When the results were compared using the categories outlined in the manual (Tables 31-35), there was 42-52% agreement in assigning consistent categories, with 6-21% with a lower level of functioning according to the PEDI-CAT (ASD) and 34-42% with a lower level of functioning according to the Vineland-3 *Parent/Caregiver Form*. When the results were compared using the larger number of categories suggested by the NDIA (Tables 36-40), there was 40-57% agreement in assigning consistent categories, with 16-32% with a lower level of functioning according to the PEDI-CAT (ASD) and 23-33% with a lower level of functioning according to the Vineland-3 *Parent/Caregiver Form*.