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Silva, Mônia Aparecida da; Mendonça, Euclides José de; Bandeira, Denise Ruschel
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Development of the Dimensional Inventory of Child Development Assessment (IDADI)

Mônia Aparecida da Silva^{1, 2, 3}

Euclides José de Mendonça Filho^{1, 2}

Denise Ruschel Bandeira^{1, 2}

¹Universidade Federal do Rio Grande do Sul, Porto Alegre, RS

²Grupo de Estudo, Aplicação e Pesquisa em Avaliação Psicológica (GEAPAP), Porto Alegre, RS

³Universidade Federal de São João del-Rei, São João del-Rei, MG

Abstract

Child development is complex and includes multiple domains, such as cognition, communication and language, motor skills, socialization, and emotional development. The objective of this paper was to present the development process of the Dimensional Inventory of Child Development Assessment (IDADI) and evidence of its content validity. IDADI was conceived to assess child development of children from zero to 72 months of age through parental reports covering Cognitive, Motor (Gross and Fine), Communication and Language (Receptive and Expressive), Socioemotional and Adaptive Behavior domains. The development process involved: description of the theoretical foundation; development of the preliminary version of the instrument; expert item analysis; semantic analysis of the items by the target population; and a pilot study. The initial item pool had 2,365 items and the final version consisted of 524, after exclusions, modifications and additions. The stages of development led to changes in most of the items. This process is considered to have ensured IDADI's content validity. Thus, it is believed that IDADI will contribute to child development assessment in Brazil in clinical and research contexts.

Keywords: child development; assessment; test development

Construção do Inventário Dimensional de Avaliação do Desenvolvimento Infantil (IDADI)

Resumo

O desenvolvimento infantil é complexo e compreende múltiplos domínios, como cognição, comunicação e linguagem, motricidade, socialização e desenvolvimento emocional. O objetivo desse artigo foi apresentar o processo de construção do Inventário Dimensional de Avaliação do Desenvolvimento Infantil (IDADI) e suas evidências de validade de conteúdo. O IDADI foi elaborado para avaliar o desenvolvimento infantil de zero até 72 meses de idade por meio do relato parental, abrangendo os domínios Cognitivo, Motricidade (Ampla e Fina), Comunicação e Linguagem (Receptiva e Expressiva), Socioemocional e Comportamento Adaptativo. O processo envolveu: fundamentação teórica; construção da versão preliminar; análise dos itens por juízes especialistas; análise semântica dos itens pela população-alvo; e estudo piloto. Partiu-se de um *pool* de 2.365 itens, chegando-se a uma versão de 524 após exclusões, modificações e inserções de itens. As etapas da construção determinaram mudanças em grande parte dos itens. Considera-se que esse processo garantiu a validade de conteúdo do instrumento. Espera-se que o IDADI contribua à área de avaliação do desenvolvimento infantil no Brasil, tanto no contexto da pesquisa como na clínica.

Palavras-chave: desenvolvimento infantil, avaliação, construção de teste

Construcción del Inventario Dimensional de Evaluación del Desarrollo Infantil (IDADI)

Resumen

El desarrollo infantil es complejo y comprende múltiples dominios, como cognición, comunicación y lenguaje, motricidad, socialización y desarrollo emocional. El objetivo de este artículo fue presentar el proceso de construcción del Inventario Dimensional de la Evaluación del Desarrollo Infantil (IDADI) y sus evidencias de validez de contenido. IDADI fue concebido para evaluar el desarrollo infantil de cero hasta 72 meses de edad a través del informe parental, englobando los dominios Cognitivo, Motor (Grueso y Fino), Comunicación y Lenguaje (Receptivo y Expresivo), Socioemocional y Comportamiento Adaptativo. El proceso englobó fundamentación teórica; desarrollo de la versión preliminar del instrumento; análisis de los ítems por expertos; análisis semántico de los ítems por la población-objetivo; y estudio piloto. El grupo inicial de ítems tenía 2.365 ítems y la versión final consistía en 524, después de exclusiones, modificaciones y adiciones. Las etapas de desarrollo determinaron cambios en la mayoría de los ítems. Se considera que este proceso ha asegurado la validez del contenido del IDADI. Esperamos que IDADI pueda contribuir a la evaluación del desarrollo infantil en Brasil en contextos clínicos y de investigación.

Palabras-clave: desarrollo infantil; evaluación; construcción de prueba

Introduction

Child development is currently understood from a dialectic perspective that emphasizes the

interconnection of the individual and context (Lerner, Liben, & Mueller, 2015; Sameroff, 2010). On an individual level, child development is a dynamic and complex process that involves continuous progress

with variations in the sequence and time with which a typical milestone is achieved (Sabanathan, Wills, & Gladstone, 2015; Thomas, Cotton, Pan, & Ratliff-Schaub, 2012). Normally, children are expected to reach developmental milestones at a certain time interval. A child who takes significantly longer than average to achieve a given milestone is considered to present a developmental delay. In this sense, developmental delay is always determined in comparison to the normative development of a given population (Fernald, Marchman, & Weisleder, 2013).

The prevalence of children with developmental delays in one or more domains reported by international studies ranges from 16% to 18%, but less than one third of these delays are detected by healthcare workers (Brothers, Glasgoe, & Robertshaw, 2008). Healthcare workers detect approximately 30% of children with developmental delays before entering school and, in general, those with more severe delays. Subdiagnosis or late identification of such delays occurs partly because there is a lack of early assessment or appropriate instruments to screen for such conditions (Thomas et al., 2012).

The assessment of children's developmental skills is widely recommended as an important preventive measure that enables the identification of developmental delays and, consequently, the implementation of early interventions (Sabanathan et al., 2015). The lack of formal assessment instruments with appropriate validity and reliability evidence diminishes the precise identification of developmental deficits (Bellman, Byrne, & Sege, 2013).

Reviewing the main theories and international gold-standard instruments available in the field, we verified that the dimensions most frequently considered in multidimensional instruments assessing child development are: Cognition; Performance and Practical Reasoning; Communication; Expressive and Receptive Language; Gross and Fine Motor Skills; Socialization; Affection and Emotion; and Daily Living Skills or Adaptive Behavior (Bayley, 2018; Filgueiras Pires, Maissonette, e Landeira-Fernandez, 2013; Newborg, 2005; Sparrow, Cicchetti, & Saulnier, 2016; Squires, Twombly, & Bricke, 2009). In general, each dimension is based on more than one child development theory, being influenced by indicators validated empirically in the clinical practice of those professionals involved in the development of instruments. For example, the domains that comprise cognitive development are influenced by Piaget's constructive theories (Piaget, 1952), information processing (Arsalidou & Pascual-Leone, 2016; Cohen

& Cashon, 2006) and executive functions (Diamond, 2013), among others. The domains that involve socialization, affective and emotional development are based on attachment theories (Bowlby, 1989), theory of mind (Astington & Gopnik, 1991), theory of socioemotional growth (Greenspan & Lewis, 2009), emotional regulation (Cole, Margaret & Teti, 1994) and joint attention (Tomasello, Carpenter, Call, Behne, & Moll, 2005). The domains related to motor skills are generally grounded on maturational theories in which development reflects the interaction of the body with its environment, following the adjustment needed by each of the life cycle stages (Payne & Isaacs, 2012). The daily living skills or adaptive behavior domain involves aspects of the other domains and is under the same theoretical influences. Additionally, researchers often use social competence theories (Masten & Coatsworth, 1998; Vaughan Van Hecke et al., 2007). Thus, instruments used to develop child development multidimensional measures take into account multiple theories that clarify specific aspects of child development.

In Brazil, the challenge to identify developmental problems among young children is aggravated by a lack of standardized instruments (Becker, Bandeira, Ghilardi, Hutz, & Piccinini, 2013; Madaschi, Mecca, Macedo, & Paula 2016). Even though there are some multidimensional instruments traditionally used internationally, only until 2018 three instruments were published in the Brazilian context: 1) the Bayley Scales of Infant Development (Bayley-III; Bayley, 2018) – it directly assesses children from one e to 42 months; 2) Denver-II Developmental Screening Test (Frankenburg et al., 2018) – aimed for children aged from birth to 72 months old and; 3) The Ages and Stages Questionnaire (ASQ-3) a parental report inventory for one to 66 month-old children validated by Filgueiras et al., (2013) but not yet commercially available. None of these instruments, however, were developed in the Brazilian context taking into account culture-specific aspects. Additionally, the first two instruments are expensive and not applicable in the Brazilian public health system, where there is a pressing need for screening child development

The development of a new instrument has the advantage that new items, which may not be included in already existing instruments, can be considered (Costa, Bandeira & Nardi, 2013). The equivalence of the construct, format of the test and its application may vary from culture to culture. Additionally, the reliability and validity indicators found in a context much

different than that where the instrument was originally developed may not be as good (Hambleton, Merenda, & Spielberger, 2005).

Given the importance of having appropriate instruments to assess child development in the Brazilian context, this study's general objective was to develop the Dimensional Inventory of Child Development Assessment (IDADI) for children aged between zero and 72 months old. The IDADI was initially developed to be a measure applied with parents to report on children's skills. This type of measurement is of low cost and provides a valuable perspective from parents, who live with children and can report their skills in a natural context (Sabanathan et al., 2015). Additionally, because it is constructed in the Brazilian context, taking into account the specificities of Brazilian children, it presents an advantage in terms of content validity compared to the instruments previously mentioned. Finally, we intend to create a short version to be used in the context of public services.

Theoretical and methodological procedures recommended by specialized literature were used to develop the IDADI (AERA, APA, & NCME, 2014; DeVellis 2016; Pasquali, 2010). The study specific objectives were: 1) Revise child development instruments published in scientific databases and the theories involved in order to develop IDADI's theoretical framework; 2) Construct items to assess child developmental milestones expected for children between zero and 72 months old; 3) Investigate content validity through a panel of experts on child development; 4) investigate the semantic validity of items using a focal group; and 5) Verify the feasibility of the inventory to assess child development in a pilot study. The initial hypothesis was that, by grounding the IDADI on classical and contemporary theories addressing the different domains of child development and also instruments internationally considered to be gold-standards, it would present content validity, as assessed by an expert panel, semantic analysis of items by a focal group, and pilot study implemented in the target population.

Procedures used in the development of IDADI

The development of the IDADI involved the use of theoretical and empirical procedures recommended for the development of psychological instruments based on constructs (DeVellis, 2016; Pasquali, 2010). The process followed five stages based on qualitative and quantitative methods, namely: 1) establishment of theoretical framework; 2) development of the

instrument's preliminary version; 3) analysis of items by an expert panel; 4) semantic analysis of items performed by the instrument's target population; and 5) pilot study. The methods and results of each of the stages will be presented separately. For those stages involving human subjects, ethical procedures were implemented according to resolutions No. 466/12 and No. 510/16 of the Brazilian Council of Health (National Council of Health, 2012; 2016). The project was submitted to and approved by the Institutional Review Board at the Psychology Institute at the Federal University of Rio Grande do Sul (UFRGS) process No. 1,274,779, CAAE: 45991815.5.0000.5334. Confidentiality of personal information was ensured for all those involved. This study's objectives and procedures were clearly explained to the expert panel and mothers. Participation was voluntary and the participants consented by signing free and informed consent forms.

Stage 1. Theoretical Framework

Method

We carefully consulted the literature addressing the psychological construct child development to develop the IDADI and select its dimensions. The theoretical review included the analysis of scientific papers, books and also instruments assessing child development that are widely used in international studies. For the latter, a systematic literature review was performed prior to the study. Experts in child development were consulted to aid in the review of conceptualization of dimensions.

Results

Based on a literature review and existing international instruments, the following domains were considered important and potentially sensitive for assessing child development: Cognitive, Motor Skills (Gross and Fine subdomains), Communication and Language (Receptive and Expressive subdomains), Socioemotional and Adaptive Behavior (Bayley, 2018; Grantham-McGregor et al., 2007; Newborg, 2005; Sabanathan et al., 2015). A constitutive definition was established for each pre-selected domain encompassing theoretical aspects that should be assessed in each domain. The theoretical assumptions that ground the definitions of the constructs involved different fields (e.g., psychology, speech-language therapy, physical education) and, especially, knowledge concerning developmental milestones

expected in each age range. An operational definition of the domains was also established (Pasquali, 2010). Each domain comprises the items considered to be the most relevant for assessing child development in a given field.

The theoretical and operational definitions of the dimensions and subdimensions were extensively discussed by the research team and with professors from the child development field. After reformulation, definitions were discussed with a professor from the Graduate Program in Psychology at the UFRGS, who is experienced in child development and new changes

were implemented. Table 1 presents the constitutional description of the domains and subdomains taken into account for the development of the instrument.

Stage 2. Development of the IDADI's preliminary version

Method

The most frequently used instruments for child development assessment identified by the systematic review of Silva, de Mendonça Filho, Mônico and

Table 1.

Establishment of the domains of the Dimensional Inventory of Child Development Assessment (IDADI)

Domains and subdomains	Description
1. Cognitive	Includes processes that enable children to interpret and respond to their environment. The cognitive skills assessed by the instrument should be related to the establishment of concepts, symbols, abstraction, perception, attention, information processing speed, visual-spatial processing, problem-solving, and memory.
2. Motor Skills	Includes items that assess the skills of children to walk, sit, run, stand up, balance, and coordinate physical activities involving the large muscles;
2.1. <i>Gross</i>	
2.2. <i>Fine</i>	Includes items that assess the skills of children to reach, grab, and manipulate objects. Involves precise coordination of small muscles, such as the muscles of the feet, hands, fingers, fist, lips, eyes and tongue.
3. Communication and Language	Includes items that assess the skills of children to understand units of meaning of spoken language including words, phrases and verbal expressions. It is also related to the understanding of different tones of voice, recognition of gestures and forms of non-verbal communication;
3.1. <i>Receptive</i>	
3.2. <i>Expressive</i>	Includes items that assess skills of children in using units of meaning of spoken language to verbally express themselves, transmit information and instructions necessary for social interaction. It also includes the use of gestures and non-verbal expressions with communicative purposes.
4. Socioemotional	Includes items that assess the ability of children to understand feelings and emotions, both of themselves and of others. Includes skills to regulate their own behavior and emotional regulation, empathy, attachment and the ability to establish and maintain social relationships (with familiar and unfamiliar people of different ages).
5. Adaptive Behavior	Assesses the skills of children in performing daily tasks necessary for personal and social autonomy, including self-care, sensorial perception, establishment and maintenance of relationships and communication of needs and feelings.

Bandeira (2018) were analyzed for selection and adaptation of potential IDADI's items. As a starting point, a set of statements that included various items and tasks was developed. The items describe behaviors that can be observed in the daily routine of children, generally assessed by the parents, caregivers or teachers, while tasks are part of the instruments used in direct assessment used by professionals to assess children in a clinical context. The behaviors and skills most relevant for the development of items were chosen. Afterwards, some items were suggested by the experts and included. Items extracted from different sources and that expressed the same behavior or very similar behavior were compared for the selection of the most appropriate according to the theoretical and psychometric criteria used to develop and adapt tests (DeVellis, 2016; Pasquali, 2010).

The items were developed considering the following criteria: they should express a particular behavior and meet principles of clarity, simplicity, relevance, precision, modality, variety, typicality, credibility, amplitude, and balance (for a review, see Pasquali, 2010). The items were also operationally defined to involve a developmental milestone that could be empirically tested, preferably a behavior that can be observed by parents in daily life. After this process, the items were grouped into one of the development domains and subdomains, while considering theoretical definitions. The response scale was established later.

Results

The initial pool of items selected for the IDADI contained 2,365 items, including questions and tasks. Of these, 218 were excluded because they assessed children older than the age intended for the instrument. After analysis of item content, another 1,591 items were excluded because they assessed other domains (e.g., disruptive behavior, visual reception) or because they expressed the same skill as was expressed by another item, or a very similar skill. The preliminary version of IDADI was composed of 556 items, namely: 100 in the Cognitive domain; 88 in Socioemotional; 53 in Receptive Communication and Language; 62 in Expressive Communication and Language; 53 in Fine Motor Skills; 73 in Gross Motor Skills; and 127 in Adaptive Behavior.

A three-point Likert scale was established where: yes (2-points), indicates that the child has already mastered the skill, even if s/he no longer performs it or was replaced by a more complex behavior (e.g., crawling

was replaced by walking); sometimes (1-point) refers that the child eventually performs the task, or even if has difficulty; and no (0-point) the child has not yet mastered the skill.

Stage 3. Expert panel

Method

At least three and at most five judges assessed each of the IDADI's dimensions. Experts were intentionally chosen based in part on their background and mainly on their clinical and professional experience in assessing and/or intervening children. A total of 18 judges participated; most assessed a single domain. Two judges assessed two domains, the Cognitive and Communication and Language domains, because they had expertise in both. The research team decided what domain each judge would assess taking into account their field of expertise and professional experience.

Five PhDs who work with intelligence and cognitive functions in their clinical practice and/or research assessed the Cognitive domain. Four of the experts were university professors; all taught in the Psychology program and two were also graduates in speech-language therapy. The assessment of the Socioemotional domain was performed by five psychologists, three of whom were PhD candidates and two were already professors (one in an international university). The Communication and Language domain was assessed by four judges, with two professors in the field of speech-language therapy, one PhD candidate working in clinical practice, and one speech-language therapist with many years of clinical practice. The assessment of the Motor Skills domain included a PhD candidate teaching in the field of Physical Education, one physician with specialization in neurology and pediatrics, and one clinical psychologist with specialization in Psychomotricity. The assessment of the Adaptive Behavior domain was performed by a psychologist working in a large institution directed to children with intellectual or physical disabilities and by an experienced clinical psychologist who was an expert in neuropsychological rehabilitation.

In regard to the instructions procedures, experts received information about the operational definition of the domain under study and its respective items, along with how content and items should be rated. They assessed the quality of items already included and were asked to suggest the inclusion or exclusion of items, whenever they deemed necessary. Each item

was assessed according to three criteria: pertinence, adequacy and familiarity. Pertinence consisted of assessing the extent to which each item was related to the theoretical domain indicated, that is, the degree of association between behavior and theory. Adequacy represented a measure of clarity of the redaction of an item, that is, whether the words and expressions that described the behaviors and skills were clear and understandable for people of different educational levels. Familiarity consisted of assessing the degree to which a behavior represented in each item could be observed and assessed by parents in daily life.

The pertinence, adequacy and familiarity of items were assessed on a five-point Likert scale, ranging from 0 to 4, where zero indicates total disagreement, that the item does not express the criterion under study and 4 indicates total agreement. The judges were asked to assign a score to each item and comment whenever they assigned 0, 1 or 2, indicating how the item should be modified or whether it should be excluded. A blank space was also available at the end of the document for them to provide general comments about the domain under study and suggest the inclusion of items not addressed in the instrument. The judges also assessed the adequacy of the response scale.

Experts' evaluation for each domain were compiled in a spreadsheet and the research team analyzed each in qualitative and quantitative aspects. The quantitative analysis was performed using the Coefficient of Validity Content (CVC) for each item. The CVC is an index used to quantify and interpret the judgment of items and scales by a group of experts in the construct the instrument is intended to measure. It ranges from 0 to 1, in which values equal to or higher than 0.80 indicate the quality of an item in regard to an aspect (Hernández-Nieto, 2002). The CVC was calculated per item, considering the three criteria assessed by the judges, resulting in three content validity indexes for each item. The qualitative analysis was performed considering the plausibility of any suggestion to change, exclude or include an item. Suggestions to change items were accepted for some items that reached the quantitative criterion ($CVC \geq 0.80$) when the research team considered the comments to be relevant to improving a given item. All the items modified or included in the IDADI were analyzed once more by one or two judges, considering the same criteria previously described. It was always the case that a different judge than the one who suggested the change would assess the new item.

In addition to assessing the aforementioned criteria, the judges were asked to mention the approximate age, in months, by which children were expected to reach the specific developmental milestone described in the items. The options were zero, three, six, nine, 12, 24, 36, 48, 60 or 72 months of age.

Results

Table 2 presents some examples of items that were modified according to qualitative and quantitative criteria. Considering the large number of items modified during this stage, we opted to select examples that represent the process, instead of presenting the full set of data.

Of all the items in the Cognitive domain, only six (6%) items did not meet the CVC criterion and were changed. One item was excluded for presenting content identical to another item and another, 52 were changed considering qualitative criteria, that is, plausibility of the experts' suggestions. The main changes involved adequacy of the redaction, changing a term or expression, or restructuring sentences to improve clarity or the operationalization of some terms in observable behaviors. (E.g., "Observes" was replaced by "look at"; "recognizes you" by "calms down when sees you".) All the items were considered to be pertinent to the Cognitive domain. Nine new items were suggested by the judges, of which eight were approved in a new round and included in the Cognitive domain of the IDADI, which after this stage, totaled 107 items.

In the Socioemotional domain, 12 items (13.6%) did not reach the expected CVC and were changed. Three items appeared more than once and were excluded. One item migrated to the Cognitive domain and 25 were modified according to the qualitative criterion. The main changes involved changing expressions to simplify redaction, the operationalization of some terms to describe observable behaviors, and changing some terms, such as "primary caregiver" or "mother," to "you", since the behavior should be observable by the respondent, regardless of being the mother or another caregiver. This last change was applied to all the domains of IDADI. The judges suggested six new items and five were approved in a new analysis. The version of the Socioemotional domain contained 83 items after this stage.

Twelve (22.6%) items in the Receptive Communication and Language subdomain were modified according to the CVC criterion. Another eight items

Table 2.

Examples of changes of items following qualitative and quantitative criteria of the analysis performed by the judges

Item	CVC Pert ¹	CVC Adeq ²	CVC Fam ³	Comments of judges	Item after changes
Cognitive domain					
Observes a single object for a few seconds	1	0.81	0.75*	<i>Judge 1.</i> Most appropriate is to ask whether the child looks at it. Observe is a subjective concept. <i>Judge 2.</i> I suggest keeping the observable behaviors. What does it involve observe?	Focuses on a single object for a few seconds
Transfers the object from one hand to the other	1	0.94	0.94	<i>Judge 1.</i> For people with a low educational level, “passes” is better than “transfers”. <i>Judge 2.</i> Passes a toy from one hand to another	Passes a toy from one hand to another
Gross Motor Skills subdomain					
Turns the head to look at objects passing in front of him/her	0.75*	0.50*	0.92	<i>Judge 2.</i> I suggest specify the distance (15 to 20 cm?) <i>Judge 3.</i> In the dimension of gross motor skill, this behavior is better assessed by “Turns the head from one side to the other while lying on his/her back” because it does not involve external social stimulus	Turns the head from one side to another while lying on his/her back.
Receptive Communication and Language Subdomain					
Correctly uses the words mine, yours, theirs, ours	1	0.83	0.92	<i>Judge 1.</i> Understanding each of these phenomena differs in terms of complexity, so I suggest separating them in different items. E.g., “Understands the difference between me and you”; “Understands the difference between me, and s/he”, etc.	Two items are created: 1. Correctly uses the words mine, hers/his and yours; 2. Correctly uses the words theirs and ours
Socioemotional domain					
Looks at or turns the face towards sounds	0.85	0.60*	1	<i>Judge 3.</i> Specifies the nature of a sound stimulus. Considering this dimension, you could specify “toward a familiar sound” (E.g, voice of mother/father/familiar people”, or “(...) when called his/her name “. <i>Judges 4 and 5.</i> Instead of “a sound” change to “your voice or that of familiar people”	Looks or turns the face toward your voice or the voice of familiar people
Responds to your touch without the need to touch him/her more firmly to call his/her attention	0.80	0.90	1	<i>Judge 3.</i> Responds how? It could be “Looks or turns the face when you touch him/her (...)”. <i>Judges 4 and 5.</i> Understanding this item can be subject to what one understands by “touching firmly”. I suggest making it clearer.	Promptly responds when you touch him/her (e.g, Looks at you, turns or smiles)

Note. 1. Pertinence; 2. Adequacy; 3. Familiarity

were changed by the qualitative criterion and five were excluded. The version the judges analyzed contained with 48 items. The main changes were the inclusion of examples, changing expressions to simplify redaction and dividing one item into two so that it would include skills expected for different ages. The exclusions mainly occurred due to the fact that an item was considered to belong to other domains. Ten (16.1%) of the Expressive Communication and Language subdomain items were changed because they presented CVC <0.80 and another 26 items were changed according to qualitative criteria. The main changes were the inclusion of examples, directing the items to the people completing the inventory (i.e., from “care-giver” to “you”) and specifying whether certain types of communication involved speech, gestures or both. Six were excluded because they were considered to be unfamiliar to parents (e.g., “Uses the irregular plural correctly”) or because they were considered to belong to the Cognitive domain (e.g., “Lists at least six of the seven days of the week in the correct order”). Five items were added based on the judges’ suggestions; so that the Expressive Communication and Language subdomain ultimately possessed 61 items.

Five items were changed in the Gross Motor Skills subdomain according to the quantitative criteria, seven according to the qualitative criterion and two were excluded. The main changes involved specifying the initial position of the child when performing the behavior expressed by the item, whether the behavior was performed independently or with assistance (e.g., “stands up and stays up without support”) and the change of some expressions in the items. This subdomain had 71 items after the analysis of judges. Eight items in the Fine Motor Skills subdomain were changed due to the CVC; one was changed according to qualitative criteria and six were excluded because they were grouped with similar items, were considered redundant or were considered to belong to other domains. The main changes were grouping items that expressed the same idea (e.g., “puts their fist to their mouth” and “puts their hand to their mouth” became a single item “puts their fist or hand to their mouth”). At the end of this stage, this subdomain had 47 items.

Twenty-eight (22.0%) items in the Adaptive Behavior domain were changed according to qualitative criteria and nine were modified according to qualitative criteria. The main changes were change of expressions for greater clarity of redaction, specifying that the child should perform certain behaviors with or

without help and the inclusion of examples. Twenty-two items were excluded and four were added based on the judges’ suggestions. At the end of this stage, the domain possessed 109 items. After the judges’ analysis, the IDADI had 526 items.

Stage 4. Semantic analysis of items

Method

The instrument was also analyzed in regard to terms of semantics, how the target population understands it. For this stage, it was expected that some terms would be changed due to regional differences in language and also lack of understanding due to the respondents’ low educational levels. Hence, a focal group was addressed in the interior of Minas Gerais, a region with differences from where the instrument was originally developed (Rio Grande do Sul).

The semantic analysis was intended to verify whether the target population understood all the items. Seven mothers aged 31.43 years old ($SD = 7.79$), on average, with a minimum of 19 and a maximum of 42 years old, participated. These mothers were intentionally chosen from the network of the primary author, due to their low educational levels and the ages of their children. Their children were aged from six to 71 months of age; that is, they represented all the age ranges that the IDADI addresses; four were boys and three were girls. The mothers predominantly had incomplete primary education (five of the seven participants), ranging from two to seven years of formal education. One mother had completed middle school and one had completed high school. All mothers had attended public schools. Only one participant reported her child presented health problems and had received neurological treatment since birth due to convulsions.

Four sessions were held with the focal group. Each of the items was discussed, taking into account clarity of redaction and semantic understanding. The procedure indicated by Pasquali (2010) was adopted. Each item was presented to the participants who were asked to reproduce with their own words or explain what they had understood by giving examples observed in their children’s daily routines. When difficulties understanding a specific item emerged, or when the participants expressed an item with a meaning other than what was expected, the item was changed considering the group’s suggestions. The modified item was then presented to the participants who should confirm whether it was

sufficiently clear. All the participants should confirm the item was clear and that they were sure as to how to assess it in daily life in order to proceed to the analysis of the next item.

Results

The stage of the semantic analysis, performed through discussion with the focal group, resulted in the exclusion of one item (the idea of which was already addressed by another item) and in changing 82 items. Of these, 19 items were addressed in the Cognitive domain, 21 in the Socioemotional, 16 in the Motor Skills, 10 in the Communication and Language, and 16 in the Adaptive Behavior domain. The main changes involved changing pronouns and terms that were difficult to understand, the inclusion or exclusion of examples, the simplification of items that appeared more than once, and providing examples that were closer to the routines of mothers, also considering the influence of regional terms.

In regard to the possessive pronoun “your”¹, it led to doubts because the mothers had difficulties identifying whether the item referred to them or their children, such as in the example “Looks at his/her² image in front of the mirror for a long period.” So that, “at his/her” was replaced by “his/her own image”. The unstressed oblique pronouns³ “lo” and “la” also hindered understanding probably, because these are not commonly used in the speech of the focal group’s participants. Hence, we opted to replace the pronoun in all the items in which it appeared.

Some of the terms indicated by the mothers as being difficult to understand are presented with their respective changes in parentheses: requested (asked), promptly (quickly), actions (gestures), assistance (aid), thrown ball (played ball), executes commands (obeys commands), damages (messes), appropriately (expected manner). We considered it important to include examples to explain terms such as facial expressions (we included in the example: squeals, smiles, or makes faces) or to facilitate understanding of a given item such as “Asks for more or another”, the example of which

was “more water” or “another piece of bread”. On the other hand, there were situations in which the example was removed for having inhibited understanding, such as “Plays make-believe with adults (e.g., feeds a doll, pretends to clean up the house)” or “Makes believe that s/he is somebody else or something else (e.g., Wears clothes or accessories to dress up)”. In the first situation, the example was removed because the mothers focused on the presence or absence of its content to provide an answer, not generalizing to other situations and, in the second case, wears clothes or accessories to dress up was associated with Carnival celebration (Fat Tuesday).

Even though the criteria to develop items were widely used in the process of the IDADI’s development, some items revealed redundancy in this stage and were changed. The item “Tells when feeling happy, sad, afraid, or angry” was changed to “Tells how s/he feels (e.g., tells if happy, sad, afraid, or angry)” to indicate that it could be any feeling. The item “Climbs on a chair, bench, box to get something that is out of reach” was corrected to “Climbs on a chair, bench or box to get something that is out of reach” to indicate the child could climb on any of these objects to reach an object.

There were also situations in which examples that were closer to the routine of the mothers were added. Looking at photo albums was indicated as being more common than looking at books or magazines; giving a no finger gesture to express “no” was more frequently used than negatively shaking the head; and using a cloth to clean oneself up was considered to be more common than using a napkin. Due to regional differences, variations of the word “you” were used (*ocê* or *ê*)⁴ to indicate the use of the pronoun “you” and the examples “velotrol or velocipede” were used to describe “*motoca* or tricycle”; *motoca* is a more common term in Rio Grande do Sul.

Some items that were considered difficult by the mothers were kept because of their potential for future use when operationalizing the IDADI’s items into tasks within a clinical context. The items include the repetition of digits (e.g., repeats three numbers) in the same order in which they are said or counting backwards (e.g., from 10 to 1). The judges had already noted that these could be difficult for the parents and, in fact, such difficulty was confirmed in the semantic validation.

After these stages, the items of all the domains of IDADI were organized in a developmental order

¹ T.N.: In Portuguese, the same word (*sen*) is used for both pronouns “your” and “his/her”.

² T.N.: In Portuguese “*sen*” could mean either “your” or “his/her” so the reader should be able to deduce that the child, not the mother, was supposed to perform the behavior.

³ T.N.: Unstressed oblique pronouns act as the direct object of verbs.

⁴ T.N.: In Portuguese, *ocê* and *ê* are the short versions of “*você*”.

and divided into seven age-based forms: from 0 to 6 months, 7 to 12, 13 to 24, 25 to 36, 37 to 48, 49 to 60, and 61 to 72 months respectively. Each form was composed by age related items varying from 209 and 357 items depending on child's age instead of the full set of items. This approach was used in order to decrease time of data collection and avoid withdrawals or response bias due to fatigue.. It included easy items, which most children usually reach by a given age, and difficult items that only older children are expected to have reached. The division into age groups considered the discussion with the judges, information in the literature and existing instruments regarding the age children are expected to reach the developmental milestones expressed by the items.

Stage 5. Pilot Study

Method

A convenience sample was selected by means of contacting mothers who belonged to the researchers' network. Their characteristics varied in terms of education, region of residence, and sociocultural characteristics. Twelve mothers who had attended from primary school to graduate studies, with children aged from four to 68 months old, participated. None of the children were identified as having developmental delays. The questionnaires were applied one at a time and, after one application, the mothers' suggestions were applied and the questionnaire was applied again. This stage ceased when no more changes were suggested after three consecutive applications.

The questionnaires were sent by e-mail or delivered in person to the participants. Following the procedure recommended by Gjersing, Caplehorn and Clausen (2010), the mothers were invited to read the instructions, answer all the items, regardless of their children's age, and highlight those items they found difficult to answer. The participants were advised that if they had more than one child who fit the instrument's age range, they were supposed to choose just one child to answer all the items. Difficulties were foreseen regarding the understanding of a given item or specific parts of an item or having difficulty assigning a score on the response scale. A blank space was left beside each of the items for the participants to add comments. They were supposed to record difficulties or problems. Any comment or observation was taken into account to guide the changes in the items. The primary author

made a qualitative analysis of the comments, consulting the research team to clarify uncertainties.

Results

All the participants fully answered all 524 items of the IDADI. Fourteen items were modified, four of which belonged to the Cognitive domain, six to Communication and Language, one to Motor Skills, and three to the Adaptive Behavior domain. No changes were suggested for the items in the Socioemotional domain. The change implemented in Receptive Communication and Language involved the term "uses words", which was replaced by "understands words", a change that was also implemented in another four items. One of the participants suggested that "uses words" was more related to Expressive Communication and Language domain and suggested replacing it with "understands words".

The first version of the response scale established in Stage 2, was: 1) yes; 2) sometimes; 3) no. In this stage, the answer 3, "no" was replaced by "not yet," because this answer conveys the idea that the skill is expected at a later time in the child's development. "Not yet" was strategically thought to avoid response biases caused by the anxiety of some mothers wanting their children to present all the developmental milestones at the time of the assessment. The mothers reported no difficulties assigning scores to the items on the response scale (yes, sometimes, not yet). Some participants used the blank space to report that they had asked their children to give answers regarding tasks they had not observed yet. The mother of one child who was younger than two years old wrote "not observed" to various items and many mothers mentioned they would become more attentive and observe skills in their children after having answered the IDADI.

At the end of the last stage of development, the IDADI totaled 524 items. Of these, 106 belonged to the Cognitive domain, 109 to Communication and Language (48 in the Receptive and 61 in the Expressive), 118 to Motor Skills (71 in the Gross and 47 in the Fine Motor Skills), 83 to the Socioemotional domain and 108 to the Adaptive Behavior domain.

Discussion

This study's objective was to describe the development of the Dimensional Inventory of Child Development Assessment (IDADI) for children from

zero to 72 months of age. The procedures employed in the development of the instrument followed theoretical and methodological guidelines presented in specialized literature. All the stages were implemented as predicted and the objectives were accomplished. The hypothesis that the development of the IDADI with theoretical and methodological rigor would provide evidence of content validity in the subsequent stages was also confirmed. The different stages resulted in changes in the items and also confirmed their theoretical and practical applicability in the assessment of child development among children aged from zero to six years old, both when assessed by experts in the child development field and by the mothers of the children.

This study's findings reinforce the importance of including different stages to ensure the content validity of an instrument in development, which is in accordance with recommendations found in the literature (AERA et al., 2014). Considering the large number of items that were changed, excluded or included over the course of the development process, we verify that all the stages were essential. The inclusion of multiple stages seems to be highly important, especially for extensive instruments such as the IDADI. Even though the development process was very thorough and followed theoretical and empirical procedures recommended in specialized literature concerning the development and adaptation of items (DeVellis, 2016; Pasquali, 2010), various items presented problems in the subsequent stages, such as items that appeared more than once or lacked clarity. These problems could be circumvented, which in some cases, involved more than one stage. Some items were changed over the course of two or three stages until a final version was reached, revealing the complexity and intensity of work involving the development of a measurement instrument (AERA et al., 2014; DeVellis, 2016).

The use of recognized and coherent theories provides a foundation for the development of quality instruments (Pasquali, 2010). This procedure is crucial to ensuring content validity and is key in the development of instruments, a procedure no psychometrist should dispense with, being at risk of producing poor instruments (Pasquali, 2010). The theoretical fundamental stage of the IDADI was characterized by a long analysis process, which required consultations of the Brazilian and international literature, a systematic literature review, as well as discussions with professionals in the field of child development.

The content analysis of the IDADI's items led to the conclusion that the instrument integrates concepts of consolidated theories in all its domains. For instance, there are items in the Cognitive domain based on the Piagetian constructivism, such as "*C70 – Separates objects according to size (e.g., Separates small from large objects)*" and from the theory of executive functions "*C101 – Counts backwards from 10 to 1*". There are items that reflect the Theory of Attachment in the socioemotional domain: "*SE25 – Shows happiness when sees you returning (e.g., Smiles or makes sounds)*"; models of the Theory of Mind, as in "*SE74 – Shows understanding that others are sad or upset (e.g., stays close or provides comfort)*", emotional regulation "*SE65 – Accepts (does not lose control) when you reprimand for bad behavior*" and shared attention "*SE33 – Points to an object and looks at you to indicate what s/he wants*". Note also that items that reflect emotional regulation skills and executive functions (inhibitory control, for instance), which are present in the socioemotional and cognitive domains, enable the development of social skills, thus are acknowledged as adaptive behavior (Vaughan Van Hecke et al., 2007). All the domains involve continuous developmental skills related to age, progressing from the simplest to the most organized and complex skills, from a maturational perspective and in terms of interaction with the environment (Payne & Isaacs, 2012; Sameroff, 2010).

In relation to the instrument's length, a large number of items (524) was obtained. This was expected because the IDADI is a multidimensional instrument that assesses a comprehensive construct, with many facets, such as child development. Instruments in the same field, internationally recognized, are equally long (Bayley, 2018; Newborg, 2005). The amount of items per domain ranged from 86 (Socioemotional domain) to 118 (Motor Skills domain). Three domains have a similar number of items (between 106 and 109). The number of items is associated with the number of facets addressed by the instrument (see Table 1) and does not substantially differ among the IDADI's domains.

In regard to the process of item generation, only the deductive method (based on the literature and existing instruments) was used, though the combination of the deductive and inductive (obtained from opinions collected from the target population) methods is considered the most consistent strategy in the development of new instruments (DeVellis, 2016; Morgado, Meireles, Neves, Amaral, & Ferreira, 2017). The deductive method used to generate items, however, is the most commonly found in reviews addressing the development

of instruments (Kapuscinski & Masters, 2010; Ladhari, 2010). Additionally, using only the deductive method does not seem to threaten the IDADI's content validity, considering that the development of items was based on internationally known instruments (i.e., Bayley Scales of Infant Development, Vineland Adaptive Behavior Scale and Battelle Developmental Inventory). The items were divided into the domains according to a consistent theoretical and operational definition and various stages were implemented to assess and refine the instrument.

The expert panel was the stage that determined the modification of more than 50% of the items in the preliminary version of IDADI. This result shows that, even though a rigorous theoretical and methodological framework was adopted and items from existing instruments were used, the development process still required extensive review. Multiple assessment criteria were adopted in this stage, both quantitative (subdivided into pertinence, adequacy and familiarity) and qualitative (comments and suggestions). A rigorous assessment involving many changes was expected, considering the judges' high levels of expertise. Even minor adjustments were suggested and computed as changes, such as the use of simple words or the order of terms in a sentence. For the most part, these changes did not alter the items' content but contributed to improving and adapting the items to the Brazilian context and to the mothers' different educational levels.

The extensive changes that were implemented in the IDADI after the judges' analysis reveal the rigor and relevance of the process of developing instruments, considering that a cross-cultural adaptation and test would not include all the stages adopted here to refine the items. The expertise of professionals is determinant in maximizing the content validity of an instrument under development (DeVellis, 2016). An analysis performed by experts from different specialties seems to be even more relevant for multidimensional instruments. Judgment of the pertinence of an item in regard to theory, clarity of redaction, and the suggestion of new items to cover the construct under interest, should be part of the analysis of judges (DeVellis, 2016; Pasquali, 2010). An expert panel is the method most frequently recommended and used to change and remove inappropriate items (Kapuscinski & Masters 2010; Ladhari, 2010; Morgado et al., 2017). The decision to accept or reject the opinion of judges is a responsibility of those developing the instrument (DeVellis, 2016). It seems that criteria that should be used to consider the opinions of

judges when modifying or excluding items from an instrument are not consistent (Morgado et al., 2017). For the IDADI, we used a combination of quantitative and qualitative methods to take the judges' assessments into account, which resulted in a large number of changes intended to improve the instrument. These procedures possibly conferred greater robustness to the process.

The stage of semantic analysis using a focal group with mothers with low educational levels resulted in the modification of 82 items and the exclusion of one item. The main modifications involved terms and expressions considered simple by the research team and which were deemed to be familiar to the parents in the analysis of the judges, as well as the change in pronouns. In contrast to expectations, the use of examples sometimes hindered understanding of the content of some items. In contrast, the inclusion of examples in some cases was a more plausible alternative for explaining concepts and expressions without altering the item's content. Semantic analysis was also useful to identify and change items that expressed the same ideas and decreased the influence of regional terms and expressions. The focal group implemented in a region other than where the instrument was developed and with mothers with low educational levels, was very important for this analysis. These results reinforce those previously highlighted by Morgado et al. (2017) in regard to the use of methodological strategies that consider the opinions of the target population when developing instruments. Focal groups are mentioned as one of the methods most frequently used in studies addressing the development of instruments, which considers original and genuine information that concerns the population for which the instrument is intended (Kapuscinski & Masters, 2010; Ladhari, 2010; Morgado et al., 2017). Thus, the discussions with the focal group were essential to refining the IDADI to be used in population studies and assessments in Brazil.

The pilot study was the shortest phase of refinement and the one that resulted in the smallest number of changes. This was expected considering that the previous stages enabled progressive improvement of items, which presented more quality in this phase. Nonetheless, relevant changes were still implemented in this stage, and the applicability of the response scale was also tested.

Despite the rigorous process implemented, this study presents some limitations. One such limitation is the fact that the procedure to verify the semantic validity of items was performed in a single Brazilian state

(Minas Gerais). Brazil is a country of continental proportions, with marked cultural and language differences among regions. For this reason, some items are likely to present a challenge to people from other regions. Additionally, because the construction of items was primarily based on tests that were developed to assess children of an age group slightly different from that intended by this new instrument, it may be that items were missing for some age groups assessed by the IDADI. Internal validity studies will be able to answer this question.

Nonetheless, in view of the entire process described earlier and its implications, we consider that the instrument presents content validity. Future studies and ongoing studies addressing other psychometric evidence will provide new indicators of the quality of the development process. Among the main evidence of validity and reliability to be investigated, we highlight those concerning the internal structure of IDADI, to test the unidimensional nature of the theoretical domains empirically, as well as the correlations among the different domains of child development; evidence based on external variables, considering criteria such as the child's age, diagnostic tests, socioeconomic status, and child's sex; the internal consistency of domains; and subdomains of the inventory by reliability indexes.

Considering a growing recognition of the importance of assessing child development and making greater investments in public policies directed to early childhood in Brazil (Ministério da Saúde, 2012), the IDADI might be useful in this context. The systematic use of child development screening techniques accounts for a significant increase in the early identification rates of problems and disorders and has been increasingly recommended to facilitate assessments performed by professionals (American Academy Pediatrics, 2006). Instruments such as the IDADI can be an important resource in public health services to improve the quality of assessments and interventions.

Final Considerations

An accurate assessment of child development, especially in early childhood, is important for various stakeholders, such as parents, clinicians, researchers, educators and the public policy managers. The Dimensional Inventory of Child Development Assessment (IDADI) was developed using rigorous theoretical and methodological criteria recommended in the literature to improve the early identification of developmental delays or disorders. The preliminary analyses of the

instrument indicate it presents content validity, confirmed by the judge panel, semantic analysis and pilot study. The individual procedures resulted in substantial changes to the instrument, attesting to the importance of implementing an exhaustive process when one intends to create a measure.

We highlight the central importance of procedures intended to ensure content validity for the quality of an instrument. This type of validity is considered more important since, without it, the others represent little. Note, however, that this study is only the beginning of the development process of the IDADI. Future research, addressing samples with heterogeneous levels of child development (typical, with delay, or developmental disorder), different socioeconomic levels, and age groups, is necessary to assess psychometric evidence. Additionally, interpretation standards will be developed to assess children in Brazil. Criteria or cutoff points will be established, as well, to identify more severe developmental delays or deficits. A brief version of the instrument was developed to enable the rapid assessment of developmental skills in a large number of children, in addition to the tasks version to assess children directly. The IDADI is expected to contribute to the challenge of identifying developmental problems among children aged from zero to 72 months of age in Brazil, contributing to the early referral of children to interventions intended to promote the development of child potential.

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Sobre os autores:

Mônia Aparecida da Silva, Assistant Professor at Universidade Federal de São João del-Rei, PhD in Psychology by the Graduate Program in Psychology (PPG) at UFRGS. Associated researcher at the Group of Study, Practice and Research in Psychological Assessment (GEAPAP) and member of the WG Cognitive and Neuropsychological Assessment of ANPEPP. Develops activities in the areas of psychological assessment and psychometrics, developmental psychology, psychopathology, and health assessment.

ORCID: 0000-0002-8840-7547

E-mail: moniapsi@gmail.com

Euclides José de Mendonça Filho, Doctoral student in the Graduate Program in Psychology at Universidade Federal do Rio Grande do Sul. Member of the Group of Study, Practice and Research in Psychological Assessment. Develops activities in the area of Psychometrics and Psychological and Educational Assessment.

ORCID: 0000-0003-4098-8247

E-mail: euclidesmendonca.f@gmail.com

Denise Ruschel Bandeira, Full Professor at UFRGS and researcher at CNPq. Masters and Doctoral advisor at the PPG in Psychology at UFRGS and coordinator of the Group of Study, Practice and Research in Psychological Assessment (GEAPAP). Head of the WG Psychological Assessment: Personality and Human Development of ANPEPP. Works mainly in the areas of construction and validity of tests and psychological measures, personality and child development.

ORCID: 0000-0001-9867-2718

E-mail: bandeira@ufrgs.br

Contato com os autores:

Rua Ramiro Barcelos, 2600, sala 120,
Bairro Santa Cecília
Porto Alegre-RS, Brasil
CEP: 90035-003

ERRATA

No artigo Development of the Dimensional Inventory of Child Development Assessment (IDADI), com número de DOI: 10.1590/1413-82712019240102 , publicado no periódico Psico-USF, 24(1):11-26.

Na página 11:

Onde se lia:

“Mônia Aparecida da Silva^{1, 2, 3}

Euclides José de Mendonça Filho^{2, 3}

Denise Ruschel Bandeira^{2, 3}”

Leia-se:

“Mônia Aparecida da Silva^{1, 2, 3}

Euclides José de Mendonça Filho^{1, 2}

Denise Ruschel Bandeira^{1, 2}”

Na página 26:

Onde se lia: “Euclides José de Mendonça Filho, Doctoral student in the Graduate Program in Psychology at Universidade Federal do Rio Grande do Sul. Head of the Group of Study, Practice and Research in Psychological Assessment and of the Developmental Processes Laboratory (York University). Develops activities in the area of Psychometrics and Psychological and Educational Assessment.”

Leia-se: “Euclides José de Mendonça Filho, Doctoral student in the Graduate Program in Psychology at Universidade Federal do Rio Grande do Sul. Member of the Group of Study, Practice and Research in Psychological Assessment. Develops activities in the area of Psychometrics and Psychological and Educational Assessment”