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Research Article

Toddlers' Early Communicative Skills as Assessed by the Short Form Version of the Estonian MacArthur-Bates Communicative Development Inventory II

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Purpose: The purpose of the current study is to develop a valid and reliable screening tool to identify children with risk of developing language difficulties for Estonian-speaking 2- to 3-year-old children.
Method: Nine hundred ninety parents of children ages 1;8–3;1 (years;months) filled in the Estonian MacArthur-Bates Communicative Development Inventory II (ECDI-II SF)—containing a 100-word vocabulary checklist, questions about decontextualized language use, and sentence production. A subset of parents filled in the long form of the MacArthur-Bates Communicative Development Inventory: Words and Sentences (n = 131). We examined the results of 31 children with language problems on the ECDI-II SF to assess the accuracy of the instrument.
Results: The concordance of scores on the ECDI-II long form and ECDI-II SF is high. Toddlers' results on the ECDI-II SF are related to their gender, with girls outscoring boys on the expressive vocabulary and sentence complexity subscales. We also found that children of highly educated mothers outperform others in the acquisition of grammatical skills. The sensitivity and specificity of the ECDI-II SF vocabulary section supported the implementation of this screening tool in order to identify toddlers with difficulties in their language development.
Conclusions: ECDI-II SF vocabulary scores are the most informative for determining whether a 2- or 3-year-old is following typical developmental patterns or should be referred to a speech and language specialist for a direct assessment. We provide a discussion on early language screening process and its implications for public health policies.

The link between language acquisition and later cognitive (Clegg et al., 2005), social-emotional (Conti-Ramsden & Botting, 2000; Forrest et al., 2020) and literacy development (Muter et al., 2004), as well as school readiness (Astington & Pelletier, 2005) has motivated systematic screening for language difficulties in infancy and toddlerhood. For this, valid and reliable screening instruments that take into account the linguistic and cultural context in which the screening is administered are needed. The current study aims to describe the adaptation of the MacArthur-Bates Communicative Development Inventory Short-Form (CDI SF; Fenson et al., 2000) into Estonian language for use in clinical and research settings.

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The Estonian language belongs to the Finnic group of the Finno-Ugric language family, and there are approximately 1 million native speakers of Estonian. Typologically, Estonian is an agglutinative type of language, and it is characterized by a large number of cases (14 productive cases), no grammatical gender (either of nouns or personal pronouns), and no articles (either definite or indefinite) and differentiation between three quantities both in vowels and consonants (see Erelt et al., 2007, in detail).

Screening Early Language Difficulties

There is a need for short and easy to administer screening instruments, as standardized testing tends to be time consuming and expensive. Parent-completed screening questionnaires, such as CDIs, have been gaining more support with children aged under 3;0 (years;months) as measures that are just as accurate as direct language assessments carried out by a specialist, as they are quick, easy to use, and are based on parental knowledge of children's language

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use in a wide variety of naturalistic contexts (Gatt et al., 2014; Sachse & Von Suchodoletz, 2008; Vehkavuori & Stolt, 2018). At the same time, filling in the long form of the CDIs is time consuming. For instance, the CDI-II includes the checklist of more than 600 words in addition to questions about child's language use and sentence complexity, which takes a long time to fill out (approximately 1–2 hr).

The motivation behind developing a short and quick parental report is to provide a reliable measure for general practitioners or family nurses for use during regular checkups to identify risk for poor developmental and education outcomes (McIntyre et al., 2017). Another use for a short screener is in educational settings for speech and language therapists employed at day care centers to get a preliminary estimate of the children's abilities. In addition to clinical screening, short and cost-effective instruments assessing children's language development can be used for assessing the direct or indirect effect of early intervention programs.

Wallace et al. (2015) showed in their systematic review that research has not consistently indicated that early screening of language delay has a significant effect on language outcomes later in life. Rescorla (2011) argues that despite late talkers scoring in the normal range by age 6 or 7 years, their language skills are significantly lower than those of typically developing peers throughout adolescence. Therefore, despite the possibility that early expressive language screening at 2–3 years of age has a low predictive value of speech and language disorders, it has its benefits in identifying at-risk groups still in need of intervention. Several studies have shown that early intervention and targeted parenting programs alleviate the long-term consequences of early language delay (Alt et al., 2020; Buschmann et al., 2015; Cunningham et al., 2019; Kruythoff-Broekman et al., 2019).

Forrest et al. (2020) explain that children who are at risk of developmental language disorder experience similar levels of socioemotional difficulties across their childhood as children who have a formal diagnosis of a language disorder (Forrest et al., 2020). Moreover, early screening for language difficulties can provide an important resource by identifying children whose delayed expressive language skills are secondary to autism spectrum disorder, intellectual disability, hearing impairment, or receptive language delay, or children whose language difficulties might be the result of environmental deprivation (Rescorla, 2011). Due to the long-term consequences and the high prevalence of expressive language delay in the population, identification and support of children with language difficulties is an important public health topic (Horwitz et al., 2003).

Short Form Versions of the CDI

CDIs (Fenson et al., 1994) and the shorter versions of the same measures (Fenson et al., 2000) are one example of widely used parental reports. The SF versions of the CDI (Fenson et al., 2000) were developed based on the original long forms (Fenson et al., 1994) using the accumulated data from the CDI norming study. CDI SFs have been adapted in several language and cultural contexts (Eriksson et al., 2002; Frota et al., 2016; Jackson-Maldonado et al., 2013; Kim et al., 2014; Pérez-Pereira & Resches, 2007; Reese et al., 2015; Rinaldi et al., 2019; Sachse & Von Suchodoletz, 2008; Soli et al., 2012; Vach et al., 2010; Vehkavuori & Stolt, 2018). Most short forms (SFs) contain a 100-word vocabulary production checklist, but did not include any other grammar scales other than a single question about whether the child combines words (Fenson et al., 2000, 2007). Thus, they are not as precise as the long CDIs (Fenson et al., 2007).

The CDI SF has been cross-validated using spontaneous speech sampling and/or direct assessments of language in a number of studies (see Jackson-Maldonado et al., 2013; Pérez-Pereira & Resches, 2007). A novel approach to developing SF versions (as short as a 25-word checklist) of the MacArthur-Bates Inventories by estimating the CDI scores based on parental responses on a limited set of sampled words extracted from the WordBank database has been provided recently (Mayor & Mani, 2019). The high correspondence between the longer CDI forms and the adapted versions of the SFs (Fenson et al., 2000; Mayor & Mani, 2019) further support the applicability of the shorter form when there are time constraints or parental-literacy concerns. In her review of language screening tools, Larson (2016) summarizes the results of several CDI SF–based assessments, concluding that the concurrent and predictive validity of the CDI SF supports the use of this measure with children up to 3 years of age.

Accuracy of Screening Tools

The cutoff values of the test score are of critical importance in determining a test's sensitivity and specificity values (Rydz et al., 2005). Therefore, when deciding the cutoff value, the advantages of identifying children with language difficulties must be compared with the disadvantages of increasing the rate of false positives (e.g., costs of additional testing, psychological effects on the family). The cutoff criteria most often used to identify children with difficulties or risk of developing problems is the < 10th percentile (Fenson et al., 2007).

According to Wallace et al. (2015), sensitivity for detecting a true speech and language delay or disorder using parent reports ranges between 50% and 94%, whereas specificity for detecting a child without speech and language delays ranges between 45% and 96%.

For example, Kim et al. (2014) analyzed the usefulness of a Korean CDI SF as a screening test of children with language delay by observing whether children with language difficulties place in the risk group or the norm group according to the cutoff values and found the CDI SF to be highly sensitive (97.2%) and specific (87.5%). However, the authors warn that a poor screening test result does not mean a diagnosis of language delay. It shows that a more detailed assessment should be carried out with the children (Kim et al., 2014).

Vehkavuori and Stolt (2018) compared the scores on the Finnish CDI SF and the Reynell Developmental Language Scales III and showed that while the Finnish CDI SF displays good specificity (92%) among Finnish 2-year-olds, the sensitivity of the measure, due to the fact that it only assesses the expressive language skills, is only low to moderate (33%; Vehkavuori & Stolt, 2018).

Some studies with longitudinal data show poor predictive validity of CDI SF–based measures (Dionne et al., 2003; Henrichs et al., 2011; Westerlund et al., 2006), while others have shown the long-term accuracy of results to be moderate to high, with CDI SF's giving accurate predictions of later language delay around the second year of life (Bello et al., 2018; Fernald & Marchman, 2012; Korpilahti et al., 2016).

Sources of Individual Variation

Several individual and environmental factors—such as child's age, gender, birth order, and parental education have been related to children's language development (e.g., Eriksson et al., 2012; Fenson et al., 1994; Huttenlocher et al., 1991; Le Normand et al., 2008; Stokes & Klee, 2009). Understanding the relative importance of these factors in determining the results of the CDI helps to decide whether separate norms (cutoff values) for various subgroups of children are needed. For example, Rescorla (2011) supports the use of gender-specific norms, since girls typically have larger vocabularies than boys do and using the same delay criterion for both genders (i.e., < 50 words or < 10th percentile on the CDI) will usually yield more boys than girls in the at-risk group. Girls, first-born children, and children of highly educated parents have scored higher on long form versions of the Estonian CDIs (Schults et al., 2012; Tulviste, 2007; Tulviste & Schults, 2020; Urm & Tulviste, 2016).

Current Study

Currently, there are only a limited number of validated language screening tools in Estonia, all of which are parental reports. The CDI-I: Words and Gestures for ages 0;8–1;4, CDI-II: Words and Sentences for ages 1;4–2;6 (Fenson et al., 1994), and the CDI-III for ages 2;6–4;0 (Eriksson, 2017) have been adapted into Estonian (see Schults et al., 2012; Tulviste, 2007; Tulviste & Schults, 2020; Urm & Tulviste, 2016, in detail). The assessment of language delay is based on parents' own worry and practitioners' knowledge about milestones in language development. The most common milestones that are observed are the acquisition of 50 words by age 2;0 and whether or not the child has started to combine words into utterances (Rescorla, 2011).

The main purpose of this study is to describe the adaptation and norming process of the Estonian MacArthur-Bates Communicative Development Inventory II Short Form (ECDI-II SF). We provide relevant psychometric statistics showing the reliability and validity of the instrument and analyze the relationships between the aspects of language development (expressive vocabulary, decontextualized language use, utterance production, and sentence complexity) measured by the subscales of the ECDI-II SF. The second aim was to focus on the accuracy of the ECDI-II SF as a screening tool for risk of language difficulties. The third aim was to analyze the effect of the child's age and gender as well as the factors of the child's social environment (i.e., birth order, parental education, day care attendance) on the results of the ECDI-II SF. According to previous studies, we expect that children's expressive vocabulary, decontextualized language use, utterance production, and sentence complexity scores on the ECDI-II SF are associated with children's age and gender, birth order, day care attendance, and their parent's educational attainment.

Method

Development of the ECDI-II SF

The ECDI-II SF is adapted similarly to the original SF versions of the CDI in English (Fenson et al., 2000) and Spanish (Jackson-Maldonado et al., 2013). The ECDI-II SF consists of a vocabulary checklist with 100 words, five questions about decontextualized language use, a question about producing utterances, and a section for sentence complexity.

We used the norming data of the long version of the ECDI-II (Tulviste, 2007; Urm & Tulviste, 2016) and compiled word frequency lists at different age levels to decide which words to include in the 100-word *vocabulary checklist* (see Fenson et al., 2000). We selected the words that at least 60% of the children at ages 1;8–3;1 produce and excluded the words that more than 90% of the children produce. Because we wanted to keep the original semantic categorization of the vocabulary checklist, we chose words from different categories to be represented on the SF (sound effects, food items, action words, etc.). Based on the ECDI-II norming data, we calculated simulated ECDI-II SF scores and observed correlations between the total ECDI-II scores and the simulated scores at different age levels and at different levels of language development (based on vocabulary scores).

According to the original CDI: Words and Sentences (Fenson et al., 1994), we included five questions about *decontextualized language use* (whether children use words to refer to the past or future, or to missing or absent objects or people) and a question about producing at least two-word utterances. We also asked whether he/she uses at least 50 words. Parents were instructed to choose between three response options, that is, their child produces at least two-word utterances "Often," "Sometimes," or "Not yet." The decontextualized language use section was scored by counting the times the parent had selected the answers "Often" or "Sometimes." The maximum score is 5. Use of at least two-word utterances was analyzed further as a categorical variable with two values (0 = does not produce at least two-word utterances, 1 = produces at least two-word utterances). Answers to the question about producing at least 50 words were analyzed in a similar way.

For the construction of the *sentence complexity section,* we used the original format of the Sentence Complexity subscale in the CDI: Words and Sentences (Fenson et al., 1994), the Finnish CDI grammar production section (Stolt et al., 2009), and ECDI-II data about the age of acquisition of different grammatical constructs by Estonian children. The ECDI-II data consisted of questions about the use of Estonian case endings in singular and plural. Parents had indicated whether their child uses the correct case ending. For example, the word table (*laud*) allative case singular/plural, onto the top of the table, tables (*lauale/laudadele*). We analyzed the data based on the observed age range and selected the items to be included in the Sentence Complexity subscale according to the 60%–90% criteria. We also selected the sentences based on naturalistic language sampling examples of typical utterances produced by Estonian children at the observed age range.

The sentence complexity section consists of 12 sentence pairs, where one sentence represented a simple and the other a more complex grammatical construct. The parents were asked to mark sentences that are more similar to the ones their child uses. For example, the parent filling in the form had to indicate, whether her/his child's speech is more similar to Sentence A:*"Auto katki"* (Car broken) or Sentence B:*"Minu auto katki"* (My car (is) broken) or A *"Ma annan"* (I give) or B *"Ma annan poisile"* (I give to the boy). The 12 sentence pairs represented the following grammatical constructs: past perfect, personal pronouns, two-word utterances, three-word utterances, plural, present perfect, and use of the following cases: allative, adessive, comitative, and illative. The scoring of sentence complexity based on the number of times the parent had selected the more complex sentence from the sentence pair. When the parent had selected Sentence A, the score is 0, and when the parent indicated that his or her child's speech resembles Sentence B, the score is 1. The total sentence complexity scores ranged from 0 to 12.

At the end of the form, parents filled in a short questionnaire about the child's health (including the question whether the child had difficulties with language development) and family background (number of older and younger siblings, maternal and paternal educational level, day care attendance, etc.).

Participants

Parents of 990 Estonian ages 1;8–3;1 children participated in the study. Children with some language development problems (as reported by their parents) were excluded from the norming sample. The data of all these children were used in the evaluation of the accuracy of the ECDI-II SF (n = 31). Children who were exposed to a language other than Estonian for more than 12 hr a week were also excluded from the norming sample (n = 51). The final norming sample consisted of 908 children. Half of them were girls (n = 455) and half boys (n = 453). The distribution of the sample based on sociodemographic factors is given in Table 1. Approximately 47.5% of the mothers and 26.9% of the fathers had acquired tertiary education. This is reflective of the Estonian population. Based on the Organisation for Economic Co-operation and Development adult education level indicator, 51.2% of 25- to 64-year-old Estonian women and 33.7% of 25- to 64-year-old Estonian men have acquired tertiary education (Organisation for Economic Co-operation and Development, 2020).

For the purposes of assessing the reliability and validity of the ECDI-II SF, a subsample of parents (n = 131) filled out the longer version of the ECDI-II within 2 weeks of completing the ECDI-II SF. The distribution of participants in the validation study by age group and gender is given in Table 1.

We evaluated the accuracy of the ECDI-II SF in a sample of 31 (nine girls and 22 boys) children ages 1;8–3 whose parents had indicated problems with their child's language development. These children were reported to be attending a speech therapist or another professional and had been suspected of or diagnosed with language disorders; two were suspected of autism spectrum disorders.

Procedure

The Research Ethics Committee of the University of Tartu reviewed and approved the study. We contacted parents online through social media, parenting websites, and

Table 1. The distribution of the Estonian MacArthur-Bates Communicative Development Inventory II Short Form adaptation study sample according to sociodemographic background and Estonian MacArthur-Bates Communicative Development Inventory II Short Form validation study sample by age group and gender.

	n	%
Adaptation study		
Maternal education		
Low	230	25.3
Medium	204	22.5
High	431	47.5
Missing	43	4.7
Paternal education		
Low	395	43.5
Medium	210	23.1
High	244	26.9
Missing	59	6.5
Birth order		
First born	362	39.9
Second or later born	546	60.1
Day care attendance		
No	188	20.7
Yes	718	79.1
Missing	2	0.2
Validation study		
Age group		
1;8–1;10	39	30
1;11–2;1	19	15
2;2–2;4	25	19
2;5–2;7	17	13
2;8–2;10	19	15
2;11–3;1	12	9
Total	131	100
Gender		
Boys	62	47
Girls	69	53

parenting groups as well as child-care facilities across Estonia. Parents who participated in the study were asked to sign the informed consent forms. Eighty percent of the parents filled in the form online (n = 732), and 20% filled in the paper form (n = 176).

Data Analysis

Reliability of the ECDI-II SF vocabulary checklist, decontextualized language use, and the sentence complexity score was examined for the entire sample based on the internal consistency of the scores. We calculated intraclass correlation coefficients (ICCs) to measure the agreement between the ECDI-II long and SF vocabulary, decontextualized language use, and sentence complexity scores. Correlations between the ECDI-II long form and the SF were calculated using Pearson correlation coefficient p with the effect of age partialed out.

Using quantile regression analyses with the logistic function, accounting for the effect of age and gender, we calculated fitted expressive vocabulary and sentence complexity scores. The cutoff value of the lowest 10th percentile was used for the ECDI-II SF (vocabulary score, sentence complexity) when calculating the specificity and sensitivity of the ECDI-II SF. We also calculated the sensitivity and specificity values of the 50-word criteria based on parental judgment.

An analysis of variance (ANOVA) was carried out to analyze the association of different factors of the child's social environment with the vocabulary, decontextualized language use, and sentence complexity scores on the ECDI-II SF. A binomial logistic regression was carried out to determine the factors associated with the production of utterances. Age group was treated as a categorical variable with six values (1–1;8 to 1;10, 2–1;11 to 2;1, 3–2;2 to 2;4, 4–2;5 to 2;7, 5–2;8 to 2;10, and 6–2;11–3;1). Birth order was dichotomized into a variable with two values (0 = first-born children, 1 = second or later born children). Parental education (maternal and paternal separately) was coded into variables with three categories each (0 = primary/vocational, 1 = secondary/postsecondary studies, 2 = tertiary education/graduate degree) to represent low, medium, and high educational level. Day care attendance was coded as a variable with two categories (0 = not attending day care, 1 = attending day care).

Results

Reliability and Validity

The internal consistency of the ECDI-II SF was very high in the expressive vocabulary section (Cronbach's alpha = .99) and the sentence complexity section (Cronbach's = alpha = .95) and acceptable in the decontextualized language use section (Cronbach's alpha = .73). These results are in accordance with previously published psychometric properties of the original CDI SF (Fenson et al., 2000) and other adaptations of the SF version of the CDI (Frota et al., 2016; Jackson-Maldonado et al., 2013; Roy et al., 2005).

ECDI-II SF Norms

The descriptive statistics for the Estonian children's (ages 1;8–3;1) expressive vocabulary, decontextualized language use, and sentence complexity are based on raw scores. The raw scores for boys and girls separately are presented in Table 2.

We present the norms (percentile scores) of Estonian children ages 1;8–3;1 based on fitted scores similarly to previous norming studies (e.g., Fenson et al., 2000; Jackson-Maldonado et al., 2013). We calculated the fitted expressive vocabulary scores using quantile regression analyses with the logistic function, accounting for the effect of age and gender. The percentile scores of the ECDI-II SF expressive vocabulary scores are presented for the 10th, 25th, 50th, 75th, and 90th percentile in Figure 1 for the whole sample. The < 10th percentile cutoff values for the vocabulary and sentence complexity scores for boys and girls separately are presented in Appendix.

Raw scores of boys and girls sentence complexity for children who are producing at least two-word utterances (n = 805) are given in Table 2. Parents who indicated that their child is not producing at least two-word utterances are not included in this sample. We calculated the fitted sentence complexity cutoff scores for children at ages 2;2 or older (n = 577). Figure 2 illustrates the fitted percentile scores of the Sentence Complexity subscale for the children ages 2;2–3;1.

Relations Among the Components of the ECDI-II SF

A statistically significant association emerged between the ECDI-II SF vocabulary score and sentence complexity score (r = .74, p < .001, with age partialed out), as well as vocabulary and decontextualized language use scores (r = .52, p < .001). A weaker correlation was observed between sentence complexity and decontextualized language use scores (r = .38, p < .001) showing the internal consistency of the ECDI-II SF.

Agreement Between the ECDI-II Long and SFs

A strong positive association appeared between the vocabulary (r = .86, p < .001), decontextualized language use (r = .84, p < .001), and sentence complexity (r = .86, p < .001) sections of the ECDI-II long and SFs. Table 3 represents the results of correlational analyses with the effect of age partialed out.

The ICC was computed to measure agreement between the two measures. ICC was .96 with a 95% confidence interval from .94 to .97 on the vocabulary score and .92 (.83–.96) on the sentence complexity score, indicating a good consistency of the scores on the different forms. The ICC of the decontextualized language use scores was .84 with a 95% confidence interval from .78 to .88, which indicates good agreement between the two assessments.

Sensitivity and Specificity

The accuracy of the ECDI-II SF was evaluated by observing the results of children with language problems

Table 2. Descriptive statistics and mean differences across age groups on the Estonian MacArthur-Bates Communicative Development Inventory II Short Form Expressive Vocabulary, Decontextualized Language Use, and Sentence Complexity scores (raw means and standard deviations).

Age group	Boys		Girls		Total		Mean difference (*SE*)	95% CI
	n	*M* (*SD*)	*n*	*M* (*SD*)	*n*	*M* (*SD*)		
Vocabulary								
1;8–1;10	65	28.29 (25.51)	75	40.32 (26.94)	140	34.74 (26.88)	–12.03(4.45)**	[–20.84, –3.22]
1;11–2;1	88	46.87 (34.46)	85	63.08 (28.85)	173	54.84 (32.76)	–16.21(4.84)***	[–25.76, –6.65]
2;2–2;4	79	60.23 (30.02)	70	74.74 (25.5)	149	67.05 (28.83)	–14.16(4.59)**	[–23.59, –5.44]
2;5–2;7	95	75.14 (26.05)	91	84.01 (23.4)	186	79.48 (25.12)	–8.87(3.64)*	[–16.05, –1.7]
2;8–2;10	78	78.73 (30.28)	80	90.99 (16.37)	158	84.94 (24.94)	–12.26(3.86)**	[–19.88, –4.63]
2;11–3;1	48	90.17 (15.97)	54	92.31 (16.42)	102	91.3 (16.16)	–2.15(3.22)	[–8.53, 4.23]
Total	453	62.54 (34.31)	455	73.69 (29.64)	908	68.12 (32.52)	–11-52(1.74)***	[–14.93, –8.1]
Decontextualized Language Use[a]								
1;8–1;10	65	3.83 (1.26)	74	4.32 (0.97)	139	4.1 (1.13)	–.49(.19)**	[–0.87, –0.12]
1;11–2;1	86	4.29 (1.01)	85	4.71 (0.55)	171	4.5 (0.84)	–.42(.12)***	[–0.66, –0.17]
2;2–2;4	79	4.57 (0.79)	69	4.75 (0.65)	148	4.66 (0.74)	–.18(.12)	[–0.42, 0.05]
2;5–2;7	95	4.73 (0.66)	90	4.9 (0.39)	185	4.81 (0.55)	–.17(.08)*	[–0.33, –0.06]
2;8–2;10	78	4.79 (0.61)	79	4.96 (0.25)	157	4.88 (0.47)	–.17(.07)*	[–0.31, –0.02]
2;11–3;1	48	4.94 (0.24)	54	4.93 (0.33)	102	4.93 (0.29)	.01(.06)	[–0.1, 0.13]
Total	451	4.52 (0.89)	451	4.76 (0.61)	902	4.64 (0.78)	–.24(.05)***	[–0.34, –0.14]
Sentence Complexity[b]								
1;8–1;10	33	1.91 (2.34)	54	2.50 (2.72)	87	2.28 (2.59)	–.59(.57)	[–1.73, 0.55]
1;11–2;1	67	3.69 (3.56)	74	5.04 (3.90)	141	4.40 (3.79)	–1.35(.63)*	[–2.61, –0.11]
2;2–2;4	73	4.68 (4.02)	65	6.03 (4.48)	138	5.32 (4.28)	–1.35(.72)*	[–2.78, 0.01]
2;5–2;7	94	6.23 (4.11)	89	7.99 (3.53)	183	7.09 (3.93)	–1.76(.57)**	[–2.88, –0.63]
2;8–2;10	76	7.84 (4.19)	79	9.66 (2.79)	155	8.77 (3.65)	–1.82(.57)**	[–2.94, –0.69]
2;11–3;1	48	9.65 (3.18)	53	9.96 (3.33)	101	9.81 (3.25)	–.32(.65)	[–1.61, 0.97]
Total	391	5.87 (4.38)	414	7.01 (4.3)	805	6.46 (4.37)	–1.14(.31)***	[–1.76, –0.54]
Produces at least two-word utterances/% of children								
	391	86.3%	414	91%	805	89%		
50-word milestone reached/% of children								
	364	70.1%	424	81.4%	788	76%		

Note. Percentage of children producing at least two-word utterances and 50 words across the whole sample and for boys and girls separately. CI = confidence interval.

[a]Missing values for six cases. [b]Sentence complexity scores are computed for children who produce at least two-word utterances (n = 805). *p < .05. **p < .01. ***p < .001.

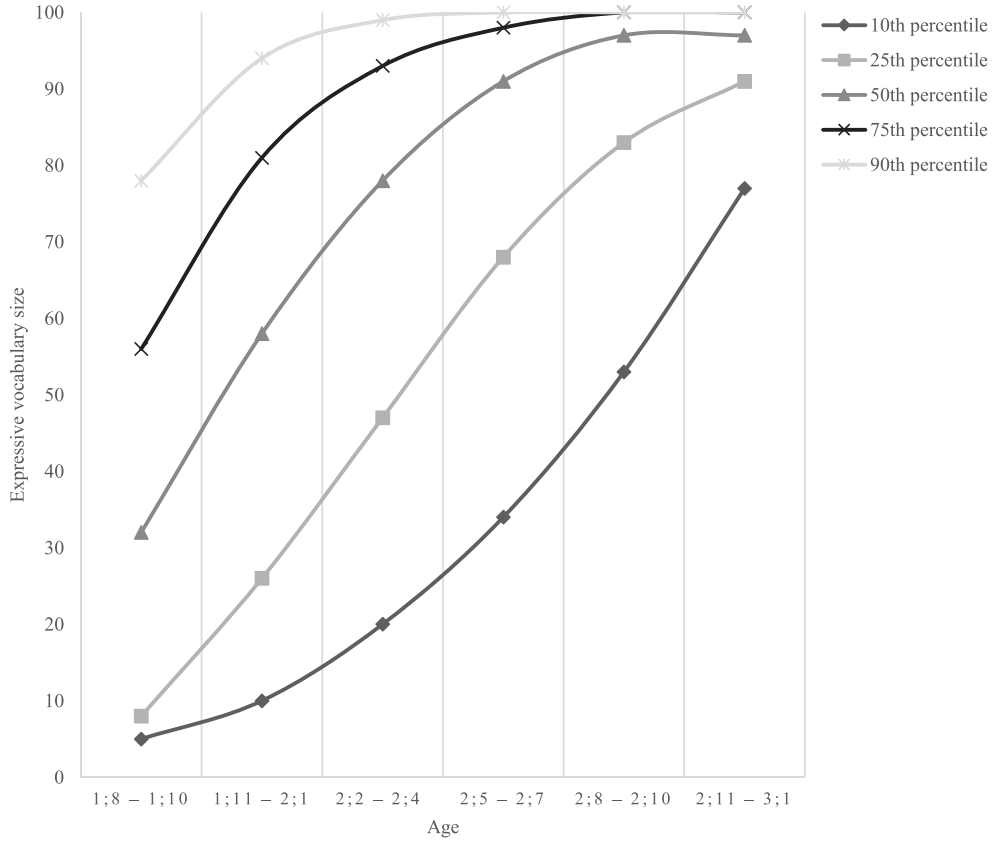
as reported by their parents (n = 31). The results of all children were below the mean of their age group. The ECDI-II SF expressive vocabulary 10th percentile cutoff revealed that the sensitivity of the measure was 73.1% and the specificity of the measure was 89.2%. An increase in the cutoff value to the 20th percentile showed an increase in the sensitivity of the ECDI-II SF (84.6%) but a decrease in the specificity of the measure (78.2%). We also estimated the accuracy of the ECDI-II SF sentence complexity score as an indicator of risk of language delay on children who were ages 2;2 up to 3;1. The sensitivity of the measure was 39%, and the specificity of the measure was 83%. An increase in the cutoff value to represent the 20th percentile showed a slight increase in the sensitivity of the measure (44%) and a specificity of 77%. Parents indicated in the parental questionnaire whether their child produces 50 words—a milestone often used for assessing risk of language delay. In our sample of at-risk children, we found that the sensitivity of the 50-word milestone would be 33%, and the specificity of this criterion would be 76%.

Effect of Age, Gender, and Sociodemographic Factors on Children's Vocabulary, Decontextualized Language Use, and Sentence Complexity

In order to analyze the association of the sociodemographic factors with vocabulary, for decontextualized language use and sentence complexity scores, we ran six preliminary one-way ANOVAs to determine the effect of the factors independently on different scales of the ECDI-II SF. A further factorial ANOVAs was carried out to determine the main effects and interactive effects of the factors that significantly explained the variability of the scores.

A one-way ANOVA revealed that age, $F(5, 907) = 86.27$, $p < .001$, and gender, $F(1, 907) = 27.45$, $p < .001$, are related to the ECDI-II SF vocabulary scores, but not parental education, birth order, or day care attendance. A two-way factorial ANOVA revealed the main effect of age group (in 3-month intervals), $F(5, 908) = 86.27$, $p < .001$, $\eta^2 = .32$, and gender, $F(1, 907) = 27.47$, $p < .001$, $\eta^2 = .03$, but no Age Group × Gender interaction on the ECDI-II SF expressive vocabulary scores. Bonferroni post hoc tests showed

Figure 1. Fitted expressive vocabulary percentile scores for the whole sample on the Estonian MacArthur-Bates Communicative Development Inventory II Short Form based on the quantile regression analyses.



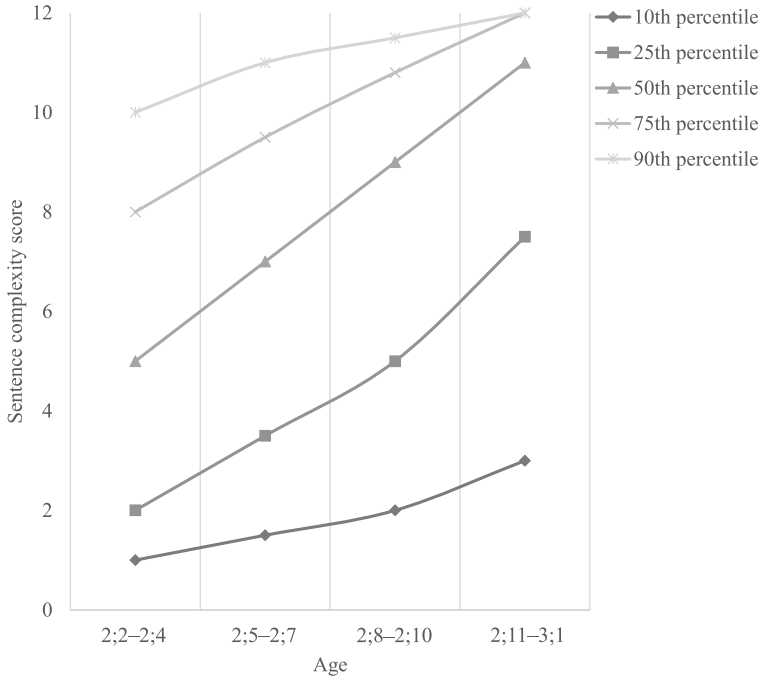
significant differences in vocabulary scores between younger age groups (1;8–1;10, 1;11–2;1, and 2;2–2;4), while the differences in the mean vocabulary scores between three older age groups were not statistically significant. Girls' vocabulary scores were significantly higher than boys' in all age groups, except the oldest (2;11–3;1; see Table 2).

A one-way ANOVA revealed that age, $F(5, 901) = 25.65$, $p < .001$, and gender, $F(1, 901) = 21.93$, $p < .001$, are related to the ECDI-II SF decontextualized language scores. A two-way factorial ANOVA performed on the ECDI-II SF decontextualized language use scores revealed a significant effect of age group, $F(5, 670) = 19.7$, $p < .001$, $\eta^2 = .13$, and gender, $F(1, 670) = 17.49$, $p < .001$, $\eta^2 = .03$, but no Age Group × Gender interaction. Bonferroni post hoc test revealed that children's decontextualized language use scores differed significantly between all age groups, except the two oldest. Boys' decontextualized language use scores were significantly lower than girls (see Table 2).

A one-way ANOVA revealed that age, $F(5, 804) = 62.9$, $p < .001$; gender, $F(1, 804)$ 13.76, $p < .001$; and maternal education, $F(2, 766) = 5.05$, $p < .01$, are related to the ECDI-II SF sentence complexity scores. A three-way factorial ANOVA performed on the ECDI-II SF sentence complexity scores revealed a significant effect of age group, $F(5, 805) = 62.9$, $p < .001$, $\eta^2 = .28$; gender, $F(1, 805) = 13.79$, $p < .001$, $\eta^2 = .02$; and maternal education, $F(2, 759) = 96.2$, $p < .01$, $\eta^2 = .02$. Bonferroni post hoc test revealed that children's sentence complexity differed significantly between all age groups, but there was no significant differences between the two oldest age groups (2;8–2;10 and 2;11–3;1). Girls' sentence complexity scores were higher than boys' scores. These gender differences were observable between ages 1;11 and 2;10, but not in the youngest (1;8–1;10) or the oldest age groups (2;11–3;1; see Table 2). Bonferroni post hoc test revealed that children of highly educated mothers (university degree) scored on average 1.2 points higher on the sentence complexity section than children of mothers with lower educational attainment (primary or vocational education; $SE = .32$, $p < .001$, 95% CI [.43, 1.96]). There were no significant differences between the sentence complexity scores of children with mothers who have medium levels of education (secondary or postsecondary studies), compared to the other two groups.

A hierarchical binary logistic regression was performed to ascertain the effects of the factors of the child's social environment as well as vocabulary and decontextualized

Figure 2. Fitted sentence complexity scores for the whole sample on the Estonian MacArthur-Bates Communicative Development Inventory II Short Form based on the quantile regression analyses.



language use scores on the likelihood of producing at least two-word utterances. The results of the analyses are presented in Table 4. In the first model, we observed how age group, gender, birth order, parental education, and day care attendance predict use of word combinations, and a statistically significant regression model emerged, $\chi^2(6) = 118.13$, $p < .001$, explaining 30% (Nagelkerke R^2) of the variance in the ability to produce word combinations. In the next step, we observed if vocabulary scores and decontextualized language use scores uniquely contributed to the prediction of combining words into utterances and found a statistically significant model, $\chi^2(8) = 269.26$, $p < .001$, explaining 61% of the variance (Nagelkerke R^2). Age group, ECDI-SF vocabulary and decontextualized language scores emerged as significant predictors of the word combinations outcome. The model correctly predicted 64% of cases where children did not produce word combinations and 97% of cases where they produced word combinations, giving an overall percentage correct prediction rate of 93%.

Discussion

ECDI-II SF shows strong internal consistency, which is comparable to psychometric properties reported in other adaptation studies (Fenson et al., 2000; Frota et al., 2016; Jackson-Maldonado et al., 2013, etc.). Strong cross-form correlations were observed between the long ECDI-II and the ECDI-II SF, and children with reported language difficulties performed lower on all subscales than children without reported language difficulties. Thus, the study confirmed that ECDI-II SF is a reliable and valid method for assessing Estonian toddlers' early expressive language development.

Our results show that child's vocabulary, decontextualized language use, the ability to produce at least two-word utterances, and complex sentences are interrelated. Decontextualized language subsection is too easy for typically developing children at this age, but in case of some language difficulties, it offers practitioners support in determining the extent of children's language problems and can

Table 3. Partial correlations between the vocabulary scores, sentence complexity, and decontextualized language use scores of the ECDI-II and ECDI-II SF.

Screening tool	ECDI-II SF Vocabulary	ECDI-II SF Sentence complexity	ECDI-II SF Language use
ECDI-II Vocabulary	.86*	.76*	.63*
ECDI-II Sentence Complexity	.74*	.86*	.47*
ECDI-II Language Use	.52*	.34*	.84*

Note. ECDI-II = Estonian MacArthur-Bates Communicative Development Inventory II; SF = short form.

*$p < .001$.

Table 4. Result of the hierarchical binary logistic regression analyses examining the factors of the social environment of the child and language production scores on the ECDI-II SF as predictors of the production of word combinations.

Factors	β	*SE*	Wald	*OR* (95% CI)
Model 1				
Age	0.29	0.04	64.95	1.35 [1.25, 1.45]***
Gender	0.84	0.26	10.11	2.31 [1.38, 3.86]***
Maternal education	0.16	0.17	0.89	1.17 [0.85, 1.61]
Paternal education	–0.09	0.16	0.34	0.91 [0.66, 1.25]
Birth order	0.12	0.26	0.23	1.13 [0.68, 1.88]
Day care attendance	0.26	0.29	0.84	1.29 [0.74, 2.28]
Model 2				
Age	0.12	0.04	6.88	1.12 [1.03, 1.23]**
Gender	0.06	0.33	0.03	1.06 [0.55, 2.04]
Maternal education	0.29	0.21	1.99	1.34 [0.89, 2.01]
Paternal education	–0.19	0.21	0.84	0.83 [0.56, 1.24]
Birth order	0.38	0.33	1.37	1.46 [0.77, 2.77]
Day care attendance	0.49	0.37	1.76	1.64 [0.79, 3.41]
ECDI-II SF Vocabulary	0.06	0.01	43.04	1.06 [1.04, 1.08]***
ECDI-II SF Language Use	0.47	0.18	6.73	1.61 [1.12, 2.29]**

Note. *SE* = standard error; *OR* = odds ratio; CI = confidence interval; ECDI-II = Estonian MacArthur-Bates Communicative Development Inventory II; SF = short form.

**$p < .01$. ***$p < .001$.

help determine the type of further assessment needed and guide planning of interventions.

The sensitivity and specificity values of the ECDI-II SF expressive vocabulary scores are within the acceptable range of developmental screening tools (70%–80% according to Law et al., 1998). At the same time, the rate of true-positives to false-negatives of the ECDI-II SF sentence complexity scores based on the < 10th percentile resulted in poor sensitivity (39%), while the specificity was moderate (83%). Our findings show that a child's expressive vocabulary seems to be a better indicator of risk of language delay at this early age than his/her grammatical skills. Thus, the findings show that it is reasonable to shorten the ECDI-II SF including only the brief vocabulary list and a single question if the child has begun to combine words, similar to most CDI short versions in other languages (see Fenson et al., 2007). Many 2-year-olds are still acquiring the more complicated sentence structures and grammatical constructs of a language, and thus, the scores on the sentence complexity scale might vary due to normal developmental variation rather than a delay in syntactical development.

We compared these results with the accuracy of a parental judgment on whether their child produces 50 words or not, which yielded a sensitivity of 33% and specificity of 76%. We can conclude that a vocabulary checklist, rather than a parental judgment on the size of the child vocabulary, will provide more information when the child is 2–3 years old or when the child's vocabulary size is around 50 words or more.

Developmental screening attempts to identify children with subtle symptoms, against a backdrop of discontinuous development, intermittent dysfunction, rapid development followed by slow mastering, and consolidation of skills and timelines when functions become pronounced enough for thorough investigation (Rydz et al., 2005). Thus, achieving the 90% and above sensitivity and specificity values is difficult. Having said that, ongoing efforts must be made to further increase the clinical accuracy of a screening test, in order to reduce the strain of under- and overreferrals on the health care system. Still, we have to consider that overreferred children perform substantially lower on tests measuring intelligence, language, and academic achievement and they could benefit from intervention services to enhance their developmental attainment (Forrest et al., 2020; Glascoe, 2001).

One reason why the sensitivity and specificity of the ECDI-II SF was only fair to moderate is the premise of imposing a fixed cutoff value on an underlying continuum, whereby children just missing the cutoff (i.e., the 11th percentile) are classified as normal (Henrichs et al., 2011). This can be alleviated with using more than one screening tool, combining measures that have different sensitivity and specificity values, to increase the identification of more children at risk of language delay. In this case, we can use ECDI-II SF, which has only moderate sensitivity but high specificity, in accordance with a measure or criteria that might have higher sensitivity but lower specificity. With the ECDI-II SF, we will correctly identify approximately 90% typically developing children as not being at risk for language delay. Roughly 25% of children with language delay will go undetected when we use the < 10th percentile criteria.

Our results show that the ECDI-II SF works especially well with children up to age 2;5. For older children (from ages 2;5 onwards) especially girls, a 100-word checklist is not as accurate in differentiating the scores of typically developing children, because of a ceiling effect.

As it has been previously shown with the ECDI-II (Tulviste, 2007; Urm & Tulviste, 2016), Estonian boys' and girls' vocabulary scores differed significantly. According to the current study, girls outperformed boys in almost every age group, except the oldest age groups where there is a leveling off. Likely, the brevity of the vocabulary list deepens the ceiling effect for girls with good language skills.

At the same time, the results indicated that gender accounts for approximately 3% of variance in the ECDI-II vocabulary scores, similarly to previous CDI-based studies in other languages (Eriksson et al., 2012; Rasmussen & Bleses, 2018; Simonsen et al., 2014; Trudeau & Sutton, 2011). Gender differences in vocabulary scores, although rather small, have practical value by showing the need for gender-specific norms and cutoff criteria of the ECDI-II SF to detect at-risk groups more accurately. Specifically, the ECDI-II SF < 10th percentile cutoff value on the vocabulary section is seven words for 2-year-old boys and 20 words for girls, while the combined norm is 10 words. Using a combined norm would result in the overreferral of 2-year-old boys, while at-risk girls would go undetected. Since the prevalence of language difficulties is higher among boys (Dockrell et al., 2014; Korpilahti et al., 2016), one can argue that the potentially overreferred group of 2- to 3-year-old boys might still be the

at-risk group. For practitioners, we propose using the combined norms along with the gender-specific norms when making decisions on children's placement in the risk group of language difficulties or when evaluating possible improvements in child's language development.

Our results indicate that the ECDI-II SF vocabulary and decontextualized language use scores are significantly related to age and gender, but not to parental education, birth order, or day care attendance. At the same time, maternal education, together with gender and age, appeared as an important factor associated with the sentence complexity scores, indicating that children of highly educated mothers outperform others in the acquisition of grammatical skills. This result can be explained by socioeconomic status–related differences in children's language environments reported in several prior studies: Children whose parents are highly educated hear a more nourishing language (Weldon, 2014); the quantity and quality of their language input is higher (Head Zauche et al., 2017; Hoff, 2003; Huttenlocher et al., 2010). Exposure to more complex syntax has found to promote children's own grammatical development (Huttenlocher et al., 2010; Vasilyeva et al., 2006). It is also possible that highly educated mothers' evaluations of their toddlers' language abilities are more accurate (Fenson et al., 2007). The sentence complexity section of the ECDI-II SF is more difficult to fill out than the vocabulary checklist. Completing the sentence complexity section requires more inference, better knowledge of language, more interest in what the child is talking about, and more abstract thought process that can appear to be more challenging to parents who are not used to analyzing their children's language use. It also has to be considered, as Oliver et al. (2002) conclude, that parental reports can be prone to bias and the accuracy of parental knowledge-based tools might be distorted, especially in clinical or educational contexts when parents are keen to prove that their child does not have any problems.

We showed that the ability to produce at least two-word utterances is related to the child's age, his/her expressive vocabulary score, and use of decontextualized language, with expressive vocabulary being the most significant predictor of grammar development. These results highlight the importance and practical value of making efforts to expose the child to a rich language environment to support his/her vocabulary development. While the use of at least two-word utterances is considered one of the milestones of language development at 2 years of age, our study shows that this developmental milestone is achieved by 90% of children at ages 2;2–2;4.

Limitations

The main limitation of our study is the fact that the validity and accuracy of the ECDI-II SF is calculated against the long form ECDI-II. The reason of it is that there is no "gold standard"—an examiner-administered standardized assessment method for Estonian-speaking children belonging to this age group. At the time of the study, the ECDI-II was the only standardized language measure for Estonian 2- to 3-year-olds. A comparison with a standardized measure or naturalistic speech sampling would provide additional support for the reliability and validity of the ECDI-II SF, and this is something to consider in future research.

The subsample for assessing the clinical accuracy of the ECDI-II SF is small, and based on parental judgment on whether their child has displayed longstanding difficulties with their language development or has serious developmental problems associated with delayed language development. Researchers explain that parental worry is an important correlate of poor expressive language, and parent's estimations can be accurate in identifying children with speech and language delays (Horwitz et al., 2003; Korpilahti et al., 2016; Sachse & Von Suchodoletz, 2008; Wallace et al., 2015). Further studies about the long-term predictive power of the ECDI-II SF need to be carried out on a larger sample of Estonian children with language difficulties.

Summary

Our study has important implications for clinical and research practice. The parental report of expressive language for 2- to 3-year-olds offers a quick measure of language development. The results of our study support the use of parent report measures in research and clinical settings, where time constraints and lack of resources are a concern. For example, the short parental report can be a useful tool for general practitioners, who can get a more exact estimate of the child's developing language skills, and, combined with parental concern and knowledge of general language development milestones, help provide necessary interventions for the children in need. In addition to that, the ECDI-II SF can be used in educational settings, where speech therapists or special education specialists employed at Estonian day care centers can determine whether children are in need of referrals for further assessment as well as provide a more focused help and intervention to at-risk groups.

In previous CDI-based studies, vocabulary production is the outcome measure most often targeted; we also described children's results on other components of the CDI such as decontextualized language use and grammar production. The ECDI-II SF identifies the risk of language difficulties and the need for further direct assessments of child communicative skills, which can specify the extent of children's difficulties. The results of our study add to the literature by providing data from a less studied non–Indo-European language. Furthermore, the clinical validity of an assessment tool based on parent report is evaluated. Future studies with longitudinal designs are required to provide information about the long-term predictive validity of the ECDI-II SF.

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Appendix

Cutoff Values for the ECDI-II SF

Table A1. Less than 10th percentile cutoff values for the Estonian MacArthur-Bates Communicative Development Inventory II Short Form vocabulary and sentence complexity scores (fitted data).

	Vocabulary						Sentence complexity					
	Boys		Girls		Total		Boys		Girls		Total	
Age group	*n*	< 10%	*n*	< 10%	*n*	< 10%	*n*	< 10%	*n*	< 10%	*n*	< 10%
1;8–1;10	65	2	75	6	140	5	33	n/a	54	n/a	87	n/a
1;11–2;1	88	7	85	20	173	10	67	n/a	74	n/a	141	n/a
2;2–2;4	79	14	70	35	149	20	73	1	65	1	138	1
2;5–2;7	95	25	91	51	186	34	94	1	89	3	183	1
2;8–2;10	78	38	80	67	158	53	76	2	79	5	155	2
2;11–3;1	48	55	54	85	102	77	48	3	53	6	101	3
Total	453		455		908		391		414		805	

Note. n/a = not applicable.

Table A2. Percentage of children combining words into at least two-word sentences at each age level.

	Boys		Girls		Total	
Age group	*n*	%	*n*	%	*n*	%
1;8–1;10	33	51	54	72	87	62
1;11–2;1	67	76	74	87	141	82
2;2–2;4	73	92	65	93	138	93
2;5–2;7	94	99	89	98	183	98
2;8–2;10	76	97	79	99	155	98
2;11–3;1	48	100	53	98	101	99
Total	391	86	414	91	805	89