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ORIGINAL ARTICLE

The Basque version of the CDI-words and gestures, extended up to age 2

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Abstract
The Basque version of the MacArthur-Bates Communicative Development Inventory (BCDI-1) can be used to evaluate 8–15-month-old children's receptive and expressive verbal skills, as well as nonverbal gesture production. This paper reports on data of 1002 children of an extended age range obtained with the BCDI-1 as a proxy measure of Basque children's communicative competence up to 24 months. Statistical analyses revealed a large effect of age on four BCDI-1 scales: phrases understood, production of gestures, receptive vocabulary, and expressive vocabulary, while sex, amount of exposure, educational level, and birth order showed small or no effect. The strong effect of age as well as the high between-scale correlations confirmed the advantage of using the BCDI-1 instrument for the extended age range.

Keywords: Basque; CDI parental report; gestures; preschoolers; vocabulary

Communicative development inventories

The Communicative Development Inventories or CDIs (Fenson et al., 1993), also called MacArthur-Bates Communicative Development Inventories (BCDI-1) (Fenson et al., 2007), are a nonexperimental method widely used to assess infants and toddlers' language skills. This group of instruments, based on parental reports on their children's verbal (and nonverbal) linguistic performance, includes three questionnaires, designed for three different age ranges: words and gestures or CDI-1 (8–16 or 8–18 months), words and sentences or CDI-2 (16–30 months), and CDI-3 (30–37 months). There are long and short CDI-1 and CDI-2 questionnaires, while there is an only short CDI-3. The CDIs contain sections corresponding to different developmental scales, some related to receptive and productive use of verbal and nonverbal communicative abilities (only in CDI-1) and others related to the productive use of the language. Since the creation of the US English instruments

over 30 years ago, CDI-1, CDI-2, and CDI-3 have been adapted to an array of over 110 languages (CDI Advisory Board, 2020). These adaptations form the baseline for a vast amount of publications, which highlights the relevance of parental information in the study of child development. See Ezeizabarrena & Kovacevic (2023) for a bunch of recent CDI studies on early lexical development in various unrelated languages such as Catalan, English, Estonian, Galician, Hebrew, Kroatian, Maltese, Norwegian, Spanish, and Swedish. Thus, in addition to the measurement of individual's communicative skills in one language, this instrument offers the possibility of conducting numerous types of studies to investigate, for instance, bilingual children's development in more than one of their languages, the relationship between vocabulary and online processing abilities, and so on (Hurtado et al., 2014; Marchman et al., 2010). Several aspects of communicative development are well under way before the end of the first year of life, and this was the reason for including items about nonverbal skills in the original CDI-1 questionnaire.

In order to capture the beginnings of gestural production and early word comprehension, starting age for the CDIs was set at 8 months in all the versions we know. In contrast, the ending age for the CDI-1 has experienced some variation in time and across adaptations. Thus, the original CDI-1 (Fenson et al., 1993) was normed for 8–16-month-olds as was the case of many adaptations, such as the Swedish CDI-1 (Eriksson & Berglund, 1999), while others, such as the Iberian Spanish (López-Ornat et al., 2005), the Galician (Pérez-Pereira & García Soto 2003), and the Basque (Barreña et al., 2008), were normed for 8–15-month-olds. This variation in age range across versions has been extended up to 18 months in the Mexican Spanish (Jackson-Maldonado et al., 2003), in the more recent versions of the American English CDI (Fenson et al., 2007), the Polish (Smozyńska et al., 2015), and the Catalan version (Serrat et al., 2022). The Danish version extended it up to 20 months (Bleses et al., 2008), and a recent study with the Hebrew version reported CDI-1 data of 12–24-month-olds (Gendler-Shalev & Dromi, 2022).

The extension of the age range to 18 or 20 months was related to absence of ceiling effects and floor effects, which are typical criteria when deciding on the accurate age range for instruments designed to assess development. Such effects "are considered to be present if more than 15% of respondents achieved the lowest or highest possible score, respectively" (Terwee et al., 2007 : 37). In the original CDI-1 (Fenson et al., 1993), no ceiling effects were found for the main scales of the instrument in the range between 8 and 16 months (*Phrases Understood, Words Understood, Words Produced,* and *Total Gestures*), which motivated the expansion of the range analyzed up to 18 months (Fenson et al., 2007). Ceiling effects were not reported for any of the word production, word comprehension, and gesture scales in the Danish CDI-1 up to 20 months (Bleses et al., 2008), nor in the Hebrew CDI-1 in the 12–24-month period of age (Gendler-Shalev & Dromi, 2022).

The BCDI-1

Basque is a language spoken in a region located in the western part of the Pyrenean Mountains, the Spanish–French border. It is considered an isolated language since no genetic relations with other languages have been proved yet. This language, with

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Table 1. Structure of BCDI-1

Subsection	Number of items
PART I. EARLY WORDS	
First signs of understanding	3
Phrases understood	28
Starting to talk	2
Vocabulary checklist: Sounds effects and animal sounds (12), Animal names (36), Vehicles (9), Toys (8), Food and drinks (30), Clothing (19), Body parts (20), Furniture and rooms (24), Small house items (36), Outside things and places to go (20), Games and routines (19), Action words (55), Words about time (8), Descriptive words (37), Pronouns (9), Question words (9), Preposition and locations (11), Quantifiers (8)	397
PART II. ACTIONS AND GESTURES	
A. First communicative gestures	12
B. Games and routines	6
C. Actions with objects	17
D. Pretending to be a parent	13
E. Imitating other adult actions	15
TOTAL Actions and gestures	63

around 800.000 adult speakers, is a minority language in the regions where it is spoken. It is in permanent contact with Spanish and/or French, and at least extent, with other languages. It is an agglutinative language with very rich morphology in both the nominal domain (case system) and the verbal domain (person and number morphemes in agreement with subject, direct object and indirect object, in addition to tense and aspect inflection).

All the long and short CDI instruments have been adapted to the Basque language as long and short BCDI-1, long and short BCDI-2 and BCDI-3, respectively (Barreña et al., 2008; Garcia et al., 2011, 2014), which maintain the structure of the original instrumentscam, but with noticeable differences in the items included in the lexical and grammatical scales. The BCDI-1 maintained the structure of the original US version (Fenson et al., 1993, 2007) in the number and typology of parts, sections, and subsections (Table 1). Most items were translated from the original in many sections, with the exception of the Vocabulary checklist, where some items and their number varied slightly across lexical classes. As in the original CDI-1, the BCDI-1 contains three initial sections in the *Part I Early Words*, preceding the vocabulary checklist: the *First signs of understanding* section with 3 items, the *Understanding of phrases* with 28 items, and two more items (*Starting to talk*) about whether the child has started repeating words or naming objects. Next, the *Vocabulary* checklist contains 397 items in which informants are asked to tick two different cells per word, depending on whether the child understands or whether it understands *and* says the word. The BCDI-1 has one more item than the

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original checklist of 396 items, but they are distributed in the same number and types of subsections, with a very similar number of items per section. Some very few exceptions are the subsections of pronouns (9 items in CDI-1 vs. 11 in the BCDI-1) and question words (9 items in CDI vs. 6 in BCDI-1). In *Part II, Actions and communicative gestures*, parents report on whether their child has already started to do any of the 62 actions or gestures, distributed in 5 blocks plus a final yes/no item about whether the child has begun to make pretend substitutions during the play, followed by some space to write down some examples. The majority of items in blocks A (First communicative gestures), C (Actions with objects), D (Pretending to be a parent), and E (Imitating other adult actions) were translated from the original CDI-1. Due to its high cultural component, the six items included in Block B (Games and Routines) were adapted rather than translated from the original CDI-1.

The BCDI-1 (Barreña et al., 2008) has been normed with 442 children aged 8–15 months, 217 girls and 225 boys, collected across 4 territories in the Basque-speaking area of Spain and France, in which 79% of the sample comes from Gipuzkoa and Bizkaia, the 2 Spanish provinces with highest rates of Basque-speaking population. The BCDI-1 showed accurate psychometric features. As for reliability, all the scales revealed high internal consistency ($\alpha > .88$, $n = 442$). Moreover, score stability was analyzed using the test–retest procedure with a small sample of 20 participants (age range 8–15 months) tested with one month interval (age range 9–16 months at retest) ($r > .83$). In both cases, the results obtained with the BCDI-1 were very similar to the ones obtained with the original CDI-1 (Fenson et al., 1993). The predictive validity of the test was measured with a group of 31 children tested with both instruments within a 6-month interval: BCDI-1 (age range 10–20 months) and BCDI-2 (16–26 months). The high correlation values found across scales between the scores obtained with the two instruments ($r = .48$ to $r = .74$) confirmed the predictive validity of the BCDI-1. More specifically, the receptive vocabulary scale of the BCDI-1 presented high correlation with the following BCDI-2 scales: expressive vocabulary ($r = .74$) and morphosyntactic complexity ($r = .61$). Similarly, the BCDI-1 expressive vocabulary scale showed high correlation with expressive vocabulary ($r = .60$) and with morphosyntactic complexity scales ($r = .48$) of the BCDI-2. Finally, high correlations were found between the BCDI-1 gesture scale and the BCDI-2 expressive vocabulary scale ($r = .63$) as well as between BCDI-1 gestures and BCDI-2 morphosyntactic complexity ($r = .56$).

Additionally, the convergent validity of the instrument was tested with a smaller sample of 11 participants, by means of the high correlations ($r > .78$) between the main BCDI-1 scales (total, gestures, receptive, and expressive vocabulary) and the communication scale of The Battelle Development Inventory, a test designed to measure child development (6 months to 8 years) in 5 domains: personal/social, adaptive, motor, communication, and cognitive (Cruz-López & González-Criado 2001).

Ceiling and floor effects were identified in some of the scales of BCDI-1 and BCDI-2. With BCDI-1, no ceiling effect was found for receptive vocabulary, expressive vocabulary, gesture production, and phrases understood along the age range tested with this instrument, while the scale of First signs of understanding was the only one showing such effect at 12 months. Floor effect was attested in

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expressive vocabulary throughout the whole age range up to age 15 months, tested with the BCDI-1, and up to 16 months tested with the BCDI-2 (Barreña et al., 2008). Floor effect was also found after age 2 in the remaining scales of the BCDI-2, all of them related to morphosyntax (word endings up to 26 months, verb inflection up to 27 months, sentence complexity up to 26 months). Late floor effects have been attested in the morphosyntactic scales of CDI-2 in many other languages. See Berglund & Eriksson (2000), Bleses et al., (2008), Fenson et al., (1993, 2007), Jackson-Maldonado et al. (2003), among others.

Thus, the absence of ceiling effects in the biggest scales of the BCDI-1 together with the floor effects found in expressive vocabulary found in both BCDI-1 and BCDI-2 instruments suggested the benefit of extending the age range of the BCDI-1. The current study analyzes the scores obtained BCDI-1 scales, which measure verbal and nonverbal communicative skills from children older than 15 months. More specifically, it aims to test the appearance of ceiling effects, in an age range extended to 24 months, in four scales: receptive vocabulary, expressive vocabulary, production of gestures, and phrases understood. Moreover, it investigates the effect of some sociodemographic factors on such scales.

The current article describes the development of the long BCDI-1 and the data obtained with it from 1002 children aged 8–24 months, with the aim of presenting a proxy measure of the receptive and expressive communicative competence of monolingual and bilingual children up to age 2 who acquire Basque as (one of) their L1. Moreover, the current article analyzes the effect of five variables: age, sex, birth order, parents' educational level, and the amount of exposure on the main BCDI-1 scales.

Method

Sample and data collection

All parents received information about the BDCI project either by personal contact or through kindergartens and schools. A total of 1053 questionnaires were obtained, most of them in printed versions filled in by hand (>95%), and very few online (<5%) by parents contacted through schools, kindergartens, and personal contacts. The procedure was approved by the Ethics Committee of the UPV/EHU. Out of them, 51 questionnaires were excluded from the sample because of incompleteness ($n = 26$) or because of falling outside the age range of 8–24 months ($n = 25$).

Due to the specificity of the Basque-speaking community, in which most speakers are regular users of (at least) one additional language, Spanish or French, bilingualism was not an exclusion criterion in this study. In contrast to other CDI studies, prematurity or ear infections were not exclusion criteria in this study either, since no significant differences were detected when comparing children born at the seventh month ($n = 6$), eighth month ($n = 74$), and ninth month of pregnancy ($n = 881$) after controlling for the effect of chronological age in receptive vocabulary ($F[2, 977] = 1{,}915$, $p = .148$, $\eta_p^2 = .004$), in expressive vocabulary ($F[2, 977] = 1{,}588$, $p = .205$, $\eta_p^2 = .003$), in gestures ($F[2, 976] = 2{,}963$, $p = .052$, $\eta_p^2 = .006$), and phrases understood ($F[2, 977] = 1{,}787$, $p = .168$, $\eta_p^2 = .004$). Nor were differences found between children with ear infections ($n = 219$) and those without ($n = 777$), controlling for the effect of age in receptive vocabulary ($F[1, 993] = .032$, $p = .859$,

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$\eta_p^2 = .000$), in expressive vocabulary ($F[2, 993] = .000$, $p = .992$, $\eta_p^2 = .000$), in gestures ($F[2, 992] = .868$, $p = .352$, $\eta_p^2 = .001$), and phrases understood ($F[2, 993] = .376$, $p = .540$, $\eta_p^2 = .000$).

Thus, the sample included the 1002 questionnaires that met the inclusion criteria mentioned. Many of them, $n = 526$, were previously analyzed in Barreña et al. (2008). Questionnaires completed for 511 girls (51%) and 491 boys (49%) were included in the sample (Table 2). In total, 613 children (61.2%) were firstborns, and 380 children were laterborns (37.9%).

As for language exposure, the majority of children were regularly exposed to (at least) one additional language, Spanish or French, depending on whether they lived in the Spanish ($n = 986$; 98.5% of the sample) or the French area ($n = 12$, 1.2%). The sample is not equally distributed across regions, since the majority of the questionnaires were obtained in the two Spanish administrative regions, namely the Basque Autonomous Community or BAC ($n = 929$) and Navarre ($n = 57$). Only four children's information regarding their living place is missing (.3% of the sample).

The information related to the amount of exposure to Basque was calculated based on the answer (*over 60% in Basque/40–60% Basque/less than 40% Basque*) informants selected for the question: *In general, in which language do people in the children's environment (parents, grandparents, teachers.) address to the child? Thus,* participants were divided into three groups according to the (relative) input or amount of exposure to that language: the Basque-dominant group, with Basque over 60% of the total language exposure ($n = 731$; 73%); the balanced group, with Basque input rate between 40 and 60% ($n = 143$; 14.3%), and the Spanish- or French-dominant group, with higher exposure to Spanish or French than to Basque, with <40% Basque input ($n = 110$; 11%). Additional input data for 18 children were not reported (1.8%).

See Table 3 for children's distribution over parental education groups in the sample and in the BAC. In line with Eriksson (2017), parental education was used as a proxy for socioeconomic status (SES) and for clarity, mother's (Column 2) and father's educational level (column 3) are presented separately from the highest educational level of the couple (column 4) in the table. The sample was divided into three levels, according to the highest educational level reported for each parental couple: primary, secondary, and university degree or higher. As shown in Table 3 (column 4), primary education was reported for 23 (2.3%) parents. The group of parents with secondary education ($n = 216$), which included secondary education, bachelor and professional education, that is, 4–6 years of additional education, reached 21.6%. The majority of the parents had university degrees ($n = 740$; 73.9%), and only a reduced set of questionnaires had this information missing ($n = 23$; 2.3%). It should be noticed that the rate of people with university qualification in the sample (73.9%) does not correspond exactly to the one for the general population (25% in the community, EUSTAT, 2023). However, it should not be disregarded that, since all the informants are Basque speakers, the current sample may be representative of the Basque-speaking community (a minority in the BAC) rather than of the general population living in the BAC.

The majority of questionnaires were completed by the children's mothers ($n = 654$, 65.3% of the sample), by their fathers ($n = 131$, 13.1%), by both

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Table 2. The sample's distribution over age (months) and sex

		Girls	Boys	Total
Age (months)	8	22	23	45
	9	31	25	56
	10	28	32	60
	11	25	28	53
	12	44	44	88
	13	45	48	93
	14	54	50	104
	15	41	66	107
	16	32	32	64
	17	23	26	49
	18	29	22	51
	19	16	15	31
	20	22	19	41
	21	24	21	45
	22	18	22	40
	23	27	25	52
	24	10	13	23
	Total	**511**	**491**	**1002**

($n = 201$, 20.1%), or by others ($n = 7$; .7%). Additional nine parents did not report this information.

The data files, the instrument, and the syntax for analyses are available at Open Science Framework (OSF) repository:

Data File:
https://osf.io/fxdrq
Syntax:
https://osf.io/7y4b8
Questionnaire:
https://osf.io/sge3b

Instrument

The instrument used was the BCDI-1 (Barreña et al., 2008). As mentioned in the introduction, this parental questionnaire contains six scales, but only four of them were included in the current study: Understanding of Phrases (28 items), Receptive Vocabulary (397 items), Expressive Vocabulary (397 items), and Actions and Gestures (62 items). The First signs of understanding and Starting to talk scales were not included in this study, for different reasons, the former scale because it showed a

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Table 3. Distribution of the educational level groups in the BCDI-1 sample and in the Basque Autonomous Community (BAC) in 2001 and 2020

Educational level	Mothers in BCDI-1 (%)	Fathers in BCDI-1 (%)	SES in BCDI-1 (%)	BAC 2001 (%)	BAC 2020 (%)
Primary education	3.9	10.6	2.29	26.19	18.13
Secondary education	25.8	44.8	21.56	50.49	56.88
University education	68.8	42.7	73.85	23.32	24.97
Missing	1.5	1.9	2.29		

ceiling effect at 12 months and the later one because of the reduced number of items (2), which hinders the calculation of the percentiles.

Statistical analyses

The reliability of the BCDI-1 scales was measured using Cronbach's alpha and Spearman–Brown split-half analysis methods; in both cases values greater than .70 are considered adequate (Cronbach, 1951). For each of the BCDI-1 scales analyzed, a regression analysis was performed taking five variables as factors: age, sex, birth order, SES, and linguistic input. With the factors that were significant in the regression analysis, analyses of variance (ANOVA) were performed to identify differences between groups, and next comparisons between groups were made using the Bonferroni post hoc test. To analyze the progression of each scale according to age, percentiles *P10, P25, P50, P75*, and *P90* were calculated. Percentiles were fitted by the quadratic model in line with Fenson et al. (1993). Finally, Pearson's correlation and partial correlations controlling for age were calculated to analyze the relationship between the scales.

Results

This section reports on the main scales of the BCDI-1. They will be presented in the following order, according to the number of items contained in each of them: receptive vocabulary (397 items), expressive vocabulary (397 items), gesture production (62 items), and phrases understood (28 items). First, descriptive statistics are presented for the scales analyzed in Table 4. Then, each subsection analyzes the internal consistency of the scale and the sociodemographic variables that have an impact on it, based on the data presented in Tables 5a–5c.

Next, percentiles will be presented for each scale in the corresponding Figures 1–4, paying attention to the potential appearance of floor or ceiling effects. At the end of this section, the correlations between the four scales are analyzed, as shown in Table 6.

Receptive vocabulary

The receptive vocabulary scale (397 items) showed good internal consistency: total sample (*Chrombach's* $\alpha = .996$), 8–15 m ($\alpha = .993$), and 16–24 m

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Table 4. Descriptive statistics of the BCDI-1 scales according to age (n = 1002)

	Receptive vocabulary		Expressive vocabulary		Gesture production		Phrases understood	
Age (months)	M	SD	M	SD	M	SD	M	SD
8	14.53	18.89	0.16	0.52	6.47	4.05	4.04	4.40
9	23.04	27.51	0.41	1.22	8.12	4.59	6.02	5.32
10	44.97	45.62	1.20	2.22	13.92	6.32	10.07	6.28
11	61.91	72.41	1.72	3.07	16.72	7.12	10.91	6.42
12	84.67	68.49	2.97	3.90	23.51	8.06	14.10	6.26
13	86.19	57.80	4.68	9.19	27.08	7.88	14.54	5.97
14	121.16	75.05	7.17	13.03	31.23	8.10	18.27	6.04
15	153.35	82.04	11.81	15.54	35.30	7.95	20.06	5.32
16	171.09	75.65	17.06	17.26	37.19	8.18	20.08	5.05
17	188.35	83.42	42.00	62.62	39.96	8.11	21.96	4.89
18	215.82	86.61	41.90	39.43	43.59	7.29	22.51	6.02
19	240.19	94.54	82.06	80.22	44.03	6.94	23.74	4.93
20	243.63	103.59	68.44	68.03	44.34	9.89	23.07	5.86
21	286.00	82.01	92.07	74.19	47.51	9.06	24.82	4.21
22	287.10	78.75	134.00	110.38	48.20	7.42	24.85	3.82
23	286.77	77.47	125.87	96.35	48.76	7.33	25.08	5.28
24	267.61	95.47	150.57	103.75	47.70	7.46	24.52	4.20

(α = .994); Moreover, the reliability values in the Spearman–Brown split-half analysis were 0.966 for the total sample, .953 for 8–15 m, and .935 for 16–24 m.

As shown in Table 5a, regression analysis of the total sample demonstrated that age accounted for 57.4% of the variance of vocabulary comprehension, while linguistic input and sex explained small percentages of the variance, 1.2% and .3%, respectively. SES and birth order were not associated with the children's receptive vocabulary. Moreover, an analysis of variance, which included linguistic input, sex, and age (F[2, 883] = 12.279, p < .001), showed higher estimated means for the Basque-dominant group, that is, the one with Basque input > 60% (M = 173.664, SD = 2.932) than for the other two groups. Scores were lower for the balanced group (M = 151.788, SD = 6.854, p = .010) and for the Spanish- or French-dominant group (M = 139.257, SD = 7.900, p < .001). No significant differences were found between these last two groups (Bonferroni, p = .694). Regarding sex, girls understood more words (M = 168.325, SD = 5.306) than boys (M = 141.805, SD = 4.916, F[1, 883] = 10.958, p < .001).

In the age range of 8 to 15 months (Table 5b), age explained 39.4% of the variance, SES and birth order explained small percentages of the variability (1.5% and 0.04%, respectively), though no differences were found in the between-group

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Table 5a. Impact of demographic variables on BCDI-1 scales for the total sample (8–24 months, $n = 1002$)

		B	*SE B*	*β*	*adjR²*
Receptive vocabulary	Age	20.146	.545	.776	.574**
	Sex	14.567	4.697	.064	.003*
$adjR^2 = .590$ $N = 959$	Birth order	−3.700	4.833	−.016	.000
	SES	−7.653	4.775	−.033	.000
	Input	−18.330	3.532	−.109	.012**
Expressive vocabulary	Age	9.646	.376	.647	.394**
	Sex	8.628	3.235	.066	.004*
$adjR^2 = .410$ N = 959	Birth order	−2.154	3.329	−.016	.000
	SES	−4.527	3.289	−.034	.000
	Input	−10.995	2.433	−.114	.012**
Gesture production	Age	2.867	.062	.834	.690**
	Sex	3.008	.531	.100	.011**
$adjR^2 = .701$ $N = 959$	Birth order	.109	.547	.024	.000
	SES	.449	.540	.015	.000
	Input	−.633	.399	−.028	.000
Phrases understood	Age	1.371	.043	.723	.496**
	Sex	1.261	.373	.076	.005**
$adjR^2 = .517$ $N = 959$	Birth order	.246	.384	.014	.000
	SES	−.667	.379	−.040	.000
	Input	−1.474	.280	−.120	.015**

Note: *$p < .05$, **$p < .01$.

comparisons. Neither sex nor input was associated with receptive vocabulary in this age range. According to the Bonferroni test ($p < .001$), children of parents with secondary education understood more words (M = 95.079, SD = 6.126) than those of university-educated parents (M = 65.721, SD = 3.307). No significant differences were found between these two groups and the children of parents with primary education. The Bonferroni test also did not identify significant differences according to birth order.

Among children from 16 to 24 months (Table 5c), age explained a smaller percentage of variance than in the previous age range (18.6%). Input (6.9%) and sex (1.3%) explained small percentages of the receptive vocabulary, while SES and birth order did not show significant results. Regarding the input, as we found when analyzing the entire sample, the children in the Basque-dominant group understood more words (M = 261.783, SD = 5.181) than those in the balanced (M = 215.861, SD = 11.003) and Spanish- or French-dominant (M = 200.414, SD = 12.026) groups. Regarding sex, girls (M = 202.889, SD = 7.414) understood more words than boys (M = 249.150, SD = 8.663).

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Table 5b. Impact of demographic variables on BCDI-1 scales (8–15 months, $n = 606$)

		B	*SE B*	*β*	*adjR²*
Receptive vocabulary	Age	20.158	1.191	.577	.323**
	Sex	7.158	5.288	.047	.000
$adjR^2 = .342$ $N = 573$	Birth order	−11.476	5.508	−.071	.004*
	SES	−19.140	5.211	−.125	.015**
	Input	−3.699	4.301	−.029	.000
Expressive vocabulary	Age	1,649	,182	,356	.123**
	Sex	1,009	,809	,049	.000
$adjR^2 = .123$ $N = 573$	Birth order	,226	,842	,011	.000
	SES	−1,164	,797	−,057	.000
	Input	−,673	,658	−,040	.000
Gesture production	Age	4,358	,135	,801	.645**
	Sex	2,050	,598	,085	.007**
$adjR^2 = .652$ $N = 573$	Birth order	−,791	,623	−,031	.000
	SES	,327	,590	,014	.000
	Input	−,835	,487	−,042	.000
Phrases understood	Age	2,333	,107	,671	.440**
	Sex	1,034	,477	,067	.003*
$adjR^2 = .460$ $N = 573$	Birth order	−,176	,497	−,011	.000
	SES	−1,674	,470	−,110	.012**
	Input	−,916	,388	−,073	.005*

Note: $^*p < .05$, $^{**}p < .01$

The curve for median or 50th percentile of words understood plotted in Figure 1 shows a progressive increase from 0 words at 8 months to 74 words at age 12 months, and from 204 words at 18 months to 321 words at 24 months of age. Interestingly, the slopes for different percentiles over age were about the same. Floor effect was found up to 9 months of age. However, no ceiling effect was observed in the entire age range analyzed.

Expressive vocabulary

The expressive vocabulary scale (397 items) also showed good internal consistency: total sample (Crombach's $\alpha = .996$), 8–15 m ($\alpha = .962$), 16–24 m ($\alpha = .995$); in Spearman–Brown split-half reliability analysis, the reliability values were .974 for the total sample, .866 for the 8–15 m, and .965 for the 16–24 m age range.

Regression analysis showed that age accounted for 39.4% of the variance of expressive vocabulary, in the whole sample, while linguistic input and sex only accounted for 1.3% and .4%, respectively. SES and birth order were not associated

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Table 5c. Impact of demographic variables on BCDI-1 scales (16–24 months, $n = 396$)

		B	*SE B*	*β*	*adjR²*
Receptive vocabulary	Age	16.106	1,591	,443	.186**
	Sex	23.145	8,394	,122	.012**
$adjR^2 = .267$ $N = 386$	Birth order	6.654	8,439	,035	.000
	SES	5.877	9,054	,029	.000
	Input	−31.176	5,794	−,242	.069**
Expressive vocabulary	Age	16,410	1,397	,504	.244**
	Sex	21,361	7,366	,125	.013**
$adjR^2 = .292$ $N = 386$	Birth order	−6,259	7,405	−,036	.000
	SES	−11,657	7,945	−,064	.000
	Input	−21,726	5,085	−,188	.035**
Gesture production	Age	1,467	,153	,428	.184**
	Sex	4,022	,808	,224	.049**
$adjR^2 = .233$ $N = 385$	Birth order	1,511	,812	,083	.000
	SES	,032	,873	,002	.000
	Input	−,359	,557	−,030	.000
Phrases understood	Age	,627	,093	,311	.089**
	Sex	1,110	,490	,105	.009*
$adjR^2 = .180$ $N = 386$	Birth order	,917	,493	,086	.000
	SES	,545	,528	,048	.000
	Input	−1,858	,338	−,260	.082**

Note: * $p < .05$, ** $p < .01$

with children's expressive vocabulary size, as shown in Table 3. A further analysis of variance, which included linguistic input, sex, and age ($F[2, 833] = 13.350$, $p < .001$), showed higher estimated means for the Basque-dominant (M = 51.641, SD = 1.864, $p < .001$) and balanced groups (M = 41.920, SD = 4.357, $p = .038$) than for the group with Basque input < 40%, namely Spanish- or French-dominant (M = 25.323, SD = 5.022). No significant differences were found between Basque-dominant and balanced groups (Bonferroni, $p = .122$). Regarding sex, girls produced more words (M = 44.780, SD = 3.373) than boys (M = 34.532, SD = 3.125, $F[1, 883] = 4.329$, $p = .038$).

In the age range of 8 to 15 months, the only variable that showed predictive power on expressive vocabulary was age, which explained 12.3% of the variance. Sex, birth order, SES, and input showed no relationship with expressive vocabulary.

Among 16–24-month-old children, age explained 24.4% of the variability in expressive vocabulary. Input and sex also explained small percentages of variance (3.5% and 1.3%, respectively), while birth order and SES were not associated with expressive vocabulary. Regarding the input, significant differences were found

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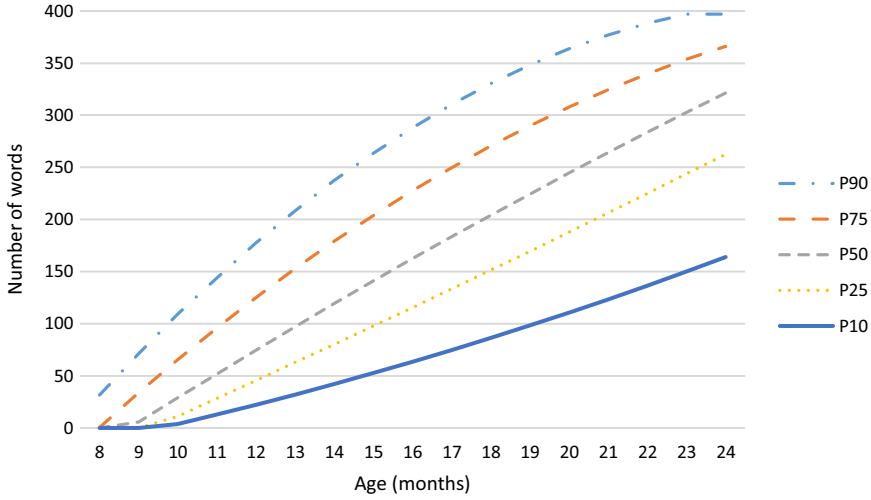

Figure 1. Receptive vocabulary scores for five percentiles over 17 age groups. Fitted by a quadratic model ($N = 1002$).

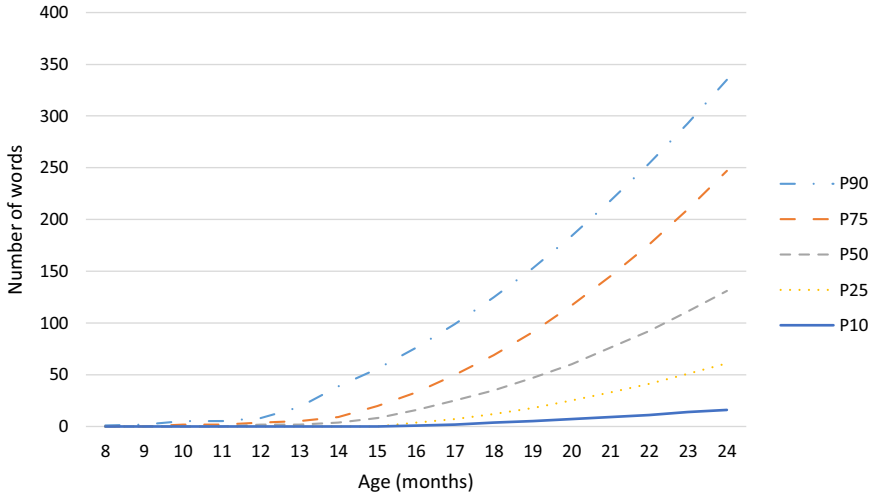

Figure 2. Expressive vocabulary scores for five percentiles over 17 age groups. Fitted by a quadratic model ($N = 1002$).

(Bonferroni $p < 0.001$) between the Basque-dominant (M = 85.894, SD = 90.146) and the Spanish- or French-dominant group (M = 47.896, SD = 61.401). The group with balanced input (M = 64.394, SD = 74.366) did not differ significantly from either group. Regarding sex, girls produced more words (M = 89,584, SD = 94,692) than boys (M = 63,532, SD = 71,853).

As plotted in Figure 2, median values of expressive vocabulary were 0 or close to 0 up to age 12 months. They increased to 35 words at the age of 18 months and

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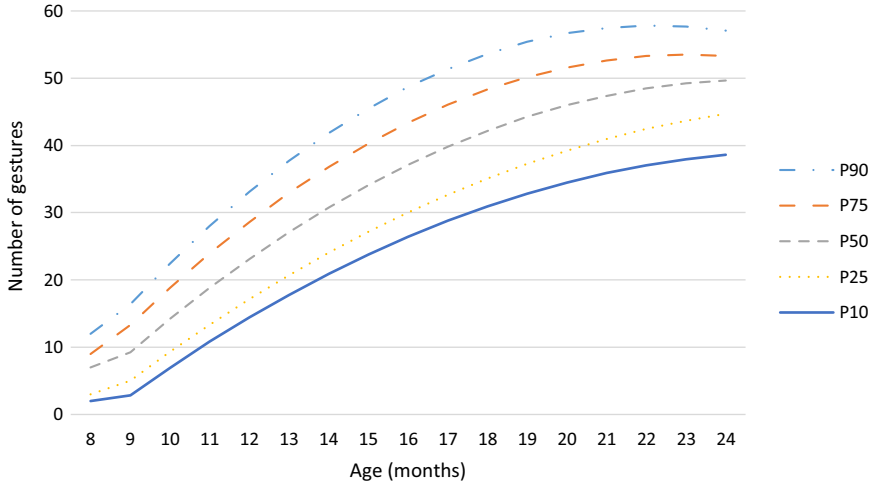

Figure 3. Gesture production scores for five percentiles over 17 age groups. Fitted by a quadratic model ($N = 1002$).

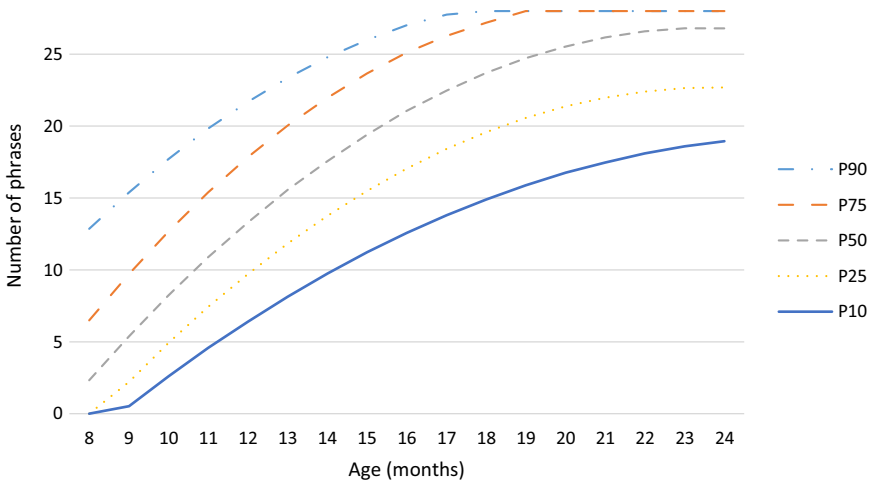

Figure 4. Phrases understood scores for five percentiles over 17 age groups. Fitted by a quadratic model ($N = 1002$).

reached 131 words at 24 months. No ceiling effect was found for the entire age range analyzed, whereas a clear floor effect was observed on this scale up to 15 months.

Gesture production

The internal consistency of the 62 items of the gesture production scale was adequate: total sample (Crombach's α = .964), 8–15 m (α = .946), 16–24 (α = .905); in Spearman–Brown split-half reliability analysis, the reliability values were .920 for the total sample, .907 for 8–15 m, and .818 for 16–24 m.

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Table 6. Correlations between four BCDI-1 scales and age. Pearson's correlations (and partial correlations controlling for age) for the total sample and for 8–15 and 16–24-month intervals

	Receptive vocabulary	Expressive vocabulary	Gesture production	Phrases understood
Total sample (n = 1002)				
Receptive vocabulary		.643**	.812**	.828**
		(.327)**	(.505)**	(.640)**
Expressive vocabulary			.550**	.488**
			(.061)	(.078)*
Gesture production				.796**
				(.530)**
Age	.756**	.629**	.830**	.700**
8–15 months (n = 606)				
Receptive vocabulary		.412**	.674**	.778**
		(.273)**	(.453)**	(.657)**
Expressive vocabulary			.452**	.378**
			(.292)**	(.203)**
Gesture production				.719**
				(.438)**
Age	.561**	.360**	.798**	.649**
16–24 months (n = 396)				
Receptive vocabulary		.586**	.692**	.741**
		(.470)**	(.620)**	(.721)**
Expressive vocabulary			.460**	.450**
			(.313)**	(.354)**
Gesture production				.569**
				(.502)**
Age	.438**	.498**	.431**	.304**

Note: * $p < .05$, ** $p < .01$.

According to the regression analysis shown in Table 5, age accounted for 69.0% of the variance of gesture production in the whole sample, while sex accounted for 1.1%. Linguistic input, SES, and birth order were not associated with gesture production. A variance analysis that included sex and age ($F[1, 9882] = 22.499$, $p < .001$) showed higher estimated means for girls (M = 35.360, SD = .558) than for boys (M = 31.201, SD = .517).

The results in the two age ranges (8–15 and 16–24 months, see Tables 5b and 5c) revealed that the variables associated with the production of gestures are the same, age and sex, while birth order, SES, and input showed no explanatory power. The variance

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explained by age in the production of gestures was very different in both age ranges: 64.5% (8–15 months) and 18.4% (16 to 24 months). However, the percentage of variance explained by sex was greater in the second age range (4.9%) than in the first (0.7%). Finally, in both age ranges, girls (M = 24.642, SD = 12.315, range 8–15 and M = 46.189, SD = 8.974, range 16–24) produced more gestures than boys (M = 21.696, SD = 11.631, range 8–15 and M = 41.935 SD = 8.434, range 16–24).

Figure 3 plots a progressive increase of gesture production throughout the studied period, in which median values increased from 7 to 23, 42, and 50 gestures, along the ages of 8, 12, 18, and 24 months, respectively. The slopes for different percentiles were about the same over age, and no floor or ceiling effects were attested.

Phrases understood

The 28 items that make up the phrases understood scale showed good internal consistency: total sample (Chrombach's $\alpha = .951$), 8–15 m ($\alpha = .936$), 16–24 m ($\alpha = .910$); in Spearman–Brown split-half reliability analysis, the reliability values were .928 for total sample, .917 for 8–15 m, and .872 for 16–24 m.

Regression analysis in the whole sample showed that age accounted for 49.6% of the variance of phrases understood. Linguistic input accounted for 1.5% and sex .5%. SES and birth order were not associated with this scale, as shown in Table 5a. A further analysis of variance that included linguistic input, sex, and age ($F[2, 883] = 9.264$, $p < .001$) showed higher estimated means for the Basque-dominant group (M = 18.763, SD = .225) than for the other two groups, Balanced (M = 17.098, SD = .526, $p = .011$) and Spanish- or French-dominant (M = 16.734, SD = .607, $p = .005$). No significant differences were found between these last two groups (Bonferroni, $p = 1.000$), and neither were significant differences found according to sex ($F(1, 883) = 1.525$, $p = .217$). The number of sentences understood was similar for girls (M = 17.996, SD = .408) and boys (M = 17.084, SD = .378).

In the age range of 8–15 months, age explained 44% of the variance in phrases understood. SES, input, and sex explained small percentages of variance (1.2%, 0.5%, and 0.3% respectively). Regarding the SES, children of parents with secondary education (M = 15.167, SD = 7.925) understood more sentences than children of parents with a university degree (M = 13.291, SD = 7.655; Bonferroni, $p = .016$). The Bonferroni test did not identify significant differences according to sex or input.

In the age range of 16 to 24 months, age and input explained very similar percentages of variance (8.9% age and 8.2% input). Sex explained 0.9%. Birth order and SES were not associated with phrases understood. Regarding the input, the Bonferroni test identified significant differences between the Basque-dominant group (M = 24.117 SD = 4.389) and the other two groups, balanced (M = 21.7887, SD = 6.602) and Spanish- or French-dominant (M = 20.448, SD = 6.015). There were no significant differences between these last two groups. Regarding sex, girls (M = 23.928, SD = 5.039) understood more sentences than boys (M = 22.402, SD = 5.434, Bonferroni, $p = .029$).

Figure 4 demonstrates the progressive increase in the number of phrases understood along the period of study. Median values of phrases understood grew

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from two phrases understood at 8 months to 13, 24, and 27 phrases at 12, 18, and 24 months of age, respectively.

A floor effect was observed among 8-month-old children. In contrast, ceiling effect was observed from 18 months on.

Correlation between scales

Almost all the correlations analyzed were statistically significant for the total sample, with the only exception of the partial correlation between expressive vocabulary and gesture production, controlling for age (Table 4). The highest partial correlations controlling for age ($r > .50$) were found between the scales of receptive vocabulary, phrases understood, and gesture production. Expressive vocabulary showed a partial weak correlation with phrases understood and a medium correlation with receptive vocabulary. All BCDI-1 scales showed a high correlation with age ($r > .60$).

Analyzing the correlations in the two age ranges, we found very similar results, where all correlations were significant. It should be noted that the scales related to gestures or comprehension (both phrases and words) showed the highest correlation with age in the range of 8–15 months, while the correlation between age and vocabulary production was higher among children from 16 to 24 months.

Summing up, the study of 1002 parental reports on 8–24-month-old children's communicative skills obtained with the Basque CDI-1 revealed a progressive increase of the scores obtained in the four scales analyzed: phrases understood, production of gestures, receptive vocabulary, and expressive vocabulary. No ceiling effect was observed for three of the four scales studied (receptive vocabulary, expressive vocabulary, or gesture production), while ceiling effect was found in the phrases understood scale, where 25% of the 18-month-old children reached the highest scores.

The internal consistency was optimal for the four scales analyzed (Cronbach's alpha >.90 and Spearman–Brown $r > .86$), both for the total sample and for the two age ranges analyzed: 8–15 months (first age range, corresponding to the original BCDI-1) and 16–24 months (second age range, current extension).

Age was the factor that better explained the variance in the four BCDI-1 scales between 8 and 24 months, since it accounted for 39.4–69.0% of such variance, which is considered a large effect size (Cohen, 1992). Additional statistical analyses conducted separately revealed that age explained a greater percentage of variance in the scales of receptive vocabulary, gesture production, and phrases understood (between 32.3% and 64.5%) than in expressive vocabulary (12.3%) in the first range. In contrast, age appeared as a better predictor of gesture production, receptive and expressive vocabulary scales (between 18.4% and 24.4%), than of phrases understood (8.2%), in the second range.

Other factors such as input, sex, birth order, or SES did not appear to be as reliable predictors as age for the BCDI-1 up to age 2. The effect of input was nonexistent or very small in the first age range, and only related to the phrases understood scale (0.5% of the variance), while it affected the variance in the phrases understood, receptive and expressive vocabulary scales (8.2%, 6.9% and 3.5%, respectively). Sex explained small percentages of gesture production and phrases understood (0.7% and 0.3%, respectively) in the first range. The explanatory power

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of this variable was very small in the second range for phrases understood (0.9%), receptive vocabulary (1.2%) and expressive vocabulary scales (1.3%), and small for gestures (4.9%).

Analyses revealed significant between-scale correlations in all the variable pairs, where receptive vocabulary, gesture production, and phrases understood appeared as highly correlated ($r > .50$), while expressive vocabulary showed lower correlation with such scales for the total sample ($r < .33$). All scales showed high correlations with age ($r > .60$) for the total sample. In the 8–15-month age range, the correlation between expressive vocabulary and age was medium in size ($r = .36$) and large for the rest ($r = .56$–$.80$), while in the 16–24-month age range the correlation between phrases understood and age was of medium size ($r = .30$) with the rest of large size ($r = .43$ to $r = .50$).

Discussion

The first goal of this study was to test the adequacy of the BCDI-1 to assess the communicative development of children up to age 2, by extending the age range of the original normed data (8–15 months) to 24 months. More specifically, it aimed to test the accuracy of the BCDI-1 to assess 16–24-month-old children's development, which has been regularly covered by CDI-2 instruments in Basque and in other languages. Second, it aimed to analyze the effect of five variables (age, sex, birth order, SES of the parents, and linguistic input) in the main four scales of BCDI-1: phrases understood, production of gestures, receptive vocabulary, and expressive vocabulary.

In regard to the first goal, the percentile analysis by month, distinguishing 17 age groups in the age range of 8–24 months, revealed a progressive increase of the scores obtained in the four scales analyzed. Furthermore, the internal consistency was optimal for the four scales analyzed, both for the total sample and for the two age ranges analyzed, 8–15 months and 16–24. Both the absence of ceiling effects for vocabulary and gestures, as well as the internal consistency in the BCDI-1 scales analyzed up to 24 months, were in line with results obtained with other CDI-1 versions, for the age range of 8–18 months (Fenson et al., 2007, Jackson-Maldonado et al., 2003), 8–20 months (Bleses et al., 2008), and even for 12–24 months (Gendler-Shalev & Dromi, 2022).

In the second goal, age revealed as the factor that better explained the variance in the four BCDI-1 scales between 8 and 24 months. The effects found in the current sample were considerably higher (25%) than the ones reported for the Basque normative sample of 8–15-month-olds (13.5–46.7%) by Barreña et al. (2008). Not surprisingly, the explanatory power of the age factor increased with the 9-month extension of the age range to 24 months for three out of the four scales studied (in 32.0% for gestures, in 25.9% for expressive vocabulary, and in 21.6% for receptive vocabulary) and less for the phrases understood scale (2.9%). In general, age revealed as a better predictor for the scales associated with comprehension (receptive vocabulary and phrases understood) and with gesture production, than with production (expressive vocabulary) in the Basque CDI, as it also did in other CDI-1 versions (Bleses et al., 2008; Eriksson & Berglund, 1999; Jackson-Maldonado

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et al., 2003, among others). In order to better understand the explanatory power of age in this extended sample, additional statistical analyses were conducted separately for the age ranges of 8–15 months (previously covered by BCDI-1 instrument) and 16–24 months (previously covered by BDCI-2 instrument). Thus, it was observed that in the first range, age explained a greater percentage of variance in the scales of receptive vocabulary, gesture production, and phrases understood (between 32.3% and 64.5%) than in expressive vocabulary (12.3%). The smaller effect in expressive vocabulary may be related to the small size of the expressive vocabulary at this age range (e.g. 11.8 words average at 15 months). In contrast, age appeared as a better predictor of gesture production, receptive, and expressive vocabulary scales (between 18.4% and 24.4%), than of phrases understood (8.2%), in the age range of 16–24 months. This weaker effect in the later scale was related to the ceiling effect found from 18 months onward.

Other factors such as input, sex, birth order, or SES did not appear as reliable predictors as age for the BCDI-1 up to age 2. To start with, the effect size of input or of the relative amount of exposure to the Basque language revealed as very small, since it accounted for 1.2–1.5% of the score variance found in the scales of receptive and expressive vocabulary and phrases understood for the entire sample. No effect of input was found in gesture production scores. These results were in line with findings with the long and short versions of the BCDI, where no input effects were found for gestures, nor for phrases understood or receptive and expressive vocabulary in the age range of 8–15 months, and a small effect was attested in expressive vocabulary in the 16–30-month age range. Despite the weak effect attested for input up to 30 months of age in many scales, this variable appeared as very relevant for the expressive vocabulary scale in particular, since its effect increased steadily in this scale contained in all, short and long, BCDI instruments covering the age range of 8–49 months (Barreña et al., 2008; Ezeizabarrena & Garcia, 2022; Garcia et al., 2011, 2014). Thus, input effect varied from null in the BCDI-1 short and long versions, to small in short and long BCDI-2 and to large in BCDI-3. Noteworthy, the effect of input in expressive vocabulary was larger than the age effect for the 30–49-month age range tested with BCDI-3 (Ezeizabarrena & Garcia, 2022). In the current study, the effect of input was nonexistent or very small in the first age range (8–15 months), while in the second age range, it explained small percentages of variance (<9%) in the phrases understood, receptive and expressive vocabulary scales.

Next, sex also appeared as a very weak factor in the entire sample studied up to 24 months, since it showed a very small effect in the scales for receptive vocabulary, expressive vocabulary, gesture production, and phrases understood, in which it accounted for only 0.3% to 1.1% of the variance. More specifically, sex was not associated with either of the vocabulary measures (receptive and expressive) among children between 8 and 15 months, and only explained small percentages of gesture production and phrases understood (0.7% and 0.3%, respectively). In the range of 16–24 months, girls show slightly higher scores than boys, although the explanatory power of this variable was still very small for phrases understood (0.9%), receptive vocabulary (1.2%), and expressive vocabulary scales (1.3%), and small for gestures (4.9%). Sex effects have been reported in many CDI studies which showed advantage for girls in some scales (Bleses et al., 2008; Eriksson et al., 2012; Fenson et al., 1993,

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2007; Kuvac-Kraljevic et al., 2021), even though the effect was small or null for gestures and vocabulary, respectively, in Swedish (Eriksson and Berglund, 1999), Mexican Spanish (Jackson-Maldonado et al., 2003), and Hebrew (Gendler-Shalev & Dromi 2022), or has been found with children older than age 2 (Holm et al., 2023; Simonsen et al., 2014). The weakness of such variable may question the need to develop separated norms for boys and girls in some languages. This seems to be the case for Basque, on the base of the current findings of no effect for sex before the age of 16 months and of a very slight advantage for girls after that age. Moreover, in a previous study, Garcia et al. (2021) found sex effects in four of the five blocks of the gestures and actions scale (8–24 months), with an advantage for girls in blocks First communicative gestures (small), Actions with objects (small), and Pretending to be a parent (medium effect) and for boys in block Imitating other adult actions (small effect). All these findings together suggest that a Basque BCDI-1 norm for boys and another for girls is not justified before age 2, in contrast to other languages such as Norwegian (Simonsen et al., 2014).

Finally, birth order and SES did not appear as predictors for communicative development for any of the four BCDI-1 scales analyzed nor for BCDI-2 (Ezeizabarrena & Garcia, 2017). Such results are in line with other studies in which no or weak effects of these variables were reported for many CDI-1 scales, although older children tested with CDI-2 and CDI-3 instruments whose parents had higher education level were reported to have bigger vocabulary size; see Eriksson (2017), Fenson et al. (1993, 2007) and Jackson-Maldonado et al. (2003) for details. Nevertheless, two facts may have had an effect on the results obtained. On the one hand, the skewness toward highly educated parents in the Basque sample might affect positively in the scores. On the other hand, the extended attendance to Basque-speaking kindergartens by the majority of preschool children might have compensated the potential socioeconomic effects found in other CDI studies. However, when we analyzed the influence of these two factors in two age ranges, we found very small effects of birth order on receptive vocabulary, and only in the first age range. Similarly, the (small) effect of SES (<2%) was only identified among 8–15-month-olds in receptive vocabulary and phrases understood.

Additional statistical analyses revealed significant between-scale correlations in all the variable pairs, where receptive vocabulary, gesture production, and phrases understood appeared as highly correlated, while expressive vocabulary showed lower correlation with such scales for the total sample. Similar results have been reported in the literature (Eriksson & Berglund, 1999; Fenson et al., 1993, 2007; Jackson-Maldonado et al., 2003; Lopez-Ornat et al., 2005). The correlations between scales were similar in the two age ranges: higher between receptive vocabulary, gesture production, and phrases understood than between these scales and expressive vocabulary. However, it is worth noting that among children aged 16–24 months, the correlations between expressive vocabulary and the rest of the scales were greater than in the range of 8–15 months.

Furthermore, all scales showed strong correlation with age ($r > .60$) for the total sample, which varied across scales from first to second age range, from medium size (expressive vocabulary) or large (rest of scales) in the first age range, to medium (phrases understood) or medium-large (the rest of scales) in the second age range.

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These results suggest that receptive vocabulary, sentence comprehension, and gesture production are the most suitable scales for the study of communication development between 8 and 15 months, while for the range of 16–30 months the most appropriate scales are vocabulary (both receptive and productive) and gesture production.

Summing up, the predictive power of age to account for the variance in the four BCDI-1 scales, as well as the strong between-scale correlations attested, provide evidence for the validity of this instrument to assess the communicative skills of (bilingual) Basque children older than 15 months, up to 24 months of age. Moreover, floor effects found in many scales of expressive vocabulary and morphosyntax in the BCDI-2, some of them remaining over age 2 (Barreña et al., 2008), question the accuracy of that instrument for the assessment of communicative development in the age range of 16–24 months. These two facts confirm the accuracy achieved by using the BCDI-1 instrument for the age range up to 24 months.

The extension in age proposed for the CDI-1 will provide professionals with an instrument for the proper assessment of children's nonverbal (gestures) and verbal communicative skills (vocabulary) during the first and very relevant years in the development of language, in a period in which children are still in the process of developing their expressive morphosyntax. Further research including new score stability and convergent validity data will be needed in order to reinforce the empirical evidence on the instrument's reliability and validity.

Replication package

Replication data and materials for this article can be found at the data files, and the instrument and the syntax for analyses are available at Open Science Framework (OSF) repository:

Data File: https://osf.io/fxdrq; Syntax: https://osf.io/7y4b8; Questionnaire: https://osf.io/sge3b.

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Competing interests. The authors declare none.

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