Adaptation of the MacArthur-Bates Communicative Development Inventory into Azerbaijani: Words and Sentences

Sabina Sharifova and Patricia J. Brooks

1. Introduction

Parent-report instruments, such as the MacArthur–Bates Communicative Development Inventories (CDI), are among the most widely used tools for assessing early vocabulary development. The CDI has been adapted for more than 100 languages, providing a rich cross-linguistic database that enables researchers to examine vocabulary development across diverse linguistic and cultural contexts (Marchman & Dale, 2023). CDI provides rapid, reliable, and ecologically valid estimates of children's lexical abilities, and has proven to be a versatile tool, not only for studying trajectories of typically developing children, but also for identifying late-talking children who may be subsequently diagnosed with developmental language disorder or autism (Farabolini et al., 2023; Heilmann et al., 2005; Mitchell et al., 2006). The CDI is also widely used to examine various facets of vocabulary development across diverse languages, including the noun bias in word learning (McDonough et al., 2011), lexical category acquisition (Frank et al., 2021), influences of socioeconomic status (McGillion et al., 2017), and gender differences (Simonson et al., 2014).

However, much of what is known about language acquisition still comes from a relatively small number of languages (Kidd & Garcia, 2022). As an example, only a few agglutinative languages are represented in Wordbank, a large cross-linguistic repository of CDI data from over 40 languages (Frank et al., 2017; https://wordbank.stanford.edu/). Azerbaijani, a Turkic language characterized by vowel harmony and rich agglutinative morphology, remains underrepresented in developmental research. Despite being spoken by an estimated 24 million people, Azerbaijani currently lacks standardized assessment instruments like the CDI. Development of an Azerbaijani CDI would address a critical methodological gap and facilitate cross-linguistic efforts to disentangle universal patterns of early vocabulary growth from those shaped by language-specific and cultural contexts.

Each CDI includes a vocabulary checklist at its core, supplemented by gestures (Words and Gestures [CDI-WG], 8–15 months) or grammar (Words and

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Sentences [CDI-WS], 16–36 months). Although the CDI framework is broadly applicable across languages, each adaptation must be tailored to the linguistic, cultural, and social context of the target population. Hence, we initiated a three-step process to develop the Azerbaijani CDI. Version 1 was adapted from the Turkish CDI, drawing on linguistic and cultural similarities between the two Oghuz Turkic languages. Using extensive parental feedback, Version 2 was created. Items were refined for cultural appropriateness, redundant or low-relevance words were removed, and culturally salient Azerbaijani terms were added. Note that the CDI will be further revised using estimates of age of acquisition and difficulty, resulting in Version 3 (in preparation).

This paper presents initial findings from the vocabulary section of the Version 2 CDI-WS checklist. Here, we focus on lexical category effects, including the noun bias in word learning, and influences of age, gender, and context (urban/rural) as predictors of vocabulary growth. The Version 2 CDI-WS checklist, deidentified data file, and analysis code are openly available in an Open Science Foundation (OSF) repository (Sharifova & Brooks, 2025).

1.1. Research aims

We analyzed item- and participant-level data from the Version 2 CDI-WS checklist with the following aims:

1. Characterize the productive vocabularies of Azerbaijani-speaking toddlers across different lexical categories.
2. Test whether nouns show an advantage over verbs in early word learning of Azerbaijani toddlers.
3. Evaluate the influences of age, gender, and rural–urban context on vocabulary development.

2. Method

2.1. Participants

Caregivers of 46 Azerbaijani children completed Version 2 of the Azerbaijani CDI-WS checklist. Most respondents were mothers; however, in five families, both parents responded jointly. Children ranged in age from 16–37 months (M = 25.2, SD = 5.6). The sample comprised 21 girls (45.7%) and 25 boys (54.3%) from 27 urban (58.7%) and 19 rural (41.3%) households.

Participants completed a language and family background questionnaire that included child age, gender, preschool/childcare attendance, household composition, parental education, and occupation. With regard to the child's language environment, the form included a section on language use: languages spoken by each caregiver, the primary language used with the child, languages heard through media (e.g., television, computer), or used at preschool/childcare. All families included in this study reported using Azerbaijani only with their child, though some children also had some exposure to Russian or Turkish.

2.2. Materials

Version 1 of the Azerbaijani CDI was adapted directly from the Turkish CDI (MacArthur–Bates CDI–Turkish), reflecting typological similarities, e.g., vowel harmony, agglutinative morphology, SOV word order (Acarlar et al., 2009). The Version 1 checklist contained 679 vocabulary items spanning a wide range of lexical and grammatical categories. Version 1 was administered twice to 21 Azerbaijani-speaking families with a 7-month gap between administrations. Version 2 was developed with an emphasis on improving cultural and contextual fit. Feedback from parents was elicited to evaluate the clarity of instructions and improve the cultural relevance of items in Version 2. Items were refined for everyday Azerbaijani usage, redundant synonyms were merged, and culturally salient words, especially those reflecting family routines, local foods, and traditional activities, were added. See Table 1 for a brief description of each version and its source material, and the OSF repository for the full checklist.

Table 1. Azerbaijani CDI adaptations, source materials, and items.

Adaptation	Source Materials	# Items
Version 1	Turkish CDI	679
Version 2	Version 1 + parental feedback	603

Version 2 provided a more streamlined and ecologically valid form of the Azerbaijani CDI with 603 vocabulary items in total. It encompassed a broad range of lexical categories designed to capture both concrete and abstract words and ensure balanced coverage across conceptual domains. Table 2 provides a list of the categories included in the Version 2 Azerbaijani CDI-WS checklist.

Table 2. Lexical composition of Version 2 CDI-WS vocabulary items

Category	#	Category	#	Category	#
conjunctions	6	places	17	home environment	28
time adverbs	10	toys	17	games & routines	31
interrogative adverbs	11	pronouns	19	outdoors	32
onomatopoeia	12	furniture & rooms	24	animals	40
transportation types	13	clothes	25	adjectives	49
direction adverbs	15	people	26	food	49
adpositions	17	body parts	27	verbs	134

2.3. Procedure

Parents completed the consent form and the language and family background questionnaire with the research assistant present to answer

questions. They were then provided with the CDI-WS form with instructions to mark each item that their child currently produces. Before administration, parents were given criteria for what counted as a produced word: an identifiable spoken form, even if not perfectly articulated. When parents reported that a child used a replacement term, only understood the item, pointed instead of naming objects, or produced babble, clarifying questions were asked to determine whether the response met criteria. Parents also completed the grammar section, indicating whether their child had begun using specific word combinations and morphological forms; these data are not included in this report.

3. Results

3.1. Developmental trajectories

All analyses were conducted in Python; raw materials and full code are available in our OSF repository (Sharifova & Brooks, 2025). We start by examining growth trajectories of individual words. For each word, we calculated (1) the mean age in months of the children who produced the word and (2) the proportion of children producing the word (item-level production proportions).

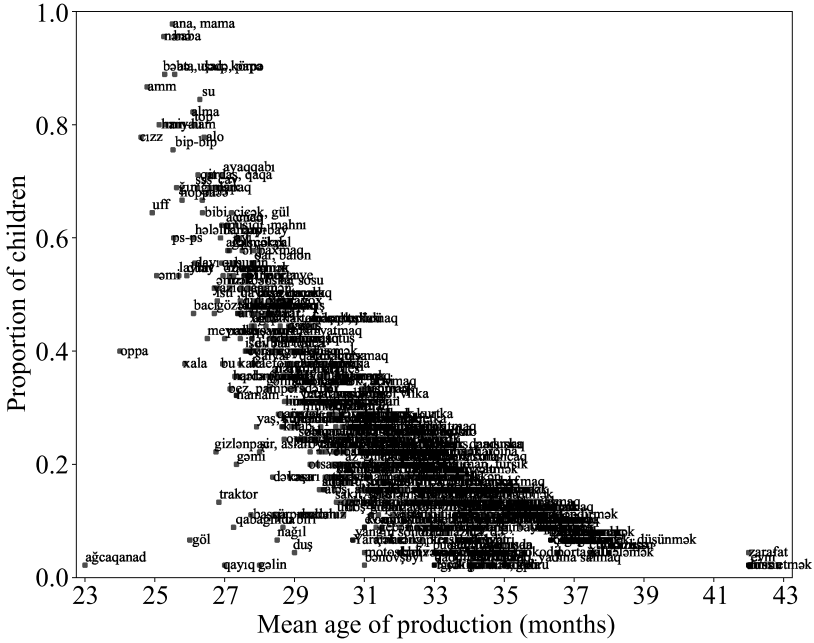

Figure 1. Proportion of children producing each word as a function of the mean age of word production for that item

The resulting scatterplot (Figure 1), created in Python (matplotlib), illustrates the relationship between the mean age of production (x-axis) and the proportion of children producing the word (y-axis). The scatter forms a dense diagonal stream from the upper left to the lower right. Words produced by a larger proportion of the children tended to be learned at younger ages than words produced by fewer children. The upper-left region includes a small cluster of high-frequency early words (e.g., *amm* [yum], *ana/mama* [mother], *bəbə* [baby]), while the lower-right region is more dispersed, reflecting increasing variability in later-acquired words.

To explore development at the level of the lexical categories listed in Table 2, we averaged the mean age of word production and the item-level production proportions across all words within that category. As shown in Figure 2, words from the most salient categories (e.g., onomatopoeia, people) were produced by a larger proportion of children at younger ages. Words from more abstract categories (e.g., adverbs, adpositions, and conjunctions) appeared later in children's expressive vocabularies. Mid-range categories, including food, animals, toys, and household nouns, occupied intermediate positions. The distribution confirms the expected advantage for concrete words in early vocabulary development (Bellagamba et al., 2022).

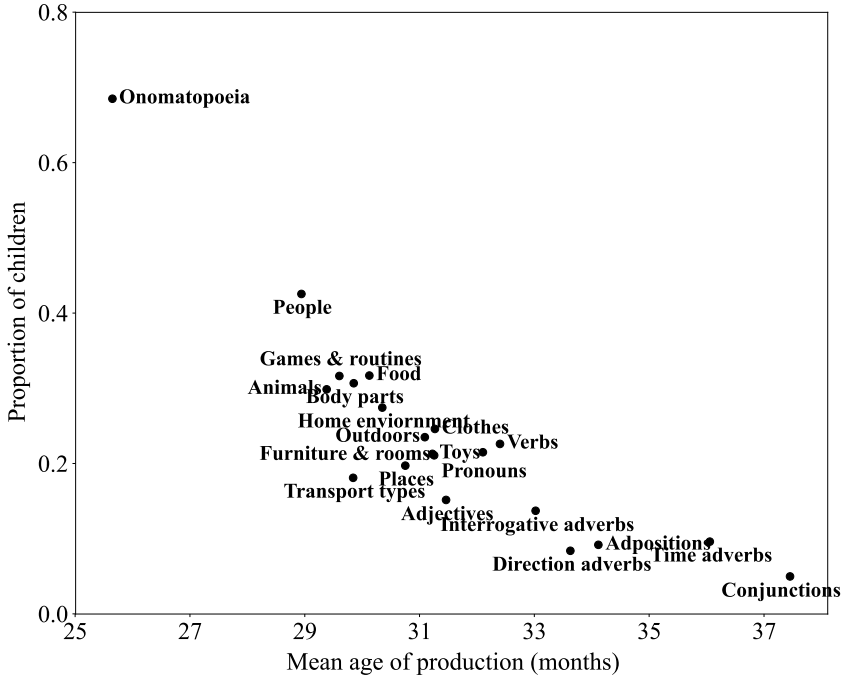

Figure 2. Word categories as a function of item-level production proportions and the mean age of production

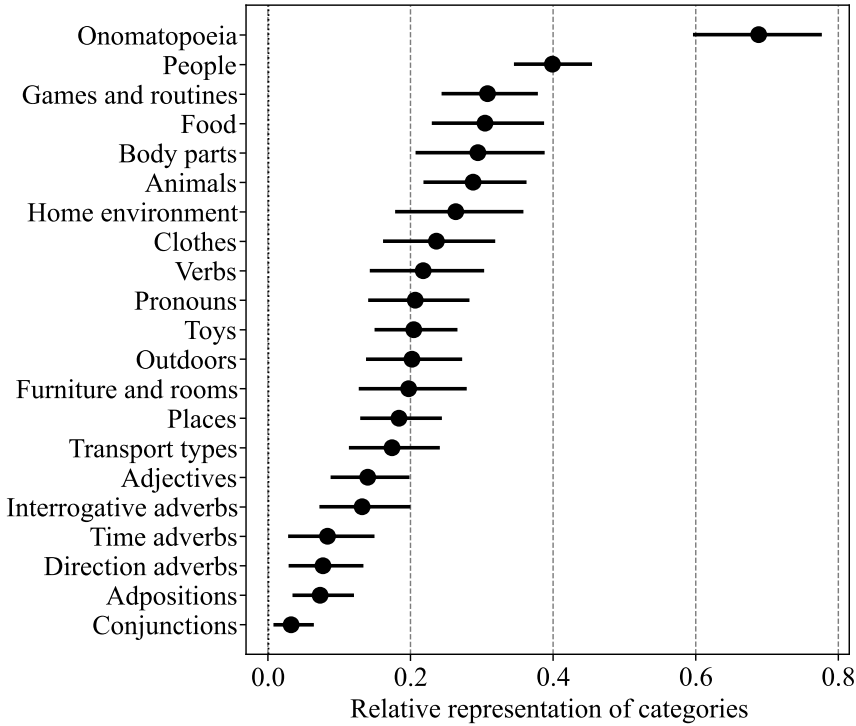

Figure 3. Relative representation scores for each lexical category

Figure 3 presents a visualization of the relative representation of each lexical category within children's expressive vocabularies. This visualization was informed by Casillas et al. (2025), who adapted the CDI for Tseltal. Specifically, we computed a relative representation score by subtracting each child's overall production proportion from their category-specific proportion. These centered values were then averaged across participants, with 95% confidence intervals (CI) estimated via bootstrapping and visualized using a horizontal dot plot generated in Python (matplotlib). Figure 3 shows a clear gradient reflecting the predominance of concrete, socially salient words in early speech and the later emergence of abstract relational terms. That is, onomatopoeic words were most highly represented in early vocabularies, whereas more abstract, grammatical words (adverbs, adpositions, conjunctions) were relatively rare. Mid-range categories (people, food, body parts, animals) clustered near the center. The progression from concrete to abstract reflects a developmental shift toward more complex semantic and grammatical representations. In particular, some of the later-acquired words (e.g., *çünki* [because], *bugün* [today]) are unlikely to be used in isolation. Their appearance may reflect children's use of word combinations and multi-word speech.

3.2. Noun bias in Azerbaijani vocabulary development

To compare acquisition patterns for nouns and verbs, we computed cumulative distribution functions (CDFs) of item-level mean age of production for nouns and verbs separately. That is, for each word, the mean age of the children who produced it was calculated. The cumulative proportions of items acquired by or before each age were plotted separately for nouns and verbs using Python. Note that the verb category comprised 134 items, all of which were produced by at least one child. The noun category comprised 329 items, of which 323 were produced by one or more children. As shown in Figure 4, the CDF for nouns appears to rise earlier than the CDF for verbs, suggesting a possible learning advantage for nouns as compared to verbs.

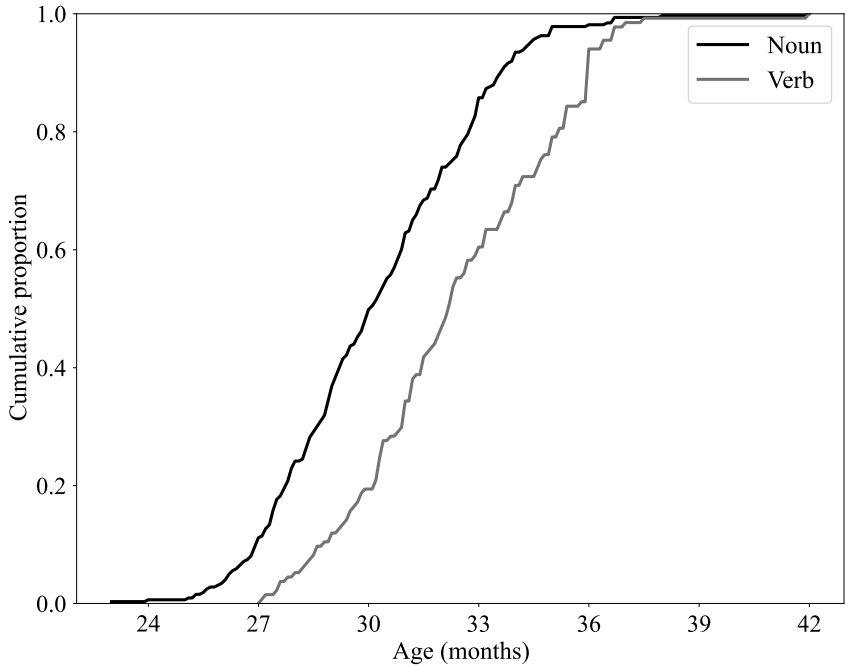

Figure 4. Cumulative distribution functions for nouns and verbs

We used a simple linear regression model to predict the mean age of production from part of speech, i.e., whether nouns were acquired earlier or later than verbs. Six nouns were excluded due to missing data (i.e., none of the children produced these words). The linear model revealed a significant effect of lexical category in predicting the mean age of production, $t(455) = -7.84$, $p < .001$, $R^2 = .12$. On average, verbs were acquired at around 32.4 months, while nouns were learned approximately 2.2 months earlier. The residual standard error was 2.7 months, suggesting that most predictions deviated by only a few

months from observed values. These results indicate influences of semantic and grammatical features on early word learning, with nouns generally preceding verbs in Azerbaijani expressive vocabulary development. This aligns with the well-established noun advantage in early lexical development, where children tend to learn concrete object names earlier than action or relational terms (McDonough et al., 2011). The findings from this dataset mirror cross-linguistic trends reported in other languages and provide further evidence that conceptual and linguistic factors underlying the noun bias are also present in Azerbaijani.

4. Socio-demographic Predictors

4.1. Age effects

To examine how vocabulary size varied as a function of child age, we fitted a quadratic function to children's total CDI scores. We chose the quadratic function over a linear model because research demonstrates that early vocabulary growth is nonlinear and accelerating (Bauer et al., 2002; Huttenlocher et al., 1991), and quadratic functions generally provide the best fit for word learning trajectories (Fernald & Marchman, 2012; Rowe et al., 2012). Each point in Figure 5 represents the total number of words produced by a given child, plotted against their age in months. The quadratic function shows a concave-upward trajectory, with acceleration at around 24 months ($R^2 = 0.43$).

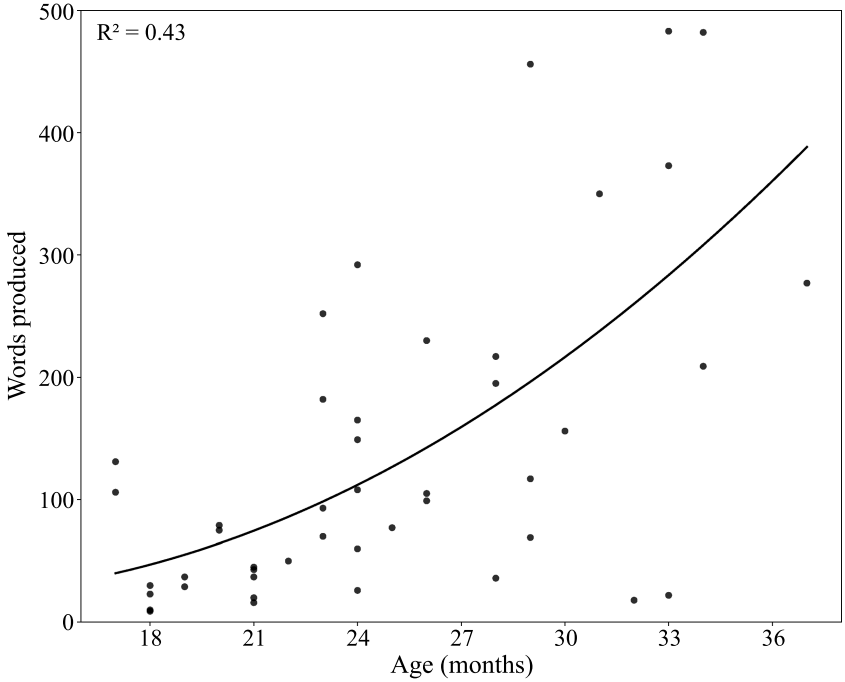

Figure 5. Total number of words produced as a function of child age

To assess the magnitude of the association between child age and expressive vocabulary size, we computed both Pearson and Spearman correlations using total CDI word counts per child (N = 46). The Pearson correlation revealed a moderate-to-strong linear relationship between child age and the total number of words produced (r = .64, p < .001; *95% CI* [.44, .79]), indicating that older children produced more words than younger children in general. The Spearman rank correlation showed a similar pattern (ρ = .58, p < .001), confirming that the association remained robust when accounting for potential non-linearities in developmental trajectories.

4.2 Gender and context effects

Next, we fitted separate quadratic functions for boys and girls to explore possible gender differences in expressive vocabulary development; see Figure 6. Across the age range, the female curve lies above the male curve, indicating that girls tended to produce a greater variety of words than boys across the age range.

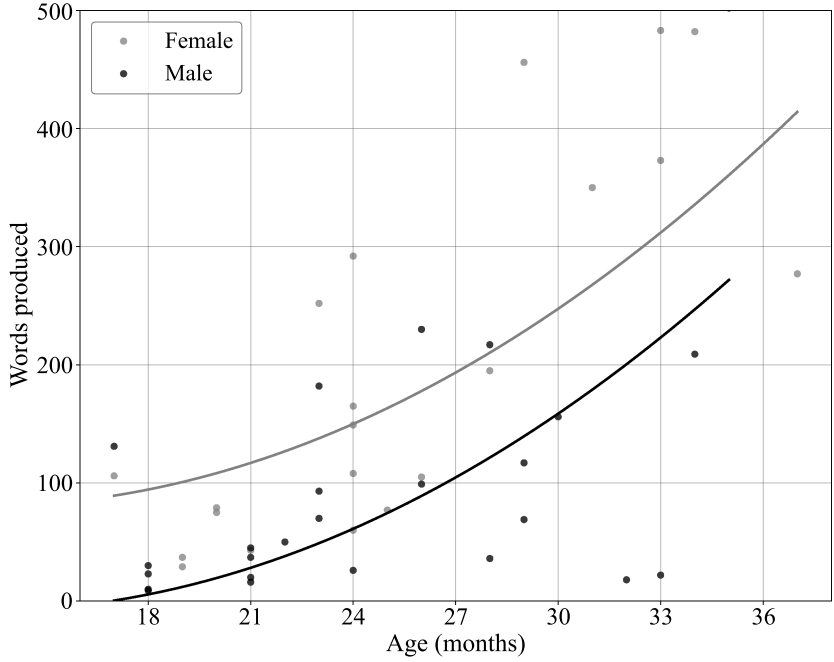

Figure 6. Total number of words produced by child gender

Figure 7 presents the same data as a function of urban and rural contexts. The quadratic model captures the accelerating growth in expressive vocabulary knowledge across both groups. Across the full age range, the rural curve lies

above the urban curve, suggesting that the children raised in rural communities were producing a greater variety of words than their urban peers.

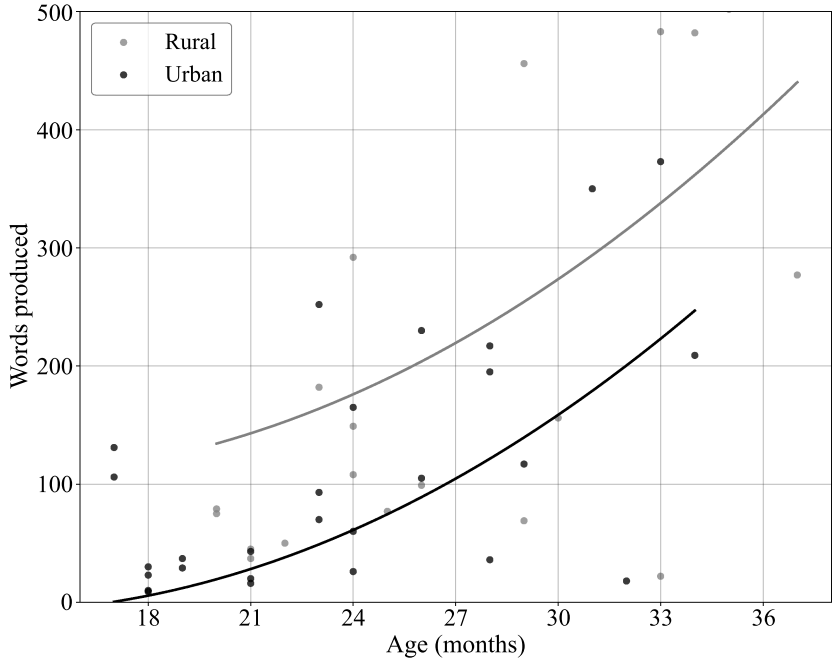

Figure 7. Total number of words produced by urban vs. rural context

It is important to note here that there were some gender differences in the composition of the urban and rural subsamples, with 16 boys and 11 girls from urban families vs. 10 girls and 9 boys from rural families. This uneven split confounds the rural/urban comparisons; hence the need to examine gender and context in a single model. We used a mixed-effects logistic regression to examine whether the probability of producing an individual lexical item was predicted by gender and context while accounting for random variability across children and items. The model revealed a significant effect of gender: boys had lower odds of producing vocabulary items as compared to girls, unstandardized $b = -1.60$, $SE = 0.45$, $z = -3.59$, $p < .001$, corresponding to roughly 80% lower odds ($OR = 0.20$, *95% CI* [0.08, 0.50]). The effect of context (urban vs. rural) was not statistically significant, unstandardized $b = -0.54$, $SE = 0.47$, $z = -1.17$, $p = .24$. Random intercept variances indicated meaningful heterogeneity across items ($SD = 1.97$) and children ($SD = 1.50$). In summary, boys tended to have smaller expressive vocabularies than girls, whereas the urban–rural distinction was not reliably associated with individual differences in vocabulary knowledge.

To confirm this pattern of results, we ran a complementary Poisson mixed-effects model predicting total CDI scores. Gender remained a strong predictor of expressive vocabulary knowledge, unstandardized $b = -0.83$, $SE = 0.23$, $z = -3.60$, $p < .001$, with boys producing ~56% fewer items than girls (*IRR* = 0.44, *95% CI* [0.28, 0.68]). Urban/rural contrast remained nonsignificant, $b = -0.26$, $SE = 0.24$, $z = -1.06$, $p = .29$. Moderate child-level variability was captured by the random intercept ($SD = 0.76$). These findings match the robust gender difference observed in the logistic model, indicating an early advantage in expressive vocabulary development for girls relative to boys.

5. Discussion

This paper reports initial findings from our efforts to create a new CDI to assess the vocabulary development of Azerbaijani-speaking children. Using vocabulary production data from Version 2 of the Azerbaijani CDI-WS form, we aimed to (1) describe early vocabulary knowledge as a function of lexical categories, (2) examine a possible noun advantage in early word learning, and (3) assess socio-demographic predictors of vocabulary size. Below, we revisit each aim and situate the findings within existing cross-linguistic research.

Analyses of item- and category-level production revealed clear developmental patterns. Early-acquired words tended to be concrete and socially salient, whereas later-acquired words tended to be more abstract and also more variable in use across children. Adpositions, adverbs, and conjunctions, all of which require some grammatical knowledge, were acquired later than other word types, consistent with the gradual development of linguistic and cognitive systems. The relative representation analysis reinforced this pattern: onomatopoeic forms were highly represented, whereas grammatical word types were less represented. This developmental gradient aligns with well-established trajectories in which children progress from concrete, familiar concepts toward increasingly abstract and relational terms. Consistent with evidence from English (Gopnik, 1988; Motamedi et al., 2021), sound-symbolic forms and names of familiar people appeared earliest in the lexicon. These early-emerging lexical classes likely benefit from perceptual salience, high frequency in caregiver talk, and embedding of words in social routines.

The second aim was to evaluate whether Azerbaijani children show a noun advantage, indicating earlier acquisition of nouns relative to verbs. Consistent with the proposal that nouns are conceptually easier to learn (Gentner, 1982), our item-level regression model indicated that nouns were acquired significantly earlier than verbs, by approximately 2.2 months on average. The cumulative distribution functions also showed this pattern, with the noun curve rising earlier than the verb curve. This aligns with cross-linguistic evidence of earlier acquisition of concrete object labels compared to action words (McDonough et al., 2011), but see Casillas et al. (2025) for evidence that this trend is not universal. In the case of Azerbaijani, the noun advantage may be attributed to early conceptual biases in word learning, the predominance of object labels in

early caregiver input, and/or less complex morphology of nouns than verbs. As a next step, it would be useful to collect and analyze recordings of the home language environment to investigate the input parents provide to Azerbaijani children and whether it supports each of these hypotheses.

Our final aim was to evaluate the influences of socio-demographic factors on vocabulary development. Age emerged as a robust predictor of vocabulary size, with children's vocabularies accelerating in the late second year of life. The observed trajectories align with data from English, suggesting a vocabulary spurt reported at 18–24 months of age (Gómez Díaz et al., 2024), though the Azerbaijani curves did not show any abrupt transitions in the efficiency of word learning. Note that the Azerbaijani language's rich agglutinative morphology, extensive suffixation, and multi-syllabic word forms may impose substantial processing costs on word learning. Future research should include naturalistic recordings of children's speech production to clarify how learners acquire morphologically complex words and other language features over time.

In investigating gender differences, we found that girls were reported to produce significantly more word types than boys. Our results match findings from English-speaking children (Bornstein et al., 2004) as well as cross-linguistic findings from large-scale datasets (Eriksson et al., 2012; Marjanovič-Umek & Fekonja-Peklaj, 2017), though such trends are not universal and may not extend to receptive vocabulary development. Although a scatterplot of data suggested that rural children had somewhat larger expressive vocabularies than urban children, the effect of context (urban/rural) was non-significant once gender was accounted for in the model. The observed trends appear to contrast with findings from other cultural contexts where urban children outperform rural peers due to greater exposure to literacy materials and more frequent child-directed talk (Leng et al., 2025; Vogt et al., 2015); however, this pattern is not reported universally (Ma et al., 2024). One possible explanation is that Azerbaijani rural households are socially dense, with multigenerational caregiving and frequent interaction embedded in household routines. These environments may provide rich linguistic input that compensates for differences in access to educational resources. However, the modest sample size and gender imbalance across contexts caution against strong conclusions.

The primary limitation of the present study is the relatively small sample size (N = 46). Nevertheless, the dataset represents a valuable first step toward establishing normative patterns of expressive vocabulary development in Azerbaijani-speaking children. The Azerbaijani CDI contributes to a growing body of cross-linguistic research documenting underrepresented languages and providing clinicians, educators, and policymakers with culturally grounded assessment tools. Building on these initial findings, we have developed Version 3 of the Azerbaijani CDI using item-level age of acquisition and item-level production proportions from Version 2. The next phase of validation will incorporate 400 hours of day-long naturalistic audio recordings, enabling direct comparison between CDI-reported vocabulary and spontaneous language use in home environments.

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