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Sometimes larger, sometimes smaller: Measuring vocabulary in monolingual and bilingual infants and toddlers

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Abstract

Vocabulary size is a crucial early indicator of language development, for both monolingual and bilingual children. Assessing vocabulary in bilingual children is complex because they learn words in two languages, and there remains significant controversy about how to best measure their vocabulary size, especially in relation to monolinguals. This study compared monolingual vocabulary with different metrics of bilingual vocabulary, including combining vocabulary across languages to count either the number of words or the number of concepts lexicalized and assessing vocabulary in a single language. Data were collected from parents of 743 infants and toddlers aged 8–33 months learning French and/or English, using the MacArthur-Bates Communicative Development Inventories. The results showed that the nature and magnitude of monolingual–bilingual differences depended on how bilinguals' vocabulary was measured. Compared with monolinguals, bilinguals had larger expressive and receptive word vocabularies, similarly sized receptive concept vocabularies and smaller expressive concept vocabularies. Bilinguals' single-language vocabularies were smaller than monolinguals' vocabularies. The study highlights the need to better understand the role of translation equivalents in bilingual vocabulary development and the potential developmental differences in receptive and expressive vocabularies.

Keywords

Bilingualism, vocabulary development, infants

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Age-appropriate vocabulary size is an important marker of typical language development and predicts a variety of language, literacy, and academic outcomes (Duff et al., 2015; Marchman & Fernald, 2008). Given the growing number of immigrant children and bilingual families (Luk, 2017; Prevoo et al., 2016; Schott et al., 2022), there is an increasing need for understanding how to best quantify vocabulary development in bilingual toddlers. For monolingual children, the words a child knows can simply be counted to yield a receptive (words understood) or expressive (words produced) vocabulary score, which can be compared with age-referenced vocabulary norms (Fenson et al., 2007). Measuring vocabulary is more complex in bilingual toddlers, as they learn words in two languages from early in development (Petitto et al., 2001).

Bilingual children's vocabulary can be measured either in a single language or by combining their knowledge across their languages. Such measures might point to different aspects of children's development. For example, single-language measures might reflect children's ability to communicate in monolingual social or educational situations, whereas measures that combine across languages might more closely reflect children's overall level of conceptual and/or linguistic development. A recent review found that most studies that measured vocabulary in young bilinguals reported single-language measures in each language (68%), but many fewer reported a combined measure (43%; Weisleder et al., 2022). When single-language vocabulary is measured, bilingual children tend to have smaller productive vocabularies than monolinguals (e.g. Bialystok et al., 2010; Hoff & Ribot, 2017; Pearson et al., 1993; Thordardottir et al., 2006; Uccelli & Páez, 2007). This monolingual–bilingual difference is typically larger in children's non-dominant (weaker/least-heard) language than in their dominant (stronger/most-heard) language (Altman et al., 2018; Cattani et al., 2014; Thordardottir, 2011).

To overcome the limitations of single-language vocabulary assessment, researchers have long advocated for assessing bilingual vocabulary in a way that considers both languages (Kohnert, 2010; Pearson et al., 1993). 'Total vocabulary' and 'total conceptual vocabulary' are two commonly used combined metrics of bilingual children's vocabulary development. In the current study, we have updated these terms to be more concise and transparent, to clarify the interpretation of the outcomes they provide. We call *word vocabulary* the measure that combines the total number of words the child knows in each of their languages (historically referred to as total vocabulary), while we call *concept vocabulary* the measure that only includes the number of concepts the child knows in either language (historically referred to as total conceptual vocabulary). These two metrics differ in their treatment of translation equivalents (i.e., cross language synonyms like English 'dog' and French '*chien*'): word vocabulary gives credit for all words the child produces, including translation equivalents, whereas concept vocabulary does not give double credit for translation equivalent pairs. As an example, a child who knows both 'dog' and '*chien*' would obtain 2 points for word vocabulary (since they know both words) but only 1 for concept vocabulary (since both words refer to the same concept).

The key difference between word and concept vocabularies is how they credit children's knowledge of translation equivalents, so it is important to consider how young bilinguals learn translation equivalents compared with singlets (i.e. words without a known translation equivalent). Some theories posit that bilingual children avoid learning translation equivalents due to constraints on learning two labels for the same object

(Volterra & Taeschner, 1978), while others posit that children prefer to learn translation equivalents if it is easier for them to associate a new label with an already lexicalized referent than to associate a word with a referent that is not already in the lexicon (Montanari, 2010). Finally, it is possible that bilingual children learn translation equivalents with equivalent difficulty/ease as they learn singlets (Pearson et al., 1995). In a recent large-scale study, Tsui et al. (2022) found that for children with larger vocabularies, children's knowledge of translation equivalents was nearly exactly what would be expected by chance overlap in the vocabularies in each language. That is, children neither preferred to learn translation equivalents, nor avoided them. However, children with smaller vocabularies showed some preference for learning translation equivalents, which is in line with some other studies (Bilson et al., 2015). Related back to the different combined vocabulary metrics, if translation equivalents are learned with similar difficulty as singlets, then as for word vocabulary they should be counted twice to yield a score that is comparable across monolinguals and bilinguals. Alternatively, if translation equivalents are learned more easily than singlets, then as for concept vocabulary they should not be double counted to yield a vocabulary score similar across monolinguals and bilinguals.

A number of studies have compared monolinguals and bilinguals on concept and/or word vocabulary. When comparing expressive word vocabularies at various ages between 14 and 36 months, multiple studies have reported that bilinguals have similar vocabulary scores to monolinguals (Spanish–English, Core et al., 2013; Hoff et al., 2012; Various language pairs, Brito et al., 2014; Russian–Finnish, Silvén et al., 2014). However, other studies reported that bilinguals have larger expressive word vocabularies than monolinguals at 18 months (Spanish–Catalan; Bosch & Ramon-Casas, 2014) and 24 months of age (English–German; Junker & Stockman, 2002). Of interest, one study of 20-month-olds found different results depending on cultural and/or linguistic context: English–Japanese and English–Korean bilinguals had similar expressive word vocabularies to their monolingual peers, while Spanish–English bilinguals had lower word vocabularies than either Spanish or English monolinguals (Cote & Bornstein, 2014).

In relation to concept vocabulary, some studies have found that this measure disadvantages bilinguals (Spanish–English expressive vocabulary, Core et al., 2013; French–English expressive vocabulary, Thordardottir et al., 2006), while other studies have found that this approach yields comparable scores across monolinguals and bilinguals (e.g. Dutch–French receptive and expressive vocabulary, De Houwer et al., 2014; English–German expressive vocabulary, Junker & Stockman, 2002; Spanish–English receptive and expressive vocabulary, Pearson et al., 1993). Studies that have looked at both word and concept vocabulary have had mixed findings, with some suggesting that word vocabulary (e.g. Core et al., 2013), and other studies suggesting that concept vocabulary (Junker & Stockman, 2002), is most similar between monolinguals and bilinguals, and still others finding that both metrics are comparable (De Houwer et al., 2014). Finally, another approach has been to develop bilingual-specific norms (receptive and expressive vocabulary in learners of English and another language, Floccia et al., 2018; receptive vocabulary in multiple language pairs, Gampe et al., 2018), although currently these are only available for children of very specific ages.

Additional large-scale data are needed given the mixed findings in the literature regarding how bilinguals compare with monolinguals when measured on different vocabulary metrics,

particularly given the small sample sizes and/or limited ages assessed in most previous studies (for a summary of the studies using the [Communicative Development Inventories] CDI, see Table 1). Such information can provide theoretical insight into the nature of bilingual vocabulary development, the role of translation equivalents, and the development of receptive versus expressive vocabulary. The research question for the current study was how young monolinguals and bilinguals compare across age on different vocabulary metrics.

We examined the vocabularies of 743 children aged 8–33 months, a much larger sample than in previous studies. Children were learning French and/or English in a community where languages have similar sociolinguistic status, providing an optimal control for potentially confounding variables that may differ systematically between monolinguals and bilinguals in some contexts. While vocabulary development is influenced by multiple variables such as language quality, family language strategies, variation in language exposure, and age of exposure to each language (e.g. De Houwer, 2011; Unsworth, 2016; see Byers-Heinlein et al. 2019 for a discussion of key variables in bilingual language development), in this study we focused on vocabulary metrics that have been consistently used to describe vocabulary development in bilingual children. Uniquely, our study examined both receptive and expressive vocabulary across four metrics: word vocabulary, concept vocabulary, dominant language vocabulary, and non-dominant language vocabulary. For single-language vocabularies, both dominant and non-dominant, we predicted that bilinguals would have smaller vocabularies than monolinguals. For combined vocabularies, we predicted that bilinguals and monolinguals would have more similar vocabularies, although we did not make specific predictions as to whether word vocabulary or concept vocabulary would yield the most comparable score.

Method

This research was conducted according to the Declaration of Helsinki, and was approved by the Human Research Ethics Board of Concordia University (certification numbers UH2011-041-1 and 10000439). Parents provided informed consent.

Participants

Data were collected from parents of typically developing infants aged 8–33 months (47% female) between 2010 and 2018. Recruitment was carried out through government birth lists, daycares, and online ads. Data were largely cross-sectional, although a subset of children contributed data at multiple time points (see data analysis section for details on how statistical analyses accounted for these repeated measures). Children visited the lab one (75.4%), two (19.9%), three (4.2%), or four (0.5%) times for experimental studies, and vocabulary data were collected on each visit (see following section for details on data collection procedures). The analyzed dataset included data from 743 infants who collectively took part in 947 lab visits. Following criteria similar to the norming sample for the American English CDI (Fenson et al., 2007), we excluded children who were born premature ($<$ 36 weeks gestation), who had low birth weight ($<$ 2500 grams), who presented with major medical conditions (e.g. meningitis, major surgeries), or who fell outside our target age range of 8–33 months. Children were mainly reported to be of

Table 1. Summary of studies comparing combined vocabulary development in monolinguals versus bilinguals using the Communicative Development Inventories (CDI).

Authors	*N*		Languages	Age	Findings			
	Bi	Mono		(months)	Expressive vocabulary		Receptive vocabulary	
					Word	Concept	Word	Concept
Bosch & Ramon-Casas (2014)	24	24	Spanish–Catalan	18	B > M	B = M	–	–
Brito et al. (2014)	18	18	Various	24	B = M	–	–	–
Core et al. (2013); Hoff et al. (2012)	47	56	English–Spanish	22 25 30	B = M B = M B = M	B = M B = M B < M	–	–
Cote & Bornstein (2014)	90	140	English–Spanish English–Japanese English–Korean	20	B < M B = M B = M	–	–	–
De Houwer et al. (2014)	31	30	Dutch–French	13 20	B = M B = M	– –	B > M –	– –
Junker & Stockman (2002)	10	20	English–German	24–27	B > M English monolinguals B = M German monolinguals	B = M English monolinguals B = M German monolinguals	–	–
Pearson et al. (1993)	24	33	English–Spanish	14–30	B = M	B = M	B = M	B = M
Silvén et al. (2014)	28	26	Finnish–Russian	14, 18, 24, 36	B > M	–	–	–
Thordardottir et al. (2006)	8	20	English–French	20–36	B = M	B < M English monolinguals B = M French monolinguals	–	–
Current Study	**416**	**337**	**English–French**	**8–33**	**B > M**	**B < M**	**B > M**	**B = M**

European descent (48%), followed by Other (12%) and Multiple Ethnicities (10%). Sixteen percent of parents did not report their child's ethnic background. Other ethnic groups each made up 5% or less of the sample.

Families lived in Montréal, Québec, a multicultural Canadian city where English and French are regularly used in everyday life and are both held in high regard (Kircher, 2014). While French is the official language provincially, French and English have official status federally. Public schooling is available in both languages, and 46% of individuals living in Québec identify as French–English bilinguals (Statistics Canada, 2022). These attributes are ideal for comparison of the two groups, as they avoid confounds often present in studies that compare monolingual and bilingual samples that differ in the proportion of immigrants, socioeconomic status, social prestige, and official status of the two languages (e.g. Cattani et al., 2014; Floccia et al., 2018; Hoff et al., 2014). Parental education was used as a proxy for socioeconomic status; maternal education was reported for 98.5% of participant visits, paternal education was reported in a further 0.3% of visits, and parental education was not reported for 1.2% of visits. Overall, parental education was high, with an average of 16.7 years for parents of monolinguals and 16.9 years for parents of bilinguals. All parents with the exception of four mothers of monolinguals and 10 mothers of bilinguals reported at least some post-secondary education.

Language background assessment

Children's language background was gathered through a comprehensive interview and defined based on lifetime exposure to different languages, as assessed by the Language Exposure Questionnaire (Bosch & Sebastián-Gallés, 2001) using the Multilingual Approach for Parent Language Estimates (Byers-Heinlein et al., 2019), which has good reliability for this population (r=.88; Orena et al., 2019). Monolingual children were exposed to either English or French 90% of the time or more. Following prior research (e.g. Byers-Heinlein & Werker, 2009), bilingual children were exposed to both English and French 25%–75% of the time, with no more than 10% exposure to a third language. Language exposure was assessed at each lab visit. Children were classified as monolingual at 437 lab visits and bilingual at 510 lab visits. Ten children who participated at multiple ages experienced differences in their language exposure between visits great enough to switch their language background category from monolingual to bilingual or vice versa.

A child's dominant language was deemed to be the language the child had greater exposure to (or for most monolinguals, exclusive exposure to). For children with perfectly balanced exposure (50% of exposure to each language), the dominant language was the one in which the child was reported to produce the most words. English was the dominant language at 523 lab visits, and French at 424 visits. For 17 children who participated at multiple ages, the language assessed to be their dominant one switched from English to French or vice versa between visits.

Vocabulary measures

The words children knew in English and/or French were measured via American English and Québec French adaptations of the MacArthur-Bates CDI (Fenson et al., 2007;

Trudeau et al., 1999), using the Words and Gestures form for children aged 8–16 months (which measures both receptive and expressive vocabulary; 396 items in English, 414 items in French) and the Words and Sentences form for children aged 17–33 months (which measures expressive vocabulary only; 680 items in English, 664 items in French).

CDIs were administered at each lab visit. Parents completed the CDI either on paper or on a tablet computer. We asked that the caregiver who was most familiar with the child's vocabulary in the specific language being evaluated complete the questionnaire. Each completion of a specific CDI form (i.e. in English or French) at a specific age was considered one administration. CDI administrations for monolingual children were filled out mainly by mothers (59%), fathers (4%), or both parents (1%); the respondent was not indicated for 36% of administrations. CDI administrations for bilingual children were completed by mothers (63%), fathers (7%), both parents (4%), or other family members ($<1\%$; e.g. grandmother); the respondent was not indicated for 25% of administrations. We note that among French–English bilingual families in Montreal, the most common family language strategy is where both parents use both languages with their child (Sander-Montant et al., 2023), and moreover Canadian mothers spend more time caregiving than Canadian fathers (Houle et al., 2017). These factors likely explain why mothers were most often judged by families to be the best person to complete the CDI in both languages.

The analyzed dataset consisted of 1338 CDI administrations ($n=647$ Words and Gestures administrations; $n=691$ Words and Sentences administrations). We retained the data from all administrations wherever possible, as our statistical models were able to account for dependencies in the data for children who contributed data at multiple ages and children whose language group or language dominance switched between lab visits, and because the additional data increased statistical power and reliability.

For monolinguals, there were a total of 510 administrations: 277 administrations in English-learning children ($n_{children}=217$) and 233 administrations in French-learning children ($n_{children}=199$). For bilinguals, there were a total of 828 administrations: 472 administrations in English-dominant children ($n_{children}=196$) and 356 administrations in French-dominant children ($n_{children}=157$). The proportion of administrations where English was the native/dominant language was similar across monolinguals (54%) and bilinguals (57%). In cases where bilingual children had missing data in one of the CDI questionnaires ($n=46$, 11 cases missing data in the dominant language, 35 cases missing data in the non-dominant language), data were excluded for analyses that required the combination of both questionnaires (e.g. concept vocabulary, word vocabulary), but were included in analyses that focused on one language (e.g. dominant language, non-dominant language).

Monolinguals' vocabulary scores were determined by tallying the number of words children produced and (when available) understood in their single native language. For bilinguals, four different scores were calculated for expressive and (when available) receptive vocabulary. Dominant and non-dominant language vocabulary were calculated by tallying the number of words bilinguals knew in either English or French, depending on the child's dominant and non-dominant languages. Word vocabulary counted the words bilinguals knew in both languages (English + French). Concept vocabulary counted the concepts for which bilinguals produced or (when available) understood a

word. To do so, it was necessary to identify words across the two languages that refer to the same concept (i.e. translation equivalents; a full list of these pairs is available at https://osf.io/78hua and methodological details are reported in Tsui et al., 2022), then subtracting these from bilinguals' word vocabulary.

Results

Data were analyzed using R Version 4.1.3 (R Core Team, 2022). Analysis scripts and the full dataset are available at https://osf.io/78hua .

Analytic approach

We conducted a series of regression models investigating how bilinguals compared with monolinguals in receptive and expressive vocabulary – with age as an additional predictor – across four ways of measuring bilinguals' vocabulary: dominant language, non-dominant language, concept vocabulary, and word vocabulary. In each model, the same score was entered for monolinguals (i.e. their vocabulary size in their single native language). Because some children contributed vocabulary data at more than one age, we used the lmerTest package (Kuznetsova et al., 2017) to fit linear mixed-effects models that included random intercepts for participants, accounting for repeated measures of the same individual (Bates et al., 2015).[1]

Previous research has suggested that patterns of early vocabulary size across age are quadratic (Bauer et al., 2002; Huttenlocher et al., 1991). Data visualizations and model comparisons showed that a quadratic age term improved fit for expressive vocabulary models (see https://osf.io/78hua), but not for receptive vocabulary models, possibly due to the smaller age range available for receptive vocabulary. We thus included a linear age term for all models, and a quadratic age term for expressive models only. The expressive models were fit with orthogonal polynomials to remove collinearity of the age predictors, thus, the intercept represents the number of vocabulary words at the average age in the dataset. To ease comparing expressive and receptive models, and because an intercept of 0 months would be outside our data range, we centered the age term in the receptive vocabulary models at 12 months. We also included the interactions between linear (and for expressive models, quadratic) age terms and language group, to examine whether the effect of age on these vocabulary measures was similar for monolinguals and bilinguals. We present analyses for expressive vocabulary prior to those for receptive vocabulary, as all children contributed expressive vocabulary data but only children 16 months and under contributed receptive vocabulary data.

Expressive vocabulary

Figure 1 displays children's expressive vocabulary across age, comparing monolinguals with bilinguals measured on word, concept, dominant, and non-dominant language metrics. Linear and quadratic terms for age were positive and significant for all models, showing that productive vocabulary size increased in an accelerating fashion (see Tables 2 and 3). All models showed significant interactions between age term(s) and language group

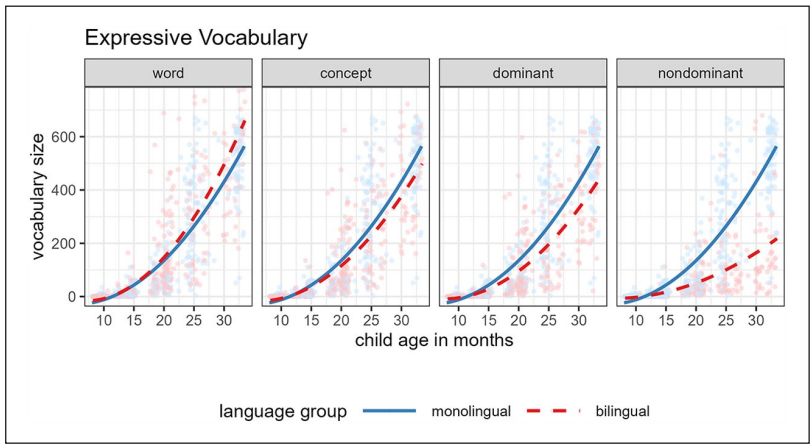

Figure 1. A Comparison of Monolinguals' Expressive Vocabulary Size Across Age to Bilinguals' Vocabulary Measured Via Four Different Metrics.
Lines show group trajectories, and points show individual scores. Values above 750 have been truncated for visualization purposes. Note that monolinguals have the same vocabulary score for word, concept, dominant, and non-dominant vocabulary.

indicating different patterns of vocabulary size across age, but the nature and the direction of the effect depended on bilinguals' vocabulary measure. Bilinguals had a steeper increase in word vocabulary size with age compared with monolinguals, as shown by the significant positive interaction between linear age term and language group. By contrast, when bilinguals' concept vocabulary or dominant vocabulary was measured, monolinguals had a higher and more steeply increasing vocabulary, as indicated by the significant negative interaction between the linear age term and language group. Monolinguals had larger, more steeply increasing, and more accelerated vocabulary slopes compared with bilinguals' non-dominant vocabulary, as indicated by significant negative interactions between language group and both linear and quadratic age terms.

In sum, when measured by word vocabulary, bilinguals' expressive vocabulary development outpaced monolinguals', whereas when bilinguals' vocabularies were measured by concept, dominant, or non-dominant language vocabulary, monolinguals' development outpaced bilinguals'. The differences with monolinguals were largest when bilinguals' vocabularies were measured in a single language (i.e. dominant and non-dominant vocabulary).

Receptive vocabulary

Figure 2 displays monolinguals' receptive vocabulary across age compared with bilinguals' word, concept, dominant, and non-dominant language metrics. Receptive vocabulary size increased with age, as indicated by the significant linear term for age across all models (see Tables 4 and 5). For word vocabulary, the pattern for receptive vocabulary was similar to that seen in expressive vocabulary: word vocabularies for bilinguals increased faster than for monolinguals, as evidenced by the higher bilingual intercept and

Table 2. Expressive vocabulary – combined measures.

Predictors	Word vocabulary				Concept vocabulary			
	Estimates	*Std. beta*	Estimates CI	*p*	Estimates	*Std. beta*	Estimates CI	*p*
Intercept	144.74	−0.04	133.56 to 155.92	**<.001**	144.78	0.05	135.82 to 153.74	**<.001**
Age (linear term)	5056.33	22.88	4764.92 to 5347.74	**<.001**	5059.74	26.46	4826.97 to 5292.51	**<.001**
Age (quadratic term)	1131.38	5.12	829.37 to 1433.40	**<.001**	1128.41	5.90	887.07 to 1369.76	**<.001**
Bilingual	20.28	0.09	3.21 to 37.36	**.020**	−17.82	−0.09	−31.50 to −4.13	**.011**
Age (linear term) × bilingual	810.61	3.67	342.56 to 1278.65	**.001**	−621.68	−3.25	−995.63 to −247.73	**.001**
Age (quadratic term) × bilingual	267.18	1.21	−197.50 to 731.87	.259	−133.17	−0.70	−504.36 to 238.02	.482
Marginal R^2/conditional R^2			.702/.826				.743/.853	

CI: confidence interval.

Table 3. Expressive vocabulary – single-language measures.

Predictors	Dominant vocabulary				Non-dominant vocabulary			
	Estimates	*Std. beta*	Estimates CI	*p*	Estimates	*Std. beta*	Estimates CI	*p*
Intercept	144.68	0.09	135.94 to 153.42	**<.001**	145.12	0.25	136.94 to 153.31	**<.001**
Age (linear term)	5067.86	27.34	4836.73 to 5299.00	**<.001**	5067.66	29.61	4851.03 to 5284.29	**<.001**
Age (quadratic term)	1127.43	6.08	888.28 to 1366.57	**<.001**	1125.85	6.58	901.75 to 1349.96	**<.001**
Bilingual	−35.10	−0.19	−48.46 to −21.74	**<.001**	−90.00	−0.53	−102.51 to −77.50	**<.001**
Age (linear term) × bilingual	−1188.08	−6.41	−1558.95 to −817.21	**<.001**	−3101.00	−18.12	−3448.56 to −2753.43	**<.001**
Age (quadratic term) × bilingual	−169.92	−0.92	−538.41 to 198.57	0.366	−660.98	−3.86	−1006.33 to −315.62	**<.001**
Marginal R^2/conditional R^2			.737/.834				.731/.829	

CI: confidence interval.

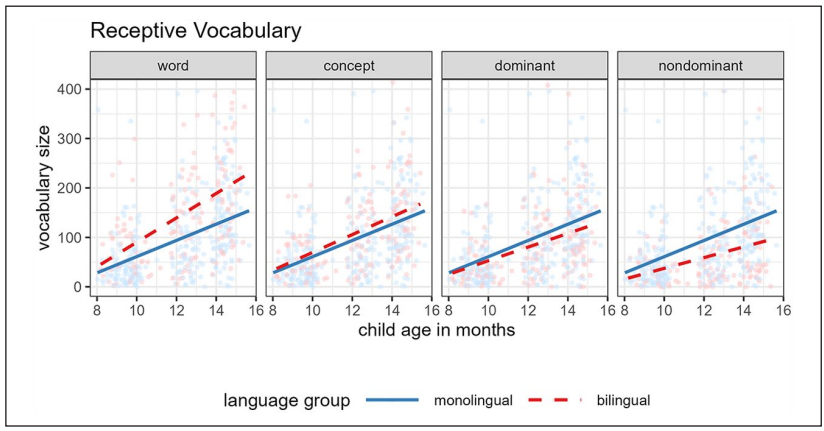

Figure 2. A Comparison of Monolinguals' Receptive Vocabulary Size Across Age to Bilinguals' Vocabulary Measured Via Four Different Vocabulary Metrics.
Lines show group trajectories, and points show individual scores. Values above 400 have been truncated for visualization purposes. Note that monolinguals have the same vocabulary score for word, concept, dominant and non-dominant vocabulary.

significant positive interaction between language group and age. For bilinguals' concept vocabulary, however, there were no statistical differences in vocabulary size across age compared with monolinguals. Monolinguals had slightly larger vocabularies when bilinguals' dominant language vocabulary was measured, although the change in vocabulary size across age was similar for both language groups, indicated by the positive baseline age term and its non-significant interaction with language group. Monolinguals again had steeper changes in vocabulary size across age when bilinguals' non-dominant vocabulary was measured, as shown by the positive age term and its negative significant interaction with language group.

To summarize, when measured by combined vocabulary metrics – word vocabulary or concept vocabulary – bilinguals had receptive vocabularies either larger than or similar to monolinguals' vocabularies, depending on the bilingual measure. For single-language vocabulary, whether bilinguals were measured in the dominant or non-dominant language, monolinguals had larger vocabularies, but the differences were less pronounced than for expressive vocabulary.

Discussion

Monolingual and bilingual children face different tasks in building vocabularies, as only bilinguals must learn words from two different languages. We examined how monolingual and bilingual language experience impacts vocabulary development across age. In a large sample of 1338 CDI administrations for 743 children learning French and/or English, we compared monolingual and bilingual children's expressive (8–33-month-olds) and receptive (the subset of children who were 8–16 months old) vocabulary sizes. The size of our sample gave us the statistical power to detect effects that might have been missed in previous studies.

Table 4. Receptive vocabulary – combined measures.

Predictors	Word vocabulary				Concept vocabulary			
	Estimates	*Std. beta*	Estimates CI	*p*	Estimates	*Std. beta*	Estimates CI	*p*
Intercept	92.97	−0.18	82.68 to 103.27	**<.001**	92.57	−0.07	83.97 to 101.17	**<.001**
Age	17.32	0.38	13.06 to 21.58	**<.001**	17.80	0.48	14.43 to 21.16	**<.001**
Bilingual	44.07	0.46	26.93 to 61.22	**<.001**	11.39	0.14	−2.91 to 25.70	.118
Age × bilingual	8.54	0.19	1.30 to 15.78	**.021**	1.16	0.03	−4.57 to 6.89	.690
Marginal R^2/conditional R^2			.260/.549				.243/.655	

CI: confidence interval.

Table 5. Receptive vocabulary – single-language measures.

Predictors	Dominant vocabulary				Non-dominant vocabulary			
	Estimates	*Std. Beta*	Estimates CI	*p*	Estimates	*Std. Beta*	Estimates CI	*p*
Intercept	92.59	0.05	84.36 to 100.81	**<.001**	92.59	0.16	84.56 to 100.61	**<.001**
Age	17.69	0.50	14.43 to 20.95	**<.001**	17.69	0.51	14.51 to 20.86	**<.001**
Bilingual	−13.79	−0.19	−27.48 to −0.10	**.048**	−34.94	−0.47	−48.29 to −21.58	**<.001**
Age × bilingual	−2.58	−0.07	−8.12 to 2.96	.361	−6.35	−0.18	−11.76 to −0.94	**.021**
Marginal R^2/conditional R^2			.229/.628				.247/.636	

CI: confidence interval.

First, we confirmed that assessing bilinguals in a single language – whether their dominant or non-dominant – yielded a smaller vocabulary size for bilinguals relative to monolinguals for both expressive and receptive vocabulary, replicating and extending previous findings (Bialystok et al., 2010; Thordardottir et al., 2006). Bilinguals' single-language vocabularies reflect their reduced exposure to these languages compared with monolinguals, with a larger discrepancy when bilinguals were measured in the non-dominant (least-heard) compared with the dominant (most-heard) language. While single-language measures might be appropriate for measuring some aspects of bilingual children's ability to communicate in monolingual situations, they do not provide an adequate measure of their overall conceptual or vocabulary development.

Second, we found that traditional metrics combining bilinguals' vocabularies across the two languages also resulted in significantly different patterns of vocabulary size across age compared with monolinguals. Word vocabulary (traditionally referred to as total vocabulary size) – which counts all words children know regardless of whether they know its translation equivalent – advantaged bilinguals in comparison to monolinguals. This effect was particularly strong in receptive as compared to expressive vocabulary, and was magnified at older ages. Concept vocabulary (traditionally referred to as total conceptual vocabulary size) – which gives no additional credit to words for which children know a translation equivalent – disadvantaged bilinguals in comparison to monolinguals, although only for expressive vocabulary. On the surface, our results appear to differ from most previous studies undertaking monolingual–bilingual comparisons on combined metrics, which have largely not found statistically significant differences in word and/or concept vocabulary (expressive concept vocabulary in Bosch & Ramon-Casas, 2014; 5 out of six comparisons in Core et al., 2013; two out of three comparisons in De Houwer et al., 2014; three out of four comparisons in Junker & Stockman, 2002; four out of four comparisons in Pearson et al., 1993). Nonetheless, when differences have been reported, the pattern was the same as in the current study: bilinguals had larger word vocabulary than monolinguals (expressive word vocabulary in Bosch & Ramon-Casas, 2014; receptive word vocabulary at 13 months in De Houwer et al., 2014; expressive word vocabulary in bilinguals compared with English monolinguals in Junker & Stockman, 2002; Silvén et al., 2014 although see Cote & Bornstein, 2014, for a counter-example) and monolinguals had larger concept vocabularies than bilinguals (30-month-olds in Core et al., 2013; bilinguals compared with English monolinguals in Thordardottir et al., 2006).

One potential explanation for these patterns is that our sample was larger by an order of magnitude than those of previous studies (hundreds of children and over a thousand CDI administrations vs. a few dozen at most). A lack of statistically robust monolingual–bilingual differences in previous studies might be due to low statistical power and/or a narrower age range than in the current study, rather than a true null effect. Moreover, our results indicate that monolingual–bilingual differences in vocabulary size are larger for older children, which would suggest that previous studies with younger children in particular might have lacked statistical power to detect monolingual–bilingual differences. Our study maximized sample size and thus statistical power by combining both cross-sectional and longitudinal observations, while controlling for dependencies in our data using linear mixed-effect models. Furthermore, by modeling age continuously rather

than comparing monolinguals and bilinguals at either a single or a small set of ages, we were able to detect age-related effects that may not have been apparent in previous studies. Future studies with large samples that include children of different ages – both cross-sectional and longitudinal – will be needed to confirm our results.

The findings with regard to concept and word vocabularies have implications for understanding the nature of word learning in bilinguals, particularly regarding translation equivalents. When evaluated based on whether they yield comparable scores for same-aged monolinguals and bilinguals, traditional combined metrics of bilingual vocabulary implicitly assume that learning a second label for a referent is equally difficult to learning the first label (word vocabulary) or that it is essentially trivial (concept vocabulary). Our data suggest that the truth lies in between, consistent with studies reporting a moderate bilingual advantage for translation equivalent learning (Bilson et al., 2015; Tsui et al., 2022). In the future, it may be possible to develop a 'bilingual adjusted vocabulary' metric, whereby monolingual and bilingual vocabularies can be equated by giving bilinguals partial credit for translation equivalents, perhaps even in a way that changes across development.

Our study also demonstrates developmental differences in receptive versus expressive vocabularies across monolinguals and bilinguals. For word vocabulary, bilinguals' receptive vocabulary development strongly outpaced that of monolinguals, with a much smaller advantage seen in expressive vocabulary. For concept vocabulary, bilinguals did not differ from monolinguals in receptive vocabulary, whereas monolinguals outpaced bilinguals in expressive vocabulary. This pattern is consistent with the so-called receptive–expressive gap in bilingual children, whereby bilinguals' receptive language ability often outpaces their expressive ability (Gibson et al., 2014; Giguere & Hoff, 2020, 2022; Kan & Kohnert, 2005; Mancilla-Martinez et al., 2018). At the same time, due to the instruments we used, our study examined receptive vocabulary across a more restricted age range (8–16 months) than expressive vocabulary (8–33 months), which could attenuate differences as our results consistently showed greater divergence between language groups at older ages. The only monolingual–bilingual comparison that did not show group differences was in receptive concept vocabulary, and it is possible that a difference would have emerged at older ages. Moreover, it is also possible that parents are less accurate in estimating receptive than expressive vocabulary (although see Ring & Fenson, 2000). Future studies could test older children using instruments appropriate to those ages, to see if our observed patterns hold.

The current findings are relevant for clinicians in assessing bilingual vocabulary using the CDI (e.g. Core et al., 2013; Hoff & Core, 2015). Although bilingual norms have been developed for specific ages and language pairs (e.g. Floccia et al., 2018), they are currently limited in their coverage of children learning different languages and of different ages. In recent years, professional organizations and researchers have increasingly recommended evaluating bilingual children in both of their languages (American Speech-Language-Hearing Association, 2004; Bedore & Peña, 2008; Kohnert, 2010), but there are not yet clear guidelines for how to interpret the results obtained from this assessment. Our results confirm that using a single-language CDI for bilinguals may not yield a score comparable to monolinguals as they only partially measure bilinguals' knowledge, and thus is typically inappropriate except possibly when children are strongly dominant in one

language (Cattani et al., 2014; see also Vagh et al., 2009). Both word vocabulary and concept vocabulary yield bilingual scores that are more similar to monolinguals' scores, although neither exactly equates the two groups, and on both measures the word gap between the two groups increases with age. In practice, given the high level of individual variability observed across both monolinguals and bilinguals, either word vocabulary or concept vocabulary might be appropriate for the assessment of vocabulary knowledge, with concept vocabulary being more conservative and word vocabulary being more liberal. Finally, our results revealed that bilinguals strongly outpace monolinguals in early receptive word vocabulary, thus bilinguals who show limited early comprehension when both languages are considered might be of particular clinical concern.

Finally, we note that our study examined one particular group of bilinguals, those learning French and English in Montréal, where both languages have high sociolinguistic status. A strength of data from this population is that results are unlikely to be due to confounding variables such as socioeconomic or immigration status. However, many bilingual populations do differ from monolinguals on these dimensions, and it is important to understand their development as well. Future studies will be needed to understand the extent to which our results generalize to bilinguals growing up in other contexts, and learning other language pairs.

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Author contributions

Krista Byers-Heinlein: Conceptualization; Formal analysis; Funding acquisition; Methodology; Supervision; Visualization; Writing-original draft; Writing-review & editing.
Ana Maria Gonzalez-Barrero: Conceptualization; Methodology; Writing-original draft; Writing-review & editing.
Esther Schott: Conceptualization; Formal analysis; Methodology; Visualization; Writing-original draft; Writing-review & editing.
Hilary Killam: Formal analysis; Methodology; Visualization; Writing-review & editing.

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Data availability statement

Analysis scripts and the full data set are available at https://osf.io/78hua/, doi: 10.17605/OSF.IO/78HUA

Note

1. Around one quarter of participants provided data at multiple time points, and to maximize statistical power, our main analyses included all data by using linear mixed-effects regression models with a random effect of participant to account for repeated measures. To check whether the inclusion of longitudinal data affected our conclusions, we ran analogous linear models with the same predictors, including only data from children's first lab participation, such that the data were purely cross-sectional. For combined-measure models (both expressive and receptive) the direction, magnitude, and significance for all predictors was very similar to the full dataset. For single-measure models, all predictors were similar in direction and magnitude, although some *p*-values fell below significance, likely due to the reduced sample size. Overall, these analyses indicate that our inclusion of both cross-sectional and longitudinal data in the main analyses did not drive our results.

References

Altman, C., Goldstein, T., & Armon-Lotem, S. (2018). Vocabulary, metalinguistic awareness and language dominance among bilingual preschool children. *Frontiers in Psychology*, *9*, Article 1953. https://doi.org/10.3389/fpsyg.2018.01953

American Speech-Language-Hearing Association. (2004). *Preferred practice patterns for the profession of speech-language pathology* [Preferred practice patterns]. https://doi.org/10.1044/policy.PP2004-00191

Bates, D., Maechler, M., Bolker, B., & Walker, S. (2015). Fitting linear mixed-effects models using lme4. *Journal of Statistical Software*, *67*(1), 1–48. https://doi.org/10.18637/jss.v067.i01

Bauer, D. J., Goldfield, B. A., & Reznick, J. S. (2002). Alternative approaches to analyzing individual differences in the rate of early vocabulary development. *Applied Psycholinguistics*, *23*(3), 313–335. https://doi.org/10.1017/S0142716402003016

Bedore, L. M., & Peña, E. D. (2008). Assessment of bilingual children for identification of language impairment: Current findings and implications for practice. *International Journal of Bilingual Education and Bilingualism*, *11*(1), 1–29. https://doi.org/10.2167/beb392.0

Bialystok, E., Luk, G., Peets, K. F., & Yang, S. (2010). Receptive vocabulary differences in monolingual and bilingual children. *Bilingualism: Language and Cognition*, *13*(4), 525–531. https://doi.org/10.1017/S1366728909990423

Bilson, S., Yoshida, H., Tran, C. D., Woods, E. A., & Hills, T. T. (2015). Semantic facilitation in bilingual first language acquisition. *Cognition*, *140*, 122–134. https://doi.org/10.1016/j.cognition.2015.03.013

Bosch, L., & Ramon-Casas, M. (2014). First translation equivalents in bilingual toddlers' expressive vocabulary: Does form similarity matter? *International Journal of Behavioral Development*, *38*(4), 317–322. https://doi.org/10.1177/0165025414532559

Bosch, L., & Sebastián-Gallés, N. (2001). Evidence of early language discrimination abilities in infants from bilingual environments. *Infancy*, *2*(1), 29–49. https://doi.org/10.1207/S15327078IN0201_3

Brito, N. H., Grenell, A., & Barr, R. (2014). Specificity of the bilingual advantage for memory: Examining cued recall, generalization, and working memory in monolingual, bilingual, and trilingual toddlers. *Frontiers in Psychology*, *5*, 1–12. https://doi.org/10.3389/fpsyg.2014.01369

Byers-Heinlein, K., Schott, E., Gonzalez-Barrero, A. M., Brouillard, M., Dubé, D., Jardak, A., Laoun-Rubenstein, A., Mastroberardino, M., Morin-Lessard, E., Pour Iliaei, A., Salama-Siroishka, N., & Tamayo, M. P. (2019). MAPLE: A Multilingual Approach to Parent Language Estimates. *Bilingualism: Language and Cognition*, *23*(5), 951–957. https://doi.org/10.1017/S1366728919000282

Byers-Heinlein, K., & Werker, J. F. (2009). Monolingual, bilingual, trilingual: Infants' language experience influences the development of a word-learning heuristic. *Developmental Science*, *12*(5), 815–823. https://doi.org/10.1111/j.1467-7687.2009.00902.x

Cattani, A., Abbot-Smith, K., Farag, R., Krott, A., Arreckx, F., Dennis, I., & Floccia, C. (2014). How much exposure to English is necessary for a bilingual toddler to perform like a monolingual peer in language tests? Language exposure and bilingual screening. *International Journal of Language & Communication Disorders*, *49*(6), 649–671. https://doi.org/10.1111/1460-6984.12082

Core, C., Hoff, E., Rumiche, R., & Señor, M. (2013). Total and conceptual vocabulary in Spanish–English bilinguals from 22 to 30 months: Implications for assessment. *Journal of Speech, Language, and Hearing Research*, *56*(5), 1637–1649. https://doi.org/10.1044/1092-4388(2013/11-0044)

Cote, L. R., & Bornstein, M. H. (2014). Productive vocabulary among three groups of bilingual American children: Comparison and prediction. *First Language*, *34*(6), 467–485. https://doi.org/10.1177/0142723714560178

De Houwer, A. (2011). Language input environments and language development in bilingual acquisition. *Applied Linguistics Review*, *2*(2), 221–240. https://doi.org/10.1515/9783110239331.221

De Houwer, A., Bornstein, M. H., & Putnick, D. L. (2014). A bilingual–monolingual comparison of young children's vocabulary size: Evidence from comprehension and production. *Applied Psycholinguistics*, *35*(6), 1189–1211. https://doi.org/10.1017/S0142716412000744

Duff, F. J., Reen, G., Plunkett, K., & Nation, K. (2015). Do infant vocabulary skills predict school-age language and literacy outcomes? *Journal of Child Psychology and Psychiatry*, *56*(8), 848–856. https://doi.org/10.1111/jcpp.12378

Fenson, L., Marchman, V. A., Thal, D., Dale, P. S., & Bates, E. (2007). *MacArthur – Bates Communicative Development Inventories (CDIs)* (2nd ed.). Brookes Publishing.

Floccia, C., Sambrook, T. D., Delle Luche, C., Kwok, R., Goslin, J., White, L., Cattani, A., Sullivan, E., Abbot-Smith, K., Krott, A., Mills, D., Rowland, C., Gervain, J., & Plunkett, K. (2018). Vocabulary of 2-year-olds learning English and an additional language: Norms and effects of linguistic distance. *Monographs of the Society for Research in Child Development*, *83*(1), 7–29. https://doi.org/10.1111/mono.12348

Gampe, A., Kurthen, I., & Daum, M. M. (2018). BILEX: A new tool measuring bilingual children's lexicons and translational equivalents. *First Language*, *38*(3), 263–283. https://doi.org/10.1177/0142723717736450

Gibson, T. A., Peña, E. D., & Bedore, L. M. (2014). The receptive–expressive gap in bilingual children with and without primary language impairment. *American Journal of Speech-Language Pathology*, *23*(4), 655–667. https://doi.org/10.1044/2014_AJSLP-12-0119

Giguere, D., & Hoff, E. (2020). Home language and societal language skills in second-generation bilingual adults. *International Journal of Bilingualism*, *24*(5–6), 1071–1087. https://doi.org/10.1177/1367006920932221

Giguere, D., & Hoff, E. (2022). Bilingual development in the receptive and expressive domains: They differ. *International Journal of Bilingual Education and Bilingualism*, *25*(10), 3849–3858. https://doi.org/10.1080/13670050.2022.2087039

Hoff, E., & Core, C. (2015). What clinicians need to know about bilingual development. *Seminars in Speech and Language*, *36*(02), 89–99. https://doi.org/10.1055/s-0035-1549104

Hoff, E., Core, C., Place, S., Rumiche, R., Señor, M., & Parra, M. (2012). Dual language exposure and early bilingual development. *Journal of Child Language*, *39*(1), 1–27. https://doi.org/10.1017/S0305000910000759

Hoff, E., & Ribot, K. M. (2017). Language growth in English monolingual and Spanish-English bilingual children from 2.5 to 5 years. *The Journal of Pediatrics*, *190*, 241–245. https://doi.org/10.1016/j.jpeds.2017.06.071

Hoff, E., Rumiche, R., Burridge, A., Ribot, K. M., & Welsh, S. N. (2014). Expressive vocabulary development in children from bilingual and monolingual homes: A longitudinal study from two to four years. *Early Childhood Research Quarterly*, *29*(4), 433–444. https://doi.org/10.1016/j.ecresq.2014.04.012

Houle, P., Turcotte, M., & Wendt, M. (2017). *Changes in parents' participation in domestic tasks and care for children from 1986 to 2015*. https://www150.statcan.gc.ca/n1/pub/89-652-x/89-652-x2017001-eng.htm

Huttenlocher, J., Haight, W., Bryk, A., Seltzer, M., & Lyons, T. (1991). Early vocabulary growth: Relation to language input and gender. *Developmental Psychology*, *27*(2), 236–248. https://doi.org/10.1037/0012-1649.27.2.236

Junker, D. A., & Stockman, I. J. (2002). Expressive vocabulary of German-English bilingual toddlers. *American Journal of Speech-Language Pathology*, *11*(4), 381–394. https://doi.org/10.1044/1058-0360(2002/042)

Kan, P. F., & Kohnert, K. (2005). Preschoolers learning Hmong and English: Lexical-semantic skills in L1 and L2. *Journal of Speech, Language and Hearing Research*, *48*(2), 372–383. https://doi.org/10.1044/1092-4388(2005/026)

Kircher, R. (2014). Thirty years after Bill 101: A contemporary perspective on attitudes towards English and French in Montreal. *Canadian Journal of Applied Linguistics/Revue Canadienne de Linguistique Appliquée*, *17*(1), 20–50. https://journals.lib.unb.ca/index.php/CJAL/article/view/21582

Kohnert, K. (2010). Bilingual children with primary language impairment: Issues, evidence and implications for clinical actions. *Journal of Communication Disorders*, *43*(6), 456–473. https://doi.org/10.1016/j.jcomdis.2010.02.002

Kuznetsova, A., Brockhoff, P. B., & Christensen, R. H. B. (2017). LmerTest package: Tests in linear mixed effects models. *Journal of Statistical Software*, *82*(13), 1–26. https://doi.org/10.18637/jss.v082.i13

Luk, G. (2017). Bilingualism. In B. Hopkins, E. Geangu, & S. Linkenauger (Eds.), *The Cambridge Encyclopedia of child development* (2nd ed., pp. 385–391). Cambridge University Press. https://doi.org/10.1017/9781316216491.062

Mancilla-Martinez, J., Greenfader, C. M., & Ochoa, W. (2018). Spanish-speaking preschoolers' conceptual vocabulary knowledge: Towards more comprehensive assessment. *HS Dialog: The Research to Practice Journal for the Early Childhood Field*, *21*(1), Article 1. https://journals.charlotte.edu/dialog/article/view/751

Marchman, V. A., & Fernald, A. (2008). Speed of word recognition and vocabulary knowledge in infancy predict cognitive and language outcomes in later childhood. *Developmental Science*, *11*(3), F9–F16. https://doi.org/10.1111/j.1467-7687.2008.00671.x

Montanari, S. (2010). Translation equivalents and the emergence of multiple lexicons in early trilingual development. *First Language*, *30*(1), 102–125. https://doi.org/10.1177/0142723709350528

Orena, A. J., Byers-Heinlein, K., & Polka, L. (2019). Reliability of the Language Environment Analysis (LENA) in French–English bilingual speech. *Journal of Speech, Language, and Hearing Research*, *62*(7), 2491–2500. https://doi.org/10.1044/2019_jslhr-l-18-0342

Pearson, B. Z., Fernández, S. C., & Oller, D. K. (1993). Lexical development in bilingual infants and toddlers: Comparison to monolingual norms. *Language Learning*, *43*(1), 93–120. https://doi.org/10.1111/j.1467-1770.1993.tb00174.x

Pearson, B. Z., Fernández, S. C., & Oller, D. K. (1995). Cross-language synonyms in the lexicons of bilingual infants: One language or two? *Journal of Child Language*, *22*(2), 345–368. https://doi.org/10.1017/s030500090000982x

Petitto, L. A., Katerelos, M., Levy, B. G., Gauna, K., Tétreault, K., & Ferraro, V. (2001). Bilingual signed and spoken language acquisition from birth: Implications for the mechanisms underlying early bilingual language acquisition. *Journal of Child Language*, *28*(02), 453–496. https://doi.org/10.1017/S0305000901004718

Prevoo, M. J. L., Malda, M., Mesman, J., & van IJzendoorn, M. H. (2016). Within- and cross-language relations between oral language proficiency and school outcomes in bilingual children with an immigrant background: A meta-analytical study. *Review of Educational Research*, *86*(1), 237–276. https://doi.org/10.3102/0034654315584685

R Core Team. (2022). *R: A language and environment for statistical computing*. R Foundation for Statistical Computing. https://www.R-project.org/

Ring, E. D., & Fenson, L. (2000). The correspondence between parent report and child performance for receptive and expressive vocabulary beyond infancy. *First Language*, *20*(59), 141–159. https://doi.org/10.1177/014272370002005902

Sander-Montant, A., Bissonnette, R., & Byers-Heinlein, K. (2023, September). Like mother like child: Differential impact of mothers' and fathers' individual language use on bilingual language exposure. [pre-print]. https://doi.org/10.31234/osf.io/uv3tw

Schott, E., Kremin, L. V., & Byers-Heinlein, K. (2022). The youngest bilingual Canadians: Insights from the 2016 census regarding children aged 0–9 years. *Canadian Public Policy*, *48*(2), 254–266.

Silvén, M., Voeten, M., Kouvo, A., & Lundén, M. (2014). Speech perception and vocabulary growth: A longitudinal study of Finnish-Russian bilinguals and Finnish monolinguals from infancy to three years. *International Journal of Behavioral Development*, *38*(4), 323–332. https://doi.org/10.1177/0165025414533748

Statistics Canada. (2022). *While English and French are still the main languages spoken in Canada, the country's linguistic diversity continues to grow* (No. 11-001-X). Statistics Canada.

Thordardottir, E. (2011). The relationship between bilingual exposure and vocabulary development. *International Journal of Bilingualism*, *15*(4), 426–445. https://doi.org/10.1177/1367006911403202

Thordardottir, E., Rothenberg, A., Rivard, M.-E., & Naves, R. (2006). Bilingual assessment: Can overall proficiency be estimated from separate measurement of two languages? *Journal of Multilingual Communication Disorders*, *4*(1), 1–21. https://doi.org/10.1080/14769670500215647

Trudeau, N., Frank, I., & Poulin-Dubois, D. (1999). Une adaptation en français québecois du MacArthur Communicative Development Inventory [A Quebec French adaptation of the MacArthur Communicative Development Inventory]. *Revue d'orthophonie et d'audiologie*, *23*, 31–73.

Tsui, R. K., Gonzalez-Barerro, A. M., Schott, E., & Byers-Heinlein, K. (2022). Are translation equivalents special? Evidence from simulations and empirical data from bilingual infants. *Cognition*, *225*, 105084. https://doi.org/10.1016/j.cognition.2022.105084

Uccelli, P., & Páez, M. M. (2007). Narrative and vocabulary development of bilingual children from kindergarten to first grade: Developmental changes and associations among English and Spanish skills. *Language, Speech, and Hearing Services in Schools*, *38*(3), 225–236. https://doi.org/10.1044/0161-1461(2007/024)

Unsworth, S. (2016). Quantity and quality of language input in bilingual language development. In E. Nicoladis & S. Montanari (Eds.), *Bilingualism across the lifespan: Factors moderating language proficiency* (pp. 103–121). American Psychological Association. https://doi.org/10.1037/14939-007

Vagh, S. B., Pan, B. A., & Mancilla-Martinez, J. (2009). Measuring growth in bilingual and monolingual children's English productive vocabulary development: The utility of combining parent and teacher report. *Child Development*, *80*(5), 1545–1563. https://doi.org/10.1111/j.1467-8624.2009.01350.x

Volterra, V., & Taeschner, T. (1978). The acquisition and development of language by bilingual children. *Journal of Child Language*, *5*(2), 311–326. https://doi.org/10.1017/S0305000900007492

Weisleder, A., Friend, M., Tsui, A., & Marchman, V. A. (2022). *Using parent report to measure vocabulary in young bilingual children: A scoping review* [Preprint]. PsyArXiv. https://doi.org/10.31234/osf.io/un6yr