How WEIRD-biased is CHILDES' data on children's linguistic input

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Abstract

In recent years, the importance of estimating demographic biases in research has become apparent. Here we provide a systematic review of the CHILDES archive, the major source of data on naturalistic recordings of children's linguistic environment. We analyzed the archive at the country and corpus level for four dimensions considered central for language learning: SES, urbanization, family structure and language. We compared these descriptive statistics to world statistics to assess whether the archive was biased in terms of the demographics of the countries represented and the families recorded within them. We found that at the country level, the 47 countries from which there were recordings in CHILDES overrepresented countries with higher educational level; were more urban; and had smaller households with less children. At the corpus level, middle- and higher-class participants were over-represented in relation to the statistics of their own countries. Corpora also included more educated families, with academics being especially over-represented. The corpora were not representative of their countries in terms of urbanization either - with a larger percentage of families residing in urban settings than is overall true for the respective countries. In terms of family structure, nuclear families were more prevalent than in the countries the data was collected in, and - surprisingly - children with no siblings appeared to be under-represented. Last, we found that corpora were linguistically diverse, but we estimate that data in CHILDES under-represents bilingual and multilingual households. We conclude that when generalizing from analysis of data obtained from CHILDES, researchers should acknowledge the potential biases of the archive.

Keywords: childes, verbal input, infant-directed speech, language, weird

Word count: XXwords

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Research highlights

We examined CHILDES, the major source of data on children's linguistic environment for potential sampling bias in terms of SES, urbanization, family structure and languages. We found that the 47 countries present in CHILDES overrepresented rich, educated, urbanized countries with small nuclear families. *Within these countries, corpora overrepresented rich, educated, urban and nuclear families - and single-child families, as well as bilingual families were underrepresented.* Interpretation of studies based on CHILDES should acknowledge these biases.

Since its foundation in 1984, CHILDES (the Child Language Data Exchange System, MacWhinney, 2000) has been the major source of naturalistic recordings and transcript data for researchers studying language acquisition. Naturalistic recordings provide insight into how children acquire language in everyday contexts and capture the richness and complexity of language use in everyday conversations. They also constitute a valuable and ecologically valid source of data necessary for computational models seeking to reverse engineer language acquisition or simulate natural language development. This repository of naturalistic recordings has been the foundation for many influential concepts in developmental science and beyond, illustrated by more than 7,000 scientific publications (MacWhinney, 2019). It has contributed to establishing seminal work in various domains such as the theory of mind (Bartsch & Wellman, 1995) and human memory (Anderson & Schooler, 1991). It has also inspired theories that help us understand the connection between language input and language development (Christiansen, Allen, & Seidenberg, 1998).

However, naturalistic recordings may also contain potential biases. One notable concern is that participants might not represent the diverse socio-economic backgrounds, cultures, or linguistic environments children typically experience. As a result, the generalizability of the related findings may be limited, necessitating cautious interpretation. Researchers in many fields are increasingly aware of the bias towards WEIRD populations (Western, Educated, Industrial, Rich, Democratic, Henrich, Heine, & Norenzayan, 2010) in the samples they study (Cychosz & Cristia, 2022 ; Moriguchi, 2022; Nielsen, Haun, K??rtner, & Legare, 2017; Singh, Cristia, Karasik, Rajendra, & Oakes, 2023). Recent calls have been made to diversify research in psychology, cognitive, and developmental science to address this issue (Blasi, Henrich, Adamou, Kemmerer, & Majid, 2022; Kidd & Garcia, 2022; Majid & Levinson, 2010). For instance, Kidd and Garcia (2022) systematically reviewed publications from child-language journals. They revealed biases towards specific continents (North America and Europe) and languages (English. Spanish, French),

highlighting the need for increased diversity in populations and languages studied. Similarly, Blasi et al. (2022) emphasize the potential consequences of generalizing observations derived solely from English speakers and how fit they are to represent our entire human species. While these studies focused on biases towards specific languages, other sources of variance might be as important for research on language development. Every area of research conceptualizes different dimensions relevant to explaining variance for a given research topic. In what follows we present the four most relevant dimensions thought to play a role in child language acquisition, particularly related to naturalistic recordings: socioeconomic status, urbanization, family structure, and language.

Socioeconomic Status. Decades of research have examined the linguistic differences among families with varying socio-economic status (SES). In the developmental literature, this is primarily indexed by parents' education (Ensminger & Fothergill, 2014; Hoff, 2014), but can also be indexed otherwise, such as by parental income, occupation, or a composite measure of these three (e.g. Hollingshead, 1975). It is beyond the scope of this paper to detail all the theories that attempt to account for the complex causal pathways that may connect SES to children's language environments. We recommend Rowe (2018) as a starting point for readers interested in this literature, along with Golinkoff, Hoff, Rowe, Tamis-LeMonda, and Hirsh-Pasek (2019) and Sperry, Sperry, and Miller (2019) for diverse theoretical perspectives. It should be noted, however, that some of this literature has been found to reflect Global North biases, including what kinds of language input are counted, and what features of linguistic experiences are valued (Scaff, Casillas, Stieglitz, & Cristia, 2024; Sperry et al., 2019). Without desiring to take a stance on how SES and language environments relate to each other, we merely indicate here that SES is undoubtedly one of the factors that has been repeatedly studied in the context of early language acquisition, particularly related to input. For example, Hoff (2014) compared the speech of high- versus low-SES American mothers. College-educated parents produced more utterances to their child, with more diverse vocabulary, longer phrases, and higher

number of utterances continuing a topic the child had brought up. Similar findings can be seen in other studies [Hart and Risley (1995); Hoff-Ginsberg (1990); Hoff (2003); Huttenlocher, Vasilyeva, Waterfall, Vevea, and Hedges (2007); see also Dailey and Bergelson (2022); Leonardo, Havron, and Cristia (2022); for meta-analyses supporting the link; and Bergelson et al. (2023) for a large-scale study finding non-significant SES effects].

Urbanization. Urbanization is the process of moving from rural to urban areas along with noticeable changes in job opportunities and living conditions. It involves the growth and development of cities, leading to increased access to infrastructure and amenities. Within the general theoretical framework of language socialization, there have been proposals that societies varying in their urbanization process have differing views and values about the role of children in conversations, and more generally in the community (Sharma & LeVine, 1998 ; Draper & Harpending, 2017; Keller, 2012; Richman, Miller, & LeVine, 1992). For instance, Keller (2012) discusses three prototypical cases: urban, rural, and hybrid. These three groups differ in terms of their goals for children, with urban families aiming for child psychological independence, rural families for child physical autonomy and interdependence, and hybrid families aiming for some mix across these values. Vogt, Masson-Carro, and Jong (n.d.) employ this conceptual classification to interpret their results on multimodal language use across three samples: urban Dutch, urban Mozambique, and rural Mozambique. They found that the number of gestures, gesture-speech alignment, and gesture types all vary across the three groups in ways that can be related to Keller's typology. Similarly, Cristia (2023) systematic review concludes that children's urbanization status maps onto the amount of input afforded by caregivers: children from rural communities are exposed to less input from caregivers than children in urban ones.

Family structure. Family structure refers to the arrangement within a household, forming the basis of a family unit. This dimension encompasses aspects such as the number of siblings, birth order, the number of caregivers in the household, and the number of

individuals sharing or competing for household resources (including caregiving attention); each of which has a significant impact on child and language development (Blake, 1981; Bornstein, Putnick, & Suwalsky, 2019; Duncan & Paradis, 2020; Havron et al., 2022, 2019; Hoff-Ginsberg & Krueger, 1991; Tomasello & Mannle, 1985). For example, birth order effects reveal that children with older siblings show lower language skills than first-born children in various cultures (e.g., Peyre et al., 2016 in France; Havron et al., 2022 for Singapore; Zambrana, Ystrom, & Pons, 2012 for Norway). Other birth order effects suggest that second-born children might benefit in production through overheard speech from their caregivers and older siblings (Oshima-Takane, Goodz, & Derevensky, 1996). Regarding household composition, in many middle-class Euro-American families, parents typically assume primary responsibility for children, often focusing on the mother as the primary caregiver (e.g. Bakermans-Kranenburg et al., 2004; Huttenlocher et al., 2010; Ispa et al., 2004; Pan et al., 2005). However, certain cultures, like Turkish families described by Isleyen (2021), may adopt a different approach, with nuclear families living in separate apartments but sharing common spaces and caregiving responsibilities, resulting in extensive support networks.

Languages. Characterizing the diversity of participant samples in terms of language (Blasi et al., 2022; Kidd & Garcia, 2022) is an important factor in language acquisition, as variations in language exposure and language use among different groups allow to explore how purely linguistic factors shape and influence the development of language skills in children. For example, based on transcriptions of conversations, it was shown that K'iche' Mayan children frequently use and understand passive constructions from a very young, unlike their English-speaking peers, refuting the idea that passive constructions can only emerge later in development (C. L. Pye, 1980; C. Pye & Poz, 1988). Similarly, many Indo-European languages show a strong noun bias in early vocabularies (a bias for acquiring words for concrete referential objects rather than actions), it has been claimed to be a universal feature of early language acquisition. However, studies have

shown that in some Mayan languages, including Tseltal and Tsotsil (Casillas, Foushee, Méndez Girón, Polian, & Brown, 2024; De León, 1999), there is little to no evidence for a noun bias and argue for a verb bias instead. This highlights significant cross-linguistic variation and underscores the importance of studying naturalistic children's recordings for describing different linguistic developmental trajectories (Casillas et al., 2024).

Another major dimension and entire sub-field in developmental science is the study of bilingualism or multilingualism McCabe et al. (2013). There is evidence that monolingual and bilingual early language development differs in some aspects, particularly regarding phonological acquisition and word learning. For example, monolingual infants' ability to discriminate non-native sounds declines during the first year of age, whereas infants exposed to one or more languages maintain the discrimination window for a longer period. Also, in terms of input, bilingual linguistic exposure is divided between two or more native languages. It has been shown that the amount of exposure to each native language can affect bilingual infants' speech discrimination abilities (Garcia-Sierra et al., 2011).

The current study. Here, we provide a systematic analysis of the naturalistic speech corpora of the CHILDES database by quantifying the diversity of each dimension presented above (see Table 1). Though some of these dimensions overlap with each other (See Figures SM.X and SM.x in the supplementary materials for illustrations), we decided to illustrate each as best as possible independently. Our systematic analysis follows three steps. First, we screened the CHILDES database, excluding the clinical and task-driven recordings. Second, we extracted information related to the four central factors in language acquisition described in the introduction. Finally, we follow Ghai (2021) recommendation to improve the description of diversity in behavioral sciences by looking at different levels: from a macro-level, with broad country comparisons to a corpus-level, where we delved into individual corpora to gain a more detailed and nuanced understanding of the data.

Methods

Analyses and visualizations were carried out using R (version 4.1.2, R Core Team, 2020) and ggplot2 (Wickham, 2016). Data, scripts, and online Supplementary Materials are available on OSF [https://osf.io/q9w82/?view_only=a013f1b25b8c4556b8248f12870402c9].

Inclusion criteria. We excluded the following corpora: a) clinical populations or non-typically developing children, b) structured tasks such as toy narratives, personal narratives, frog stories, picture or movie descriptions, structured storytelling, and other elicitation tasks; c) only child or adult speech without a conversational partner; and d) non-naturalistic setups, such as recordings conducted exclusively in a lab environment or in a diary format. ### Screening Following a thorough examination of each corpus, which involved reviewing the corpus description available on the CHILDES website, checking for any accompanying references such as articles, book chapters, or dissertations, and conducting spot-checks on associated transcripts, we identified 180 corpora that met our inclusion criteria mentioned above. For a detailed breakdown of the included corpora, please refer to the flowchart in Supplementary Materials.

Descriptive-statistics. Descriptive statistics Firstly, we present an overview of the countries within the CHILDES database, specifically the distribution of participants by continent (Table 2) and geographical location (Figure 1) and examining three out of our four key dimensions: SES, urbanization, family structure (Figure 2). Our goal is to provide insights into the representativeness of our CHILDES sub-sample when compared to global statistics. Figure 2 draws data from official sources such as the World Bank, Our World in Data (WDI), and the United Nations (UN). It is noteworthy that information on the Language dimension is omitted due to the lack of official world statistics on multilingualism. This limitation arises from the exclusion of certain languages or dialects in official country counts (REF). For additional details on Figure 2 and the corresponding variables, please refer to the Supplementary Materials (SMX).

Secondly, we offer corpus-level statistics to assess the representativeness of our sub-sample of CHILDES in a more detailed manner across our four dimensions: SES, urbanization, family structure, and languages (See Table 1 for the complete list of variables and definitions). Data was extracted from the provided sources mentioned in CHILDES such as articles, book chapters, dissertations, and transcripts to pre-fill the categories. Corpus curators were contacted to request missing or incomplete information, and an online table was provided to facilitate data entry. Over a third of the contacted curators (XX corpora, XX%) provided additional data or confirmed missing information. Unfortunately, curators for 180 corpora (XX%) could not be contacted due to unresponsive email addresses (38), or the curator's passing (12).

Table 1

Dimension	Macro.level.variable	
SES	Percent of the population completing lower secondary school*	
SES	GDP per capita (log 10)	
Urbanization	Percent of the population living in urban areas	WDI from the World
Family structure	Average household size	
Family structure	Average number of member under 15 in households	
Language	NA	

Table 2

Definition of the corpus-level variables

Dimension	Corpus.level.variable
SES	Parents' socio-economic status

Table 2 continued

Dimension	Corpus.level.variable	
SES	Parents' education level	Highest le
SES	Parents' occupation	
Urb	Type of community	
Family structure	Household composition	Whether the family was composed primarily of care
Family structure	Percent children with sibling(s)	
Family structure	Average number of siblings	How
Language	Language(s) spoken	
Language	Lingual status	Whether more than one language is s

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210 **Results**

211 The 180 corpora included in this study represent 48 different countries across all
212 populated continents. Out of the 48 different countries or areas included in the sample, 28
213 of them belong to the OECD (Organisation for Economic Co-operation and Development).
214 This corresponds to 149 out of 180 corpora or to 82.78% of this sub-sample of CHILDES.
215 OECD countries represent 19.5% of world countries.

216 [1] 0

Table 3

Descriptives

Continent	N.corpora	N.total.children	N.children.growing.in.continent
Africa	3.00	16.00	X

Table 3 continued

Continent	N.corpora	N.total.children	N.children.growing.in.continent
Asia	32.00	602.00	X
North America	34.00	177.00	X
Latin America	5.00	6.00	X
Europe	105.00	1,091.00	X
Oceania	1.00	5.00	X

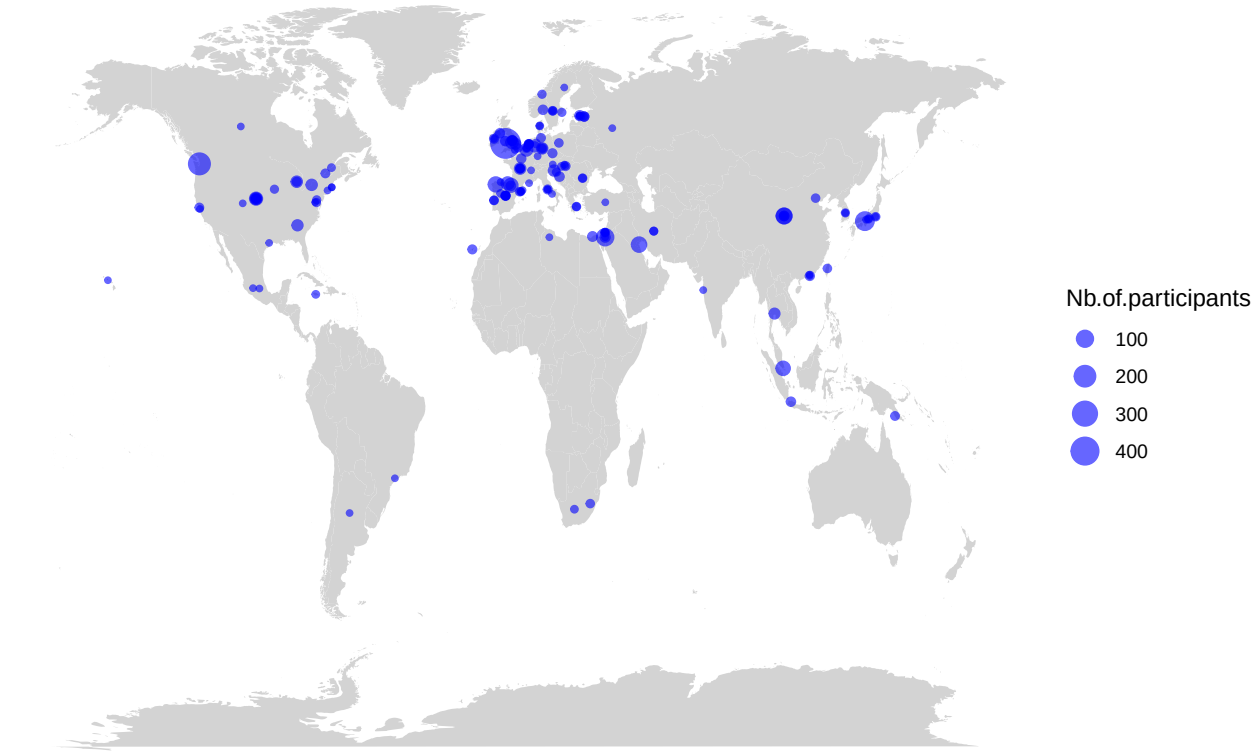


Figure 1. World map showing corpus. Size proportional to number of children per corpus

We assessed the extent to which the countries with data in our sub-sample of

CHILDES were a representative sample of countries in the world. Density plots are portrayed in Figure 2.

By comparing our sub-sample of CHILDES to the world statistics using unpaired samples t-tests without assuming equality of variance (Welch's t). Countries in our sub-sample of CHILDES had a higher proportion of the population completing lower secondary school than the world wide sample (% compl. LSS, t(130.41)=-6.19, p = 0); they were more urban (% urban, t(79.48)=-3.44, p = 0); richer (log GDP per capita, t(102.35)=-6.02, p = 0) and had smaller households (average household size, t(118.80)=7.12, p = 0) and less average number of members under the age of 15 (average under 15 size, t(26.12)=5.01, p = 0).

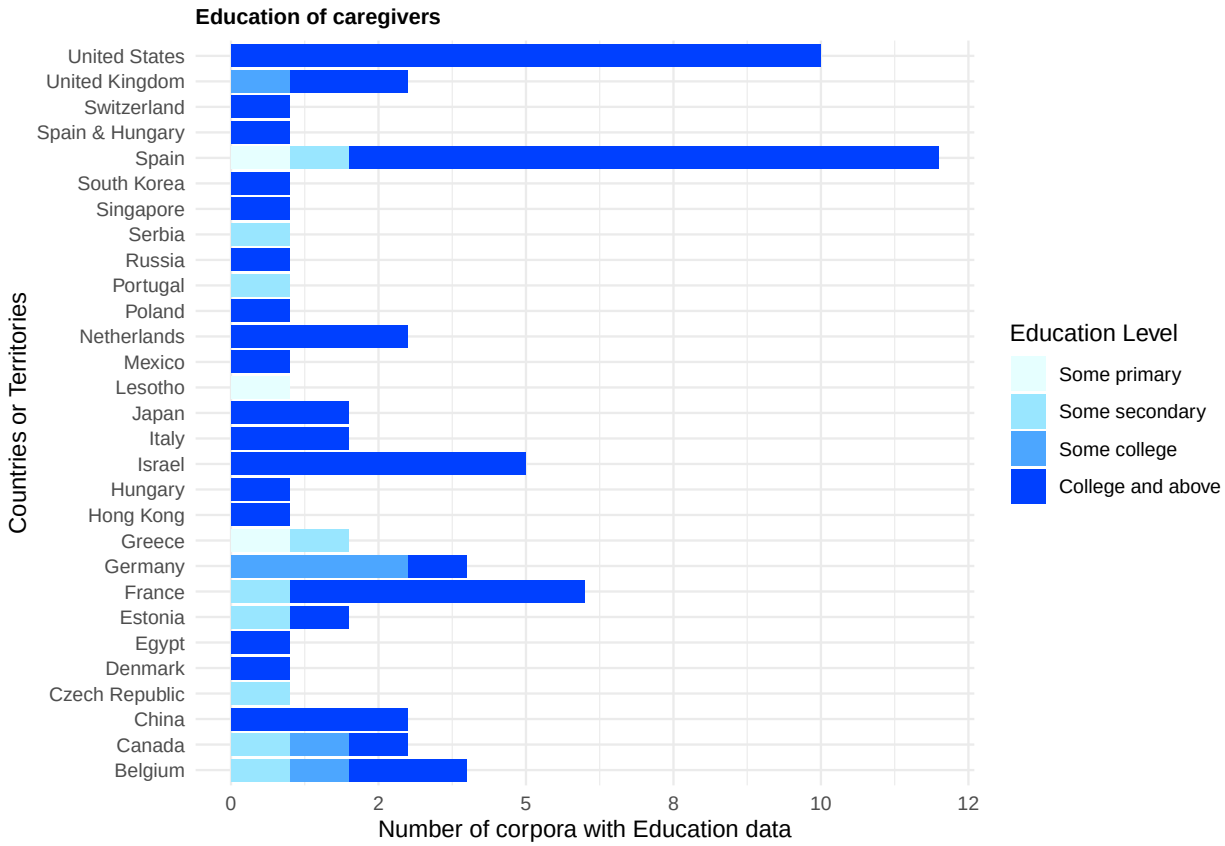
Corpus-level

We then investigated at the corpus level the variables described in Table 2. The information collected allows us to have more detail about the characteristics of the individual families that compose our sub-sample of CHILDES. However, it is important to acknowledge that for the majority of the corpora, this information was missing, not known, or not provided.

SES. Of the 102 (43%) corpora, 5 were described as having low SES; 16 were described as spanning both lower and middle or higher SES; and 81 were described as middle or higher SES exclusively (79%). Given that most countries represented in our sub-sample of CHILDES are in the OECD, we can compare this proportion with the proportion of the population in these countries that are middle class. According to a 2016 report, "Almost two-thirds of people live in middle-income households in OECD countries", for whom "household net income [is] between 0.75 and 2 times the median". Thus, middle and higher-class participants appear to be over-represented in our sub-sample of CHILDES data.

For socioeconomic status, there were 106 missing values (33%). Of the remaining 215 samples, were described as having low SES; were described as spanning both lower and middle or higher SES; and were described as middle or higher SES exclusively. Given that most countries represented in CHILDES are in the Organization for Economic Cooperation and Development (OECD, 0 out of the 321 corpora), we can compare this proportion with the proportion of the population in these countries that are middle class. According to a 2016 report, "Almost two-thirds of people live in middle-income households in OECD countries", for whom "household net income [is] between 0.75 and 2 times the median". Thus, middle and higher class participants appear to be over-represented in CHILDES data, composing 81% of available data.

Education. 76% of the corpora (n = 58) include children whose parents had at least a graduate, if not a postgraduate, degree. 4% (n=3) had at least some parents with primary-level education; 12% (n=9) had parents with secondary school education as the lower bound of the education range, and a further 8% (n=6) had some college as the lower bound. 4 corpora were described as "diverse", without clarifying the range of education covered. These numbers do not accurately represent the demographics of the countries they were obtained from. For instance, while the U.S. Census Bureau reported that only 36% of the adult population held a bachelor's degree or higher in 2020, our data indicates that 100% of the corpora of the parents from the United States had a college education or higher. As seen in Figure 3, the same result is seen for corpus from China, Denmark, Egypt, Hong Kong, Hungary, Israel, Italy, Japan, Mexico, The Netherlands, Poland, Russia, Singapore, South Korea, Switzerland and the United States where 100% of parents with data are college-educated or above. Thus, it seems that our sub-samples of CHILDES are very skewed toward higher-educated parents.



Occupation Professions were overall varied. The majority, comprising62% (n=52), was associated with the field of education. Notably, within this category, 56% (n=47) of the individuals were identified as parents with professions linked to graduate-level education. This included roles such as Master's or Ph.D. students, professors, linguists, researchers, scientists, and academics. Some of the other occupations reported were psychologists, speech therapist or home makers.

Urbanization. 89% of the corpora (n=58) corpora were described as industrialized or urban, and an additional one as both rural and urban. Only 7 corpora were described as farming or rural. In these same countries, the proportion of the population residing in urban settings was 76%, suggesting that samples were not representative of their countries in terms of rural versus urban settings either.

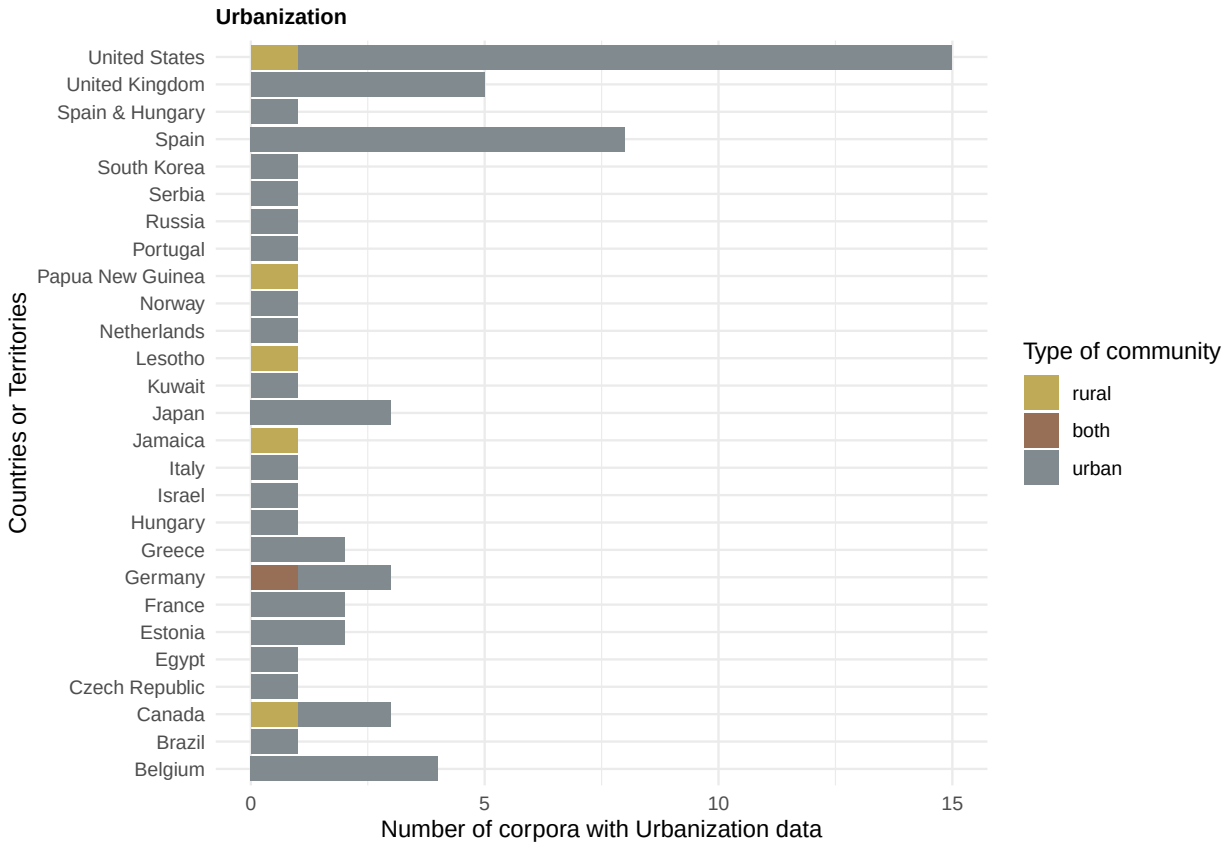
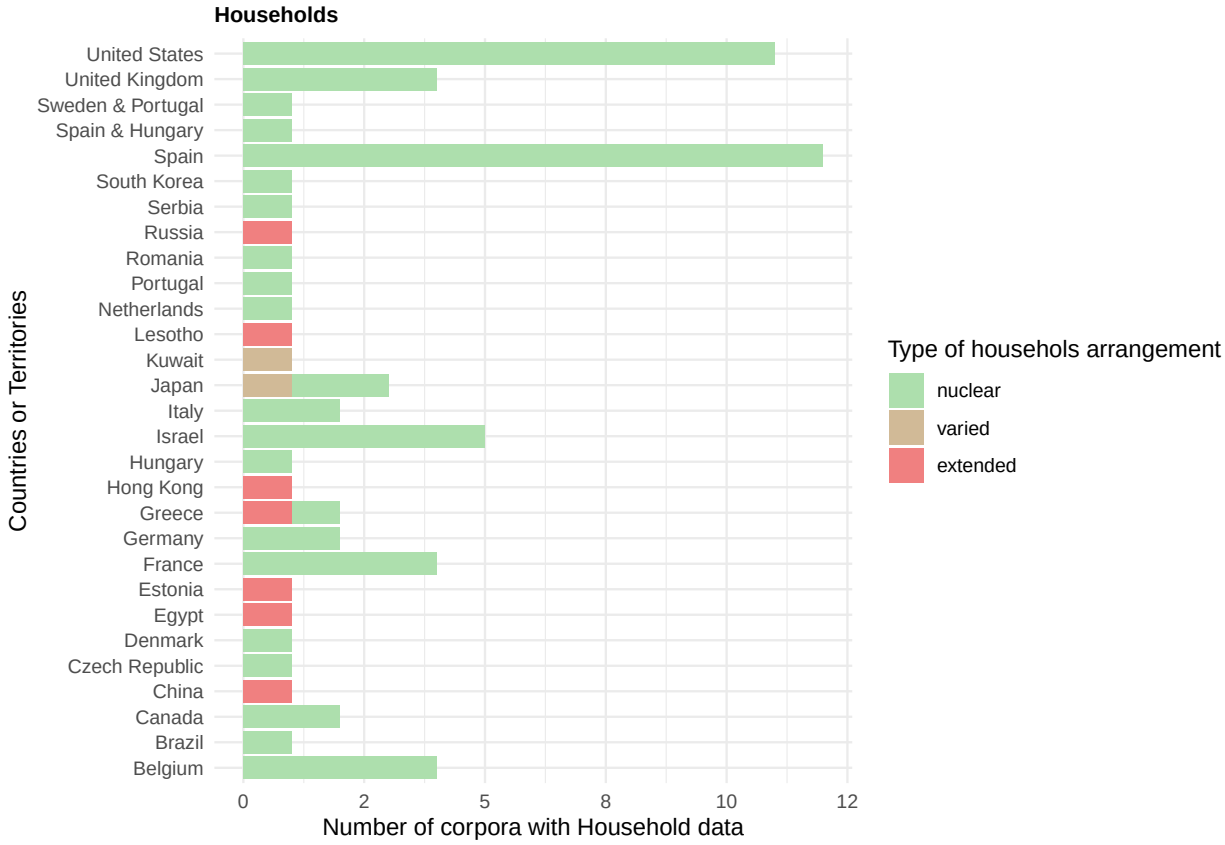


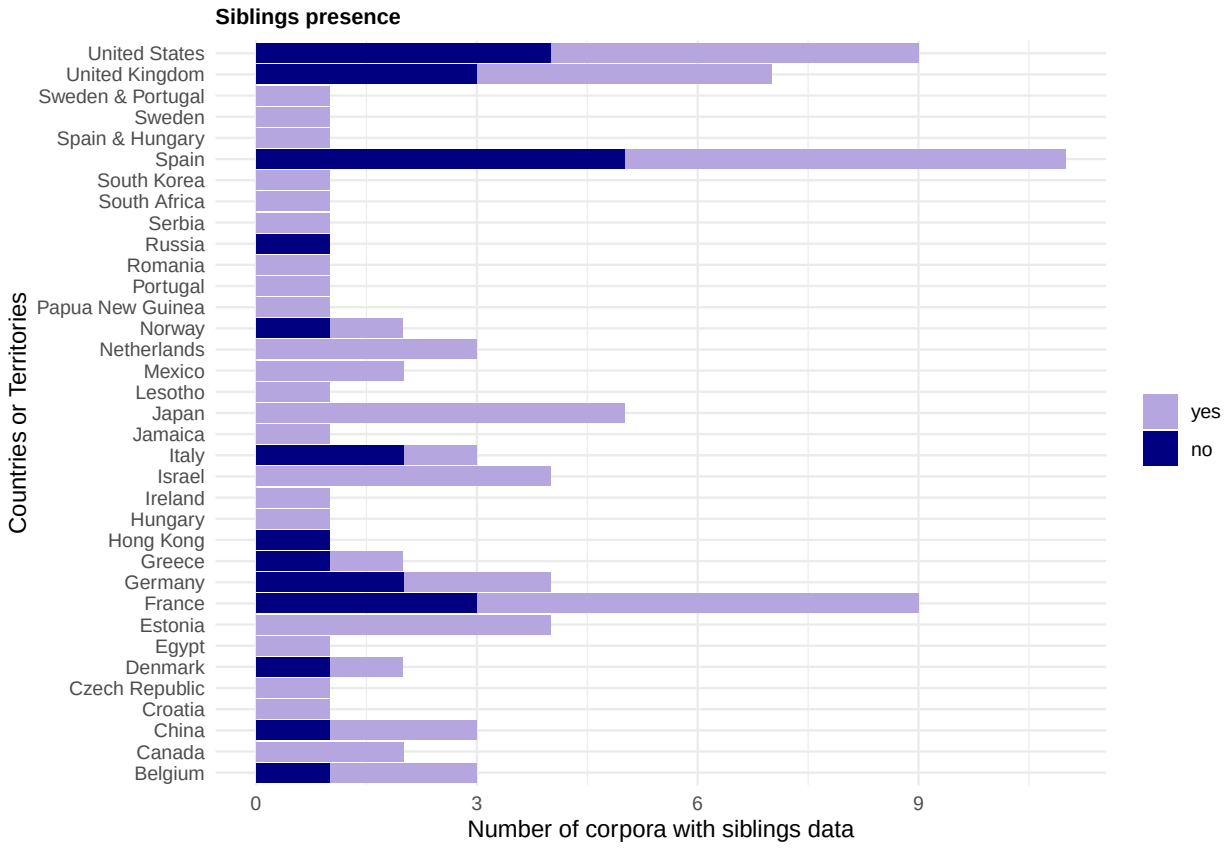
Figure 2. Urbanization by country.

Family structure.



Nuclear households As for household composition, 60 corpora (87%) were based on nuclear families; 7 extended families(10%); and in 2 corpora the structure was varied (3%). We compare side by side the average per country of the nuclear households (the sum of the percentages of couples with children households, and single parents with children households; United Nations, 2022).

Sibling presence. A majority of corpora in our sub-sample of CHILDES include children who have siblings. In fact, only 28% of corpora (among the 93 corpora having information on siblings) were constituted exclusively of children with no siblings, and the remaining had at least one sibling, with the overall average being 0.8 siblings. Since 83% of countries in CHILDES are in the OECD, we draw a comparison point for such countries: 46% of children had no siblings in OECD countries according to 2015 data. In this sense, children with no siblings appear to be under-represented in CHILDES.



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295 ### Languages We had two variables of interest here: language spoken in the corpus and
296 lingual status. A total of 62 different languages or language combinations (for bilingual and
297 multilingual children) were reportedly spoken in the corpora.

Table 4

Total number of participants per language,

Monolingual_Language	Total_Participants	Multilingual_Languages	Total_Partic
Afrikaans	2.00	Dutch/English, Dutch/French	
Arabic (Egyptian or Kuwaiti)	80.00	Dutch/Italian	
Basque	46.00	Spanish/Catalan	
Cantonese	8.00	Spanish/Galician	
Catalan	17.00	English/Cantonese	
Cree	1.00	English/French	

Table 4 continued

Monolingual_Language	Total_Participants	Multilingual_Languages	Total_Partic
Croatian	3.00	English/Hebrew	
Czech	6.00	English/Japanese	
Danish	2.00	English/Japanese/Danish	
Dutch	23.00	English/Mandarin	
English	210.00	English/Mandarin/Cantonese	
Estonian	32.00	English/Russian	
Farsi	5.00	English/Spanish	
French	46.00	French/Russian	
German	46.00	Hungarian/Catalan/Spanish	
Greek	6.00	Hungarian/Farsi/English	
Hebrew	122.00	German/Spanish	
Hungarian	8.00	Italian/Japanese	
Icelandic	1.00	Italian/German	
Indonesian	8.00	Portuguese/Swedish/English	
Irish	7.00	NA	
Italian	8.00	NA	
Jamaican	2.00	NA	
Japanese	148.00	NA	
Korean	4.00	NA	
Mandarin	157.00	NA	
Norwegian	11.00	NA	
Nungon	5.00	NA	
Polish	4.00	NA	
Portuguese (Brazilian or European)	9.00	NA	

Table 4 continued

Monolingual_Language	Total_Participants	Multilingual_Languages	Total_Partic
Romanian	6.00	NA	
Russian	2.00	NA	
Serbian	8.00	NA	
Sesotho	4.00	NA	
Slovenian	20.00	NA	
Spanish	75.00	NA	
Swedish	9.00	NA	
Taiwanese	4.00	NA	
Tamil	1.00	NA	
Thai	18.00	NA	
Turkish	1.00	NA	
Welsh	475.00	NA	

About a third (32%) of the included corpora that had available data for this variable (N = 110) were not monolingual. It is hard to find reliable estimates of the percentage of the population which is not monolingual in the world or in the countries represented in our sub-sample of CHILDES, but for instance, in Europe in 2016, 65% of adults reported knowing multiple languages (Eurostat, 2022). According to such estimates, even if samples are linguistically diverse, it would appear that input data in our sub-sample of CHILDES under-represents bilingual and multilingual households.

Discussion

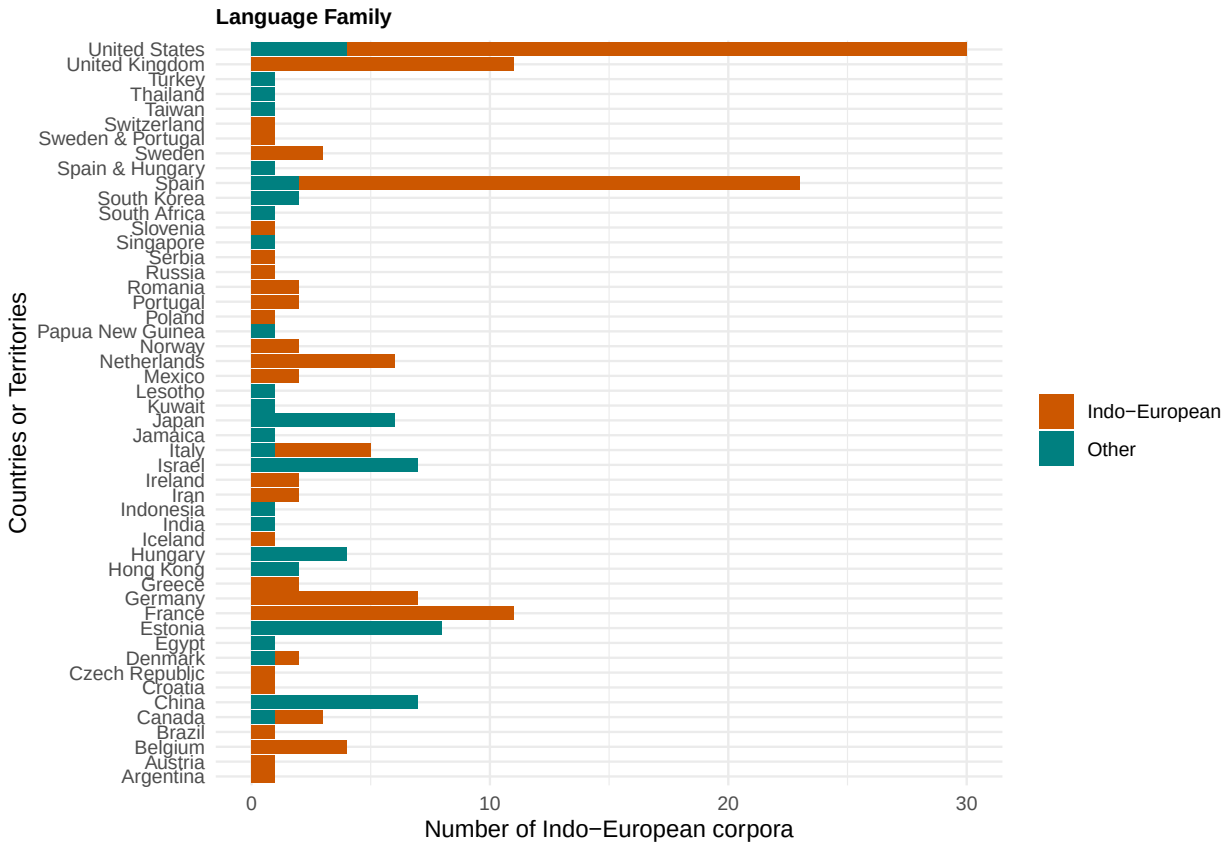

Figure 3. Indo-European languages by country.

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