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Methodological considerations in the study of children's early language environments: A scoping review

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Abstract
Children's early language experiences have a significant effect on later communication development and academic success. Most research on language input has been conducted in Western mainstream contexts where adults use a distinct register when speaking to young children. Since language socialization patterns are culture-bound, existing research can be considered representative of only a relatively small segment of the world's population. Further research on children's early language environments in underrepresented communities is needed to develop culturally sensitive and effective intervention programmes. However, the methodological decisions that researchers make when studying children's early language environments may be inherently biased toward Western, mainstream language socialization practices. This scoping review systematically examined recent literature on preschool children's language environments to summarize researchers' methodological considerations regarding the way in which data on language input in children's home environments are collected, coded, and analysed. Data sources included EBSCOHost (CINAHL, ERIC and Health Source), PubMed, Scopus, and Web of Science. After the title and abstract review was completed, a total of 53 articles were obtained through full-text review, but six were excluded during coding, bringing the total to 47 articles published between 2019 and 2023. Findings on researchers' methodological considerations reveal an increased awareness of the importance of social and contextual information in analysing input to children but still reflect a relatively limited focus on children's language environments in minority world (i.e., high-income, predominantly English-speaking) countries. This scoping review reports findings with methodological implications for future research on children's early language environments in majority world (i.e., low- and middle-income) contexts.

Keywords: methodological considerations, language environment, child-directed speech, language research methods, language input

1. Background

Children's first experience with language as a communication tool occurs in the context of early interactions with their primary caregivers and other individuals in their immediate environment. As pointed out by Hoff (2006: 76), "all human environments provide children with opportunities to see language used for communicative purposes", which may drive the language acquisition process. In many (but not all) languages and cultures, adults tend to adapt their speech in systematic ways depending on whether they are speaking to infants and toddlers or to adults. This register has been referred to as child-directed speech (CDS)[1] and is characterized by the use of exaggerated prosody (e.g., a slower speaking rate, a higher pitch, and a differentiated pitch range) and the use of a simplified lexicon and syntax (Genovese, Spinelli, Romero Lauro, Aureli, Castelletti & Fasolo 2020). This type of tailored language input has been found to enhance aspects of auditory discrimination and initial word learning in children (Hart & Risley 1995; Rowe 2012).

Most of what is known about CDS and children's early language development has been obtained through observations of young children and their parents from Western, educated,

[1] It is also referred to as infant-directed speech, motherese, fatherese, parentese, or child-directed language.

industrialized, rich, and democratic (WEIRD[2]) contexts (Henrich, Heine & Norenzayan 2010), also called "minority world contexts". In these contexts, children are often treated as the centre of attention and directly addressed by adults via speech, gestures, and physical activities (Bates, Benigni, Bretherton, Camaioni, & Volterra 1979, as cited in Vogt, Mastin & Schots 2015) with speech typically adapted for the infant by the mother and/or primary caregiver. However, decades of research have shown that the distinctive CDS register described in the literature is not used by all language and culture[3] groups. Instead, the specific characteristics of language input vary considerably depending on the social and cultural context in which children grow up. For instance, in many rural communities, infants and toddlers are not yet considered to be conversational partners, and, therefore, adults rarely engage in communicative exchanges with them (e.g., Heath 1983; Winking, Gurven & Kaplan 2011). In their description of the language socialization practices in a village in Botswana, Geiger and Alant (2005) report that mothers showed little verbal interaction with their young children, especially infants younger than one year of age. Where verbal communication did take place, it tended to be instructional in nature (e.g., directing the child's behaviour through commands such as "stop that"), with the child not expected or encouraged to respond. For adults to engage in verbal play or cooing with an infant was considered unusual in this Botswanan community, despite there being ample opportunity for infants to practice these prelinguistic skills during play with siblings and other children. Although many studies have found positive associations between specific aspects of CDS as it is used in minority world contexts, the fact that most research and knowledge on CDS has been obtained within linguistic and cultural backgrounds that are not representative of most of the world's population limits the generalizability of CDS-related findings (Kidd & Garcia 2022). More research on underrepresented language learning contexts is clearly needed. However, simply replicating the same research methodologies used to describe children's early language environments in minority world contexts when studying majority world populations may still not yield representative findings. Several researchers, for instance, highlight persistent sampling biases in the available research on child language acquisition (Nielsen, Haun, Kärtner & Legare 2017).

The term *methodological considerations* is used in this paper to refer to the variety of approaches selected by researchers to collect and analyse data in research studies that may have an impact on the estimated differences found between groups included in studies on children's early language environments (Dailey & Bergelson 2022a). For this study, these methodological considerations have been broadly categorized according to the following: (i) whose language environments are being described through the research sample (Section 2), (ii) how and when data on children's language environments is being collected (Section 3), and (iii) which aspects of language input from the environment are considered for analysis (Section 4). Each of these types of considerations are discussed with reference to existing research on young children's language environments. Thereafter, we state the objectives of the current study (Section 5),

[2] While WEIRD refers to specific socio-economic and political characteristics of study populations, the related term "minority world" is used in this review to emphasize global research imbalances between high-income contexts and the majority world.

[3] Culture can be defined as:

> [….] a set of factors from multiple dimensions that can describe how one person or a group of people experience life and engage in daily practices. Culture is learned and transmitted socially through patterns of behaviour driven by such factors as problem-solving strategies, value systems, beliefs, symbols, attitudes, religion, artifacts, and communication.
>
> (Hyter & Sals-Provance 2021: 6)

discuss the methodology used during our scoping review (Section 6), and present our results (Section 7).

2. The research sample (*who*)

A diverse participant pool in child language acquisition research may be attained through methodological decisions about location (e.g., country or region), the language(s) spoken by participants, and their linguistic profiles (e.g., monolingual vs. multilingual), socio-economic status (SES), ethnicity, nationality and/or race.[4] Most developmental data have been collected in North America and Europe while most children live in Africa and Asia (Nielsen, Haun, Kärtner & Legare 2017). In terms of linguistic diversity, only approximately 1.5% of the world's languages are represented in research published in four influential child language acquisition journals over the past 45 years, with most focusing on monolingual children (Kidd & Garcia 2022).

Although variation may be found within the same cultural group, language socialization practices differ in meaningful ways between cultural groups in rich, educated, and industrialized communities and those in poorer, more rural, and less industrialized communities of the world (Van Kleeck 1992). In Western middle- to upper-middle class contexts, it is often assumed that the child's mother is the primary caregiver and that meaningful language interaction takes place in the child-mother dyad (Honig 1982). However, various caregivers may be involved in child-rearing practices in other contexts due to the variety of family structures that exist across (and within) cultures. Extended hours of childcare (and, as a result, language input) may be provided by either one or both biological or adoptive parents as well as by grandparents, siblings, relatives, and/or community members or by domestic workers. For example, in South Africa, domestic workers are employed by up to 37% of non-African households and 17% of African households (Hatch & Posel 2018). Many children in Africa are cared for physically and financially by their biological mothers as well as the child's grandmother or another female relative. In South Africa, for instance, only 8% of primary caregivers of African children and 13% of non-African children are male, and children often do not live with both their parents in the same household; rather, they typically stay predominately with their mother or with neither parent, due to labour migration, low marital rates, or other socio-economic factors (Hatch & Posel 2018). In many cultures, children are looked after by their older siblings, especially when the child starts to become mobile (Van Kleeck 1992; Tronick, Morelli & Ivey 1992).

Several studies have reported meaningful differences in the way parents/caregivers from financially disadvantaged backgrounds communicate with their young children (e.g., Hart & Risley 1995). For instance, mothers from low-SES or rural backgrounds are more likely to use language to direct their children's behaviour, whereas mothers from mid-SES backgrounds are more likely to encourage their children to verbalize (Alam, Rosemberg, Garber & Stein 2021; Vogt et al. 2015). SES is determined in various ways, such as by considering maternal/parental

[4] Historically, the concept of *culture* was typically confounded with that of *race* and *ethnicity*, and these three concepts are often combined into one during the collection of empirical data. Race can be described as a socially defined construct in which there is perceived to be unchanging differences between racial groups based on genetic and biological characteristics (Quintana, Aboud, Chao, Contreras Grau, Cross, Hudley, Hughes, Liben, Nelson-Le Gall & Vietze 2006), whereas ethnicity is a broader concept relating to "social categorisation based on an individual's membership in or identification with a particular cultural or ethnic group" (American Psychological Association n.d.).

educational level, household income, and/or employment status (Southwood, White, Brookes, Pascoe, Ndhambi, Yalala, Mahura, Mössmer, Oosthuizen, Brink & Alcock 2021). The same methodological considerations, however, cannot be applied uncritically when sampling from different SES groups due to the significant difference between the language learning environments of children with high SES and those with low SES (Dailey & Bergelson 2022a). For example, the widely cited finding of a 30-million-word gap between American children from low- and high-SES homes before they enter school (Hart & Risley 1995) is based on the methodological decision of the researchers to include only CDS in their language measures rather than all speech in a child's environment. A meta-analysis by Dailey and Bergelson (2022a) find that although SES has a significant effect on the quantity of language young children are exposed to, the effect is moderated by the type of language included in language quantity measures (CDS only or also overheard speech). Further in-depth research on the language environments of children in low-SES homes is clearly needed to disentangle in a culturally sensitive manner the complex issues underlying between-group differences.

3. Data collection methods and procedures (*when* and *how*)

The consideration of naturalistic linguistic interactions extracted from diverse everyday activities in real time will aid researchers in understanding how children acquire language (Kuchirko 2019). These activities may include indoor and outdoor play, book reading, mealtime, interactions around different forms of visual media (e.g., tablets, smartphones, laptops, television), personal care routines, and transport. The types of activities that young children and their caregivers engage in are largely influenced by the family's social and cultural background. Balton, Uys and Alant (2019) examine family-based activities in a low-SES community in Soweto, South Africa, and identify different categories of activities that contribute to language exposure. For example, the Child Routine Activity category includes visiting the local clinic and being carried on their caregivers' back, whereas the Play Activities category includes playing traditional games of the culture concerned. Researchers may observe a naturalistic play activity in the child's home with their own toys or may instead provide a standard set of toys. Naturalistic language data is increasingly collected using so-called *wearables* (e.g., audio-recording equipment incorporated into a child-sized vest or backpack, or head-mounted video-recording equipment) that can (i) be worn unobtrusively by the child without the need for the researcher to be present and (ii) allow for longer observation periods. However, without contextual information, audio data gathered from naturalistic recordings may be difficult to interpret (d'Apice, Latham & von Stumm 2019).

4. Data analysis (*what*)

The child's language environment may include direct linguistic interactions between children and parents/caregivers and/or other adult or child communication partners (CPs) as in CDS or overheard speech. Deciding on which aspect of the language input to focus represents an important methodological decision if the aim is to accurately represent the language learning realities of all children. Historically, CDS has been described in the context of the mother-child dyad, but in many communities, child language socialization is more likely to occur in triadic interactions (i.e., the child and two other people) or multiparty interactions (i.e., the child and three or more people at one time) (Brandone, Stout & Moty 2020; Tare & Gelman 2011). Increasingly, researchers also are considering the potential role of exposure to so-called *overheard*, *bystander*, or *ambient* speech in children's language acquisition (i.e., linguistic input

that children are exposed to in their environment but is not aimed directly at them). Overheard speech constitutes a sizeable amount of linguistic input in particularly majority world and middle-class contexts (Fitch, Lieberman, Luyster & Arunachalam 2020) as it is not limited to language input provided by the parent(s)/caregiver(s). Exposure can therefore arise from a variety of individuals such as other family members (including siblings and extended family members), similar aged peers, and any other adults in the child's home environment (Loukatou, Scaff, Demuth, Cristia & Havron 2022). Low rates of CDS have been reported in some communities. For instance, Cristia, Dupoux, Gurven and Stieglitz (2019) study the verbal input to children in a Bolivian pre-industrial community and find that less than one minute per daylight hour is spent by parents and caregivers talking to children younger than four years. This is significantly lower than the time the child spent talking to same-aged and slightly older peers (approximately four minutes per daylight hour). Some researchers also argue that overheard speech constitutes an integral source of linguistic input for language learning of children with low SES (Kuchirko 2019).

CDS and overheard speech differ from one another in terms of linguistic characteristics and the presence and accessibility of joint attention cues (Foushee, Griffiths & Srinivasan 2016). Some researchers have proposed that the modified linguistic and prosodic features characteristic of CDS are more appropriate for infants and, therefore, significant in children's development of language across cultures (Foushee et al. 2016). By contrast, overheard speech is not necessarily modified by adults to be more accessible to young children and thus may represent a highly complex source of input for children who are still acquiring the lexicon of their first language (Foushee et. al. 2016). During CDS, interactions are directed specifically at the child; therefore, word learning is assisted by joint attention between the child and the CP (Fitch et al. 2020). During overheard speech, however, the child plays an observing role; therefore, the presence of joint attention between CPs may not affect the child's encounter with the sound form and their ability to pair the word with a referent to the same degree (Fitch et al. 2020). Measuring the child's individual vocabulary knowledge – hence, their familiarity with words – assists in estimating when the child will learn effectively from overheard speech. Foushee et. al. (2016) find that when the words a child is already familiar with are considered, 12- to 30-month-old children may comprehend and learn from overheard speech.

The increased availability of recording technology and machine-learning tools has enabled researchers to collect and analyse larger amounts of naturalistic data. This makes it more logistically feasible to include overheard speech in automated analyses, thereby reducing additional costs of training and research assistance required for manual analyses and increasing accuracy by reducing human error. However, some automated measures produced by the software can be considered more accurate than others. For instance, Language Environment Analysis (LENA) software (LENA n.d.) has been found to perform poorly when measuring Conversation Turn Taking (CTC), male adult input, and input from other children. This shortcoming may be due to an algorithm bias related to the training data used to develop automated analysis methods (Cristia, Lavechin, Scaff, Soderstrom, Rowland, Räsänen, Bunce & Bergelson 2021).

Language input is often described in terms of quality and quantity (see, however, MacLeod and Demers (2023) for a critical review of the concept of "quality of language input"). The *quantity* of language input (verbal productivity) can be described as the total number of words, tokens, or utterances directed towards the child, or the total number of conversational turns per hour.

These are typically considered a crucial indicator of the quality of early language environments (Gilkerson, Richards, Warren, Oller, Russo & Vohr 2018; Rowe 2012). The *quality* of language input typically refers to the diversity and complexity of the vocabulary and syntax. This is often reported as the number of different words (NDW) or Wh-questions in an utterance, the mean length of utterance (MLU) of the utterances directed at the child, or in terms of utterance content (e.g., information vs. affect salience) and mental state talk (Anderson, Graham, Prime, Jenkins & Madigan 2021; Bang, Adaio, Marchman & Feldman 2020).

Only looking at verbal productivity, however, may not be sufficient for creating a full picture of language practices. In their seminal study (referred to in Section 2) on the early language experiences of young American children from different socio-economic backgrounds, Hart and Risley (1995) find that parents from low-income (so-called *welfare*) backgrounds speak to their children significantly less often than parents from professional backgrounds. Based on their extrapolated data, children from more affluent homes are likely to hear 30 million more words than children from low-income homes by the time they are four years old – a finding that is often referred to in literature as *the 30-million-word gap*. Although their study has been hugely influential in informing policy and research on children's early language environments, it has also received criticism, partly because the 30-million-word gap finding is based solely on the frequency of words directed at children and does not provide information about the quality of what is being said, how it is said, or when it is said. It is argued that researchers should include these qualitative aspects that require capturing the complex social reality, of which language is an important facet, to provide a more complete picture of language practices in different groups (Kuchirko 2019).

Although there is increased awareness amongst researchers of methodological biases in child language research, it is unclear whether (or to what extent) this is reflected in current research practices. More information is needed on the methodological considerations researchers bear in mind when describing children's language environments to establish what implications these considerations have for the field of child language research and for the interpretation of the available research findings in this field.

5. Objectives

The background provided above raises this two-part question: *What methodological considerations do researchers bear in mind when studying children's early language environments, and are those considerations appropriate when applied to majority world populations?* To answer this research question, this scoping review set the following objectives:

1. To map the existing literature in terms of the methodological considerations in research on children's early language environments.
2. To analyse and describe the methodological considerations during the investigation of children's early language environments.
3. To consider the clinical and research implications of these methodological considerations for the field of child language research.

6. Methods

This study adopted a scoping review methodology to explore the methodological considerations researchers apply when studying children's early language environments, giving specific attention to the appropriateness of these approaches in majority world contexts. The following section describes the specific research methods, including the research design, search strategy, screening and selection of evidence, data extraction, and analysis.

6.1 Research Design

A scoping review was performed based on the methodology of the Joanna Briggs Institute (Peters, Godfrey, McInerney, Munn, Tricco & Khalil 2020) and the PRISMA-ScR checklist (Tricco, Lillie, Zarin, O'Brien, Colquhoun, Kastner, Levac, Ng, Sharpe, Wilson, Kenny, Warren, Wilson, Stelfox & Straus 2016). This methodology was chosen for its alignment with the study's purpose and objectives. Scoping reviews are frequently employed to provide insights into the breadth and characteristics of research on a specific topic (Arksey & O'Malley 2005); in this case, the methodology-related decisions made by researchers of early child language environments.

6.2 Search strategy

Six databases (CINAHL, ERIC, Health Source, Scopus, Web of Science, and PubMed) were searched for studies investigating early language environments. Filters were applied to include only peer-reviewed articles published in English between January 2019 and February 2023. Only articles with abstracts were selected.

The researchers collaborated with a librarian from Stellenbosch University's Faculty of Medicine and Health Sciences in South Africa to craft a search strategy encompassing the population, concept, and context (PCC) for this scoping review:

- Population: Typically developing preschool children (0-6 years) and their CPs
- Concept: Methodological considerations related to language input to preschool children
- Context: Children's home environments

The medical subject headings assigned to those articles (i) identified in an initial search phase and (ii) meeting the inclusion criteria (based on titles and abstracts) were examined to formulate the search strategy. To ensure that no potential articles were excluded, the researchers had to consider the various ways CDS was referenced, as well as constructs that underpin early language environments, as part of the definition clarification (see Box 1).

Box 1. Search terms related to children's early language environments.

*"*child-directed speech" *or* "child directed speech" *or* "cds" *or* "child-directed language" *or* "child directed language" *or* "child-directed utterance" *or* "child directed utterance" *or* "infant-directed speech" *or* "infant directed speech" *or* "ids" *or* "infant-directed language" *or* "infant directed language" *or* "parentese" *or* "motherese" *or* "fatherese" *or* "infantese" *or* "language input" *or* "language environment" *or* "overheard speech" *or* "bystander speech" *or* "overheard language" *or* "bystander language" *or* "baby talk" *or* "language interaction"

and "parent" *or* "mother" *or* "father" *or* "caregiver" *or* "guardian" *or* "caretaker" *or* "maternal" *or* "paternal" *or* "grandparent" *or* "grandmother" *or* "grandfather" *or* "primary carer" *or* "carer" *or* "sibling" *or* "family" *or* "primary caregiver" *and* "home" *or* "home environment" *or* "naturalistic" *or* "house" *or* "home context"

6.3 Screening and selection of evidence

Each article's title and abstract were considered by two researchers. Articles were considered for inclusion if their titles or abstracts were reflective of the PCC of this scoping review. Any discrepancies were resolved through discussion, and where a resolution could not be reached, a third researcher was consulted. The included articles were read by two researchers in full to determine final selection of the studies based on the eligibility criteria presented below. Five discrepancies were raised during the full text article review, and four of the articles involved in these discrepancies were excluded after consultation with all the researchers in the team.

The following eligibility criteria ensured relevance and alignment with the scoping review's objectives:

- Primary Study Emphasis: To address methodological considerations, only primary studies were chosen. Reviews, commentaries, and secondary studies lacked the comprehensive details required to meet this study's objectives and were thus excluded.

- Direct Assessment Focus: Studies relying on secondary reports, such as parent questionnaires, were excluded as they did not fulfil the comprehensive methodological analysis sought in this review.

- Participant Criteria: This review focused solely on typically developing child participants and intentionally excluded studies involving adult participants who had mental health problems. This approach aimed to conduct a precise examination of children's early language environments in the absence of any developmental or acquired disorders.

- Studies had to focus on exploring children's early language environments exclusively within their home settings. Daycare-based studies, for instance, were excluded.

6.4 Data extraction and analysis

A charting table was developed in Microsoft Excel to systematically document pertinent data from the selected studies. Development of the table was an iterative process and was only finalized after each researcher had charted between 10 and 12 of the articles. All adjustments to the table were discussed, and all articles were charted again given the changes made to the table. In addition to standard information such as author names, article titles, dates of publication, study locations, study aims, and sample sizes, the charting table also facilitated the documentation of details concerning the dynamics of the language environments under investigation. This entailed extraction of information about the CP(s) involved, the languages and ages of the children, and the caregivers' ethnicity, education levels, and SES. Moreover, to address the main aim of this scoping review, the following details about the data collection procedures and analysis of language input were meticulously reviewed and carefully charted in

the table: equipment utilized for data collection and analysis, materials engaged with during observations, type/s of activity observed, number and duration of recordings, communication contexts, CP(s), type of language input analysed, measures of language input/exposure, and additional measures of communication interaction.

The chosen studies were distributed evenly among five researchers. Each researcher independently extracted data and recorded it on the charting table. All recorded data underwent review by at least one other researcher on the team. The data extraction process was deemed complete only after both parties were content with the accuracy of the charted information. Numerical analyses and frequency counts were employed to identify the predominant study locations, participants' linguistic characteristics, and the type of language input (child-directed or overheard speech). The analysis of caregiver characteristics, including ethnicity, education, and SES, involved a combination of descriptive statistics and thematic analysis.

Determining the number and duration of recordings that were analysed involved quantitative methods, including mean calculations and ranges. To describe the communicative contexts and CPs, categorical analysis was employed to categorize and quantify the prevalent contexts and partners. Lastly, for the productivity and quality of language measures as well as the measures for communication interaction, a combination of categorical and qualitative thematic analysis was used to identify and categorize the various measures employed across the studies.

7. Results

In this section, an overview is provided on the considerations researchers bear in mind when studying children's early language environments. The search strategy yielded 297 articles after removal of duplicates (see Figure 1). Upon reviewing the titles and abstracts of the articles, 208 were excluded. After assessing the full text of the remaining 89, an additional 36 were excluded. Consequently, 53 articles met the inclusion criteria, of which six were excluded during the charting process.

7.1 General description of the sources of evidence

A total of 47 publications, provided in Appendix 1, fulfilled the eligibility criteria for the scoping review. The publication year with the highest number of included studies was found to be 2022 (n=17). The average number of child participants in the selected studies is approximately 100, ranging between three and 1292 per individual study. Twelve of the studies utilize data from already existing databases for their analysis.

7.2 Study location

The United States of America (USA) dominates as the country from which the most studies have originated (n=26), followed by Argentina with three studies. While Canada, Greece, Sweden, Australia, and China each contributed two studies, only a single study each was identified as originating from Bolivia, Brazil, and New Zealand. Two publications are not specific about their study location(s), only indicating that they originate from North America and North-Eastern Europe. One study does not provide any information regarding the country of origin.

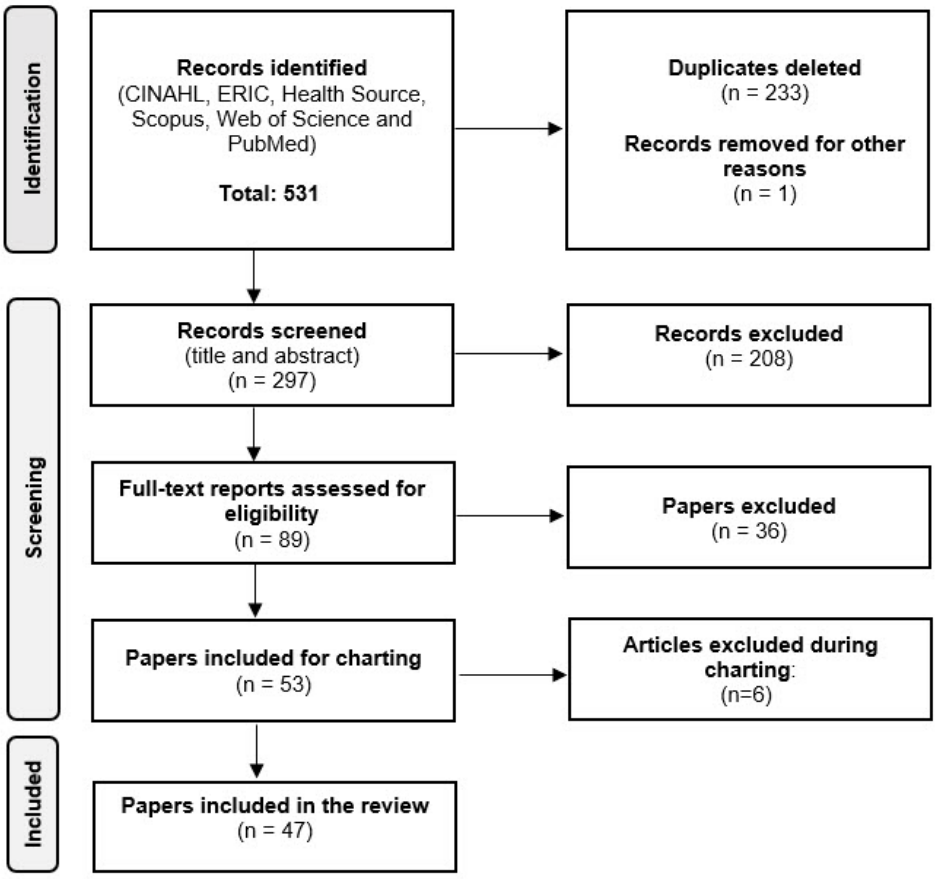

Figure 1: Flow diagram depicting the process of the selection of sources of evidence.

7.3 Linguistic diversity of participants

English is the predominant language spoken by the studies' participants and is represented in 72% of the studies. Twenty-two studies report that their samples are only English speaking, with an additional nine studies indicating that their participants speak English *and* another language, such as Spanish (n=7) or French (n=1), and two studies indicating that participants speak either English *or* another language (Spanish, Chinese, Arabic or Korean). Spanish is commonly spoken by participants in several studies (n=12). Other languages represented are Swedish (n=2), Mandarin (n=2), Greek (n=1), Estonian (n=1), and Brazilian Portuguese (n=1). Four studies do not specify the language of the participants.

7.4 Monolingual, bilingual, or multilingual samples

Most studies (n=26) do not specify whether participants in their samples are monolingual, bilingual, or multilingual. Of the 47 studies, only one reports including multilingual participants, whereas eight studies include bilingual samples, and 12 studies have monolingual samples.

7.5 Categorization of participants in terms of race/ethnicity and/or nationality

Many studies (n=17; 36%) do not specify participants' race/ethnicity or nationality. Of the 30 that do, about half (n=14) provide information on race/ethnicity only (e.g., White/Caucasian,

European American, Asian, Hispanic), eight on nationality only (e.g., Mexican, Chinese), and eight on both race/ethnicity and nationality (e.g., Latine immigrant mothers born in the Dominican Republic). Twelve studies include participants from more than one racial/ethnic background. When considering the race/ethnicity of child participants across all studies, half (50%) are White,[5] as demonstrated in Figure 2.

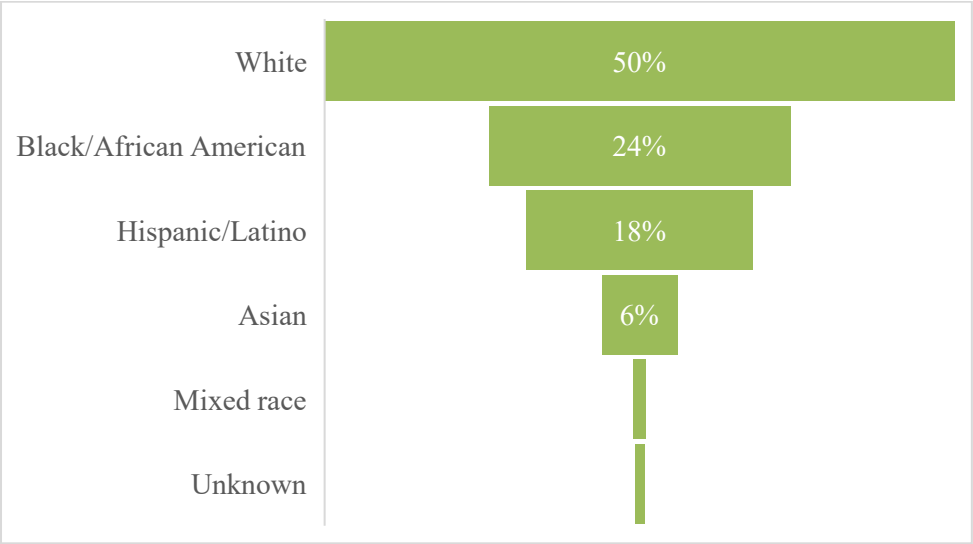

Figure 2. Distribution of reported information about child participants' race/ethnicity across studies.

7.6 Caregiver education

Thirty-five publications report the education of their participants, and many of these (n=12) include participants with varying levels of education. Participants' education ranges from no education to graduate school training. Education is reported in varying manners across studies; for instance, through the number of years studied or by specifying completed education levels like high school or college. Eleven of the studies provide no information regarding education levels.

7.7 Caregiver SES

SES is described in different ways in the research, which made it difficult to draw comparisons across studies. For example, one study refers to caregivers' employment status whereas others report annual household income (n = 3) or SES levels (n = 21). Twenty-two studies do not provide any information about the SES of the caregivers involved. One study indicates that while some of their participants are from low-SES backgrounds, they do not have this information about the rest of their sample. The number of studies that report their participants' SES are depicted in Figure 3.

[5] For the review and to simplify comparison across studies (a) *Caucasian* and *European American* was grouped together under the term *White*, (b) *African American* was grouped together with *Black*, and (c) *Hispanic* and *Latino* was grouped together under the same broad category.

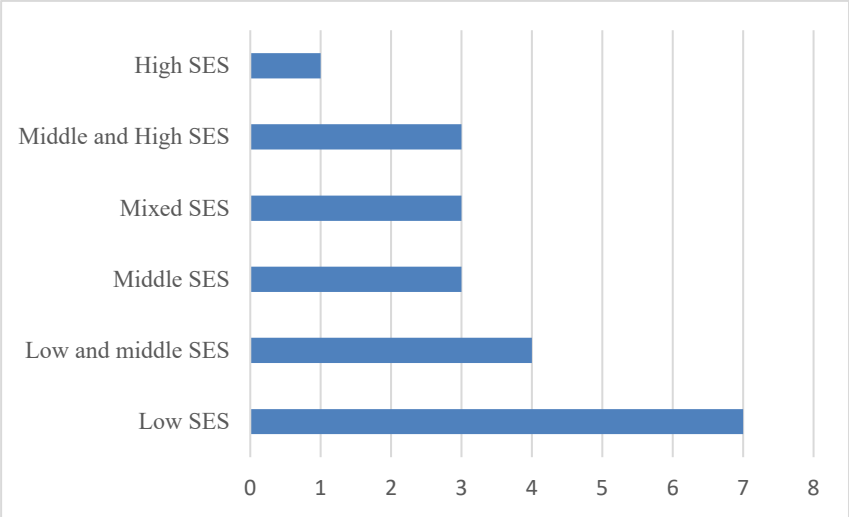

Figure 3: Reported SES of caregivers included in studies on early language environments.

7.8 Equipment utilized for data collection and analysis

Half of the studies (n=24) utilize only audio data, whereas the other half (n=23) collect and analyse both video and audio recordings. LENA digital language processors, consisting of a device and vest, are the most frequently used equipment (n=21). Three other studies report using vests with digital devices for recording purposes that are not LENA. Video recorders are also used in eight of the studies. One paper refers to using a "small digital recorder". Other devices mentioned in the publications include a small waist pack and lapel microphone and a high-quality wireless microphone.

More than half of the studies utilize software for data analysis. While some studies analyse their data manually only, an equal proportion employ software in combination with manual analysis. In addition to the LENA software, ADEX, CHAT, CHILDES, CLAN, ELAN, Interact, MAUS, PRAAT, and SALT are some of the software packages utilized for analysis. Two publications do not indicate whether any software is used. Figure 4 shows the distribution of methods used to analyse the language samples from the 47 studies.

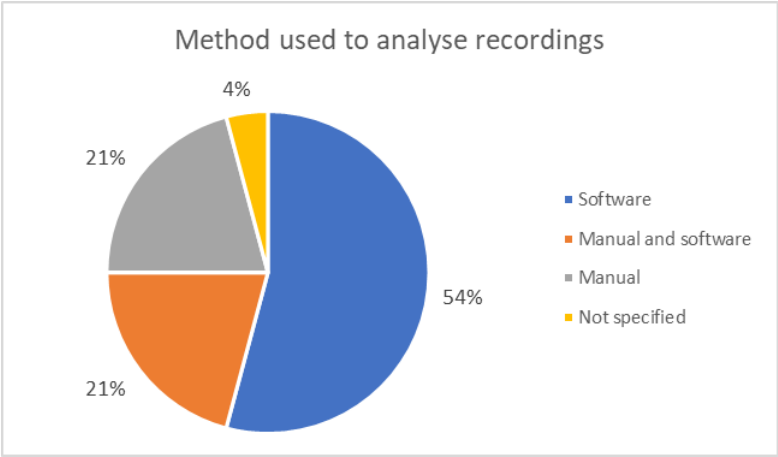

Figure 4: Percentage of studies using software, manual analyses, or a combination.

7.9 Types of activities observed

The observed early language environments entail various activities across the studies. Most studies observe and analyse naturalistic activities and routines (n=24), whereas others collect data during play (n=8) or shared reading (n=3). Some studies observe more than one type of activity; for example, book reading and play (see Figure 5).

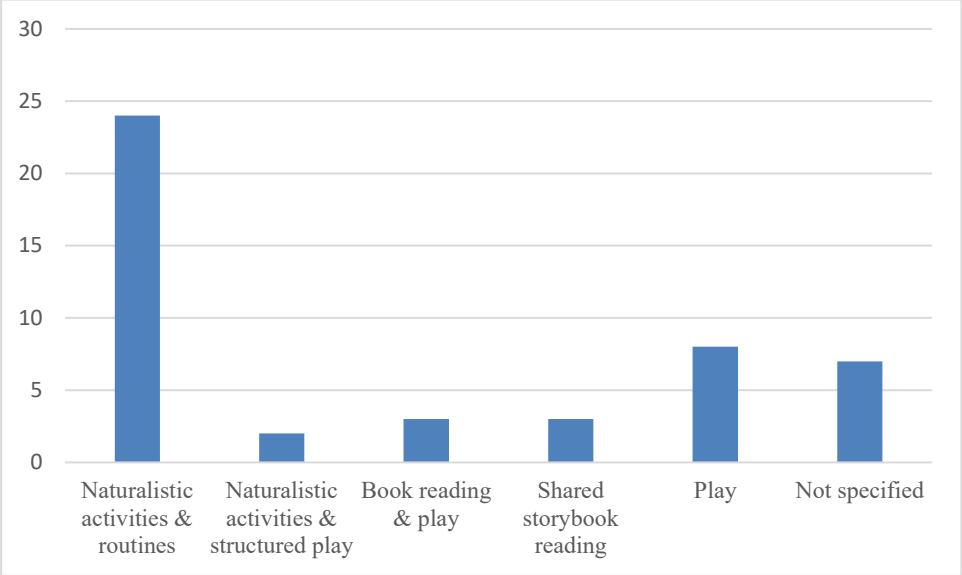

Figure 5: Types of activities observed.

7.10 Materials engaged with during observations

While not all the studies report on the items or toys available during data collection, materials mentioned include toys, books, and household items. Analysis shows that in many cases (n=20), participants were not provided with specific materials or toys for purposes of the studies. Only nine of the studies supplied materials for the observed activity. One study reports that although some materials were provided, the participants also used toys or items that belong to the family. Many studies (n=17) do not report on whether the toys or items are provided by the researchers.

7.11 Number and duration of recordings

Most studies (n=26) utilize more than one data collection event, including more than a single recording in their analysis. The study by Sperry, Sperry and Miller (2019) includes the largest number of recordings (280 in total). Not all the studies report on the length of recordings analysed per child, but the shortest reported data unit is three minutes and the longest 60 hours.

7.12 Communicative contexts

Whereas 15 studies do not specify the communicative context, the prevalent context is found to be dyads (n=29) with only two of the studies observing triads. Only one study involves contexts of more than three interlocutors.

7.13 Communication partner(s)

The CPs involved in the studies are mostly mothers only (n=21). Twenty studies report including either mothers or fathers, or both. Only six studies include CPs other than the parents, such as grandparents, older siblings, other family members, neighbours, or community members.

7.14 Type of language input analysed

The utilization of speech data in the studies involves two primary types of language input. These types are direct speech (n=29) and a combination of direct and overheard speech (n=18).

7.15 Measures of language input/exposure: quality and quantity (verbal productivity)

Twenty studies employ a combination of verbal productivity measures and measures of the quality of the CP's input. Eighteen exclusively perform verbal productivity measures while nine focus solely on measures of the quality.

For ease of interpretation, the different verbal productivity measures employed across the studies were organized into broader categories. Table 1 lists these different categories with examples of specific verbal productivity measures as well as the number of studies that employ them, whereas the range of measures of quality of CP input are presented in four broad categories in Table 2.

Table 1: Verbal productivity measures and the number of studies that use them.

Number of studies	Verbal productivity measures	Examples of specific measures performed
21	Total number of word tokens	Adult word count (AWC) Total number of word tokens (TNW) Total number of male-adult words and female-adult words
16	Conversational turns	Conversation turn taking (CTC) Mean length of turn (MLT) Rate of questions Number of questions Rate of responding to questions Number of consecutive utterances
9	Total number of utterances	Total number of utterances Number of infant directed words Total number of mothers' utterances Total number of mothers' utterances related to the object(s) of infant touch Utterances per minute
2	Acoustic and prosodic measures	Mean pitch and pitch range Number of vowels per word Vowel space area between each vowel and vowel length
1	Percentage of segments where parentese was used and the percentage of different language uses within a segment	

Table 2: Different measures of the quality of the communication input and the number of studies that use them.

Number of studies	Category of input quality	Specific measures
5	Sentence / morphological complexity	• Mean length of utterance (MLU) • MOR: the morphologic composition of utterance: identified nouns, verbs, and adjectives
10	Lexical diversity	• Number of different words (NDW) • Total number of different words (TNDW) • TNDW and MATRR (Moving-average type token ratio, 10-word window) • Types of words used • Number of different word types per minute • Thematic sequences (with reference to the infant's internal state or physiological state) • Mental state words per category: cognition, emotion, desire, modulation • Closed-class and open-class words (first two monosyllabic words of statements and WH-questions)
12	Pragmatic analyses	• Thematic sequences • Non-speech sounds • Vocal expressions • Vocal or verbal games • Vocalization prompts • Coding of speech acts: declaratives, imperatives, directives, prohibitions • Presence of encouragement and praise, discouragement and caution • Regulatory language: attention directives, action directives, prohibitions, vocalization prompts • Presence of naming, descriptions, questions, imitation, recasting, expansion, reading, songs • Types of questions • Whether adult speech was infant-directed or other-directed • Event sequences analyses (adult-infant-adult) • Presence of action verbs and object talk • Coding of complexity categories (semantic complexity, repetitiveness) • Referential language (description, emotion)
6	Acoustic and prosodic analysis	• Adjustment of speaking rate in more demanding situations • Proportions of language and speech registers • Acoustic analysis of infant-directed and adult-directed speech data • Pitch register, pitch span, speech rate, final syllable duration, and quality of voice • Hyper-articulation of vowels during book reading in comparison to when speaking to adults

7.16 Additional measures of communication interaction

Eleven studies include measures of aspects of communication interaction that are not directly related to productivity or quality of verbal interactions. These studies include measures that rely on supportive video-recorded data providing visual cues about non-verbal and environmental aspects of the communication interaction (see Table 3).

Table 3: Additional areas of communication interaction studied.

Spatial context	• The physical environment in which interactions occur, including the layout and arrangement of objects and people • The specific location within a room where naming events take place and how this might influence interaction • The distance between the CP and the child during interactions • Whether the object or referent being discussed is within the child's visual field • Electronic media exposures such as an electronic speaker, radio, TV, electronic toy, or smart home device
Infant object bouts	• How long children engage with specific objects • CPs' manual actions during infants' interactions with objects
Communication partner's visual and tactile behaviours	• How CPs engage with their child during naming events, such as making eye contact or touching • How CPs physically interact with objects during interactions • Types of CP gestures (movement, showing, pointing, requesting, and indicating) • Examining broader body movements or postures during interactions
Caregiver warmth	• Assessing the emotional tone and warmth of CP interactions with the child

8. Discussion

The purpose of this scoping review was to explore methodological considerations in recent studies of children's early language environments. The results will now be discussed according to what they reveal about whose language environments are currently being researched, how and when data is collected, and what aspects of the data are being analysed.

8.1 The research sample (*who*)

The results indicate that child language research published during the past five years continues to reflect a relatively small segment of the world's population, although some efforts are being made to diversify the participant pool. This was evident in the findings relating to study location, language and linguistic profile, SES, ethnicity and/or race, and parental/maternal education. Most studies were conducted in the USA, which, along with most of the other study locations (Sweden, Canada, Australia, China, and New Zealand), is among the top developed countries (UNDP 2022). Research production may be concentrated in these countries due to greater access to the considerable resources required to conduct research (Kidd & Garcia 2022). Only two studies were found to be conducted in so-called developing countries (one each in Bolivia and Brazil). In line with findings from Kidd and Garcia (2022), most studies in this scoping review report on the language environments of English-speaking participants. This could in part be explained by the fact that most studies were conducted in the USA where

English is the dominant language or that only peer-reviewed English studies were included in the review. Spanish was the second most common language reported on, followed by single studies on other Indo-European languages/language varieties such as French, Quechuan Spanish, Brazilian Portuguese, Swedish, Greek, and non-Indo-European languages (Arabic, Estonian, Korean, Mandarin). Four studies did not specify participants' language, which is surprising given that the subject matter of the included studies relates directly to language and communication interaction, which is known to be influenced by culture and the linguistic characteristics of the language(s) spoken in the research setting. Furthermore, more than half of the studies did not explicitly report whether participants in their samples are monolingual, bilingual, or multilingual, making it difficult to draw conclusions about the generalizability of findings to other linguistic contexts. In the remaining studies, most participants are monolingual, followed by bilingual participants and only a small number of multilingual participants. The scarcity of studies reporting on language input to children in bi- and multilingual contexts seems to indicate that language diversity and its possible effects on the research domain are not being recognized fully by child language researchers. The inclusion of participants with varied linguistic profiles will contribute toward a more thorough understanding of variation in children's language environments and generalizability of research findings from one environment to others.

The adult participants in the studies were found to be predominantly of White ethnicity, although several studies incorporated caregivers from diverse ethnic backgrounds. These studies either encompass multiple ethnic backgrounds or focus on a single ethnic background such as Latino/Hispanic or Dominican. Information on participants' social categorization is reported either in terms of their race and/or ethnic descent (e.g., European American, Latinx) and/or their nationality (e.g., Mexican, Chinese), reflecting the overlap often found between these conceptual categories (Quintana et al. 2006). Notably, however, approximately a third of the studies do not specify the participants' race/ethnic background or nationality. Sampling that reflects increased diversity in caregiver ethnicity may provide valuable insight into early childhood communication patterns and the influence of cultural factors on these patterns within distinct linguistic and socio-cultural settings.

Most studies were found to specify the educational level of caregivers, which ranges from no educational experience to a higher-level degree. Some studies include only participants who had completed a bachelor's degree or higher, but in many studies, the educational level of caregivers varies within the same study. There is considerable variation in the way in which educational experience is reported; for example, in terms of level of education reached – which is dependent on the educational system of a particular country – versus years of schooling completed. The results of this study indicate that, although participants with higher levels of education continue to be represented in many studies, there seems to be an increased awareness of the importance of selecting participants from a variety of educational backgrounds. Most of the reviewed studies do not provide explicit information on the SES of caregivers. However, those studies that do specify this information include participants from a variety of socio-economic backgrounds, sometimes within the same study. As with educational level, there is also considerable variation in terms of the terminology used by the researchers to report this information, with SES often stated as a range (e.g., low-to-middle income, middle-to-high income backgrounds), as a single term (e.g., middle-class, poor, or low wealth rural communities) or classified in terms of caregivers' employment status (e.g., part-time or full-time employment). This diversity in terms of classification and/or reporting of SES may

complicate comparison of information between study settings. However, there remains a need for future research on participants from lower socio-economic backgrounds, associated with lower levels of educational attainment and opportunity, to better understand the influence of caregiver education on language socialization patterns. As stated by Dailey and Bergelson (2022a), SES may affect language learning environments, and, therefore, different methodological considerations may be required for participants from different socio-economic backgrounds.

8.2 Data collection methods and procedures (*how and when*)

The results highlighted increased use of wearable audio-recording devices, with LENA daylong audio recorders most used. All studies collected audio data, whereas only approximately half also collected video-recorded data. Naturalistic daylong recordings of language input to children have many advantages, amongst them the potential to collect large amounts of audio data in under-researched languages and cultures as well as the ability to access representative language input from a variety of caregivers/adults who would typically interact with the child during everyday activities (Anderson et al. 2021). Further research is, however, needed to improve accuracy for some of its key measures (e.g., precision in identifying input from male adults and other children) (Cristia et al. 2021). In under-researched communities where patterns of language socialization have not yet been (well) described, there remains a need to conduct in-depth ethnographic, descriptive research based on comprehensive audio and video-recorded data that reflect key contextual information about the communication interaction (d'Apice et al. 2019; Kurchinko 2019).

Most of the studies collected language recordings in the home environment during naturalistic activities and routines, followed by free play, shared reading, or a combination of these activities. However, several studies did not specify the communication context. Children were most often recorded playing with their own toys, but in about a quarter of the studies the researchers provided the toys or materials. The decision whether to provide children with a specific set of toys or materials largely depends on the study purpose and design. While it may allow for a degree of standardization across participants in terms of conversational topics and interactions, it also reduces the likelihood of documenting representative communication exchanges during familiar, naturalistic routines in a particular community. The observed trend for collecting data during naturalistic activities highlights one of the advantages offered by the increased availability of inconspicuous wearable recording equipment.

8.3 Data analysis (*what*)

Most of the reviewed studies collected data within the communicative context of a dyad, with the adult CP most likely to be the child's mother. The small number of studies that specified the adult CP in broader terms to also potentially include older siblings, fathers, and other family members seems to indicate a growing awareness amongst researchers that a predominant focus on only mother-child dyadic interaction represents a limited view of the language environment for most children, including those from middle-class Western families. Very few studies examine triadic or multiparty interactions, and almost a third of the studies do not specify this information. A creative approach is firstly needed to address the considerable logistical challenges in data collection of input from multiple CPs. Secondly, there is a need for greater transparency in reporting methodological decisions regarding the communication context(s)

from which samples are drawn. Daylong recordings collected through wearable recording devices encompass all language interactions involving the child, or around the child, throughout the day. These studies are more likely to present global measures averaged over a day's audio recording, which may lead to a lack of detailed specification regarding the nature of the communication interaction and context. This information is, however, still needed to accurately interpret the data.

Most studies only analyse speech directed at the child, while about a third of studies include both direct and overheard speech in their analyses. Reliance on recordings of direct speech could be influenced by logistical considerations related to limitations of the recording devices or time and funding constraints, since transcription and systematic analysis from an audio or video recording is more time-intensive for overheard speech than for CDS. Notwithstanding the comprehensive access that researchers utilizing wearable devices and software have to all speech occurrences in the child's proximal environment, the depth of analysis may not be equivalent to that achieved through manual examination of data derived from a video-recorded sample, which takes into consideration the specific context of the interaction. Furthermore, depending on their theoretical orientation, researchers may not consider overheard speech to be a valuable or meaningful source of language input to young children that should be included in their analysis – this despite overheard speech constituting a sizeable amount of linguistic input not only in majority world, low-SES contexts but also in minority world contexts (Cristia et al. 2019; Fitch et al. 2020).

Regarding data analysis, more than half of the studies reviewed employ software, with LENA software being preferred over other options. Advancements in technology have made it easier to use primarily sophisticated software programmes to analyse large datasets of language samples in a short time without the need for manual transcription, thereby minimizing researcher bias (Cristia et al. 2021; LENA n.d.). Automated software analyses could, however, be limited by a potential algorithm bias related to the training data used during its development. Although children who are dissimilar from the LENA training set may not necessarily perform worse, some automated measures may be less accurate; for example, due to the specific distribution of CPs in various language environments (Cristia et al. 2021). Combining manual and software-based analyses might allow researchers to capitalize on the advantages of both approaches while minimizing their disadvantages when describing under-researched language environments.

Deciding which aspect(s) of language input to analyse represents an important methodological consideration. Most publications report using only verbal productivity measures (e.g., total number of word tokens, utterances, or conversational turns) or a combination of these measures and measures of the quality of the CP's input (e.g., pragmatic function, lexical diversity, or syntactic/morphological complexity). A minority of studies solely focus on measures of the quality of the CP's input. The predominance of verbal productivity measures could be due to the increased use of automated software analyses, which do not require language samples to be transcribed, in contrast to measures relating to complexity and/or diversity of input, which require more manual analyses.

9. Conclusions

A better understanding of the language socialization patterns of different communities and how they shape children's language development trajectories is crucial for robust theories of language development and has important implications for clinical practice. The findings of the present study support increased calls for researchers in the field of child language to, firstly, broaden their data sets to include linguistically and culturally diverse participants and, secondly, to critically consider which approaches and tools for data collection and analysis present the most accurate way of describing the realities of children from under-researched communities.

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Appendix 1: 47 Studies included in scoping review

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