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Language development in Slovenian toddlers: the role of electronic media, parental knowledge of language development, and parental input

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Introduction: This study examines the relationships between toddlers' language production, parental language input, media exposure, and parental knowledge of early language development.

Methods: We used a unique collection of daylong recordings of Slovenian toddlers (age: 16–30 months, $N = 40$, 18 girls) to measure the language environment, toddlers' language production and media exposure. In addition, parental reports of toddlers' media exposure and language ability (using the Slovenian adaptation of the CDI) were collected.

Results: The results indicate that toddlers' average exposure to electronic media was rather low, with exposure varying widely across the sample. Parental language input was related to various measures of toddlers' language. Parents with a greater knowledge of early language development used more parentese, while their toddlers had less exposure to electronic media. In addition, toddlers' media exposure was related to their age, with older toddlers having more exposure to electronic media, and was marginally related to the number of words spoken by adults and parents' education. No significant relationship was found between toddlers' language ability and media exposure when controlling for toddlers' age.

Discussion: The findings underline the importance of parental knowledge about language development and the characteristics of the language environment for toddlers' language ability.

KEYWORDS

media exposure, language development, parental knowledge and practice, vocabulary, language input

1 Introduction

The impact of electronic media exposure on early language development is a topic of significant interest and debate among researchers. Infants and toddlers are in a critical period for brain development and language acquisition (Kolb and Fantie, 2008; Wolf et al., 2018) and are highly receptive to linguistic input from their environment (Ferjan Ramírez et al., 2024a; Huber et al., 2023; Ramírez-Esparza et al., 2016; Romeo et al., 2021; Tamis-LeMonda et al., 2001; Weisleder and Fernald, 2013). Understanding how media exposure affects this process is crucial for guiding parents in making informed decisions about media use.

Professional recommendations (e.g., American Academy of Paediatrics, Council of Communication and Media, 2016; Slovenian Association of Paediatrics, 2021) in general advise against any screen media use for infants and toddlers under the age of two, while for

children between 2 and 5 years of age, a maximum of 1 hour of daily screen time is advised but only under the supervision of parents and with high-quality content. Previous research has shown that excessive early exposure to electronic media presents can lead to numerous negative outcomes for a child, such as difficulties in language development, attention, and executive functions (Cheng et al., 2010; Christakis et al., 2009; Li et al., 2020; Nathanson et al., 2014).

The sociocultural theory of development and learning (Vygotsky, 1962, 1987) offers insights into how electronic media might affect early language development, emphasizing the role that social interaction plays in early psychological development and posits that language acquisition occurs through dynamic interactions with more knowledgeable others, primarily parents. It suggests that human learning is largely a social process and that our cognitive functions are formed based on our interactions with those around us who are more skilled. In line with the sociocultural theory of development and learning, research using daylong recordings of parents' and children's language within a home setting has identified strong, positive associations between parental child-directed speech (particularly the use of parentese, a style of infant-directed speech distinguished by its higher pitch, slower tempo, and exaggerated intonation) and child language outcomes, as well as between turn-taking and children's language outcomes in infancy, toddlerhood, and early childhood (Ferjan Ramírez et al., 2024a; Huber et al., 2023; Ramírez-Esparza et al., 2014, 2016; Romeo et al., 2018, 2021). These findings support the notion that the social-interactional features of parental language input are the foundation of infants' and toddlers' language skills. However, exposure to electronic media may displace critical face-to-face interactions necessary for language learning.

In the present study, we aimed to establish how media exposure in Slovenian toddlers aged 16–30 months relates to parental linguistic input, on one hand, and toddlers' language production, on the other. We were also interested in the role of parental knowledge of early language development in toddlers' media exposure. Slovenian toddlers' use of electronic media has yet to be systematically studied, particularly in naturalistic settings or in relation to early language development. Existing research indicates there may be some cultural differences in media use among toddlers (e.g. Ferjan Ramírez et al., 2022; Kulakci-Altintas, 2020; Radesky et al., 2020). Most children in Slovenia grow up monolingually speaking Slovenian, a Slavic (Indo-European) language spoken by approximately 2.4 million people. The majority enter the public early education and care system at approximately 11 months old, following a government-funded, 12-month paid parental leave (Statistical Office of RS, 2023). Although preschool enrollment is not mandatory, 94% of Slovenian children aged 1–5 attend preschool (Statistical Office of RS, 2023), making Slovenia one of the EU countries with the highest enrollment rates for children younger than 3. All public preschools in Slovenia adhere to the "Preschool Curriculum," a national framework developed by the Slovenian Ministry of Education (https://www.gov.si/en/policies/education-science-and-sport/early-childhood-education-and-care). This curriculum ensures high-quality early education, provides a foundation for professional planning, and, with its nationwide implementation, upholds the principle of equal opportunity for all children.

1.1 Associations between children's media exposure, language environment, and early language development

In most Western societies, children are exposed to electronic media from a very young age (Dumuid, 2020; Reid Chassiakos et al., 2016). Furthermore, rapid increases have been documented in the amount of time toddlers and young children spend using various device types (American Academy of Paediatrics, Council of Communication and Media, 2016; Canadian Paediatric Society, 2017; Collier et al., 2016; Seršen et al., 2024). Despite official recommendations, many modern-day children begin experiencing screens in infancy; in toddlerhood and early childhood, many show well-established patterns and habits of screen time use (Chaudron et al., 2018). Children from families with a low socioeconomic status (SES) have been documented to have higher rates of exposure to media compared to children from families with a higher SES (Kwon et al., 2024; Mendelsohn et al., 2008; Tomopoulos et al., 2010). As such, children from families with a low SES are likely to be most vulnerable to any adverse effects of media exposure on early development.

Empirical studies on the relationship between electronic media exposure and various domains of language development, such as vocabulary and grammar, have yielded mixed results. Some studies have described no significant relationship between children's screen exposure and language abilities (e.g., Dore et al., 2020; Dynia et al., 2021; Martinot et al., 2021; Taylor et al., 2018). However, multiple studies have linked early onset and/or high media exposure to slower language development (e.g., Massaroni et al., 2023; Zimmerman et al., 2007). Extensive use of electronic devices was found to be a risk factor for delayed language development in children younger than 5 years (Contreras-Silva et al., 2023; Karani et al., 2022; Perdana et al., 2017). Zimmerman et al. (2007) report that among infants aged from 8 to 16 months, each hour per day of viewing baby DVDs/videos was associated with a 16.99-point decrement in infants' vocabulary score on the Communicative Development Inventory (CDI)–Short Form. Similarly, Byeon and Hong (2015) found that the risk of language delay, measured in terms of communication skills, in 2-year-old toddlers increased proportionately with the increase in toddlers' TV-watching time. These authors also report a significant rise in the risk of language development delay with an increase in average screen time from 2 to 3 h. Martinot et al. (2021) especially emphasize the negative effect of toddlers' exposure to TV during family meals, which was found to be consistently associated with lower expressive vocabulary at the age of 2 years. In their review of 18 articles, Massaroni et al. (2023) found that prolonged screen time and exposure to screens in the first 2 years of life can negatively affect language development and communication skills in terms of comprehension and vocabulary size. In addition, these authors report that overexposure to screens in the early years can affect overall cognitive development, social experiences, problem-solving, and communication with others. Another meta-analysis of 16 studies conducted by Bhutani et al. (2024) found that 9 studies reported a negative impact of screen time on language development, 5 studies reported no significant impact, and 2 studies reported a positive effect.

Negative associations have also been reported between media exposure and parental use of parentese and turn-taking (Cycyk and De Anda, 2021; Ferjan Ramírez et al., 2022). Specifically, it has been observed that children who spend more time on screens have decreased parent–child interactions, which may hinder their development (Christakis et al., 2009). An Australian study (Brushe et al., 2024) examining the longitudinal relationship between screen time and parent–child talk between the ages of 12 and 36 months found that an additional minute of screen time in 36-month-old children was associated with a reduction of 6.6 adult words, 4.9 child vocalizations, and 1.1 conversational turns (CTs) in 16-h daylong recordings. In particular, these findings suggest that electronic media exposure may decrease opportunities for children to engage in conversation with parents, which is a critical mechanism for successful language acquisition.

By comparison, some research suggests that high-quality educational media can support language learning, particularly the acquisition of vocabulary (e.g., Linebarger and Vaala, 2010; Madigan et al., 2020; Rai et al., 2023). Specifically, some studies indicate that infants can learn new words from screen media, especially when the content is of high quality and designed for their age group. A meta-analysis of 63 studies (Jing et al., 2023) on media use in early childhood, word learning, and vocabulary size revealed an overall low, positive relation between the use of screen media and the children's vocabulary. In particular, the experimental studies showed stronger effects for e-books than for TV/video or games/apps and non-significant effects for video chats. As far as the correlational studies were concerned, the authors reported no overall relationship between vocabulary size and naturalistic media exposure, except for educational media use. Linebarger and Vaala (2010) argue that screen media effects are dependent on the degree to which media content resembles infants' and toddlers' real-life experiences, including the use of simple stories and familiar objects or routines. This research line argues that the presence of a competent co-viewer can support infants' language learning from screen media in ways similar to live scenarios. Thus, the presence of an adult co-viewer seems to significantly enhance the potential benefits of electronic media (Tu et al., 2024), with infants learning more effectively when parents engage with them during and after screen time, reinforcing the content and providing additional linguistic input. Having a parent who participates and comments on screen content has a positive effect on the child's learning even before the age of 3 (Guellai et al., 2022).

1.2 Why parental knowledge of child language development matters?

Parental knowledge refers to factual information or empirical evidence, usually endorsed by members of the scientific community that is critical to parents' evaluation of their children's behavior and development and parents' daily decisions about their children's care (Ribas and Bornstein, 2005). In particular, parental knowledge of child development has been shown to be the most important dimension of parenting competency (Vale-Dias and Nobre-Lima, 2018). This is because parental knowledge and beliefs about child development affect how they shape children's home learning experiences, which, in turn, affect children's developmental outcomes (Luo et al., 2021; Sahidullah, 2015). In fact, parents who are well aware of language development milestones are more likely to provide appropriate linguistic input and create an environment that supports the child's language acquisition (Ferjan Ramírez et al., 2021; Hwang et al., 2022; Rowe, 2008). Parents who understand that responsive communication and social engagement are key to language acquisition may therefore be more cautious about using screen media as a substitute for face-to-face interaction.

Research suggests that parents with lower levels of education may know less about early cognitive and language development (Luo et al., 2021; Suskind et al., 2017). Higher parental knowledge of early cognitive and language development has been found to be related to higher parental education levels, language ability, and more language stimulation available to the child at home (Suskind et al., 2017). By comparison, lower levels of maternal education have been associated with a belief that children acquire basic cognitive skills (e.g., vision, hearing, and language comprehension) somewhat later and that introducing certain cognitively stimulating activities (e.g., talking to the baby, telling stories, talking about absent objects, buying the first book) should occur later in a child's life (e.g., Williams et al., 2000).

Parents play a very important role in a child's introduction to and engagement with different types of electronic media as a child's screen habits are co-formed by family or parental characteristics (Gentile and Walsh, 2002; Livingstone et al., 2017; Nathanson, 2001). Knowledge about the differential impact of the quality and quantity of media exposure on children's early development and learning can help parents make better decisions about their child's media use. For example, recognizing that high-quality, interactive media can be beneficial in moderation and that excessive or inappropriate media consumption can be harmful allows parents to more effectively manage and consider media exposure with their child (Seršen et al., 2024). Many parents believe that screen media, especially educational programs and apps, can promote their child's learning and language development. This belief can lead to increased media exposure as parents seek to provide their children with perceived educational benefits. Conversely, some parents are concerned about the potential negative effects of screen media on their child's development, including language delays and decreased social interaction. These parents may limit screen time and prioritize other activities that they believe are more conducive to language development, such as reading and talking. Because parents are often considered to be responsible for their children's screen use, children's excessive screen exposure can cause parental feelings of guilt, which, in turn, increases the amount of stress parents feel about their children's screen use and is also linked to lower satisfaction in the parent–child relationship (Findley et al., 2022; Wolfers et al., 2024).

1.3 The present study

The main goal of the present study was to assess the relationships between toddlers' language production and early media exposure, parental language input and knowledge about early language development. Our main method included daylong audio recordings within a home setting (Language ENvironment Analysis, LENA), used for the first time in a sample of toddlers

residing in Slovenia, to assess both parental and toddlers' language as well as toddlers' media exposure (see also Ferjan Ramírez et al., 2024c). In addition, both the toddlers' media exposure and their language ability were assessed using parental reports [using the Slovenian version of the MacArthur-Bates Communicative Development Inventory: Words and Sentences (CDI; Marjanovič Umek et al., 2013) to assess vocabulary, mean length of utterance, and sentence complexity]. The study is of particular importance as the use of electronic media by Slovenian toddlers has not yet been systematically investigated in naturalistic settings. However, recent data suggest that Slovenian children aged 1–6 years are indeed frequently exposed to various electronic media at home (e.g., television, computer, cell phone, video games, etc.; Seršen et al., 2024). At the same time, the vast majority (more than 70%) of Slovenian toddlers aged 1–3 years attend full-time programs in public preschools, that is, 6–9 h per day from Monday to Friday (SiStat, 2024). As has been shown for other languages, exposure to electronic media among Slovenian toddlers is expected to be related to demographic factors (e.g., parents' education levels or child's age), parental language input, and child's language development; however, such relationships have not yet been demonstrated in this particular context. Of particular interest here is the high enrollment of toddlers in preschools, which could influence the previously discussed relations between media exposure, parental language input, and child language development. This study is also important because, to our knowledge, no study has examined parental knowledge of early language development in relation to toddlers' early media exposure.

In alignment with broader goals, we ask four specific research questions:

Research Question 1: How frequently are Slovenian toddlers exposed to electronic media according to daylong audio recordings and parental reports? Are the two measures of toddlers' media exposure related?

Research Question 2: Which demographic or family factors (parental education levels, toddler's age, and sex) are related to toddlers' media exposure? What are the associations between toddlers' media exposure, their language environment (adult word counts [AWCs], CTs, and exposure to parentese), and measures of toddlers' language production (e.g. vocalization, vocabulary, and sentence complexity)?

Question 3: Does parental knowledge of early language development correlate with toddlers' media exposure, on one hand, and with parental language input and toddlers' language ability, on the other?

Question 4: What are the predictors of toddlers' media exposure, on one hand, and parental use of parentese within the home setting, on the other?

2 Methods

2.1 Participants

Toddlers were recruited via advertisements through flyers, social media, and public preschools in Slovenia. The preschool teachers who helped with the recruitment within the preschools did not receive any compensation or incentive for participating. The criteria for inclusion were the child was between 16 and 30 months of age; the child was born full-term (within +14 days of their due date), of normal birth weight (5.5–10 lb or 2.5–4.5 kg), and had no birth or postnatal complications; and Slovenian is the only language spoken in the home. The desired sample size ($n = 40$) was determined based on prior research that used the LENA technology for recording parental and toddlers' language with North American samples (see Bergelson et al., 2019; Ferjan Ramírez et al., 2022; Ramírez-Esparza et al., 2014, 2016; Shapiro et al., 2021, all of which report between 18 and 61 participants). Recruitment continued until the target sample size of 40 infants was achieved. The power analysis showed that to achieve the power of at least 80%, the Pearson correlation coefficient for the anticipated sample size ($n = 40$) must be at least 0.43 (with a significance level of 0.05, two-sided test). To achieve the power of at least 80% in multiple regression using the model with five parameters, a significance level of 0.05 and a Cohen's f effect size of 0.35, which is considered a large effect size (Cohen, 1992), the sample size should also include 40 individuals.

Forty families (18 with girls, 22 with boys) were included in the present study. The toddlers enrolled in the study ranged in age from 492 days to 935 days ($M = 705$ days, $SD = 144$ days). All toddlers resided with their mothers and fathers; attended full-time programs in public preschools, which means 6–9 h per day; and were not systematically exposed to another language in preschool. Parental education level was measured via a questionnaire: Parents indicated, for mothers and fathers separately, which of the 9 levels of education they completed: (1) incomplete primary education, (2) primary education, (3) vocational education, (4) technical secondary education, (5) general secondary education, (6) 2-year postsecondary degree, (7) bachelor's degree, (8) master's degree, or (9) doctorate. Parents' answers were then converted into "points," that is "primary education": 2 points, "vocational education": 3 points, and so on. For each family, we then calculated a joint parental education score by adding the points entered for maternal and paternal education. Parents in the present sample achieved, on average, relatively high levels of education (the median education level was 7: bachelor's degree), although parents ranged from completed primary school (one parent) to a doctorate (five parents).

2.2 Measures

2.2.1 Assessment of language environment, child language, and electronic media exposure via LENA recordings

Participating families received a package with a LENA recorder and a LENA T-shirt and were instructed to record a "typical" weekend day. While there is no agreement in the literature as to how one should select a "typical" day to collect daylong recording, we opted for a weekend recording because weekends tend to be the only days when the toddlers were at home and not in preschool. We further stipulated that within a typical weekend, parents select a day when both would be home and not working, with the goal of including both parents in the recordings. Parents were asked to start each recording in the morning when the child woke up and turn

off the recorder at night when the child went to sleep. They were asked to go about their activities as usual while their toddler wore the lightweight LENA device inside the front pocket of the LENA T-shirt. The average duration of the LENA recordings was 13 h 25 min (range: 9–16 h). The data were collected in 2022 and 2023.

The LENA data preparation procedures followed those outlined in previously published studies conducted in North America (Ferjan Ramírez et al., 2020, 2021, 2022; Ramírez-Esparza et al., 2016, 2017). Parent and child speech were quantified by combining the LENA software's automatic annotation and manual (human) annotation. The LENA software produces an automatic count of child vocalizations (child vocalization count [CVC]), words produced by nearby adults (AWC), adult–child conversational turns (conversational turn count [CTC]), based on acoustic modeling of sounds (Christakis et al., 2009).

Our main variables of interest were manually annotated in the present data set, as in multiple previously published studies with North American families (Ferjan Ramírez et al., 2020, 2021, 2022; Orena et al., 2020; Ramírez-Esparza et al., 2016, 2017). The LENA Advanced Data Extractor Tool was also used to identify intervals with the language activity of interest (high AWC) for manual analysis to avoid manual annotation when there is no social or linguistic activity (e.g., during naps). Each participant's recording was segmented into 30-s intervals. This decision was based on previous research demonstrating that a 30-s snapshot of ambient sound provides sufficient information for reliable judgment of behaviors (Mehl et al., 2007; Ramírez-Esparza et al., 2009). Then, for each participant, one hundred 30-s intervals with the highest adult word count were selected for further manual annotation. To collect a broad range of environments, we further required that the selected intervals be spaced at least 2 min apart. Four research assistants, students, or recent graduates of the Department of Psychology at the University of Ljubljana, and native speakers of Slovenian followed the procedures outlined in Ramírez-Esparza et al. (2014, 2016, 2017) and Ferjan Ramírez et al. (2020, 2021, 2022). During training, annotators listened to examples of each coding category (discussed later). Any uncertainties about annotation (typically between zero and five 30-s segments per participant) were resolved after discussion with the annotation supervisor. To identify parentese and distinguish it from standard child-directed speech, the same criteria were adopted as described previously by Ramírez-Esparza et al. (2014), who verified that the intervals defined as parentese or standard speech contained the acoustic differences characteristic of these two speech styles (i.e., higher pitch and larger pitch range for parentese). In these analyses, 60 occurrences of the word *you* were analyzed. The 60 occurrences of *you* represented 30 pairs (30 produced as parentese and 30 as standard speech) produced by the same adult addressing the same toddler. The mean pitch and pitch range were significantly higher for parentese than standard speech ($ps < 0.001$); see Table 1 for variable definitions.

Annotators listened to each 30-s interval and entered a "YES" (present) or a "NO" (absent) for each of the following coding categories: (1) Parentese speech: The mother, father, or other adult spoke directly to the child wearing the recorder; parentese speech was used; and one or more than one adult voice was recorded during the interval. (2) All child speech: The child produced fully resonant vowels; consonant–vowel syllables; variegated strings of consonant–vowel syllables (see Smith et al., 1989); speech utterances intermixed with non-speech, word-like strings; words (see 3); or word combinations (see 4). (3) Child words: The child produced one or more than one Slovenian word(s). Child vocalizations were counted as words if they were recognized by the annotator as Slovenian words, even if their pronunciation was not completely correct. (4) Child word combinations: The child produced one or more than one utterance, defined as a combination of two or more Slovenian words. Words within an utterance should fall into their own meaning categories (e.g., actor, descriptor, action, etc.). Repetitions of the same word do not count as word combinations. (5) Electronic media: These segments had sounds emanating from an electronic speaker (TV, radio, video chat, electronic toy, etc.) present. Note that the five coding categories are not exhaustive and not mutually exclusive. For example, a given interval may contain child words and child word combinations, just one of these, or neither.

The resulting matrix of YES and NO responses for each 30-s interval indicated that a specific category occurred or did not occur in that interval. The data matrices were aggregated to provide relative time use data by calculating the percentage of intervals coded for each category. For any individual child, a specific percent value for any one variable means that a particular variable occurred in that particular percentage of the annotated segments (i.e., for a specific child, 56% for "% baby words combined" means that the child produced word combinations in 56 out of 100 segments that were annotated). These percentages were then aggregated to produce group statistics (reported in Table 2).

The annotators also counted the number of CTs within each 30-s segment, following the same procedures as Ferjan Ramírez et al. (2021). While the LENA software automatically identifies adult and child speech in close temporal proximity (termed CTC), recognizing that these "turns" are estimated without distinguishing between child-directed and overheard speech is important. This means that turns can be identified in error due to "accidental contiguity" (i.e., the mom is talking on the phone to a friend and the child is babbling nearby), the frequency of which has recently been shown to be high for the age range studied here (Ferjan Ramírez et al., 2021, 2024b). As a result, the present analyses rely exclusively on manually identified CTs. In brief, as with the LENA algorithm, CTs were counted in discrete pairs, and pauses of 5 s or more constituted the end of a conversation. Critically, and unlike with the LENA algorithm, cases of accidental contiguity were not counted as CTs. The total number of CTs was counted across all 100 intervals for each participant.

After training, all coders were tested independently with a training file from the present data set, used to evaluate intercoder reliability (ICC; Shrout and Fleiss, 1979). The reliability analysis produced an average intra-class correlation of 0.96 (maternal parentese: 0.96; paternal parentese: 0.95; child vocalization: 0.98; child words: 0.96; child word combinations: 0.96; electronic media: 0.93; conversational turns: 0.99), indicating effective training and reliable coding based on a two-way random effects model (ICC [2, *k*]; Shrout and Fleiss, 1979; see also Ferjan Ramírez et al., 2021, 2022; Ramírez-Esparza et al., 2016, 2017). The definitions of all

TABLE 1 Daylong recordings: variable names, types, and definitions.

Variable name	Variable type	Variable definition
AWC	LENA	Total number of adult words heard by the child during the recording, estimated automatically by LENA.
Parentese	Manual	Percentage of segments where mother, father, or other adult spoke directly to the infant, parentese speech style was used (high pitch, larger pitch range), and one or more than one adult voice was recorded during the interval.
CVC	LENA	Number of vocalizations containing speech-related activity produced by the child wearing the recorder, estimated automatically by LENA. Child vocalizations can be of any length, as long as they are surrounded by 300+ milliseconds of non-speech.
C_Words	Manual	Percentage of annotated segments where the child wearing the recorder produced one or more than one Slovenian word(s).
C_ Combinations	Manual	Percentage of annotated segments where the child wearing the recorder produced one or more than one Slovenian utterance. Utterances are defined as a combination of two or more Slovenian words.
CTC	Manual	Total number of adult utterances directed to child, followed within 5 s by child utterances directed to adult, or vice versa; counted in discrete pairs (child to parent = 1 turn, parent to child to parent = 1 turn, child to parent to child to parent = 2 turns; see Ferjan Ramírez et al., 2021)
Media_LENA	Manual	Percentage of annotated segments in which any sounds (dominant or background) originating from an electronic speaker were identified in the child's environment.

AWC, adult word count; CTC, conversational turn count; CVC, child vocalization count; LENA, Language ENvironment Analysis estimate; Manual, manually coded.

TABLE 2 Descriptive statistics for language measures, media exposure, and parental knowledge of language development.

	M	*SD*	Skew	Kurt
AWC	24,310.5	9,724.2	0.71	0.82
CVC	2,927.4	1,304.5	0.76	0.49
C_Words	0.6	0.3	−1.05	−0.21
C_Combinatons	0.4	0.3	0.18	−1.6
CTC	225.2	97.0	0.14	−0.62
Parentese	0.8	0.1	−0.72	0.92
PLDK	89.6	5.2	−0.19	−0.97
Media_LENA	0.2	0.2	0.87	−0.32
Media_Report	17.7	14.82	2.34	6.56
CDI_Vocab	269.4	212.3	0.17	−1.59
CDI_M3L	3.0	2.5	0.31	−0.9
CDI_Compexity	10.1	11.5	0.74	−0.83

Descriptive statistics for Media_Report (daily media exposure in minutes as reported by parents) were calculated with 20 %winsorization. SE (standard error) for skewness = 0.39; SE for kurtosis = 0.78.
AWC, adult word count; CVC, child vocalization count; CTC, conversational turn count; PLDK, Parental language development knowledge; LENA, Language Environment Analysis; CDI, MacArthur-Bates Communicative Development Inventory: Words and Sentences; Media_Report, screen time (in minutes) reported by parents; CDI_Vocab, vocabulary size as measured with CDI; CDI_M3L, mean length of utterances as measured with CDI; CDI_Complexity, sentence complexity as measured with CDI; Skew, skewness; Kurt, kurtosis.

final variables are summarized in Table 1. The total number of annotated 30-s segments was 4,000 (100 segments per participant, 40 participants), which equals 2,000 min of annotated audio in total.

Because the LENA recordings varied in duration, projected 12-h values were used for all LENA automatic measures. The 12-h projections are part of the standard LENA package, are automatically generated by LENA for recordings at least 10 h in length, and represent the interpolated values for AWC and CVC at the 12-h mark for the day's recording (see Gilkerson et al., 2017; see also Tion et al., 2009, which uses the same method to report the normative data for a sample of U.S. English-speaking children).

2.2.2 MacArthur-Bates CDI

Families received the Slovenian adaptation of MacArthur-Bates CDI (Marjanovič Umek et al., 2013). Three CDI measures were included in the present study: (a) Productive vocabulary, which contains a list of words divided into 22 categories (e.g., food and drinks, interjections, animals, interrogatives, etc.). Parents are asked to indicate the words their child uses, and the maximum score equals the number of words checked by the parent (i.e., 680 words; CDI_Vocab). (2) M3L (mean length of three longest sentences) is used to assess children's ability to form multiword utterances. Parents write down the three longest sentences they recall their child using recently, from which the average utterance length is calculated (CDI_M3L). (3) Sentence complexity contains 37 pairs of utterances, of which one is grammatically less complex than the other. Parents mark the utterance that is typical of their child's speech. The highest possible score is 37 (CDI_Complexity). See Marjanovič Umek et al. (2013) to learn more about how the Slovenian CDI was adapted from the American English version (Fenson et al., 1994, 2006) and its psychometric characteristics.

2.2.3 The background survey

A background survey was created for the purposes of the present study and consisted of two sections. The first section included a Demographic and Toddler Media Exposure Questionnaire. This section collected the information about the demographics of both parents and the toddler: the basic information regarding the toddler's health, family composition, exposure to Slovenian and potential exposure to additional languages, enrollment in preschool, and the parents' education levels. In addition, parents reported on their toddler's average daily use of various electronic media (in minutes); namely, they estimated the average time their child spends (1) watching video content (on TV or portable video device), (2) using a computer, (3) using a mobile device or webcam to video chat, (4) using a mobile phone to talk to someone (without video), (5) playing video games, (6) using a touchscreen device (e.g., iPad, mobile phone, Kindle), and (7) using other electronic media (parents reported on possible additional devices a toddler might use). Time (in minutes) reported by parents for each of the above activities was summed into a variable Media_Report. Parents were also asked if their toddler owns their own electronic device (e.g., iPad

or mobile phone). According to parental reports, none of the toddlers had their own device. By far, the most frequent use of electronic media was "Watching video content (TV, portable video device)," all the other categories were stated at least 10 times less frequently than this category. Next in order was "Using a mobile device or webcam to video chat," followed by "Using a touch screen device" and then "Using a mobile phone to talk to someone (without video)."

The second section of the survey asked parents about their knowledge on early language development. For this purpose, an adapted subset of the questions from the Survey of Parent/Provider Expectations and Knowledge (SPEAK) survey was used (Suskind et al., 2017; Ferjan Ramírez et al., 2022). Specifically, a total of 25 statements about early language development were listed, and parents were asked whether they agreed or disagreed with each, on a 4-point Likert scale. Example statements included: *"Television sound in the background is an excellent way for infants and toddlers to learn new words"* and "*When infants make sounds, such as 'bababa' or 'papapa', it is helpful if parents respond and try to have a conversation*". Responses were scored on a point value out of 100 possible points, yielding a "parental language development knowledge" (PLDK) score (see Ferjan Ramírez et al., 2022, which used this adaptation of the SPEAK survey in a sample of American toddlers).

Experimental procedures were approved by the institutional review boards of the University of Washington and the University of Ljubljana, and written informed consent was obtained from all parents of participating children.

2.3 Statistical analysis

Two toddlers had extreme values on the media exposure variable (i.e., more than two standard deviations from the mean). Because there was no indication that these data points are from a reporting error, we kept them in the sample. To correct for the possible effects of these outliers, we report the 20% winsorized descriptive statistics for the affected variables.

The 20% winsorized Pearson correlations with corresponding 95% confidence intervals were calculated between different measures of toddlers' media exposure, family factors, parental knowledge of early language development, and toddlers' language environment and language production.

We aimed to predict parentese and daily media exposure as reported by parents (Media_Report) through two robust multiple linear regression models. The first model consisted of Media_Report, toddlers' ages and sex, and parental education as possible predictors of parental use of parentese. The second model included PLDK, toddlers' ages and sex, and parental education as possible predictors of daily media exposure as reported by parents. The bootstrap approach with 5,000 random repetition samples from the original data set was used to estimate the *p*-values and confidence intervals for the regression coefficients. We computed the coefficient of determination corresponding to WLS regression, computed from the original residuals before the WLS transformation (Willett and Singer, 1988). The authors noted that R^2 calculated from weighted least-squares (WL)- transformed data is generally higher than corresponding ordinary least-squares (OLS) one because it capitalizes on lowering heteroscedasticity of the data. Therefore, reporting the R^2 from original data is more appropriate. The formula used was $1-\frac{SSe}{SSt}$, where *SSe* was computed from unweighted residuals.

All statistical calculations were carried out with the R 4.4.0. software environment for statistical computing and data visualization (R Core Team, 2023) using the packages *psych* (Revelle, 2023) and *car* (Fox and Weisberg, 2019) for descriptive statistics and data visualization, respectively; *correlation* (Makowski et al., 2019) for partial correlation calculation; and *WRS2* (Mair and Wilcox, 2020) for robust analyses. Statistical significance was calculated with the two-sided risk for an alpha error of 0.05.

3 Results

3.1 Research question 1

Based on parental report, the amount of daily exposure to electronic media in Slovenian toddlers was 18 min ($SD = 15$), as calculated with 20% winsorized mean. The variable was positively skewed (see Table 2), indicating a clustering of values around the left tail of the distribution. As such, this variable is more accurately described by its median value, which indicates that half of the participants were exposed to electronic media for <13 min daily; however, there were a few noticeable outliers for whom the daily electronic media exposure was higher. Namely, for two toddlers, media exposure was more than twice the value of two standard deviations for that measure. In addition, six (15%) toddlers were not exposed to media at all; they were about 5 months younger than those who had already been exposed to media, with the difference in age between the two groups being statistically significant ($M_{younger} = 19.0$, $SD_{younger} = 81.3$, $M_{older} = 23.9$, $SD_{older} = 140.9$, $t = -3.684$, $df = 11.23$, $p = 0.004$, $d = 1.12$). Looking at the two measures of toddlers' media exposure estimated by the LENA records and reported by parents, they were positively related, although the correlation was only marginally significant ($p = 0.08$; see Table 3).

3.2 Research questions 2 and 3

The descriptive statistics for the measures of parents' and toddlers' language, toddlers' media exposure, and PLDK are presented in Table 2, while the winsorized correlations of forementioned measures and family demographic characteristics are shown in Table 3. Normality assumptions for the included variables were not too severely violated, as the raw values of skewness and kurtosis did not exceed 1.96 times the standard error for the corresponding measure (see Table 2), indicating approximately normally distributed data (Kim, 2013).

As can be seen in Table 3, toddlers' age was related to their language production. This was evident from their LENA speech production estimates (CVC), as well as their CDI scores. There was also a positive correlation between toddlers' age and turn taking. Parental language input was significantly related to several measures of toddlers' language, namely to toddlers' vocalizations (CVC), word production (C_Words), the number of conversational turns (CTC), as well as with toddlers' CDI vocabulary. Parents with

TABLE 3 20% winsorized correlations with 95% confidence intervals for language measures, media exposure, and parental knowledge of language development.

	Age	Education	AWC	CVC	C_Words	C_ Combinations	CTC	Parentese	Media-LENA	PLDK	Media_ Report	CDI-Vocab	CDI-M3L
Age	1.00												
Education	0.13 [−0.19, 0.42]	1.00											
AWC	0.03 [−0.28, 0.34]	0.17 [−0.15, 0.46]	1.00										
CVC	0.46** [0.18, 0.68]	0.08 [−0.24, 0.38]	0.34* [0.03, 0.59]	1.00									
C_Words	0.70*** [0.49, 0.83]	0.23 [−0.09, 0.51]	0.37* [0.07, 0.61]	0.69*** [0.49, 0.83]	1.00								
C_combinations	0.79*** [0.64, 0.89]	0.26 [−0.06, 0.53]	0.18 [−0.14, 0.47]	0,56*** [0.30, 0.74]	0.82*** [0.68, 0.90]	1.00							
CTC	0.37* [0.06, 0.61]	0.11 [−0.21, 0.41]	0.49** [0.22, 0.70]	0.60*** [0.36, 0.77]	0.80*** [0.65, 0.89]	0.57*** [0.31, 0.75]	1.00						
Parentese	−0.09 [−0.39, 0.23]	0.08 [−0.24, 0.38]	0.60*** [0.36, 0.77]	0.37* [0.06, 0.61]	0.40* [0.11, 0.64]	0.19 [−0.13, 0.47]	0.63*** [0.40, 0.79]	1.00					
Media-LENA	0.19 [−0.13, 0.47]	−0,31 [−0.57, 0.00]	−0.28 [−0.55, 0.03]	−0,12 [−0.42, 0.20]	−0,09 [−0.39, 0.22]	−0.01 [−0.32, 0.31]	−0.13 [−0.43, 0.19]	−0,17 [−0.46, 0.15]	1.00				
PLDK	−0,39* [−0.62, −0.08]	0.26 [−0.05, 0.53]	0.18 [−0.14, 0.47]	−0,20 [−0.48, 0.12]	−0.12 [−0.41, 0.20]	−0,16 [−0.45, 0.16]	0.07 [−0.25, 0.37]	0.49** [0.21, 0.70]	−0,17 [−0.46, 0.15]	1.00			
Media_Report	0,40* [0.10, 0.63]	−0.08 [−0.38, 0.24]	−0,20 [−0.48, 0.12]	0,19 [−0.13, 0.47]	0.17 [−0.15, 0.46]	0.27 [−0.04, 0.54]	−0.01 [−0.32, 0.30]	−0,34* [−0.59, −0.03]	0.28 [−0.03, 0.55]	−0.49** [−0.70, −0.21]	1.00		
CDI-Vocab	0.72*** [0.53, 0.84]	0.12 [−0.20, 0.42]	0.33* [0.02 0.58]	0.49** [0.21, 0.70]	0.65*** [0.43, 0.80]	0.75*** [0.57, 0.86]	0.41* [0.11, 0.64]	0.20 [−0.11, 0.49]	0.06 [−0.25, 0.37]	−0.25 [−0.52, 0.06]	0.32* [0.01, 0.57]	1.00	
CDI-M3L	0.75*** [0.58, 0.86]	0.13 [−0.19, 0.43]	0.12 [−0.20, 0.42]	0.39* [0.09, 0.63]	0.70*** [0.50, 0.83]	0.79*** [0.64, 0.89]	0,55*** [0.29, 0.74]	0.13 [−0.19, 0.43]	0.11 [−0.21, 0.41]	−0.16 [−0.45, 0.16]	0.20 [−0.12, 0.48]	0.70*** [0.50, 0.83]	1.00
CDI-Complexity	0.78*** [0.62, 0.88]	0.18 [−0.14, 0.46]	0.14 [−0.18, 0.43]	0.45** [0.16, 0.67]	0.66*** [0.44, 0.81]	0.79*** [0.63, 0.88]	0.33* [0.02, 0.58]	0.05 [−0.26, 0.36]	0.10 [−0.22, 0.40]	−0.35* [−0.60, −0.04]	0,43** [0.13, 0.65]	0.91*** [0.83, 0.95]	0.73*** [0.54, 0.85]

Age, toddler's age; Education, Parental education. In order to achieve the power of at least 80 %, the Pearson correlation coefficient for the anticipated sample size must be at least 0.43.

AWC, adult word count; CVC, child vocalization count; CTC, conversational turn count; PLDK, Parental language development knowledge; LENA, Language Environment Analysis; CDI, MacArthur-Bates Communicative Development Inventory: Words and Sentences; Media_Report, screen time (in minutes) reported by parents; CDI_Vocab, vocabulary size as measured with CDI; CDI_M3L, mean length of utterances as measured with CDI; CDI_Complexity, sentence complexity as measured with CDI; Skew, skewness; Kurt, kurtosis.

*$p < 0.05$. **$p < 0.01$. ***$p < 0.001$.

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a higher score on the knowledge of early language development questionnaire used more parentese, while their toddlers were less exposed to electronic media (according to parental reports). By comparison, children whose parents showed higher knowledge of early language development used less complex sentences as assessed by CDI; however, this association was no longer statistically significant after controlling for age, $r = -0.04$, 95% CI [−0.34, 0.28], $p = 0.829$.

Compared to parents of older toddlers, parents of younger toddlers expressed a greater knowledge of language development. While media exposure estimated by LENA was marginally related to the number of words spoken by adults (AWC; $p = 0.056$) and parental education ($p = 0.057$), parental report of toddlers' media exposure was related to toddlers' age (with older toddlers being more frequently exposed to electronic media), the use of parentese, and PLDK (with parents who reported a lesser media exposure of their toddlers using more parentese and expressing a greater knowledge of early language development). By comparison, toddlers who were more exposed to electronic media, according to their parents' reports, expressed a larger vocabulary and formed grammatically more complex sentences as assessed by CDI (see Table 3). However, these correlations were no longer significant after controlling for the toddlers' age: Partial correlations between Media_Reports and CDI_Complexity and between Media_Reports and CDI_Vocab were, respectively, 0.29, 95% CI [−0.02, 0.55], $p = 0.14$, and 0.01, 95% CI [−0.30, 0.32], $p = 0.94$, after controlling for toddler's age. Furthermore, the results showed that boys were more exposed to electronic media compared to girls ($M_{boys} = 21.04$, $SD = 16.88$; $M_{girls} = 12.57$, $SD = 8.38$, $t = 2.065$, $df = 31.98$, $p = 0.048$; $d = 0.63$).

3.3 Research question 4

To establish the predictors of parental use of parentese and toddlers' daily media exposure, two robust multiple regressions were conducted, due to the daily media exposure variable being influenced by two influential outliers (see Table 1 for descriptive statistics). Additionally, diagnostic plots used to assess violations of regression assumptions indicated the presence of influential cases, as identified by Cook's distances, as well as abnormalities in the residual distribution. Table 4 shows the outputs of both regression analyses in which p-values and confidence intervals were calculated using the bootstrap approach with 5,000 repetitions. Using parentese was not significantly associated with any of the included predictors; however, toddlers' daily media exposure reported by parents could be considered a marginally important predictor of parentese ($p = 0.053$). By contrast, the model predicting toddlers' daily media exposure reported by parents as the outcome variable contained two significant predictors, namely, PLDK and toddlers' sex. In particular, a higher PLDK score and being a girl predicted less media exposure. With the predictors included in both regression models, we explained 11% of the variance in the use of parentese and 31% of the variance in toddlers' daily media exposure; however, a power analysis computed on five model parameters, a significance level of 0.05, and a sample size of 40 individuals showed insufficient power for the first model (0.37) and appropriate power for the second model (0.90).

4 Discussion

The empirical findings outlined in this study shed light on various factors influencing toddlers' media exposure and language development within naturalistic home settings. The goal of the present study was to explore four specific questions, and we discuss our findings in relation to each.

4.1 Research question 1

According to the parents' reports, we found that toddlers are exposed to media for an average of 18 min per day, with the most common use of electronic media being watching video content on TV or portable video devices. This represents a low level of media exposure overall compared to the results of several other studies, in which the authors report significantly higher media exposure among infants and toddlers. For example, Radesky et al. (2020) report that at least a third of U.S. preschool children by the age of 3 years had access to a mobile device, which they used for an average of ∼2 h per day. Australian infants and toddlers younger than age 2 were also found to use screens for an average of 2 h per day (Rhodes, 2017). Furthermore, Dynia et al. (2021) report 3.79 h per day for 2-year-old American toddlers in low-income households, while Kulakci-Altintas (2020) finds that almost half of Turkish infants and toddlers use at least one technological device for an average of 2–5 h per day. However, when interpreting the results of our study, which was conducted after the COVID-19 pandemic, it should be noted that the parents in our sample were relatively highly educated and that higher levels of parental education were found to be associated with lower levels of media exposure (e.g., Kwon et al., 2024; Tomopoulos et al., 2010). In addition, parents may knowingly or unknowingly report what they perceive to be socially desirable. In fact, the questionnaire on parental knowledge about early language development included two statements directly related to toddlers' screen exposure. On average, parents demonstrated a high level of knowledge on both statements, namely, "Infants and toddlers can learn just as much language from television as they can from their parents during the first two years of life" ($M = 3.72$, $SD = 0.64$) and "Infants can learn more from watching children's educational programs on television than from being read to by their parents" ($M = 3.95$, $SD = 0.22$).

In our sample, the toddlers' low media exposure in their home environments may also be influenced by a broader cultural factor: like most Slovenian toddlers, the toddlers in our study attended a full-day preschool program and therefore spent only part of the day with their parents. That is, it may be that when parents are able to complete their work and some other obligations while their child is in preschool, they may be better able to control their child's media exposure in the home when they are together.

The daylong LENA recordings provided a more objective measure of the toddlers' media exposure; however, it included all media in a child's environment, including, for example, the radio. The media exposure as measured by LENA correlated positively with the parents' reports, although the correlation was marginally significant. The percentage of annotated LENA segments in which electronic sounds were present was 20%,

TABLE 4 Results of multiple robust regressions for two models predicting the use of parentese and toddlers' daily media exposure.

Outcome	Predictor	*B*	CI lower	CI upper	*t*	*p*
Parentese						
	Media_Report	2.3 × 10 – 5	−5.4 × 10 – 5	2.5 × 10 – 8	−1.83	0.053
	Age	−1.0 × 10 – 5	−3.1 × 10 – 4	3.0 × 10 – 4	−0.07	0.988
	Sex-girls	−0.027	−0.106	0.061	−0.69	0.501
	Education	0.003	−0.012	0.020	0.40	0.701
Media_report						
	PLDK	−106.9	−187.9	−24.8	−2.78	0.002
	Age	2.471	−0.369	5.235	1.81	0.090
	Sex—girls	−815.1	−1,533.7	−91.0	−2.36	0.024
	Education	−20.8	−173.2	112.4	−0.30	0.764

CI lower, confidence interval lower bound; CI upper, confidence interval upper bound for regression coefficients; PLDK, parental language development knowledge.

which is lower than in a U.S. sample of infants and toddlers aged 1–24 months (Ferjan Ramírez et al., 2022). Thus, our findings may suggest that parents in the present study may have been familiar with the recommendations for early media use (American Academy of Paediatrics, Council of Communication and Media, 2016; Slovenian Association of Paediatrics, 2021). Recommendations for parents on early media use may also be provided by preschools, which, in Slovenia, employ well-educated preschool teachers and regularly organize lectures for parents on creating a quality environment for children's development and learning. It is important to note, however, that while the average media exposure was low, there were significant individual differences between the toddlers, with the shortest time toddlers were exposed to media being 1 min and the longest being 2.5 h, demonstrated that some toddlers were exposed to the media for much longer than recommended. This type if variability has previously been reported in the literature (e.g., Nikken and Schols, 2015; Seršen et al., 2024).

4.2 Research question 2

The results of our study show large variability in terms of the amount of media exposure in Slovenian toddlers. One factor contributing to this variability is age, as we found that daily media exposure was significantly higher among older toddlers. We found that 15% of toddlers were not exposed to media at all. These toddlers were ∼3 months younger than those who had already been exposed to media.

Research suggests that parental education level is related to children's media exposure (Kwon et al., 2024; Mendelsohn et al., 2008; Tomopoulos et al., 2010). In our sample of relatively highly educated parents, only media exposure recorded by LENA was marginally related to parental education level, with toddlers of parents with higher education being less exposed. By comparison, parental report of daily media exposure was not related to parental education level. In our study, this may be due to the parents' high educational levels, resulting in low variability in parental education levels. Consistent with several studies (e.g., Ferjan Ramírez et al., 2024a; Ramírez-Esparza et al., 2016; Romeo et al., 2021), our results suggest that characteristics of the home language environment are related to several measures of toddlers' language. Toddlers who heard more words from adults vocalized more, produced more words themselves, and participated in more CTs as measured by LENA. They also demonstrated a larger vocabulary as measured by the CDI. Parental use of parentese also seemed to be associated with infants' more frequent vocalization and higher word production, as well as a higher number of CTs. These results outline the importance of parental language input for toddlers' early language development; both the number of words toddlers hear at home and how parents talk to the child were shown to be important in the present study.

Furthermore, the evidence from our study suggests that toddlers' media exposure may be related to the amount of language input provided by parents. Namely, parents of toddlers who experienced more media exposure spoke fewer words and used less parentese when talking to their child. In this regard, the results suggest that higher media exposure might have a negative effect on parent–child conversations, which is in line with several studies (Cycyk and De Anda, 2021; Ferjan Ramírez et al., 2022), indicating that children who spend more time on screens have decreased parent–child language interactions. It seems important to note that although the overall media exposure of toddlers was low, the negative effect on parents' language was nevertheless demonstrated. Conversely, media exposure was not associated with toddlers' language, aligning with several studies that have found no significant link between children's screen exposure and language ability (e.g., Dore et al., 2020; Dynia et al., 2021; Martinot et al., 2021; Taylor et al., 2018). However, multiple studies have connected early and/or high media exposure with slower language development (e.g., Massaroni et al., 2023; Zimmerman et al., 2007). Future research should examine the quality of media content accessible to Slovenian toddlers and investigate the role of parental involvement during screen time to better understand the observed relationships.

4.3 Research question 3

Our results suggest that parental knowledge of early language development might play an important role in the media exposure

of toddlers younger than age 3. Toddlers whose parents had better knowledge about language development appeared to be less exposed to electronic media, suggesting that these parents are more aware of the potential negative effects of early media exposure on their child's language development and therefore limit exposure and engage in other activities with the child. Parents with greater knowledge of language development also tended to use more parentese when talking to their children, suggesting that better informed parents may engage in more effective language-promoting behaviors and may be more cautious about their children's media consumption. They may also be more familiar with the recommendations for their children's media consumption. Several studies suggest that parents who are well aware of language development milestones are more likely to provide a supportive environment for the child's language acquisition (Ferjan Ramírez et al., 2021; Rowe, 2008). In the present sample, these parents were also more educated, which is consistent with several other studies (Luo et al., 2021; Suskind et al., 2017). Interestingly, toddlers' age also appeared to be related to parents' knowledge of language development, with parents of younger toddlers expressing a greater knowledge of language development.

4.4 Research question 4

The regression analyses provide further depth in understanding the factors that influence toddlers' early media exposure, on one hand, and parental use of parentese, on the other. Parentese has previously been shown to have a positive effect on the language development of infants and toddlers in North American samples (Ferjan Ramírez et al., 2024a; Huber et al., 2023). In predicting parental use of parentese, of the predictors included (parental education level, toddler media exposure, age, and sex), only toddlers' daily media exposure was found to be a marginally significant predictor in the negative direction. That is, higher toddler media exposure predicted lower parentese use. With the predictors included, we were able to explain a small proportion (11%) of the variance in parental use of parentese.

More robust results were observed in the model predicting toddlers' media exposure, which identified parental knowledge of language development and toddlers' sex as significant predictors. In particular, higher parental knowledge and being a girl were associated with lower media consumption and explained 31% of the variance in toddlers' daily media exposure. Research on media exposure of boys and girls is not consistent, with some authors reporting that girls are more exposed (e.g., Brushe et al., 2023), while others report higher media exposure for boys (Rodrigues et al., 2020). Our findings thus suggest that better informed parents and the sex of the child might influence media exposure practices, potentially impacting language development outcomes. However, due to the small number of girls and boys in our sample, further studies are needed to identify possible gender differences in media exposure and the factors that may contribute to these differences.

5 Conclusion

The present study represents the first attempt to document toddlers' media exposure in Slovenia via naturalistic daylong recordings and parental questionnaires. Using these methodologies allowed us to explore the links between parental knowledge, parental language input, children's media exposure, and children's language production. The findings of our study underline the importance of parental knowledge about language development and the characteristics of the language environment for toddlers' language ability. Namely, parental language input appeared to be related to various measures of toddlers' language, while parents with a greater knowledge of early language development used more parentese and their toddlers were less exposed to the electronic media. By comparison, no significant relationship was found between early media exposure and language production in toddlers. However, the obtained results should be interpreted with caution because of the study's small sample size. Specifically, considering the power analysis results, several observed correlations should be viewed as marginal, highlighting the need for further research. Future studies should explore these dynamics more thoroughly with larger, more diverse samples of children, including those from disadvantaged families, to gain a more comprehensive understanding. Specifically, longitudinal studies that track early media exposure and parental practices over time are essential for understanding the causal relationships and potential long-term effects of media exposure on children's language development in both the present and the future.

Data availability statement

The datasets presented in this study can be found in online repositories. The names of the repository/repositories and accession number(s) can be found at: https://osf.io/6pybt/?view_only=55cbc976c2dc4c69b92ed7555d0de03b.

Author contributions

UF: Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation, Writing – original draft, Writing – review & editing. LM-U: Conceptualization, Investigation, Methodology, Project administration, Supervision, Validation, Writing – review & editing. NP-J: Data curation, Formal analysis, Methodology, Writing – review & editing. NF: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Supervision, Validation, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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