Natural Language Input: Maternal Education, Socioeconomic Deprivation, and Language Outcomes in Typically Developing Children

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The authors declare no conflict of interest.

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Abstract

Purpose. The current study was designed to investigate the differences in language input related to family factors (maternal level of education “MLE”, and socioeconomic level of deprivation “SLD”) and their association with language outcomes in preschoolers.

Method. This study used New Zealand SLD and MLE classification systems to examine differences in language input related to these factors among typically developing twenty preschool children aged 2 to 5 years. The quantity of children’s language input (adult words “AWs”, conversational turns “CTs”) was calculated from using Language ENvironment Analysis (LENA) audiotaping technology for two typical weekend days. Four five-minute LENA recording segments were transcribed and coded, and parental language strategies (LSs) were classified as optimal (OLS), moderate (MLS), or sub-optimal (S-OLS) for child language outcomes. The receptive and expressive language of each child was assessed using the Preschool Language Scales-fifth edition (PLS-5).

Results. Mann–Whitney U tests showed significant differences between the quantity of language input (AWs/hour, CTs/hour) for high and low MLE and high and low SLD groups. Consistent with the literature, the use of S-OLSs was significantly lower for families with high MLE (*Median* = .25, *IQR* = .14) and low SLD (*Median* = .22, *IQR* = .13) than for families with low MLE (*Median* = .41, *IQR* = .24) and high SLD (*Median* = .41, *IQR* = .26). Spearman’s correlation coefficients indicated significant associations between language input (AWs/hour, CTs/hour, S-OLSs) and language outcomes.

Conclusions. Reduced language input and the frequent use of S-OLSs associated with low maternal education and high deprivation, and low language outcomes for these children highlight the importance for all parents/families to learn optimal language strategies to support the development of strong language skills in their children in young age.

Keywords: language input, quantity, language strategies, maternal level of education, socioeconomic level of deprivation

Introduction

Several studies have shown that children's learning of language is shaped by language input and parents are the main source of this input in early childhood (Carpenter, Nagell, & Tomasello, 1998; Cox Eriksson, 2014; Girolametto et al., 2002; Hart & Risley, 1995; Mishina-Mori, 2011; Vernon-Feagans et al., 2008). Parental language input varies according to the amount of talk to children and with children (Gilkerson & Richards, 2009; Hart & Risley, 1995), and the quality or styles of oral interaction (Cruz, Quittner, Marker, & DesJardin, 2013; Girolametto et al., 2002; Hampson, 1993; Huttenlocher, Waterfall, Vasilyeva, Vevea, & Hedges, 2010).

Assessment of the variation in parental language input is not straightforward due to the involvement of many factors such as parent/primary caregivers' natural talkativeness, upbringing, living standards, knowledge, awareness, and consciousness about strengthening their children's language development (Topping, Dekhinet, & Zeedyk, 2013). It is important to take into consideration the investigation of these factors that may be reasons for variation in language input in different home environments. Based on previous studies, level of parental education (Dollaghan, Campbell, Paradise, Feldman, Janosky, Pitcairn et al., 1999), and socioeconomic status (Hoff, 2003; Hoff & Tian, 2005) are the most powerful environmental/family factors that have been considered in studies of variation in parental language input.

Language Input and Maternal Level of Education

Few studies have considered maternal level of education (MLE) as a separate contributing factor to socioeconomic status (SES) when examining variations in maternal language input. Indeed, most studies have considered the MLE and SES as a compound variable or have used maternal education as a proxy for SES when examining differences in language input. Studies examining the effects of education level have found a positive relationship between high level of education and better language input both in terms of quality and quantity. For example, more educated mothers talk more to their children and tend to use longer and more complex utterances (Hammer & Weiss, 1999; Heath, 1982; Hoff, 2003). In addition, several studies have shown that less-educated parents in low-income homes talk to their children less frequently than more educated parents with high income (Hoff, 2003; Huttenlocher, Vasilyeva, Waterfall, Vevea, & Hedges, 2007; Rowe, 2008).

Furthermore, studies showed comparatively a higher number of adult words per hour (AWs/h) and conversational turns per hour (CTs/h) for children whose mothers had obtained a college degree (considered higher education) than those with a school-level certificate (considered lower level of education) (Dickinson & Neuman, 2006; Gilkerson & Richards, 2008), and positive association with great vocabulary development (Dickinson & Neuman, 2006, pp. 165-168). Similarly, Rowe (2012) examined parental education as a measure of SES and its association with measures of language quantity and quality. She found that educated parents used significantly more word tokens and more varied vocabulary with their children at different ages than less-educated parents. Parental language input in children aged 18, 30, and 42 months was correlated with their scores for vocabulary assessment and use of grammar in sentences at 30, 42, and 54 months.

To examine reasons for variation in parental language strategies (LSs) during oral interactions with their young children, Kloth et al. (1998) examined whether mothers' oral interactional styles differed by level of education. To this end, three education level groups were distinguished. Group 1 (low level) included mothers with primary and lower general secondary education (n = 37), Group 2 (average level), mothers with general secondary education (n = 21), and Group 3 (high level), mothers with college or university education (n = 13). A post hoc Newman–Keuls test revealed that the highly educated mothers used a verbal communicative style that was significantly less directing than less educated mothers because of their lack of knowledge about the importance of optimal oral interaction styles. Clearly, maternal education is a key variable that should be considered in all future studies related to the assessment of language environments for optimizing language learning skills in children.

Language Input and Socioeconomic Status

Socioeconomic status (SES) is a compound variable that includes occupation, education level, and income (Kohn, 1963). Several seminal studies by Hart and colleagues revealed significant differences in the amount of parental language input between high and low SES groups (Hart & Risley, 1992, 1995, 2003). These studies found that children from high SES families were, on average, exposed to 215 adult words/hour more than children from low SES families. Sperry, Sperry, and Miller (2019) found similar mean differences in adult words/hour across different social classes based on home observations of 42 children (18–48 months) in a longitudinal study.

Older studies have examined oral maternal-child interaction styles during conversations with their children comparing high-, middle-, and low-income families (Estrada, Arsenio, Hess, & Holloway, 1987; Pianta, Nimetz, & Bennett, 1997; Pianta, Smith, & Reeve, 1991). These studies showed that mothers in high-income families used optimal language strategies (OLSs), such as open-ended questions, positive reinforcement, and elaboration of verbal activities, more often than those in the middle- and low-income families. Hart and Risley (1995) found that children living in professional families heard significantly more affirmations (i.e., encouragement) and fewer prohibitions (i.e., discouragement) than those living in poverty. Similarly, Farran and Haskins

(1980); Heath (1983) and Hoff (2013) reported that low-SES mothers often used speech to direct their children's behavior, while high-SES mothers often used speech to elicit conversation with their children. Praise and encouragement from parents and adults during oral interactions not only help children participate in oral communication, but also enhance their comprehension and verbal expressions (Tempel, Wagner, & McNeil, 2009).

Overall, these studies indicate that the natural environment of low-SES families does not offer exposure to a large amount of language input and specific styles of oral interactions that promote the development of stronger oral language in young children. These maternal language behaviors are thought to put children at greater risk for both behavioral problems and language impairment that may delay school readiness (Aughinbaugh, 2001), and social and academic achievements (Saracho, 2002; Watson, 2002). The research suggests that children in low-income households may have fewer opportunities to experience supportive language interactions. Unfortunately, there is little information on how optimal language strategies may alter or change in the preschool period, especially as the child's language skills develop.

Some methodological concerns limit the conclusions from these studies, however. For example, many studies involve observation of parent-child interaction in structured settings in home and laboratory with structured activities and instructions using audio/video recorders. Conclusions from these studies may be useful as the study designs control for the effect of different activities (book reading, or play with toys), and material used during these activities (type of toys, and books), however the findings do not reflect natural language behaviors in natural settings. Also, information regarding SES has been based on parental demographic reports of income level, education and occupation, which may influence reliability of the data.

To ensure uninterrupted naturalistic observations for assessment of parent/primary caregiver-child oral interactions, more recent studies have turned to recordings in natural environments using tools such as the Language ENvironment Analysis (LENA) system recorder to reduce the limitations of traditional recorders (e.g., parents and children were not free to move around) (Gilkerson et al., 2018; Hart & Risley, 1995; Hoff & Naigles, 2002; Hurtado et al., 2008; Huttenlocher et al., 1991; Zimmerman et al., 2009).

Quantity of Language Input and Language Outcomes

There are well-documented variations in the amount of parent talk, which can be defined as the number of adult words (AWs) or the number of conversational exchanges with children. More talkative parents use more individual words, and their children are exposed to a higher frequency of talk. Pan, Rowe, Singer, and Snow (2005) found that children mirrored the language they were exposed to, emphasizing the importance of the amount and complexity of parental language (i.e., number of words, conversational exchanges) and the use of dense and rich syntactic structures. Indeed, the diversity of parental language input (i.e., the variety of words, phrases, and clauses produced) has been linked to children's later overall development of receptive and expressive language (Huttenlocher et al., 2002, 2010).

Several studies have found stronger lexical outcomes (Hoff & Naigles, 2002; Hurtado, Marchman, & Fernald, 2008; Huttenlocher, Haight, Bryk, Seltzer, & Lyons, 1991) and better receptive and expressive language scores (Hart & Risley, 1995) in children exposed to more AWs. More recent studies argue that simply counting AWs is insufficient to describe the child's language experiences (Sperry et al., 2019; Zentella, 2015).

Zimmerman et al. (2009) estimated the number of conversational exchanges using Language ENvironment Analysis technology (LENA). They showed a positive association between a parent-child higher number of conversational turns (with children aged 2 to 48 months) and stronger receptive and expressive language skills 18 months later. The 10-year (2006-2016) longitudinal study of Gilkerson et al. (2018) examined the automatic calculation of the number of conversational turns (CTs) at a young age (between 2 and 36 months) and its association with receptive and expressive vocabulary 10 years later (between 9 and 14 years old). They recruited 146 families in natural settings and collected data using day-long (12 hours) LENA audio recordings at home for six months (recordings per family: $M = 5.17$, $SD = 1.35$, *range* = 1-7). In this study, it was unclear why the researchers chose day-long recordings and whether the day selected was a typical school day, a day at the daycare, or a weekend day. This important information could affect the interpretation of the data regarding whether the recordings were representative of typical interactions between children and adult(s)/parent(s). The current study provided information regarding the days selected and a justification for the selection of these days in the methodology section.

In Gilkerson et al's. (2018) study, the number of conversational exchanges was analyzed using the LENA software, and language outcomes were obtained using the Peabody Picture Vocabulary Test (PPVT) and the Expressive Vocabulary Test (EVT). Pearson's correlation coefficients showed that conversational exchanges were highly correlated with stronger receptive ($R^2 = .04$, $p = .01$) and expressive language vocabulary ($R^2 = .04$, $p = .01$) measured 10 years later.

Language Strategies and Language Outcomes

During communication exchanges parents often employ different types of language strategies (LSs). For example, they may use expansion by supplying missing grammatical and semantic elements, or recasting the child's utterances into questions, commenting on the child's actions, and directing commands to the child (Hampson & Nelson, 1993). An early study by

Newport, Gleitman, and Gleitman (1977) suggested that using yes/no questions more frequently was related to the development of stronger auxiliaries in children. On the other hand, maternal oral interactional styles, such as self-repetitions (Hoff-Ginsberg, 1986), expansions, and recasts (Nelson, 1981), were strongly associated with better expressive language development. Hoff-Ginsberg's (1986) study found that maternal requests for unknown information (i.e., open-ended '*wh*' questions) were a positive predictor of children's expressive language skills and confirmation requests (i.e., closed-ended questions) were a positive predictor of receptive language skills.

To understand how the use of LSs in daily routine can impact language outcomes, Yoder and Kaiser (1989) studied of 10 typically developing children the relationships between three LSs (i.e., open-ended questions, close-ended questions, and directives) and language outcomes (i.e., mean length of utterance, 'MLU'). Consistent with Hoff-Ginsberg (1986), open-ended questions were found positively related with children's MLU ($rs = .74$, $p < .01$). Kloth, Janssen, Kraaimaat, and Brutten (1998) also examined mother-child interactions with children aged 2 to 5 ($N = 71$). Pearson's product-moment correlation coefficients indicated a positive correlation between expansions and children's MLU ($r = .28$). Conversely, Yoder and Kaiser (1989) found negative associations between children's MLU and mothers' use of directives ($rs = -.80$, $p < .01$) and close-ended questions ($rs = -.75$, $p < .01$). Moreover, consistent with Yoder and Kaiser (1986), negative correlations were found between children's MLU and directives ($r = -.51$), receptive language scores ($r = -.47$), and expressive language scores ($r = -.38$). Trivette et al. (2010) reported a positive relationship between open-ended questions and receptive and expressive language skills, basing this conclusion on 21 studies with 1,275 toddlers between 12 to 42 months of age.

Thus, the literature provides strong evidence supporting the use of some specific LSs (i.e., *'wh,' 'yes/no'* questions, and directives) used by parents which are related to better language outcomes while the use of some other strategies correlates with poorer language outcomes. Roberts and Kaiser (2015) reported a randomized controlled trial. This interventional study was tested to examine the effects of parental LSs (i.e., match turns, responsiveness, time delay, expansion, and prompting) on receptive and expressive language outcomes 97 toddlers age ranged 24 and 42 months who were at risk for persistent language delays. Two groups were divided included in this study; 1) 45 children who received intervention, and 2) 52 children served as controls and did not receive intervention. The first group was trained by professional trainers for 28 play sessions based 20 minutes. Result showed caregivers in the intervention group improved their use of all language facilitation strategies, such as matched turns (adjusted mean difference, intervention-control, 40; 95% confidence interval 34 to 46; p = .01). Children in the intervention group had significantly better receptive language skills (5.3; 95% confidence interval 0.15 to 10.4), but not broad-based expressive language skills (0.37, 95% confidence interval 24.5 to 5.3; p = .88). This research focused on optimizing the use of expansion as a language strategy.

To our knowledge DesJardin et al. (2014) is the only study that examines whether a wide range of different types of language input indeed are correlated with better language outcomes. They classified potential LS into two levels: high level (i.e., parallel talk, open-ended '*wh*' questions, expansion, and recast) and low level (i.e., linguistic mapping, comments, imitation, labeling, directive, and closed-ended '*yes/no'* questions), without providing a rationale for this classification. Sixty typically developing children aged birth to three years were observed for 5 minutes during videotaped book reading sessions. Children's auditory communication skills were correlated with the use of high-level LSs (M = 50.23, SD = 45.70, p < .05). Imitation (Girolametto et al., 2006), directives (Hurtado, Marchman, & Fernald, 2008; Rowe, 2008), and linguistic mapping (Yoder, McCathren, Warren, & Watson, 2001) were considered less important and strategies such as expansion (Tiegerman-Farber & Radziewicz, 2008) were more important for better language outcomes (Cruz, Quittner, Marker, & DesJardin, 2013; DesJardin et al., 2014).

Relatively few studies have examined links between the use of optimal language strategies and language outcomes. The current study addressed this gap by classifying the range of parental LSs derived from literature and the parent-child interaction therapy (PCIT) guidelines (Eyberg, Nelson, Duke, & Boggs, 2005) into three categories (optimal, moderate, and sub-optimal). This classification was based on the independent judgments of a group of experienced early interventionist and speech and language therapists currently working clinically with children aged from birth to 5 years.

The Current Study

This study examined the overall quantity and types of parental LSs that the children were exposed to and the relationships between these measures and the children's receptive and expressive language outcomes.

The secondary aim of this study evaluated influence of MLE and SLD on language input. We used LENA technology to record the interactions of caregivers with their typically developing preschoolers to determine the quantity of language input and strategies in the everyday communication environment. We hope that the results of this study will raise awareness of the factors and challenges associated with language input in different home environments and bridge the gap in oral interactions between parents/primary caregivers and their children to develop stronger language skills. The 5-minute segments of parent-child oral interaction included everyday routines, such as mealtime, indoor play, dressing/clothing, and toileting rather than specifically targeting structured activities such as book reading which have been the focus of earlier studies. The results may assist professionals to shape parental language input so that children's language learning is optimized. These findings may be relevant to children facing other challenges affecting language development, such as intellectual, social, hearing and language difficulties.

This study addressed two research questions:

1. Are there differences in the amount of language input (number of AWs, CTs) and the types of LSs used between high and low MLE and high and low SLD groups? *Based on the existing literature, we hypothesized that the quantity of language input and the use of optimal language strategies would be higher in high MLE and low SLD groups.*
2. Are there associations between the amount of language input (number of AWs, CTs) and the types of LSs and language outcomes (receptive and expressive)? *Based on the existing literature, we hypothesized that higher quantity of language input and greater use of optimal language strategies would be associated with better language outcomes.*

Method

Participants

Twenty typically developing CwNH and their parents/primary caregivers completed the study. The recruitment process specified the following inclusion criteria: children aged 2 to 5 exhibited no known developmental delay, come from monolingual English-speaking families, and had normal hearing (no ear infection) reported by the parents and based on the results of the newborn hearing screening test. Initially, 28 families signed a written consent to participate in the study. However, this number was reduced to 20 participants, as 3 families declined to participate after signing their consent, 2 families completed only one day of recording, 2 families requested the deletion of their data due to privacy concerns after completing all of the recordings, and 1 child refused to wear the LENA vest. Table 1 compares the demographic characteristics of the 20 participants and 8 dropouts. The families and 20 children all lived in the greater Auckland area (New Zealand). Nine female and 11 male children (age *range* = 24-58, *M* = 39.90, *SD* = 12.63) were recruited from early childhood centers. All children had siblings (*range* = 1-4, *M* = 1.10, *SD* = 1.60) and different birth orders (*range* = 1-4, *M* = 1.6, *SD* = 0.88), and the number of adult family members at home, including parents, also varied (*range* = 2-6, *M* = 3.35, *SD* = 1.31). The primary caregivers were mainly the mothers of recruited families. All of the children attended preschool, and 18 of the 20 children attended every day (*range* = 2-5, *M* = 4.50, *SD* = 0.99). The number of hours per day spent in preschool ranged from 6 to 10 (*M* = 7.70, *SD* = 1.14). Statistics New Zealand reported a high proportion of preschool attendance (80%), which is consistent with our data retrieved from https://www.stats.govt.nz/. Due to the children's attendance at preschool on weekdays, only weekend days were chosen for full-day recordings to focus on parent-child oral interactions. All families completed the recordings on two weekend days. The mothers' self-reported number of hours spent with their children on weekdays (*range* = 2-9, *M* = 4.90, *SD* = 1.64) was lower than that on weekends (*range* = 6-13, *M* = 11.1, *SD* = 2.10; see Table 2). This result was not surprising, as the children attended preschool on weekdays.

Material

LENA Technology

LENA is a small cassette-sized recorder that fits into a pouch sewed onto special LENA clothing (i.e., vest and t-shirt) having the capacity to collect up to 16 hours of continuous recording in a natural environment. The LENA software automatically calculates the adult words (AWs), and conversational turns (CTs) based on an algorithm that identifies adult-child interactions in which one speaker initiates a conversation and the other responds within five seconds, with data presented as AWs and CTs/day/hour, and every five minutes. The quantitative outcomes that are automatically generated by the LENA software have demonstrated reliability and validity (Gilkerson et al., 2017). The number of AWs and CTs estimated by LENA, was strongly correlated with human manual transcription (AWs: $r = .95$; CTs: $r =. 82$; all $p < .001$). The recordings obtained with LENA have high face validity compared with traditional language recordings, as the interactions are less likely to be influenced by the interference and presence of unfamiliar adults (e.g., researchers), the use of artificial recording settings (e.g., laboratories or observation rooms to observe parent/mother-child interactions), and the need for bulkier and more obvious technical equipment (e.g., recorders, microphones, and cables).

A recent study by Busch, Sangen, Vanpoucke, and Wieringen (2018) has challenged the reliability of LENA quantitative data. This study was conducted with six Dutch children aged 2 to 5 and found a mean difference between manual counts and the number of AWs (LENA: $M = 228.5$, $SD = 231.7$; Manual: $M = 284.4$, $SD = 253.7$) and CTs (LENA: $M = 8.4$, $SD = 7$; Manual: $M = 22.9$, $SD = 21.9$) automatically calculated by LENA software with eight full-day LENA audio recordings. LENA calculations were lower than manual counts. This contrasts with Gilkerson et al. (2017) who used a much larger sample size of 94 children and found good agreement.

In the current study the reliability of LENA calculations was checked by determining discrepancies in the calculation of AWs between manual and automatic measurements (for five randomly selected 5-minute recordings) as per the method used in the study by Caskey, Stephens, Tucker, and Vohr (2014). The Pearson product-moment correlation coefficient comparing manual and automatic AW calculations showed that these results were highly consistent ($r = 0.93$), supporting the reliability of LENA estimates.

To address gaps in the previous literature, the current study considered LENA full day naturalistic recordings for the analysis of quantity of language input with LENA automatic calculations of adult words (AWs) and conversational turns (CTs). Segments of LENA recordings were also extracted and manually transcribed/coding for LS. The current LENA software only allows the automatic estimation of the quantity of language input (number of AWs and CTs) and is not a sophisticated tool for the analysis of other essential aspects of language input such as the interactional features of utterances (e.g., whether utterances were repetitions, paraphrases, or expansions), and the degree to which such utterances questioned the child's knowledge or prohibited the child's actions. Thus, information on the quality of language input was based on manual transcription.

To overcome methodological concerns regarding parent reports of SES, the standardized New Zealand deprivation index 2013 was used to determine high and low levels of socioeconomic deprivation (SLD).

New Zealand Deprivation Index (NZDep)

The New Zealand Deprivation Index 2013 (NZDep) is a tool for analyzing the socioeconomic level of deprivation (SLD) combining nine variables communication, income, employment, qualifications, own home, support, living space, and transport providing a deprivation score obtaining from geographic units by Statistics New Zealand (Atkinson, Salmond, & Crampton, 2014). This index has two forms: an ordinal scale and a continuous score. The ordinal scale ranges from 1 to 10, where 1 represents areas with the least deprived scores reflected high socioeconomic status, and 10 = most deprived areas reflected low SES associating with low economic activities, high unemployment rate, unhealthy life styles, high level of limiting long-term illness and disability, low life expectancy, poor educational attainment, poor housing quality and overcrowding, and high levels of crime and anti-social behaviors) was used representing SLD. It should be noted that deprivation scores apply to areas rather than individual people (Atkinson, Salmond, & Crampton, 2014). The NZDep has been used in many published studies in New Zealand to examine equal access to public health services in different SES groups (McFadden, McConnell, Salmond, Crampton, & Fraser, 2004; McKenzie, Ellison-Loschmann, & Jeffreys, 2011; McLeod & Cormack, 2006; Wilson et al., 2012). However, it has never been used to analyze differences in language input between SLD groups. This index does not address the potential effects of other family factors such as the influence of child gender and age on parental language input.

Preschool Language Scale—Fifth Edition (PLS-5)

The choice of an accurate language output measure is also important. The Preschool Language Scale—Fifth Edition (PLS-5) is a comprehensive scale for identifying receptive (i.e., basic vocabulary, concepts, morphology, and syntax) and expressive (i.e., naming, describing, expressing quantity, using specific prepositions, grammatical markers, and sentence structures) language skills in children from birth to 7 years and 11 months. The PLS-5 generates norm-referenced scores, including standard scores, percentile ranks, and age equivalents for two subscales, auditory comprehension, "AC," and expressive communication, "EC," and Total Language scores, "TL." The test-retest reliability of the PLS-5 ranges from good to excellent (r = .86-.95). The internal consistency of auditory comprehension is $r > .80$ and that of expressive communication is $r > .9$. As mentioned earlier, the PLS-5 generates norm-referenced test scores, including standard scores (M = 100, SD = 15; Zimmerman et al., 2012). In recent studies, this test has been used to analyze total scores in receptive and expressive language in young children (Betancourt, Brodsky, & Hurt, 2015; Gilkerson & Richards, 2008; McDaniel & Purdy, 2011; Phillips, Wiley, Barnard, & Meinzen-Derr, 2014; Shenoy, 2015).

Procedure

Sample Selection

A convenience sampling approach was used for the selection of eligible participants from local early childhood centers. The primary investigator contacted the managers by e-mail, phone calls, and personal meetings to obtain their agreement for participant recruitment process (i.e., advertisement, selection of potential participants, signed a consent, and distribution of devices). Approved information and consent forms for the families were distributed by the centers. After obtaining consent from willing families, the primary investigator contacted them by e-mail or phone to discuss in more detail the data collection process. For example, the use of the LENA audio recorders, liaison with the researcher to deliver and return the LENA recorders, and the time and place of the children's language assessments.

Ethical Principles

Ethical approval was obtained from the Human Research Ethics Committee (HREC) via the Faculty Research Ethics Committee (FREC) of the University of Hong Kong, the Human Participants Ethics Committee of the University of Auckland, and the Programme Research and Development Committee of the Hearing House (Auckland). The consent forms and complete information about the study were prepared with respect for the rights of human participants and for the privacy of the participants and their data, such as ensuring that individual participants cannot be identified in the reported results or from original or archival data available to the public.

Data Collection

LENA Recordings and Quantity of Language Input

To collect the recordings, a package was prepared for each family, which included two fully charged LENA recorders with the labels Weekend Day 1 and Weekend Day 2, two LENA vests (according to the child's body size), a document with pictorial instructions to use the recorders, and a file with a demographic information sheet. Some packages were delivered to the managers of the centers to pass on to the families, some were directly delivered to the families, and some were shipped to their home address. Three out of the 20 families received NZD20 in cash to compensate for travel costs when the family returned the LENA packages in person. The other 17 families posted the LENA packages back to the researcher using return courier bags provided at the time of delivery. There was no difference in demographics or any of the measured variables between those families that did and did not receive monetary compensation.

The families were informed that the child would wear a comfortable vest with a pocket to carry the LENA recorder. They were advised to turn on the LENA recorder in the morning as early as possible when the child woke up and to turn it off at night when the child went to bed. They were instructed to turn off the LENA recorder and remove the vest during bath or nap time. Similar recording procedures have been used in previous LENA natural language analysis studies (Gilkerson & Richards, 2008; Oller et al., 2010; VanDam, Ambrose, & Moeller, 2012; Warren et al., 2010). The families completed two full days of recordings (typical weekend days when the family was not engaged with special occasions, such as birthday parties). During the recording days, the families were instructed that they should behave naturally and interact with their children as usual. There were no restrictions for the parents and the children to stay at home, and they could go outside for shopping, visit a playground, or have a picnic. After completing the recordings, the data were uploaded to the LENA software to process the audio files and estimate the number of AWs and CTs for each individual. Recording two typical days was chosen to ensure that the data reflected the variety of language input to which the children were naturally exposed.

The researcher was available by phone or e-mail during the recording periods to answer questions. The families were informed that if they felt uncomfortable with the recording due to an unusual day, they could stop recording or withdraw their participation at any time during the data collection process. The children's receptive and expressive language outcomes were assessed using the PLS-5 administered by the primary investigator (a qualified speech and language therapist) during a home visit (17 families) or in a therapy center (3 families), at a convenient time for the families.

Parental Language Strategies

Although the parents were informed that the LENA recorders and software can calculate the number of daily AWs and CTs automatically, and some recording segments would be transcribed and coded, they were not given information on the types of language strategies (LSs) that would be extracted from the recordings.

The literature review identified 17 potential LSs. These strategies were grouped into categories by 10 speech and language therapists/early interventionist working with young children in the Ministries of Education and Health (experience ranging from 5 to 25 years) who had at least a Masters degree in speech therapy/pathology or special education/early childhood education. Therapists were given 17 cards labeled with each LS with a description and examples on the back of the card. They independently grouped these strategies into three main categories: optimal language strategies (OLSs), moderate language strategies (MLSs), and sub-optimal language strategies (S-OLSs). Twelve of the 17 (71%) strategies were consistently categorized by 80 to 100% of the therapists. There was less consensus across therapists for the five remaining language strategies (PM, LB, DR, LM, AC). In each case, the therapists differed only in one category (see details in Table 3). For these five strategies, categorization was based on the majority decision (60% of the therapists). The range of agreement was between 60% and 100% (100 = strong agreement, 80% to 100% = moderate agreement, and 60% to 80% = agreement). The agreed-upon categorization of LSs is presented in Table 4.

Parental Level of Education

The New Zealand education classification system (retrieved from https://www.nzqa.govt.nz) was used to examine parental education using self-reported demographic information. This system defines level of education as 10 = Doctoral, 9 = Masters, 8 = Bachelors Honors, 7 = Bachelors, 6 = A certificate for theoretical and technical knowledge and skills within a specific field and study, 5 = A certificate for technical knowledge and skills within a specific field and study, 4 = Certificate to work or study in broader and specified field/area, 3 = Certificate to work in specified field/area, which is almost equal to the level of academic qualifications in Australian, Europe, and the United Kingdom (The New Zealand qualifications authority (NZQA) & the European Commission, 2016). Overall, the fathers' level of education ranged from 3 to 10 (*Median* = 7.00, *IQR* = 3.75) and maternal level of education (MLE) among the mothers also ranged from 3 to 10 (*Median* = 7.00, *IQR* = 5.00). There was no significant difference between fathers' and mothers' education levels based on a Mann–Whitney U test ($z = -.76$, $p = .445$). MLE was used for analysis of two groups: high MLE with education levels ranging from 7 to 10 and low MLE with education levels ranging from 3 to 4.

The Socioeconomic Level of Deprivation

The 2013 New Zealand index of socioeconomic level of deprivation (SLD) was used to estimate the level of deprivation (Atkinson, Salmond, & Crampton, 2014). The standardized classification of coding software version 4.0.2 was used to obtain mesh block data on SLD, retrieved from https://www.stats.govt.nz/. The participants' street addresses were used to obtain a code for each mesh block and matched with a number between 1 and 10 (1 = least deprived areas (high SES), and 10 = most deprived areas (low SES) representing SLD. SLD data were available for 19 families (one family refused to share their street address).

Measures

Quantity of Language Input

The recording duration over the two days varied slightly in terms of total minutes (Day 1 = 593-877, Day 2 = 569-881), but these differences were not significant between Day 1 and Day 2 ($Median_{\text{day1}}$ = 779.50, *IQR* = 190.75 versus $Median_{\text{day2}}$ = 789.50, *IQR* = 110.50, $z = -.45$, $p = .655$). However, these slight differences in terms of minutes in duration could lead to an increase or decrease in the quantity of AWs and CTs and affect the results. To correct variations in recording time across families, AWs/min and CTs/min were calculated by dividing the observed daily values by the number of total minutes and converting the results to AWs/h and CTs/h, following the literature (VanDam et al., 2012). To check the reliability of the study, five sets of five-minute LENA audio recordings were randomly extracted to estimate the number of AWs and CTs. The descriptive statistics and Pearson's product-moment correlation coefficients between LENA automatic calculations and manual estimations of the number of AWs and CTs showed a very good agreement: AWs: M_{LENA} = 125.60 (*SD* = 110.36) versus $M_{\text{manual calculation}}$ = 123.60 (*SD* = 105.24), $r = 1.00$, $p < .05$; CTs: M_{LENA} = 22.20 (*SD* = 17.71) versus $M_{\text{manual calculation}}$ = 22.40 (*SD* = 16.65). This showed a significant association between automatic and manual calculations ($r = 0.94$, $p < .05$).

Parental Language Strategies

To identify the language strategies (LSs) used, 20 minutes of recordings for each participant (i.e., two per day for 2 days, resulting in four 5-minute excerpts per family) were extracted from LENA recordings using the LENA pro-software version (V3.4.0-143) to identify intervals with oral communication exchanges (i.e., CTs) for manual transcription and coding. The 20-minute recordings were composed of one 5-minute audio excerpts per day that registered the highest number of CTs (indicating focused parent/child interactions), following the method used in recently published study (D'Apice & Stumm, 2019), and one 5-minute audio recording excerpts per day that matched the median value of CTs/day for that child (indicating a routine amount of parent/child interactions) for each day of the recording (i.e., 2 recordings per day x 2 days). This method was adopted to sample more intensive and more typical interactions across the day. The audio recordings were played offline and manually transcribed and coded. Frequent activities noted during listening to the recordings were mealtime, indoor play, clothing, picture description, and story time at night. A transcription sheet was designed for coding in Excel (Office 365), which included 17 potential LSs identified from previous studies (Cruz et al., 2013; DesJardin & Eisenberg, 2007; Girolametto & Weitzman, 2002; Tulviste, 2003; Eyberg, Nelson, Duke, & Boggs, 2005): Expansion (EX), Recast (RC), Reason (RS), Open-ended Question (OQ), Closed-ended Question (CQ), Comment (CM), Positive Marker (PM), Repetition (RP), Labeling (LB), Action (AC), Directive (DR), One Word response in terms of only yes/no/ok/alright (OW), Joint Speech (JS), Linguistic Mapping (LM), Negative Marker (NM), Imitation (IM), and Other (OT). All 17 types of parental LSs were identified in the data (see detail description in Table 4).

The language transcripts were transcribed manually by the principal investigator. To calculate a frequency score for parental/primary caregiver's LSs, the pre-identified codes of each strategy were assigned to each adult utterance/sentence or phrase for four transcripts/ two per day within the family. Microsoft Excel (office 365) was used for coding and scoring of each transcript.

An expert who was trained in the coding system was hired to code LSs. Prior to any transcription and coding, the primary investigator and the second coder were trained by a language expert (a highly experienced speech-language therapist). During training, the language expert defined and played examples of 'styles of oral interaction/language strategies' that were coded.

After training, both coders independently coded a recorded segment of parent-child oral interaction this formed the basis for further training that evaluated the 17 types of LSs used in the present study. After 100% agreement was achieved for the training samples, a randomly selected subset of transcripts (25% of transcripts, 100 minutes) was independently coded to verify inter-rater reliability, following the method in previous studies (Cruz et al., 2013; Girolametto & Weitzman, 2002; D'Apice & Stumm, 2019). Each utterance (linguistic phrase or sentence) of the parents was coded for 1 of the 17 possible LSs. In case of disagreement between the coders, they reviewed the audiotapes and transcripts together. Following the method used by Girolametto and Weitzman (2002) the percent agreement between two transcribers/coders after the consensus process was calculated using the following formula: (number of agreements) / (number of agreements + number of disagreements) x 100. For transcription reliability, the agreement was 100% for each utterance (linguistic phrase or sentence). The inter-rater reliability for all 17 types of LSs was high (95% for LM, RP, AC, LB, OQ, CQ, OW, JS, NM, OT; 93% for PM, RC, DR, 90% for RS, EX, and 88% for CM). The overall inter-rater reliability agreement obtained using Cohen's kappa was in the range between .88 and .93. This level of inter-rater agreement is almost similar within the range of 88% to 98% of inter-rater agreement has been found in previous studies (DesJadin & Eisenberg, 2007; Girolametto & Weitzman, 2002).

Proportion scores for each category of parental LSs were calculated by dividing the total number of uses for each type of LSs by the overall number of LSs used by that parent for the 20 minutes of coded utterances, which generated a percentage for each category of LSs. As a result, less talkative parents were not penalized and were used in the analysis, following the method used by Cruz et al. (2013).

No significant differences were obtained in the average proportional score of any category of LSs between the two weekend days and two segments/day, so we combined the two/day transcripts per family and estimated proportional average scores for the two days and four recordings. Proportional average scores of the 20 participants for each LS were calculated for each category (Table 5).

Language Outcomes

A measure of receptive and expressive language was included in this analysis. The test of PLS-5 kit contains scoring sheets, a manual, language checklists, and test materials, including picture cards, storybooks, shapes, toys, and objects. The primary investigator (an experienced speech and language pathologist) administered the test following the standard protocols of PLS-5 for language assessment. To test the child's comprehension, the administrator provided a series of instructions designed to test the child's language understanding. For example, after presenting a teddy bear, a cup, a bowl, a cloth, and a spoon, the administrator asked, 'the bear is tired' 'make him go to sleep'. For testing the child's expressive skills , the administrator provided a series of instructions designed to test the child's oral language skills. For example, after presenting some picture (e.g., ball, balloon, shoe etc.) the administrator asked, what is this? The child uttered the name of the object. Test raw scores were recorded and converted to age-standardized scores based on published norms. Standard scores were used for correlation analysis with language input.

Mann-Whitney U tests were used to determine group differences in quantity of language input and language strategies (low vs. high MLE and SLD groups). Spearman's correlation coefficients were used to determine the relationship between language input and language outcomes.

Results

Descriptive Data

Quantity of Language Input

Overall, during the two days of recording, the children were exposed to an average of 1,243 AWs per hour (*M* = 1242.61, *SD* = 426.30, *range* = 667.74-1977.85) and had an average of 61 oral communication exchanges per hour (CTs/h; *M* = 60 .94, *SD* = 21.34, *range* = 21.41-98.61; see Table 5).

Parental Language Strategies

The means and standard deviations for the proportion of each type of language strategies (LSs) were examined in each category. On average, the children were more exposed to OLSs (CM, OQ, PM, RC, EX, RS; *M* = .47, *SD* = .16) than to MLSs (CQ, LB, RP, AC; *M* = .18, *SD* = .06) and S-OLSs (JS, DR, OW, LM, IM, NM, OT; *M* = .33, *SD* = .14; see Table 5). However, there was considerable variability between groups (high versus low MLE, and high versus low SLD). For example, on average, mothers with high MLE used mainly OLSs (50%). In contrast, those with low MLE used mainly S-OLSs (53%). The families with high SLD used mainly S-OLSs (44%), and those with low SLD used mainly OLSs (57%) for oral interactions with their children. Highly educated mothers and families with low SLD used mainly OLSs with their children (Figures 1B & 2D). The pattern was less consistent for less-educated mothers and families with high SLD, who mainly used MLSs (Figure 1A) and S-OLSs (Figure 1C), respectively.

Language Outcomes

The means, standard deviations, and ranges for the children's PLS-5 scores are presented in Table 4. Raw scores for receptive language (RL; *M* = 36.80, *SD* = 8.07) and expressive language (EL; *M* = 34.25, *SD* = 7.65) were obtained using manual calculations and converted to standard scores according to PLS-5 protocols. The average standard scores for RL (*M* = 91.40, *SD* = 16.84, *range* = 64-121) and EL (*M* = 88.00, *SD* = 19.56, *range* = 43-116) were slightly below the normative mean of 100 of the tests.

Maternal Level of Education and Socioeconomic Level of Deprivation

Thirteen mothers were classified as high maternal level of education “MLE” (*range* = 7-10, *M* = 8.62, *SD* = 0.53) and seven were in the low MLE group (*range* = 3-4, *M* = 7.17, *SD* = 0.41; see Table 2). Overall, socioeconomic level of deprivation “SLD” ranged from 1 to 10, with 1 representing the least deprived areas and 10 the most deprived areas in New Zealand (*N* = 19, *M* = 5.68, *SD* = 3.02). Ten participants belonged to the high SLD group (*range* = 6-10, *M* = 8.2, *SD* = 0.98) and nine to the low SLD group (*range* = 1-5, *M* = 2.89, *SD* = 1.17; see Table 2). A chi-square test showed a significant association between MLE and SLD ($p < .05$). Indeed, highly educated mothers had lower SLD. However, although there was a link between MLE and SLD, the grouping differed.

Group Comparison

Quantity of Language Input

The first question in this study focused on whether there are differences in the amount of language input (number of AWs, CTs) and the types of LSs used between high and low MLE and high and low SLD groups. Table 6 summarizes the quantity of language input (number of AWs/h, and CTs/h) for the group comparison: high versus low MLE and high versus low SLD. Shapiro–Wilk tests showed normal distributions for the data related to the number of AWs/h and CTs/h across the MLE and SLD groups ($p > .05$), except for AWs/h for high SLD ($p < .05$) children. Mann–Whitney U tests showed that all group differences were significant, with large effect sizes

(Cohen, 1992). The familywise Type 1 error rate across five tests at the .05 level was controlled by using the Holm's Sequential Bonferroni procedure (Holm, 1979).

MLE Groups

The box plots in Figure 2 display the medians and quartiles for the quantity of language input (AWs/h and CTs/h), comparing high and low MLE groups. On average, the children in the high MLE group were exposed to 2.56 times more AWs/h than those in the low MLE group. In addition, they were engaged in 1.87 times more oral communication exchanges (CTs/h) than those in the low MLE group. Mann–Whitney U tests showed significant differences between high and low MLE groups for AWs/h (p = .002, *Cohen's* r = .49) and CTs/h (p = .002, *Cohen's* r = .49; see Table 6).

SLD Groups

Figure 2 shows an outlier in AWs/h for the high SLD group. This child was from a family with a high level of deprivation was exposed to a high number of AWs. On average, the children from high SLD families were exposed to 1.74 times fewer AWs/h than those in the low SLD group. High SLD families were engaged with their children in 1.71 times less oral communication exchanges (CTs/h) than those in the low SLD group. Mann-Whitney U tests showed significant differences between high SLD and low SLD groups for AWs/h (p = .014, *Cohen's* r = .32) and CTs/h (p = .007, *Cohen's* r = .38; see Table 6).

Language Strategies

MLE Groups

Mann–Whitney U tests revealed only a significant difference in S-OLSs between high MLE and low MLE groups (p = .021, *Cohen's r* = .27). There was no difference in the proportion of OLSs and MLSs between high MLE and low MLE groups (Table 7).

SLD Groups

There was a significant difference in OLSs (p = .003, *Cohen's r* = .47) and S-OLSs (p = .001, *Cohen's r* = .55) between high SLD and low SLD groups. In contrast, the use of MLSs did not differ between high SLD and low SLD groups (Table 7).

Associations between Language Input and Language Outcomes

The second question in this study examined whether there were associations between the amount of language input (number of AWs, CTs) and the types of LSs and language outcomes (receptive and expressive).

Quantity of Language Input and Language Outcomes

Spearman's correlation coefficients between the quantity of language input (i.e., number of AWs/h, CTs/h) and language outcomes (i.e., PLS-5 receptive language standard scores, "RLSS," and expressive language standard scores, "ELSS") are listed in Table 8. There were significant positive correlations between the number of AWs/h and the number of CTs/h and the two outcome variables (RLSS, ELSS), indicating that the children exposed to a high number of AWs/h and CTs/h had stronger receptive and expressive language skills.

Parental Language Strategies and Language Outcomes

Spearman's correlation coefficients between the proportion of parental language strategies (OLSs, MLSs, S-OLSs) and language outcome variables (RLSS and ELSS) are reported in Table 8. There were significant positive correlations between OLSs and the two outcome variables (receptive, expressive), indicating that the children exposed to a high proportion of OLSs had stronger receptive and expressive language skills. In contrast, there were significant negative correlations between S-OLSs and the two outcomes variables, indicating that the children exposed to the highest proportion of S-OLSs had the lowest receptive and expressive language skills.

Discussion

This study was the first attempt to examine differences in the quantity of natural language input and the types of parental language strategies (LSs) during parent-child oral interactions while considering family factors (i.e., MLE and SLD), and association with language outcomes in typically developing children. Firstly, this study generated two important findings regarding high MLE and low SLD (high SES) families – these families spoke more and engaged their children in more conversational exchanges using optimal language strategies during oral interactions. Secondly, there were significant positive associations between a high number of AWs and CTs and optimal language input with better language outcomes (receptive and expressive), highlighting the importance of language input for language development in young preschool children.

The following discussion relates to the first question in the current study, regarding whether there were differences in the amount of language input (number of AWs, CTs) and the types of LSs used between high and low MLE and high and low SLD groups.

Group Differences in the Quantity of Language Input

The children in the high MLE group were exposed to significantly more AWs/h in their natural environment than those in the low MLE group. This result is consistent with a published LENA study by Gilkerson and Richards (2009). Their results showed that the average daily number of AWs/12 hours used by professional parents (usually mothers) with at least a Bachelor's degree was significantly higher (M = 14,926) than that (M = 12,024) of less-educated parents (high school only; $t(327) = 5.53$, $p < .01$). The current study showed larger differences in median values of about 850 AWs/h and 22 CTs/h between high and low MLE groups. In addition, Greenwood et al. (2011) revealed in their study that mothers with high school education and above used 514.8 more words per day with their children than those who had not completed high school. The results of these studies showed that higher MLE made a difference in the number of AWs exposure at home. Similarly, in the current study, adult-child conversational turns (CTs) were significantly higher in the high MLE group than in the low MLE group. This is the first study that compared between high and low MLE groups. Although, there is no systematic evidence to explain why highly educated mothers engage in a higher quantity of language input. We reported that highly educated mothers have a better understanding of how language input could affect children language outcomes and therefore they used more optimal language input.

The children in the low SLD (high SES) group were exposed to significantly more AWs/h and CTs/h in their natural environment than those in the high SLD (low SES) group with larger differences in median values of about 683 AWs/h and 33 CTs/h between high and low SLD groups. This result suggested that high SLD families had few adult–child communication exchanges, and the child was exposed to less adult talk. Similarly, previous studies have also concluded that children from high SLD families are exposed to fewer AWs/h and CTs/h during natural oral interactions weather the calculations were done using LENA (Suskind et al., 2016; Weisleder & Fernald, 2013; Wood, Diehm, & Callender, 2016), or manually (Hart & Risley, 1992, 1995, 2003; Hoff-Ginsberg, 1998; Hoff, 2003; Lawrence & Shipley, 1996). Consistent with this, Schwab and Lew-Williams (2016) also concluded in their review of the literature that the SES of families could predict differences in parental language input.

However, the current finding that there is more AWs exposure in low SLD than high SLD is highly supported by previous literature. The current study used a more elaborate evaluation of natural language input based on both automatic calculation of CTs/h, and the proportional analysis of LSs and hence may be more sensitive to the effects of high versus low SLD (high-SES). To enrich language learning parental teaching is required especially in low income households. It seems essential because most early intervention programs are developed on the premise that parents are their children's first teachers.

Group Differences in Parental Language Strategies (LSs)

The categorization of LSs (OLSs, MLSs, and S-OLSs) in this study was the first in the literature, so a direct comparison with other studies was not possible. Although the parents primarily used OLSs (M = .47) when the entire sample was considered, there were differences between groups. The strategies used most often for the entire sample were CM (22%, OLSs), DR (17%, S-OLSs), CQ (12%, MLSs), OQ (11%, OLSs), and OW (8%, S-OLSs), which vary slightly from the results of Cruz et al. (2013), who reported that CM (24%), DR (27%), CQ (17%), and OQ (6%) were the main strategies used in baseline observations in an interventional study focusing on children with hearing loss. Although the percentages were different due to the children in this study having hearing loss, CM (OLS), DR (S-OLS), and CQ (MLS) were the most common styles of communication adopted by the parents in our study with hearing children and in the study of children with hearing loss by Cruz et al. (2013). Typically developing children whose mothers use more questions and expansions, extending their children's verbal responses, show faster syntactic development than those whose mothers use these LSs less frequently (Hoff-Ginsberg, 1986; Nelson, Denninger, Bonvillian, Kaplan, & Baker, 1984). In the current study, the parents used expansions less frequently (7%) during conversations with their children than open-ended questions (11%) and closed-ended questions (12%). Earlier studies have not undertaken a detailed comparison of the frequency with which parents use these different strategies.

The results indicated that the parents in the most advantaged high MLE, low SLD families used S-OLSs, such as DR and NM, less frequently than those in the least advantaged families with low MLE, and high SLD and children in the most advantaged families exhibited better oral language scores than those from least advantaged families. As mentioned in Kloth et al. (1998), Farran and Haskins (1980), and Heath (1983) reported increased use of directives among mothers with low SES and low education levels, as expected.

Similarly, the current study found a significant difference in the use of OLSs between low and high SLD (low-SES) families. This difference was not found between high and low MLE groups, although it was expected due to the association between SLD and MLE. This suggests that a high level of education alone does not necessarily give parents the skills to use the OLSs to enhance their children's language development. The use of OLSs as a specific type of LSs may be related to parental availability. Highly educated parents may have more work commitments and less time for oral interactions as a use of language strategy, such as expansions, explanations, and recasts, which take longer than simple repetitions.

Although, the current findings were obtained in natural environments to avoid parent bias cause by structured activities it is still possible that the use of LSs may be affected by mother's awareness that the interaction was recorded and would be analyzed. To be focused on task oriented activities such as book reading (Dunn, Wooding, & Herman, 1977; Hoff-Ginsberg, 1991; Tulviste, 2003), and play with the specific type of toy chosen during free play has been found to affect the quantity and purpose of maternal speech (O'Brien & Nagle, 1987). A more comprehensive transcription and analysis of the recordings might allow for the effects of contextual factors such as the type of activity to be analyzed in future studies.

Language Input and Language Outcomes

The second question addressed in this study was the association between the amount of language input (number of AWs, CTs), types of parental language strategies (LSs) and language outcomes (receptive and expressive). The exposure of children to a high amount of AWs/h and CTs/h in their natural environment had a positive influence on their receptive and expressive language skills. Talkative families exposed their children to more language input and oral communication exchanges during adult/parent–child oral interactions. According to Zimmerman et al. (2009), each increase of 1000 AWs/h was associated with a .44 increase in PLS-4 language scores (95% CI = .09-.79). In the current study, receptive language scores of the children in the high MLE group (M = 99.08, SD = 15.15) were higher compared with those in low MLE households (M = 77.14, SD = 8.63). The expressive language scores of the children in the high MLE group (M = 95.62, SD = 18.79) were also higher compared with the children in low MLE families (M = 73.85, SD = 12.10). The parents in the high MLE group exposed their children to more AWs and CTs and their children showed better (and age-appropriate) receptive and expressive language outcomes than those with less talkative parents who had limited conversational exchanges with their children.

LENA measures the total number of AWs and does not distinguish between child-directed speech and adult-directed speech in the ambient environment. Therefore, it is difficult to determine whether an interaction needs to be child-directed to make a significant difference in language development. Based on Weisleder and Fernald (2013) who found that the total number of AWs was not associated with the parent report of productive vocabulary (r = .25, p = .2) in typically developing children and most studies showing that child-directed speech enhances language development, we anticipate that it was the child-directed speech that made a difference in terms of

AWs. Clinically, this suggests that parents/caregivers need more training on how to use child-directed speech in everyday settings to enhance their child's language outcomes.

In contrast to exposure to a higher quantity of AWs which has shown inconsistent effects (Sultana, Wong, & Purdy, 2019), the number of CTs is an important predictor of oral language skills (Zimmerman et al., 2009). Zimmerman et al. (2009) found that each 100 CTs/day increase was associated with a 1.92 increase in PLS-4 language scores (95% CI = 1.12-2.73, $p < .05$). Consistent with this result, we found a significant association between more CTs and better language outcomes. Similarly, in their correlation analysis, Greenwood et al. (2011) showed a significant positive association between LENA CTs/day and PLS-4 auditory comprehension ($r = .50$, $p < .01$), PLS-4 expressive language scores ($r = .43$, $p < .05$), and PLS-4 total language scores ($r = .50$, $p < .01$).

In this study, a high proportion of OLSs was significantly and positively associated with receptive and expressive language outcomes, as expected based on the results of previous studies linking OLSs (i.e., expansions, explanations, positive encouragement, comments on children's actions, and "Wh" questions) with faster language development (receptive and expressive; e.g., Chapman, 2000; Girolametto, Weitzman, & Wiigs, 1999; Hart & Risley, 1995; Kavanaugh & Jirkovsky, 1982; Rowe, 2012). These results enhance the parental awareness to expose OLSs during CTs to foster expressive language learning in young children.

The current study showed moderately positive correlations between OLSs and RLSS ($r = .46$, $p = .043$) and between OLSs and ELSS ($r = .44$, $p = .052$) and strong negative correlations between S-OLSs and RLSS ($r = -.66$, $p = .002$) and between S-OLSs and ELSS ($r = -.63$, $p = .003$). DesJardin and Eisenberg (2007) reported similar magnitudes. That is, there were significant positive associations between open-ended questions and expressive language ($r = .51$, $p < .01$), significant negative associations between expressive language and linguistic mapping: $r = -.42$, $p < .05$; labeling: $r = -.45$, $p < .05$; directives: $r = .49$, $p < .05$. Similarly, DesJardin and Eisenberg (2007) found significant negative associations between receptive language and linguistic mapping: $r = -.50$, $p < .01$; labeling: $r = -.44$, $p < .05$; and directives: $r = -.58$, $p < .01$. In other words, although positive language input is important for better oral language development, we did not evaluate how variables other than those studied in our study contribute to language development.

Clinical & School Implications

Important lessons can be learned from these analyses concerning how to design early intervention programs. Coaching low income parents on how to interact with their young children to foster language learning is an important component of early intervention. Here, it can be seen that this coaching needs to focus on shaping the natural styles of optimal parent-child oral interactions, as well as the quantity. Previous studies indicate that parents in low income households talk less frequently to their children (Lacroix, Pomerleau, Malcuit, Seguin, Lamarre, 2001), spend less time in mutual play and use less questioning for the purpose of engaging the child in non-goal oriented communication (Farran & Haskins, 1980; Hart & Risley, 1995), and engage in fewer joint attention activities (Galboda-Liyanage, Prince, & Scott, 2003). Coaching may help overcome these patterns of behavior (Levickis, Reilly, Girolametto, Ukoumunne, & Wake, 2018). In particular, parents should ask leading questions that can't be answered with a simple Yes or No (e.g., "Which piece of fruit would you like?", "What would you like to do today?). Extensions and recasts should also be encouraged. These interaction styles should be encouraged among clinicians and teachers who provide intervention to children in group settings during the preschool years.

Clinicians could, for example, use videos to provide examples and mobile text messages to encourage the use of OLSs during mealtime and during book reading to coach parents on how to use these strategies in their natural environment. This requires a more active investment in parent support and training. Policy makers can help by providing access to e-books, websites, mobile text messages, and phone and tablet Apps to enhance the use of OLSs at home, for example following the methods described by Cook (2016). Free seminars and workshops could be arranged at preschools. Parents who are exposing to their children to effective oral language input at home could be role models other parents. Further intervention studies are needed to understand if and how training can change parents' quantity and quality of language input and whether positive changes lead to improvements in children's language development.

Although it is rare (only 10.1% of New Zealanders) to have more than two adult family members living at home (Baker, Goodyear, Telfar, & Howden-Chapman, 2012), families could consider increasing visits from family members (e.g., grandparents), friends, and playmates to help increase the number of AWs and CTs. Also, parents and teachers should be encouraged to increase the number of communication exchanges with OLSs by engaging other children in play activities.

Limitations and Directions for Future Research

Although, LENA offers many advantages, we must note here some limitations in the use of LENA recordings. First, LENA audio recordings only capture the number of AWs and conversational exchanges between adults and children. Information on maternal/parental involvement, sensitivity, eye contact, and facial expressions during oral interactions could not be recorded. Second, speech produced by an adult near the child wearing the LENA recorder was recorded without considering the type of words and the structure and complexity of the sentences. Third, intensive analyses of LS and oral interaction styles (e.g., types of questions, explanations, expansions, comments, and recasts) during conversational exchanges could not be performed. Human observers are still needed for these analyses.

Finally, although the current study did not separately evaluate fathers versus mothers, or natural vs recorded speech, the LENA technology has additional features to estimates the amount of time an audible television is present in the children's environment and can separate the number of AWs and CTs from the amount of time television sounds. This information was not analyzed in the current study, although, there is now some evidence for the impact of fathers' language input on child language development (Rondal, 1980). Moreover, this study did not consider the potential differences in the preschool language environment between high and low SLD groups. Therefore, future research should pay attention to these variables.

Conclusions

Language input was significantly associated with children's language outcomes. The children in high MLE and low SLD (high-SES) families were exposed to more AWs/h and CTs/h and a higher proportion of OLSs than those living in low MLE and high SLD (low-SES) households. In high SLD (low-SES) and low MLE groups, the parents used a higher proportion of MLSs and S-OLSs. These strategies showed significant negative associations with receptive and expressive language scores in young children. As a result, language outcomes could potentially be improved by using fewer MLSs and S-OLSs and more OLSs during daily parent-child oral interactions. This information can help guide families who are unaware of the significance of language input and the challenges children face in acquiring oral language skills. Future studies should include an evaluation of the structure and complexity of oral interactions. This study also provides an excellent basis for clinicians and those directly involved in early intervention to help families enrich natural language environments. However, we acknowledge that the small sample size and wide age range may limit the generalizability of these results. Preschool teachers could consider parent language input when observing children who are showing a delay in school readiness (Aughinbaugh, 2001), or social and academic achievements (Saracho, 2002; Watson, 2002).

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