Describing communication profiles of low-risk preterm and full-term late talkers

Mariagrazia Zuccarini [a],[*], Annalisa Guarini [b], Dino Gibertoni [c], Chiara Suttora [b], Arianna Aceti [d],[e], Luigi Corvaglia [d],[e], Arianna Bello [f], Maria Cristina Caselli [g], Alessandra Sansavini [b],[*]

[a] Department of Education Studies "Giovanni Maria Bertin", University of Bologna, Italy
[b] Department of Psychology "Renzo Canestrari", University of Bologna, Italy
[c] Research and Innovation Unit, IRCCS Azienda Ospedaliero-Universitaria di Bologna, Italy
[d] Neonatal Intensive Care Unit, IRCCS Azienda Ospedaliero-Universitaria di Bologna, Italy
[e] Department of Medical and Surgery Sciences, University of Bologna, Italy
[f] Department of Education, Roma Tre University, Italy
[g] Institute of Cognitive Sciences and Technologies, National Research Council, Italy

ARTICLE INFO

ABSTRACT

Introduction: Late talkers represent a heterogeneous population. We aimed to describe communication profiles of low-risk preterm and full-term late talkers according to their receptive and expressive vocabulary size, considering communicative, linguistic, cognitive, and motor skills, as well as biological and environmental risk factors.

Methods: Sixty-eight late talkers (33 born low-risk preterm and 35 full-term) were identified through a language screening at 30 months. Parents filled out the Italian Short Forms of the MacArthur Bates Communicative Development Inventories and the Socio Conversational Skills Rating Scales. Children were assessed with the Picture Naming Game test and the Bayley Scales of Infant and Toddler Development.

Results: A two-step cluster analysis identified three distinct profiles among late talkers according to their receptive and expressive vocabulary size. *Severe* late talkers (25%) showed less frequent use of pointing, limited verbal imitation, receptive vocabulary size, lexical and sentence production, responsiveness and assertiveness, and lower cognitive scores than *mild* late talkers (40%). *Moderate* late talkers (35%) showed less frequent verbal imitation, limited lexical and sentence production and lower cognitive scores than *mild* late talkers. Male gender was significantly more represented in the *severe* late profile, whereas other biological and environmental factors did not differ among the three profiles.

Conclusions: Findings highlighted the relevance of assessing communicative, lexical, grammar, pragmatic, and cognitive skills to describe late talkers' profiles. A deeper investigation of phonological skills might also contribute to a further understanding of interindividual variability in this population.

---

* Corresponding authors.
  E-mail addresses: mariagrazia.zuccarini@unibo.it (M. Zuccarini), alessandra.sansavini@unibo.it (A. Sansavini).

1. Introduction

Language is one of the main achievements of human beings in the first years of life (Kuhl, 2010). In the absence of atypical constraints, children achieve language development milestones spontaneously and without much effort within the first three years of life. They start to present with their first communicative gestures and signs of word comprehension by 8–9 months of age and with their first words around 12–13 months. Receptive and expressive vocabulary size increase during the second and third year of life, with word comprehension developing earlier and supporting word production (Caselli et al., 2012; Fenson et al., 2007; Sansavini, Bello, et al., 2010, Sansavini, Favilla, et al., 2021). As expressive vocabulary increases, usually between 20 and 24 months, children combine words and produce their first sentences; generally, around 30-36 months, they express themselves with complete and complex sentences, characterized by the use of bounded and free morphemes. By age three, typically developing children produce 400–600 words and master basic morphological and syntactic structures of their language (Bates & Goodman, 1997; Caselli et al., 2015; Sansavini, Favilla, et al., 2021). Acquisition of lexical items is also related to phonological abilities. During the first two years of age, children discriminate and tune on the phonological characteristics of their native language (Stoel-Gammon, 2011). Consequently, they begin to articulate words more accurately (Chiat & Roy, 2007), even if some phonological errors may still be common until three years of age (Hodges et al., 2017). With increasing receptive and expressive lexical skills, children also develop socio-conversational abilities. By two years of age, they tune with the conversation topics proposed by adults and answer them appropriately, carrying on conversations; subsequently, by three years of age, they become able to start a conversation and generate questions (Bonifacio et al., 2007, 2013).

Although the path described above usually characterizes language development, great variability in timing has been described among children (Fenson et al., 2007). In addition, for some children, communicative-linguistic development does not flow according to the expected timing (Hawa & Spanoudis, 2014; Rescorla & Dale, 2013; Rudolph & Leonard, 2016). These children, called "late talkers", acquire language at a slower rate with respect to their typically developing peers between 18 and 35 months of age, despite the absence of cognitive, neurological, sensory, and socio-emotional deficits (Rescorla, 1989; Thal et al., 2013). The shared criteria for identifying late talkers are based on expressive vocabulary measures assessed through parental questionnaires, such as the MacArthur-Bates Communicative Development Inventories (MB-CDI; Fenson et al., 2007) or the Language Development Survey (LDS; Rescorla, 1989). Specifically, an expressive vocabulary size at or below the 10th percentile (Bello et al., 2018; Desmarais et al., 2010; Sansavini, Zuccarini, et al., 2021; Suttora et al., 2020) or lower than 50 words and no word combinations by the age of 24–30 months were used to identify late talkers (Thal et al., 2013).

The prevalence of late talkers ranges from 9% to 21% in 24- to 36-month-old children (Collisson et al., 2016; Horwitz et al., 2003; Reilly et al., 2007; Sansavini, Zuccarini, et al., 2021; Zubrick et al., 2007). These rates decrease after age three, when several late talkers, labeled "late bloomers", catch up to their typically developing peers, achieving appropriate language skills (Chilosi et al., 2019; Dale et al., 2003). However, some late talkers, about 5–7% of the general population (Fisher, 2017), show persistent language difficulties in expressive vocabulary, syntax, phonology, and/or pragmatics (Dale & Hayiou-Thomas, 2013; Paul et al., 1993; Roos & Weismer, 2008). These children will likely be diagnosed with Developmental Language Disorder- DLD (Bishop et al., 2016; Sansavini, Favilla, et al., 2021). This diagnosis is frequently associated with cognitive and/or motor weaknesses (Finlay & McPhillips, 2013; Pauls & Archibald, 2016), and has long-lasting effects on academic achievements (Rescorla, 2011) and socio-emotional and behavioral functioning (Conti-Ramsden et al., 2013).

Language delays can be limited to expressive lexical skills or more widespread and associated with weaknesses in other communicative functions such as gesture production (Thal & Tobias, 1992), verbal imitation (Gathercole, 2006), lexical comprehension (Bello et al., 2018; Chilosi et al., 2019; Desmarais et al., 2008; 2010), morphosyntactic (Chilosi et al., 2019; Paul & Alforde, 1993; Rescorla et al., 2000), phonological (Carson et al., 2003; Chiat & Roy, 2007; Hodges et al., 2017; Mirak & Rescorla, 1998; Paul & Jennings, 1992), and pragmatic skills (Bello et al., 2018; Bonifacio et al., 2007). In addition, weaknesses in the cognitive domain, such as symbolic play (Rescorla & Goossens, 1992), and in the motor domain (Zubrick et al. 2007) often characterize late talkers.

Despite this variability, relatively little systematic research has investigated the specific linguistic and non-linguistic skills that can differentiate subgroups of late talkers (Desmarais et al., 2010) and predict later outcomes (Chilosi et al., 2019; Desmarais et al., 2008; 2010). Moreover, several studies have highlighted that multiple biological and environmental risk factors may be related to language delay (Collisson et al., 2016; Eade et al., 2022; Hawa & Spanoudis, 2014; Korpilahti et al., 2016; Sansavini, Zuccarini, et al., 2021; Zambrana et al., 2014; Zubrick et al., 2007), among these preterm birth, but how the latter together with other risk factors contribute to the variability among late talkers has rarely been investigated. The current study aims to fill these gaps in the literature.

1.1. Communicative, linguistic, cognitive, and motor skills in late talkers

Findings on the use of communicative gestures in late talkers are mixed. Thal and Tobias (1992) examined communicative gestures in ten late talkers followed up to 3 years of age, showing that late talkers who caught up, i.e., late bloomers, used significantly more communicative gestures than language-matched and age-matched controls between 18 and 28 months. By contrast, truly delayed late talkers, who did not catch up, did not differ in the number, type, or functions of communicative gestures from control groups. In addition, they had lower language comprehension than their age-matched controls at the first assessment suggesting an association between gesture production and language comprehension (Thal et al., 1991). Further evidence corroborating this association has been brought by a recent study conducted on twelve children with expressive language delay (ELD) and ten children with receptive-expressive language delay (R/ELD), aged 2–3 years (O'Neill & Chiat, 2015). This study showed that gesture use and symbolic comprehension in the R/ELD group was significantly poorer than that of the ELD group and was associated with receptive language, but not with expressive language.

A further communicative function related to vocabulary acquisition in the early stages of language acquisition (Gathercole, 2006) is verbal imitation. Researchers argued that this function is essential for phonological representation and vocabulary development (Gathercole, 2006). Indeed, late talkers showed poor performance in verbal imitation at 30 months of age (Bello et al., 2018; Sansavini, Zuccarini, et al., 2021). However, literature examining whether verbal imitation may be a reliable index of language difficulties needs to be expanded.

Concerning language functions, 10% to 60% of late talkers showed weaknesses in lexical and syntactic comprehension between 2 and 3 years of age, as assessed through direct measures or parental questionnaires (Bello et al., 2018; Chilosi et al., 2019; Desmarais et al., 2008; 2010; Sansavini, Zuccarini, et al., 2021). This evidence spurred research to investigate the role played by receptive skills in explaining the heterogeneity of late talkers (Bello et al., 2018; Dale et al., 2003; Desmarais et al., 2010). Findings on this issue were concordant in considering late talkers with comprehension difficulties at a higher risk for DLD, highlighting that weaknesses in receptive skills can be considered a reliable predictor of persistent language difficulties (Chilosi et al., 2019; Desmarais et al., 2008; 2010; Fisher, 2017; Thal et al., 2013).

Concerning expressive skills, several studies have found more than half of late talkers not combining words at 30 months of age (Bello et al., 2018; Chilosi et al., 2019; Paul et al., 1993; Rescorla et al., 2000; Rescorla & Dale, 2013; Sansavini, Zuccarini, et al., 2021). Difficulties in expressive grammar skills have been observed up to preschool age in children with persistent language delay, suggesting that this linguistic function can be considered a relevant marker in the third year of life of later linguistic outcomes (Bello et al., 2018; Chilosi et al., 2019; Paul et al., 1993).

Late talkers also showed delays in phonological development in terms of variety, complexity, and accuracy of the produced phonological structures, assessed through structured tasks, spontaneous language samples, and parental questionnaires (Bello et al., 2018; Carson et al., 2003; Chiat & Roy, 2007; Hodges et al., 2017; Paul & Jennings, 1992; Petinou & Spanoudis, 2014). These delays continued at preschool age (Neam et al., 2020). In addition, those late talkers showing a more restricted phonetic inventory at two years of age were at higher risk for persistent language delay at three years of age, pinpointing this skill as a predictor of later outcomes (Carson et al., 2003; Petinou & Spanoudis, 2014).

Finally, pragmatics has been investigated in late talkers with controversial evidence. Desmarais et al. (2010) found that late talkers with a more severe language delay were less engaged in communication at 29 months. Along these lines, some studies showed that late talkers displayed difficulties in responsive and assertive socio-conversational skills, as assessed through a parental questionnaire between two and three years of age (Bello et al., 2018; Bonifacio et al., 2007). Another study found that 24- to 30-month-old late talkers with good receptive skills, observed during a play session with their mothers, had difficulties initiating conversations but not responding to communicative acts (Rescorla & Merrin, 1998). Along these lines, also Vuksanovic (2015) found that late talkers, assessed at 26 months, made fewer initiations of social interaction behaviors with respect to a control group of typically developing children matched for language abilities, whereas the two groups did not differ in responding to social interaction behaviors. In addition, those late talkers who reported lower scores in language comprehension at 26 months initiated social interaction more frequently at the same age; the authors suggested that this association could be explained by the need of a partner's scaffolding to overcome communicative lack.

Besides communicative and language skills, abilities characterizing other developmental domains have been considered for explaining the heterogeneity of late talkers' profiles (Desmarais et al., 2010; Sansavini, Zuccarini, et al., 2021), as language is built upon some basic abilities, among them cognitive (Bates & Dick, 2001) and motor ones (Iverson, 2010).

Concerning cognitive skills, positive associations were found with more developed word comprehension (Bello et al., 2018; Desmarais et al., 2010), word production, and expressive lexical diversity, rate, and composition (Suttora et al., 2020). Research also revealed that late talkers having both receptive and expressive language delay often showed cognitive difficulties (Buschmann et al., 2008; Desmarais et al., 2010), and suggested that these children had a higher risk of persistent language delay at preschool age (Desmarais et al., 2008). In addition, Rescorla and Goossens (1992) showed that two-year-old children with expressive language delay had less advanced, rich, and varied symbolic play abilities assessed through specific pretend play tasks than their typically developing peers. A recent study also found that almost half of late talkers with expressive delay lacked symbolic play abilities at 29 months (Bello et al., 2018).

Concerning motor skills, late talkers may show weaknesses at 24 (Klee et al., 1998) and 30 months (Sansavini, Zuccarini, et al., 2021). Findings underscored that lower levels of motor performance, both in gross motor (Iverson & Braddock, 2011; Zubrick et al., 2007), and fine motor skills (Iverson & Braddock, 2011), as assessed through direct measures and parental questionnaires, could be predictive of later language delay (Zubrick et al., 2007), suggesting the relevance of including motor skills in the clinical assessment of late talkers.

1.2. Biological and environmental risk factors associated with language delay

As argued in several studies, multiple interrelated factors are involved in language delay, both intrinsic to the child and related to the environment (Desmarais et al., 2008; Sansavini, Favilla, et al., 2021, Sansavini, Zuccarini, et al., 2021). Concerning biological factors, male gender (Collisson et al., 2016; Reilly et al., 2007; 2010; Zubrick et al., 2007), being born preterm (Sansavini, Favilla, et al., 2021, Sansavini, Guarini, et al., 2010; Suttora et al., 2020; Zubrick et al., 2007), and having a family history of language problems (Collisson et al., 2016; Dale et al., 2003), are all considered risk factors of language delay. Zubrick et al. (2007) found that males were almost three times more at risk for language delay than females, and Reilly et al. (2010) revealed that the male gender predicted receptive and expressive outcomes at four years of age. Zubrick et al. (2007) also found that being born preterm, with gestational age at or below 32 weeks, or having less than 85% of the optimal birth weight expected for gestational age, almost doubled

the risk of being a late talker. Indeed, it has been found that one out of four very preterm children at 30 months of corrected age and one out of three very preterm children at 42 months of corrected age were at high risk for language impairment (Sansavini, Guarini, et al., 2010). However, when all children born preterm (i.e., all those born before 37 weeks of gestational age), including those at low-risk (i. e., being less immature and not having severe brain injuries and/or severe perinatal complications), were considered, findings were controversial. Some studies also found language difficulties in less immature 24-month-old preterm children (Charkaluk et al., 2019; Cheong et al., 2017), whereas another study did not in 30-month-old low-risk preterm children (Pérez-Pereira et al., 2014). Other studies highlighted that low-risk preterm birth status itself did not increase the risk for language impairment (Reilly et al., 2010; Sansavini, Zuccarini, et al., 2021), but more specific perinatal conditions did, like a low birth weight (Reilly et al., 2010) or a birth weight small for gestational age (Sansavini, Zuccarini, et al., 2021). Some studies also highlighted that a family history of language delay was a risk factor for language delay (Collisson et al., 2016; Dale et al., 2003; Zubrick et al., 2007), but other research did not find enough evidence for this factor (Fisher, 2017; Sansavini, Zuccarini, et al., 2021).

Based on the idea that the quality and quantity of language input a child receives impacts on language development (Hoff, 2003), some studies have investigated the environmental factors associated with language delay. Low parental education (Horwitz et al., 2003; Reilly et al., 2010; Sansavini, Zuccarini, et al., 2021), low socioeconomic status (Dicataldo & Roch, 2020; Horwitz et al., 2003; Save the Children, 2019), having parents not engaged in paid work (Sansavini, Zuccarini, et al., 2021) and not attending a daycare center (Hammer et al., 2017) negatively affected child language-learning experiences and increased the risk for language delay. In addition, Desmarais et al. (2010) found that lower maternal education level characterized children with impairment in language comprehension, expression, and engagement skills. However, other studies found mixed results, showing that these factors were not predictive of later language delay (Dale et al., 2003; Zubrick et al., 2007).

Interestingly, a recent study by Eadie et al. (2022) highlighted that the risk of poor language outcomes increased when multiple biological and environmental risk factors were present. In other words, accumulating and interacting risk factors increase the probability of developmental language difficulties.

1.3. Aims of the present study

Considering the evidence described above, the purpose of the current study was to identify distinct communication profiles among low-risk preterm and full-term late talkers screened at 30 months of age. To address this purpose, we first aimed to describe their communication profiles based on word comprehension and production indexes, as using both indexes together should more effectively highlight different late talkers' profiles. We also aimed to characterize these profiles on several communicative and linguistic (i.e.,

Table 1
Biological, clinical and sociodemographic characteristics of all late talkers and comparisons across late talkers' profiles (severe, moderate, and mild).

Participants' Characteristics	All Late Talkers (n = 68)		1. Severe Late (n = 17)		2. Moderate Late (n = 24)		3. Mild Late (n = 27)		test	p	Post-hoc
	M/n	SD/%	M/n	SD/%	M/n	SD/%	M/n	SD/%			
Preterm birth, n,%	33	48.5	5	29.4	13	54.2	15	55.6	3.33	.190§	
Gestational age (weeks), M, SD	36.71	3.31	37.7	3.4	36.2	3.2	36.5	3.3	1.09	.343*	
Birthweight (grams), M, SD	2638	859	2945	909	2471	776	2591	876	1.61	.208*	
Gender (male), n,%	46	67.6	16	94.1	13	54.2	17	63.0	7.71	**.021**§	1+
Firstborn, n,%	33	48.5	9	52.9	13	54.2	11	40.7	1.09	.579§	
Twins, n,%	19	27.9	2	11.8	9	37.5	8	29.6		.206ˆ	
Type of delivery (cesarean), n,%	37	54.4	7	41.2	13	54.2	17	63.0	2.00	.368§	
Length of stay in hospital (days), M, SD	12.87	25.36	13.5	23.7	16.5	35.9	9.3	12.0	0.61	.737˘	
Otitis media > 4 episodes/year, n,%	3	4.4	2	11.8	0	0	1	3.7		.251ˆ	
Family history of language/learning disorders, n,%	11	16.2	3	17.6	4	16.7	4	14.8		1.000ˆ	
Daycare attendance, n,%	48	70.6	12	70.6	13	54.2	23	85.2	5.9	.053§	
Exposure to another language, n,%	9	13.2	3	17.6	2	8.3	4	14.8		.735˘	
Mother's age [a] (years), M, SD	38.13	5.50	36.6	7.1	37.5	5.4	39.6	4.2	1.8	.178*	
Father's age [b] (years), M, SD	40.08	6.07	38.8	7.5	40.1	6.0	40.9	5.2	0.5	.591*	
Parental educational level									4.47	.360§	
Low (both parents ≤13 y), n,%	21	30.9	4	23.5	9	37.5	8	29.6			
Middle (one parent >13 y), n,%	24	35.3	4	23.5	8	33.3	12	44.4			
High (both parents >13 y), n,%	23	33.8	9	52.9	7	29.2	7	25.9			
Mother's Nationality (Italian), n,%	61	89.7	15	88.2	22	91.7	24	88.9		1.000˘	
Father's Nationality (Italian), n,%	60	88.2	16	94.1	22	91.7	22	81.5		.441˘	
Mothers not engaged in paid work, n,%	22	32.4	6	35.3	10	41.7	6	22.2	2.3	.319§	
Fathers not engaged in paid work, n,%	0	0	0	0	0	0	0	0	–	–	

Note. Tests used were: Chi-square test (§); Fisher's exact test (ˆ), ANOVA (*) or Kruskal-Wallis test (˘). Significant results in bold. Post-hoc comparisons were made by analysis of adjusted residuals. Post-hoc analyses notation: + Adjusted residuals > 2: the variable had a significantly higher than expected frequency in the reported class(es); ˘ Adjusted residuals < −2: the variable had a significantly lower than expected frequency in the reported class(es).
Data was missing for: [a]1 participant: 1 Severe Late; [b]7 participants: 2 Severe Late, 2 Moderate Late, 3 Mild Late.

lexicon, grammar, phonological accuracy, and pragmatics), cognitive and motor skills, as well as on biological and environmental characteristics.

2. Methods

2.1. Participants

The sample included 68 late talkers identified through a language screening (see the Procedure paragraph for details). All children were born between May 2015 and August 2018. The language screening targeted low-risk preterm children born before 37 weeks of gestational age at the Sant'Orsola-Malpighi Hospital of the University of Bologna, and living in the metropolitan area of Bologna, capital of the Emilia-Romagna region in Northern Italy, and a group of full-term children born at the same hospital or in the same geographical area, with similar socio-demographic characteristics. Late talkers were included in the study according to the following criteria: a. being monolingual or mainly exposed to the Italian language from birth onward (i.e., weekly exposure to Italian > 65%; see Onofrio et al., 2012); b. not having any severe neurological impairment (i.e., periventricular leukomalacia, intraventricular hemorrhage> Grade II, hydrocephalus) and/or congenital malformations, sensory (i.e., retinopathy of prematurity > Grade II, blindness, mono- or bilateral hearing loss), or motor impairments, or severe cognitive deficits (i.e., a cognitive score < 70). According to the latter criterion, all preterm children were at low risk.

Biological, clinical, and sociodemographic data (i.e., gestational age, birth weight, gender, birth order, multiple birth, type of delivery, length of hospital stay, and perinatal complications—being small for gestational age, respiratory distress syndrome, mechanical ventilation, apnea, bronchopulmonary dysplasia, intraventricular hemorrhage, sepsis, retinopathy of prematurity) of the low-risk preterm and full-term children participating in the study were obtained from clinical records. Information concerning the children's health and environmental experiences (i.e., recurrent otitis media, family history of language and/or learning disorders, exposure to languages other than Italian, and daycare attendance) and parents' sociodemographic characteristics (i.e., age, nationality, educational level [≤ 13 years, i.e., having at most a high school diploma, or > 13 years, i.e., having a 3-year or higher university degree]) were collected with a parental questionnaire.

As shown in Table 1, reporting participants' biological, clinical, and sociodemographic characteristics, 33 out of 68 participants (48.5%) were low-risk preterm infants, and the other 35 (51.5%) were born full-term. Forty-six children (67.6%) were assigned males, and the other 22 (32.4%) were assigned females at birth. Thirty-three children (48.5%) were first born and 19 (27.9%) were twins. Few children had medical complications, a family history of language delay, or were exposed to other languages beyond Italian. About two-thirds of the children (70.6%) attended a daycare center. Mothers' mean age was of 38.13 years (*SD*= 5.50) and fathers' mean age of 40.08 years (*SD*= 6.07). Parental level of education was low (≤13 years for both parents) for one-third (30.9%), middle (≤13 years for one parent and >13 years for the other parent) for another third (35.3%), and high (>13 years for both parents) for another third (33.8%) of the sample. The majority of mothers (89.7%) and fathers (88.2%) were Italian; about one-third of the mothers (32.4%) were not engaged in paid work, whereas all fathers were employed in paid work.

As shown in the Supplementary materials (see Table S1), low-risk preterm late talkers did not differ from full-term late talkers for most biological, clinical, and socio-demographic characteristics, except for those characteristics which are strongly linked to prematurity, such as lower gestational age and birth weight, a higher rate of twin birth and cesarian delivery, longer hospitalization, and a higher incidence of respiratory distress. Furthermore, among low-risk preterm late talkers, a higher percentage of mothers was not engaged in paid work.

The study met ethical guidelines for human subject protections, including adherence to the legal requirements of Italy, and received formal approval from the Bologna Health Authority's Independent Ethics Committee (protocol numbers: EM 194–2017_76/2013/U/Sper/AOUBo, EM 193–2018_76/2013/U/Sper/AOUBo, EM1229–2020_76/2013/U/Sper/AOUBo). All parents gave informed written consent for study participation, data analysis, and data publication.

2.2. Procedure

All children were targeted as late talkers if they showed an expressive vocabulary size at or below the 10th percentile at 30 months of age (*M* = 30.35; *SD* = 0.97). We assessed the expressive vocabulary size through the Italian version of the MacArthur Bates Communicative Development Inventories (MB-CDI), Words and Sentences (WS) Short-Form (Caselli et al., 2015) filled out online by parents. We also assessed gestures, verbal imitation, symbolic play, sentence production, and phonological accuracy with the MB-CDI WS Short-Form. At the same age, parents filled out online the Italian version of the MB-CDI, Gestures and Words (GW) Short-Form (Caselli et al., 2015) for assessing the receptive vocabulary size. MB-CDI questionnaires are valid and reliable tools, that have been used for screening programs on preterm and full-term late talkers in several languages (e.g., Bello et al., 2018; Desmarais et al., 2010; Reilly et al., 2010; Sansavini, Zuccarini, et al., 2021).

Once identified by the use of the MB-CDI WS Short-Form, late talkers were invited with their parents at the Developmental Psychology Lab, Department of Psychology "Renzo Canestrari", University of Bologna, to assess lexical (nouns and predicates) comprehension and production skills with the Picture Naming Game test (PiNG; Bello et al., 2012), pragmatic skills (i.e., responsiveness and assertiveness) with the Italian version of the Socio Conversational Skills Rating Scales (ASBC; Bonifacio et al., 2013), language, cognitive, and motor skills (language, cognitive, and motor composite scores) through the Italian version of the Bayley Scales of Infant and Toddler Development, Third Edition (BSID-III, Bayley, 2006; Ferri et al., 2015). At this assessment, late talkers were around 31 months of age (*M* = 31.19; *SD* = 1.30). Corrected age for preterm children at the screening and the assessment was used to consider

their neurobiological immaturity, as done in previous studies on preterm children (Sansavini et al., 2011; Sansavini, Zuccarini, et al., 2021; Suttora et al., 2020). Therefore, at the time of the direct assessment, low-risk preterm children had a mean corrected age of 31.38 months (*SD* = 1.24) and a mean chronological age of 32.88 months (*SD* = 1.38). The difference between low-risk preterm children's corrected age and full-term children's chronological age was not significant at the direct assessment, *t*(66) = - 1.164, *p* = 0.249.

2.3. Tools

2.3.1. Assessment of communicative skills

Communicative skills were assessed through the Italian version of the MB-CDI WS Short Form (Caselli et al., 2015). Specifically, we considered questions concerning the use of declarative pointing ("Does he/she point to a picture or an object whom he/she pays attention to name it?") and verbal imitation ("Does he/she repeat words just pronounced by the adult?"). For each question, parents were asked to indicate the frequency of these abilities (i.e., absence, sometimes present, often present).

2.3.2. Assessment of language skills

2.3.2.1. Lexical skills.
We assessed receptive vocabulary size through the Italian version of the MB-CDI GW Short Form (Caselli et al., 2015) for children aged 8–24 months or older if having an expressive language delay. Parents were asked to check the words understood by their child within a list of 100 words. We assigned a score of 1 for each item checked. The receptive vocabulary size was calculated by summing up all checked items. As the manual guidelines explain, this tool allows measuring the receptive vocabulary size as a predictive index for identifying children with later language disorders. Even if it is not possible to compare the measurements obtained after 24 months of age with age-appropriated normative data, it is possible to compare the obtained receptive vocabulary size with the corresponding normative percentile values available up to 24 months of age (Caselli et al. 2015). In addition, we assessed the presence of decontextualized comprehension, through a question ("Does he/she understand when you speak about past and future events?") of the Italian version of the MB-CDI WS Short Form (Caselli et al., 2015). Parents were asked to indicate the frequency of this ability (i.e., absence, sometimes present, often present).

The expressive vocabulary size was assessed using the MB-CDI WS Short Form (Caselli et al., 2015). Parents were asked to check the words spontaneously produced by their child among a list of 100 words. A score of 1 was assigned for each item checked. The expressive vocabulary size was calculated by summing up all checked items. In addition, according to the normative values concerning the expressive vocabulary size at 30 months (Caselli et al., 2015), we further distinguished children with an expressive vocabulary size ≤ 5th percentile (≤ 29 words produced) or comprised between the 6th and the 10th percentile (30 to ≤ 40 words produced).

We also assessed lexicon through the PiNG, a standardized test evaluating noun and predicate comprehension and production in children aged 19–37 months (Bello et al., 2012). It includes four subtests (each consisting of 20 items), respectively assessing noun and predicate comprehension and production. The two subtests assessing noun comprehension and production refer to objects and tools; the two subtests assessing predicate comprehension and production refer to actions (verbs) and qualities (adjectives and locative adverbs). We assessed noun and predicate comprehension by asking the child to identify the picture representing the word pronounced by the experimenter. Three stimuli for each target were proposed (i.e., lexical target, semantically related distractor, and semantically unrelated distractor). To assess noun and predicate production, children were asked to name the picture shown by the experimenter. One point was assigned to each correct response given by the children. We summed up the correct responses in the noun and predicate comprehension subtests and the noun and predicate production subtests to obtain noun and predicate comprehension and production scores respectively.

2.3.2.2. Grammar skills.
We assessed grammar skills through the MB-CDI WS Short Form (Caselli et al., 2015). Parents were asked to indicate whether their child had already begun to combine words. If their answer was "no", the absence of word combination was scored. If their answer was "sometimes" or "yes", they were required to indicate, among 12 pairs of sentences that could be incomplete or complete with function words, which sentence for each pair best reflected how their child talked. We defined sentence production by computing the total number of sentences checked.

2.3.2.3. Phonological accuracy.
Phonological accuracy was assessed using an item of the MB-CDI WS Short Form (Caselli et al., 2015). Parents were asked to indicate the intelligibility of words pronounced by their child ("How is the speech of the child?"). Three response options are given: "He/she speaks adult-like", corresponding to complete phonological accuracy (e.g., the child uses the word "banana"), "He/she produces simplified words" (e.g., the child uses the word "nana" for "banana"), corresponding to partial phonological accuracy, or "His/her words are understood only by caregivers", corresponding to the absence of phonological accuracy (e.g., the child uses the word "dede" for "banana").

2.3.2.4. Pragmatic skills.
The ASBC is a standardized parent-administered questionnaire (Bonifacio et al., 2013) assessing pragmatic skills of children aged 12–36 months in everyday conversational exchanges. It is a useful tool for assessing child's pragmatic skills and suggesting goals for intervention (Bello et al., 2018; Bonifacio et al., 2007). It includes two scales assessing children's responsiveness, i. e., the ability to answer questions (10 items), and assertiveness, i.e., the ability to initiate conversations and generate questions (15 items). Parents were required to report the frequency of their child's responsive and assertive behaviors using a five-point scale ranging from never (score = 1) to always (score = 5). We computed the mean scores of the responsiveness and assertiveness scales by dividing

the total score of each scale by its number of items. As normative values are available at 3-month-intervals from 12 to 36 months, we referred to those at 30 months. According to the test, both for responsiveness and assertiveness, scores ≤ 2.9 correspond to absent/infrequent skills, scores comprised between 3.0 and 3.9 correspond to emerging/less developed skills, and scores ≥ 4.0 correspond to well-developed skills (Bonifacio et al., 2013).

2.3.2.5. Language score. We calculated a language composite score using the language scale of the BSID-III (Bayley, 2006), a standardized test for assessing cognitive, motor, and language development in children between one and 42 months of age. The BSID-III is a valid and reliable tool in both research and clinical practice that has been used in previous studies on full-term and preterm late talkers (Bello et al., 2018; Suttora et al., 2020; Zuccarini et al., 2020). In particular, the language scale assesses receptive, i.e., preverbal and verbal comprehension, receptive vocabulary, and expressive skills, i.e., preverbal communication and expressive vocabulary. The BSID-III provides standardized composite scores with a mean of 100 and a *SD* of 15. According to the BSID-III, children's levels of language skills are classified as average (mean composite score 90–109), low average (mean composite score 80–89), borderline (mean composite score 70–79), and delayed (mean composite score < 70).

2.3.3. Assessment of cognitive and motor skills

For assessing cognitive skills, we administered the cognitive scales of the BSID-III (Bayley, 2006), that examines sensorimotor development, exploration and manipulation, memory, and cognitive processing. In addition, we assessed symbolic play, by employing the question concerning the use of this ability ("Does he/she use an object pretending to be another object with a different function"), reported in the Italian version of the MB-CDI WS Short Form (Caselli et al., 2015). Parents were asked to indicate the frequency of this ability (i.e., absence, sometimes present, often present).

For assessing motor skills, we administered the motor scales of the BSID-III (Bayley, 2006), that examines both fine motor skills, i.e., visual tracking, reaching, grasping, object manipulation, and functional hand skills, and gross-motor skills, i.e., static positioning such as sitting and standing, and dynamic movements, such as locomotor and coordination skills, balance and motor planning. The BSID-III provides standardized composite scores with a mean of 100 and a *SD* of 15. According to the BSID-III, children's levels of cognitive and motor skills are classified as average (mean composite score 90–109), low average (mean composite score 80–89), borderline (mean composite score 70–79), and delayed (mean composite score < 70).

2.4. Statistical analyses

Participants' characteristics were summarized using mean and standard deviation for continuous variables, and absolute frequency and percentage for categorical variables.

We conducted a two-step cluster analysis to identify homogeneous subgroups of late talkers according to their receptive and expressive vocabulary size measured respectively with the MB-CDI GW and WS Short Forms (Caselli et al., 2015), using the Bayesian information criterion (BIC) to detect the optimal number of clusters (Bacher et al., 2004; Chiu et al., 2001).

After choosing the best-fitting solution, each participant was assigned to the most likely cluster. To examine differences across the clusters, participants' biological, clinical, and sociodemographic characteristics as well as communicative, linguistic, cognitive, and motor skills, were compared using chi-square test or Fisher's exact test with post hoc analyses (adjusted standardized residuals > |2| indicating a significant difference) and ANOVA or Kruskal-Wallis test with post-hoc analyses, with Šidák p-value correction for multiple comparisons. All analyses were performed with IBM SPSS Statistics for Windows, Version 27.0. Statistical significance was set at $\alpha = 0.05$.

3. Results

The whole sample of all late talkers (see Table 2) had a mean receptive vocabulary size at the MB-CDI GW corresponding to about the 50th percentile for 22-month-old children's receptive vocabulary size (Caselli et al., 2015) and a mean expressive vocabulary size at the MB-CDI WS lower than the 50th percentile for 18-month-old children's expressive vocabulary size (Caselli et al., 2015). Wide heterogeneity was also observed within the whole sample for most of the abilities investigated in the current study. The two-step cluster analysis performed on the whole sample generated three distinct clusters based on the lowest Bayesian information criterion index (see Supplementary materials, Table S2). We considered this an optimal solution as it was consistent with evidence that emerged in a previous study (Desmarais et al., 2010) and readily understandable from a clinical point of view.

Table 2

Mean (M) and standard deviation (SD) of MB-CDI receptive and expressive vocabulary size of all late talkers and across late talkers' profiles (severe, moderate, and mild).

MB-CDI Measures	All Late Talkers (*n* = 68)		1. Severe Late (*n* = 17)		2. Moderate Late (*n* = 24)		3. Mild Late (*n* = 27)	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Receptive vocabulary size (GW)	87.59	15.89	65.12	15.28	95.54	4.46	94.67	6.99
Expressive vocabulary size (WS)	18.94	13.03	8.00	5.81	10.79	6.79	33.07	5.36

Note. MB-CDI= MacArthur Bates Communicative Development Inventories- Short Form. GW= Gestures and Words. WS= Words and Sentences.

As displayed in Fig. 1 and Table 2, late talkers assigned to Cluster 1 ($n = 17$; 25%), which we defined as *severe* late talkers, reported the lowest receptive vocabulary size, corresponding to about the 50th percentile for 16–17-month-old children's receptive vocabulary size (Caselli et al., 2015), and a very limited expressive vocabulary size, lower than the 50th percentile for 18-month-old children's expressive vocabulary size (Caselli et al., 2015).

Late talkers assigned to Cluster 2 ($n = 24$; 35.3%), which we defined as *moderate* late talkers, had a less delayed receptive vocabulary size, corresponding to about the 50th percentile for 23–24-month-old children's receptive vocabulary size (Caselli et al., 2015), but a still very limited expressive vocabulary size, corresponding to about the 50th percentile for 18-month-old children's expressive vocabulary size (Caselli et al., 2015).

Finally, late talkers assigned to Cluster 3 ($n = 27$; 39.7%), which we defined *mild* late talkers, reported a less delayed receptive vocabulary size, corresponding to about the 50th percentile for 23–24-month-old children's receptive vocabulary size (Caselli et al., 2015), similarly to that of *moderate* late talkers, but an only partially limited expressive vocabulary size, corresponding to about the 50th percentile for 22-month-old children's expressive vocabulary size (Caselli et al., 2015).
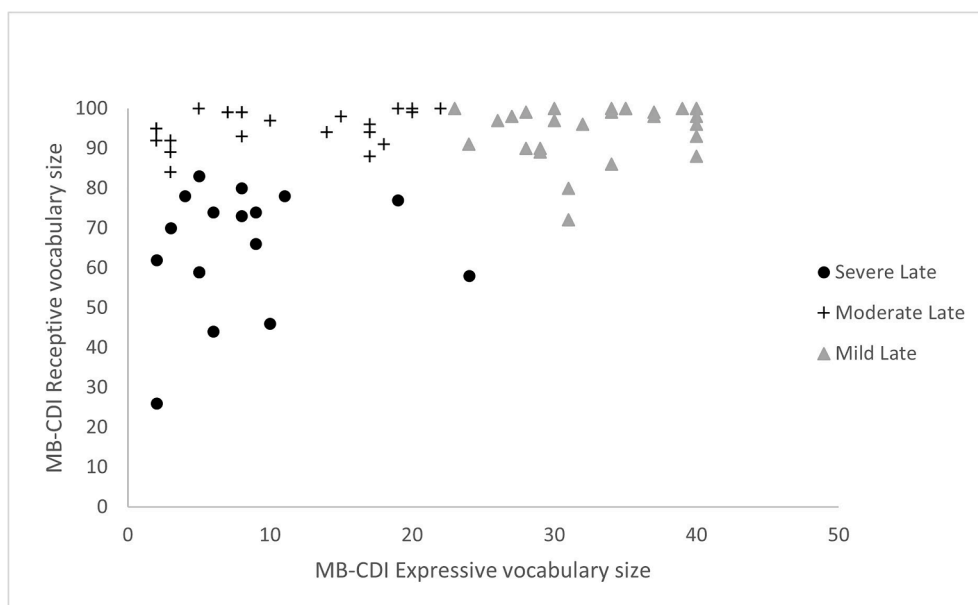
3.1. Late talkers' profiles

3.1.1. Communicative skills

Concerning communicative skills, assessed with the MB-CDI WS (see Table 3), looking at the whole sample, declarative pointing was shown by all late talkers, with about 80% of them showing it often, rather similarly to the normative data (about 90% of 30-month-old children; Caselli et al., 2015). Significant differences in the frequency of pointing use emerged among the three profiles (see Table 3). Compared to the expected frequencies, the percentage of children often showing declarative pointing was significantly lower in the *severe* late profile and higher in the *moderate* late profile. By contrast, the percentage of children sometimes showing declarative pointing was higher in the *severe* late talkers and lower in the *moderate* late talkers.

Concerning verbal imitation (see Table 3), looking at the whole sample, about 80% of late talkers presented with this ability, but only about 40% of them often displayed it, differently from the normative data, reporting more than 80% of 30-month-old children often displaying verbal imitation (Caselli et al., 2015). Significant differences in the frequency of verbal imitation emerged among the three profiles (see Table 3). In particular, compared to the expected frequencies, the percentage of children not showing verbal imitation was higher in the *severe* late talkers and lower in the *mild* late talkers; the percentage of children sometimes showing verbal imitation was higher in the *moderate* late talkers; the percentage of children often showing verbal imitation was lower in the *moderate* late talkers and higher in the *mild* late talkers.

3.1.2. Linguistic skills

3.1.2.1. Lexical skills. Concerning decontextualized comprehension, assessed with the MB-CDI WS (see Table 4), looking at the whole sample, about 80% of late talkers showed this ability, but only about 50% of them often showed it, differently from the normative data, reporting more than 80% of 30-month-old children often displaying decontextualized comprehension (Caselli et al., 2015). No

Fig. 1. Receptive (MB-CDI Gestures and Words Short Form) and Expressive (MB-CDI Words and Sentences Short Form) Vocabulary Size according to Late Talker Profile Assignment (Severe, Moderate, Mild).

Table 3

Communicative skills of all late talkers and comparisons across late talkers' profiles (severe, moderate, and mild).

MB-CDI WS Measures	All Late Talkers (n = 68)		1. Severe Late (n = 17)		2. Moderate Late (n = 24)		3. Mild Late (n = 27)		Fisher's exact p	Post-hoc
	n	%	n	%	n	%	n	%		
Declarative pointing									**.031**	
Absent	0	0	0	0	0	0	0	0		
Sometimes	13	19.1	6	35.3	1	4.2	6	22.2		$1^+, 2^-$
Often	55	80.9	11	64.7	23	95.8	21	77.8		$1^-, 2^+$
Verbal imitation									**<.001**	
Absent	14	20.6	9	52.9	5	20.8	0	0		$1^+, 3^-$
Sometimes	27	39.7	4	23.5	14	58.3	9	33.3		2^+
Often	27	39.7	4	23.5	5	20.8	18	66.7		$2^-, 3^+$

Note. MB-CDI= MacArthur Bates Communicative Development Inventories- Short Form. WS= Words and Sentences.
The Fisher's exact test was used, as at least one expected value was < 5. Significant results are in bold.
Post-hoc analyses notation: $^+$ Adjusted residuals > 2: the variable had a significantly higher than expected frequency in the reported class(es); $^-$ < −2 Adjusted residuals: the variable had a significantly lower than expected frequency in the reported class(es).

Table 4

Linguistic skills of all late talkers and comparisons across late talkers' profiles (severe, moderate, and mild).

Measures	All Late Talkers (n = 68)		1. Severe Late (n = 17)		2. Moderate Late (n = 24)		3. Mild Late (n = 27)		test	p	Post-hoc
	M/n	SD/%	M/n	SD/%	M/n	SD/%	M/n	SD/%			
Lexical skills											
Decontextualized comprehension[A], n,%										.323^	
Absent	13	19.1	6	35.3	4	16.7	3	11.1			
Sometimes	21	30.9	5	29.4	6	25.0	10	37.0			
Often	34	50.0	6	35.3	14	58.3	14	51.9			
Noun comprehension[B a], M, SD	15.83	3.39	14.81	4.26	15.96	3.15	16.33	2.99	1.0	.361*	
Predicate comprehension[B b], M, SD	12.16	4.69	9.71	5.74	12.35	4.35	13.26	4.04	2.8	.068*	
Expressive vocabulary size[A], n,%										**<.001**^	
≤ 5th	50	73.5	17	100	24	100	9	33.3			$1^+, 2^+, 3^-$
≥ 6th to ≤ 10th	18	26.5	0	0	0	0	18	66.7			$1^-, 2^-, 3^+$
Noun production[B c], M, SD	3.81	3.73	1.53	2.23	1.86	2.23	6.77	3.46	24.6	**<.001***	1, 2<3
Predicate production[B d], M, SD	1.97	3.56	.83	1.53	.45	1.33	3.77	4.62	11.2	**.004**°	1, 2<3
Grammar skills											
Absence of word combination[A], n,%	32	47.1	11	64.7	19	79.2	2	7.4	29.10	**<.001**§	$2^+, 3^-$
Sentence production[A], n,%	2.98	4.09	.71	1.10	.54	1.25	6.59	4.31	33.3	**<.001**°	1, 2<3
Phonological Accuracy[A], n,%										.189^	
Absent	47	69.1	15	88.2	15	62.5	17	63.0			
Partial	20	29.4	2	11.8	9	37.5	9	33.3			
Complete	1	1.5	0	0	0	0	1	3.7			
Pragmatic skills											
Responsiveness[C e], M, SD	3.63	.77	3.21	.80	3.59	.87	3.90	.56	3.9	**.025***	1<3
Assertiveness[C e], M, SD	3.62	.62	3.26	.70	3.56	.62	3.88	.45	5.2	**.009***	1<3
Language composite score[D f], M, SD	80.32	10.23	73.92	12.23	79.08	7.94	84.26	9.71	5.1	**.009***	1<3

Note. [A]MB-CDI WS= MacArthur Bates Communicative Development Inventories Words and Sentences Short Form. [B]PiNG= Picture Naming Game. [C]ASCB= Socio Conversational Skills Rating Scales. [D]BSID-III= Bayley Scales of Infant and Toddler Development. Results of Chi-square test (§) or Fisher's exact test (^), when at least one expected value was < 5. Post-hoc analyses notation: $^+$ Adjusted residuals > 2: the variable had a significantly higher than expected frequency in the reported class(es); $^-$ Adjusted residuals < −2: the variable had a significantly lower than expected frequency in the reported class(es). Results of ANOVA (*) or Kruskal-Wallis tests (°) with Šidák post-hoc analyses are reported. Significant results in bold.
Data were missing for: [a]2 participants: 1 Severe Late and 1 Moderate Late; [b]4 participants: 3 Severe Late and 1 Moderate Late; [c]5 participants: 2 Severe Late, 2 Moderate Late, 1 Mild Late; [d]8 participants: 5 Severe Late, 2 Moderate Late, 1 Mild Late; [e]10 participants: 3 Severe Late, 4 Moderate Late, 3 Mild Late; [f]5 participants: 5 Severe Late.

significant differences in the frequency of decontextualized comprehension emerged among the three profiles (see Table 4).

As for noun and predicate comprehension, assessed with the PiNG test (see Table 4), looking at the whole sample, mean late talkers' scores were below the 10th percentile compared to the 31-month-old normative sample, in which the number of correct responses, corresponding to the 10th percentile, are 16 for nouns and 13 for predicates for both males and females (Bello et al., 2010). No significant differences were found among the three profiles.

Concerning the expressive vocabulary size, assessed with the MB-CDI WS (see Table 4), about two third of late talkers displayed an expressive vocabulary size ≤ 5th percentile, compared to the 30-month-old children's normative data (Caselli et al., 2015). Significant differences emerged among the three profiles. Compared to the expected frequency, the percentage of children showing an expressive vocabulary size ≤ 5th percentile was higher in the *severe* and *moderate* late talkers, all of them having an expressive vocabulary size ≤ 5th percentile, and lower (33.3%) in the *mild* late talkers, whereas the percentage of children showing an expressive vocabulary size comprised between the 6th and the 10th percentile was lower in the *severe* and *moderate* late talkers and higher (66.7%) in the *mild* late talkers.

As regards noun and predicate production, assessed with the PiNG test (see Table 4), late talkers' mean scores in the whole sample were below the 10th percentile (i.e., 9 and 10, respectively for males' and females' nouns, and 7, for both males' and females' predicates) compared to the normative sample at 31 months (Bello et al., 2010). All late talkers reported scores below the 10th percentile, but with significant differences among the three profiles as the *severe* and *moderate* late talkers had significantly lower noun and predicate production scores compared to the *mild* late talkers (see Table 4).

3.1.2.2. Grammar skills. Concerning word combination, assessed with the MB-CDI WS (see Table 4), looking at the whole sample, 47% of late talkers lacked it, differently from the normative data, showing that only 3% of 30-month-old children does not display word combination (Caselli et al., 2015). Significant differences in the absence of word combination emerged among the three profiles (see Table 4). Compared to the expected frequency, the percentage of children lacking word combinations was significantly higher in the *moderate* late talkers and lower in the *mild* late talkers.

As regards sentence production, assessed with the MB-CDI WS (see Table 4), late talkers' mean scores in the whole sample were extremely low compared to the 30-month-old normative sample, which has a mean score of 10 (83%) out of the 12 sentences (Caselli et al., 2015). A significant difference among the three profiles was found with *severe* late and *moderate* late talkers showing a lower production of sentences than *mild* late talkers (see Table 4).

3.1.2.3. Phonological accuracy. Concerning phonological accuracy, assessed with the MB-CDI WS (see Table 4), looking at the whole sample, about two-thirds of late talkers lacked it, whereas the other third had partial phonological accuracy, except for one child having complete phonological accuracy. Late talkers' phonological accuracy was much different from the 30-month-old normative sample, in which only 20% of the children lacked it, 40% had partial phonological accuracy and another 40% had complete phonological accuracy (Caselli et al., 2015). No significant differences in phonological accuracy emerged among the three profiles (see Table 4).

3.1.2.4. Pragmatic skills. Concerning pragmatic skills, assessed with the ASCB questionnaire (see Table 4), looking at the whole sample, the mean responsiveness score was -2 *SD* and the mean assertiveness -1.5 *SD* compared to the mean scores of the 30-month-old normative sample (Bonifacio et al., 2013; responsiveness: $M = 4.4$, $SD = 0.4$; assertiveness: $M = 4.2$, $SD = 0.4$). The comparison among the three profiles on these skills revealed that the *severe* late talkers had lower responsiveness and assertiveness scores than the *mild* late talkers.

3.1.2.5. Language score. Regarding the language composite score, assessed with the BSID-III (see Table 4), the late talkers' mean score in the whole sample was in the low average range corresponding to -1.3 *SD* compared to the mean score of the normative data (Ferri et al., 2015). The *severe* and *moderate* late talkers had a borderline mean language composite score, whereas the *mild* late talkers reported a low average mean language composite score. The comparison among the three profiles showed a significant difference, with the *severe* late talkers having a significantly lower mean language composite score than the *mild* late talkers.

Table 5
Cognitive and motor skills of all late talkers and comparisons across late talkers' profiles (severe, moderate, and mild).

Measures	All Late Talkers ($n = 68$)		1. Severe Late ($n = 17$)		2. Moderate Late ($n = 24$)		3. Mild Late ($n = 27$)		test	p	Post-hoc
	M/n	SD/%	M/n	SD/%	M/n	SD/%	M/n	SD/%			
Cognitive skills											
Cognitive composite score[A], *M, SD*	88.16	9.26	83.23	6.83	86.46	8.91	92.78	9.02	7.3	**.001***	**1, 2 <3**
Symbolic play[B], *n,%*										.149ˆ	
Absent	9	13.2	5	29.4	1	4.2	3	11.1			
Sometimes	35	51.5	9	52.9	12	50.0	14	51.9			
Often	24	35.3	3	17.6	11	45.8	10	37.0			
Motor Skills											
Motor composite score[A] [a], *M, SD*	82.85	11.38	77.77	11.50	82.22	12.54	86.08	9.40	2.4	.095*	

Note. [A]BSID-III= Bayley Scales of Infant and Toddler Development. [B]MB-CDI= MacArthur Bates Communicative Development Inventories- Short Form. WS= Words and Sentences. Results of Fisher's exact test (ˆ), when at least one expected value was < 5. Results of ANOVA (*) with Šidák post-hoc analyses are reported. Significant results in bold.
Data were missing for: [a]7 participants: 4 Severe Late, 1 Moderate Late, 2 Mild Late.

3.1.3. Cognitive and motor skills

Regarding cognitive skills, assessed with the BSID-III (see Table 5), late talkers' mean cognitive composite score in the whole sample was within 1 *SD* below the mean compared to the normative data (Ferri et al., 2015). The *severe* and *moderate* late talkers reported low average mean cognitive composite scores, whereas the *mild* late talkers had an average mean cognitive composite score. The comparison among the three profiles showed lower mean cognitive composite scores in *severe* and *moderate* late talkers compared to *mild* late talkers.

Regarding symbolic play, assessed with the MB-CDI WS (see Table 5), looking at the whole sample, only one-third of all late talkers often showed it, differently from the normative data, reporting that 52% of 30-month-old children often show symbolic play (Caselli et al., 2015). Although no significant differences in symbolic play emerged among the three profiles, it is noteworthy that about one-third of the severe late talkers did not display symbolic play at 30 months (see Table 5).

Regarding motor skills, assessed with the BSID-III (see Table 5), late talkers' mean motor composite score in the whole sample fell in the low average range below -1 *SD* compared to the mean score of the normative data (Ferri et al., 2015). The *severe* late talkers exhibited a borderline mean motor composite score, whereas the *moderate* and *mild* late talkers reported low average mean motor composite scores. No significant differences were found among the three profiles.

3.1.4. Biological, clinical, and socio-demographic characteristics

The comparison among the three profiles on participants' biological, clinical, and sociodemographic characteristics (see Table 1) revealed that the percentage of males in the *severe* late talkers was significantly higher than the expected frequency in this cluster. The three profiles did not differ significantly for the other biological, clinical, and sociodemographic characteristics (see Table 1).

4. Discussion

This study identified three distinct language profiles, i.e., *severe, moderate*, and *mild* late talkers, in a sample of 30-month-old late talkers bringing a new contribution to the existing literature. Late talkers differing in their birth condition (either low-risk preterm or full-term) were examined. A cluster analysis based on receptive and expressive vocabulary size was employed to identify distinct language profiles. Each profile was further investigated by considering a set of communicative, linguistic, cognitive, and motor variables, measured through direct child assessment and parental questionnaires, as well as participants' biological and environmental characteristics.

4.1. Communication profiles of low-risk preterm and full-term late talkers

Severe late talkers (25%) showed less frequent use of pointing, limited verbal imitation, receptive vocabulary size, lexical and sentence production, responsiveness and assertiveness, and lower cognitive scores than *mild* late talkers (40%). *Moderate* late talkers (35%) showed less frequent verbal imitation, limited lexical and sentence production, and lower cognitive scores than *mild* late talkers. Communicative and linguistic skills across the three profiles fell mostly below the normative values.

Our findings highlighted the existence of a wide heterogeneity among late talkers by assessing several linguistic skills beyond expressive vocabulary size, bringing new evidence to the findings by Desmarais et al. (2010). These authors identified three profiles in a sample of late talkers, born full-term, with a mean age of 29 months: a first profile (10%) impaired in language comprehension, expression, and communicative engagement, a second profile (26%) impaired in language expression and communicative engagement, a third profile (64%) less compromised in linguistic and communicative skills with respect to the other two profiles. Noteworthy, the percentages of children belonging to the *severe* or *moderate* late profile in our sample were higher than those of the first and second profiles found by Desmarais et al. (2010). Our findings could reflect some methodological differences, as we included both low-risk preterm and full-term late talkers and used the receptive and expressive vocabulary sizes obtained with the Italian versions of the MB-CDI, as criteria for identifying late talkers' profiles, whereas Desmarais et al. (2010) created two scores, one for comprehension, the other for expression and engagement, based on the Infant Toddler Language Scales-ITLS- questionnaire (Rossetti, 1990). Our findings also expanded those by Desmarais et al. (2010) by more deeply characterizing the profiles of late talkers on a broader set of communicative, linguistic, cognitive, and motor skills, including both low-risk preterm and full-term children.

4.2. Communicative, linguistic, cognitive, and motor characteristics across late talkers' profiles

4.2.1. Communicative skills

Looking at the communicative skills which contributed to identifying different profiles among late talkers, our findings revealed that verbal imitation discriminated among the three profiles. Previous studies found that 24% to 43% of late talkers did not show verbal imitation around 30 months of age (Bello et al., 2018; Sansavini, Zuccarini, et al., 2021). Our findings expanded these results showing that the absence of verbal imitation at this age was mostly associated with receptive-expressive lexical delay characterizing *severe* late talkers. Indeed, verbal imitation was lacking in more than half of the *severe* and in one-fifth of the *moderate* late talkers, whereas it was always present and more often dslayed in the *mild* late talkers. Thus, it would be crucial to examine the predictive value of verbal imitation on later language outcomes in future studies. Along these lines, a study by Dohmen et al. (2016) has found that verbal imitation and body movement imitation may predict social communication and language outcomes in late talkers at preschool age. Altogether, these findings highlight that verbal and non-verbal communication behaviors may be promising predictors of late talkers' language development.

Concerning the use of gestures, declarative pointing was produced by all late talkers at 30 months of age, but with different frequency, with the *severe* late talkers sometimes rather than often producing it. This finding suggests that, whereas at 12–18 months of age, the absence of pointing is a reliable index of later language delay (Lüke et al., 2017; Sansavini et al., 2019), at 30 months of age, a scarce frequency of pointing is an index discriminating severity of language delay.

4.2.2. Linguistic skills

4.2.2.1. Lexical skills.
Concerning linguistic skills, our data brought new evidence on the crucial role of receptive, beyond expressive, skills in explaining the heterogeneity of late talkers, bringing further evidence to the findings of previous studies (Chilosi et al., 2019; Desmarais et al., 2010). Using both receptive and expressive vocabulary sizes reported by parents with the MB-CDI GW and WS, our findings highlighted that the *severe* late talkers were characterized by a widespread language delay affecting receptive and expressive lexical skills. Direct child assessment confirmed this delay as the *severe* late talkers reported a lower language composite score than the *mild* late talkers. In addition, low scores in noun and predicate comprehension with respect to those of the normative sample (Bello et al., 2010) were found in all three profiles. Delays in lexical comprehension could also be linked to weaknesses in sustained attention skills, necessary for successfully collaborating in a structured lexical task, that is more demanding for assessing lexical skills with respect to daily observations in ecological contexts. A recent study has indeed found a significant association between late talker condition and attention difficulties at 24 months of age (Hammer et al., 2017). Noteworthy, Chilosi et al. (2019) have found that 61% of late talkers, assessed with a standardized task at 28 months, were delayed in syntactic comprehension and this measure predicted language outcomes at 4 years of age. Concerning lexical production, the *severe* and *moderate* late talkers had a more limited expressive vocabulary size as well as lower scores in noun and predicate production tasks than the *mild* late talkers, highlighting convergent results between the MB-CDI WS and the PiNG test in assessing lexical production and discriminating among late talkers' profiles. With respect to the normative sample (Bello et al., 2010), across all three profiles, low scores in noun and predicate production were found, with comprehension and production for nouns more developed than for predicates. The advantage of nouns with respect to predicates has been found across several languages, mainly depending on the higher number of contextual cues accompanying noun use with respect to the morphosyntactic cues primarily associated with predicates (Bello et al., 2014; Caselli et al., 1999). These findings strengthened the relevance of carefully assessing receptive and expressive lexical skills with both parental reports and structured tasks, considering also vocabulary composition in late talkers.

4.2.2.2. Grammar skills.
Late talkers' profiles were also differentiated in word combination and sentence production. Our data showed that most *severe* and *moderate* late talkers lacked word combinations and children of these profiles reported lower sentence production than *mild* late talkers. As all *severe* and *moderate* late talkers had an expressive vocabulary size ≤5th percentile, our findings brought new evidence of the existence of a strict link between lexical and morphosyntactic development, with the emergence of word combination depending on the expressive vocabulary size (Bates & Goodman, 1997), as already shown by previous studies conducted on full-term and low-risk preterm late talkers (Bello et al., 2018; Chilosi et al., 2019; Sansavini, Zuccarini, et al., 2021). Recent studies have shown that delays in receptive and expressive grammar abilities between 30 and 36 months are predictive of later language difficulties and developmental language disorder (Chilosi et al., 2019; Sansavini, Favilla, et al., 2021). Our findings further highlighted that word combination and sentence production are useful indexes for distinguishing *mild* late talkers from *moderate* and *severe* late talkers at 30 months.

4.2.2.3. Phonological accuracy.
Phonological accuracy, although still lacking in about two-thirds of late talkers and only partially developed in the other third, did not discriminate among late talkers' profiles at 30 months of age. It should be noted that a wide interindividual variability in phonological skills characterizes also typically developing children at this age (Caselli et al., 2015; Hodges et al., 2017). Along these lines, a recent review identified 4 to 5 years of age as appropriate to assess phonological skills as a marker of developmental language disorder (Sansavini, Favilla, et al., 2021). Furthermore, the current study assessed this ability with a single question in a parental questionnaire. Indeed, some studies highlighted that elicited word/non-word repetition may be an effective measure for examining phonological abilities in late talkers by 25 months of age (Chiat & Roy, 2007; Hodges et al., 2017; Stokes & Klee, 2009). This measure is also considered an indirect but robust way of examining phonological memory, an ability positively associated with vocabulary size and useful to detect children with language impairment (Chiat & Roy, 2007; Marini et al., 2017; Moyle et al., 2011). Therefore, even if phonological accuracy is still developing before three years of age, measuring it with direct tools, besides indirect ones, may be relevant as children more delayed in phonological skills between 2 and 3 years of age tend to persist in language delay at preschool age (Carson et al., 2003; Marini et al., 2017; Petinou & Spanoudis, 2014).

4.2.2.4. Pragmatic skills.
Also, pragmatic skills discriminated among late talkers' profiles. Desmarais et al. (2010) have found that children more severely delayed in expressive skills were also less engaged in communication, but without specifying which communicative functions, i.e., responding and/or initiating, were delayed. Furthermore, research investigating communicative functions in late talkers with only expressive delay brought contrasting results, with some studies finding weaknesses in both responsiveness and assertiveness (Bello et al., 2018; Bonifacio et al., 2007), whereas others only in assertiveness (Rescorla & Merrin, 1998; Vuksanovic, 2015). Our study represents a new attempt to address this issue more in-depth, indicating that, at 30 months, *severe* late talkers had weaknesses in pragmatic skills, reporting significantly lower scores in both responsiveness and assertiveness than *mild* late talkers and showing an absence of responsiveness and assertiveness in about one-third of children. Our findings brought new

evidence to those of previous studies (Bello et al., 2018; Bonifacio et al., 2007; Rescorla & Merrin, 1998; Vuksanovic, 2015), pointing out that weaknesses in pragmatic skills were more evident in children with both receptive and expressive delay, who appeared more passive and less ready to initiate communicative acts with respect to children with only expressive delay. This finding apparently contrasts with that of Vuksanovic (2015), who showed that children with lower language comprehension initiated social interaction more frequently. However, it should be noted that the author found this correlation at 26 months but not at later ages. Our data suggested that around 30 months, children with spread underlying lexical delay also exhibited limited pragmatic skills, in terms of both responding to and initiating communicative interaction, needing a partner's scaffolding for engaging in communication, as Rescorla and Merrin (1998) argued in their study. Noteworthy, limited abilities to respond to and initiate communicative interactions with others, in turn, reduce the possibilities of acquiring new words, negatively impacting later language development.

4.2.3. Cognitive and motor skills

Our findings also highlighted that cognitive abilities should be considered in distinguishing late talkers' profiles at 30 months of age. Both *severe* and *moderate* late talkers showed lower scores in cognitive skills than *mild* late talkers. This finding is consistent with that of Desmarais et al. (2010). In agreement with their study, we found higher cognitive scores in the group with larger expressive vocabulary size. Regarding the use of symbolic play, although it did not discriminate among late talkers' profiles at 30 months, it was noteworthy that all children did not show this skill often as expected for their age and about one-third of the *severe* late talkers did not master this competence yet. A deficit in symbolic play had previously been observed in late talkers with expressive or receptive-expressive delay through a parental questionnaire or a play context (Bello et al., 2018; Rescorla & Goossens, 1992; Sansavini, Zuccarini, et al., 2021). Our findings brought new evidence about the relevance of symbolic play, which allows one to represent and convey meanings with actions and gestures, building a bridge from action to word acquisition (Capirci & Volterra, 2008). Taken together, these data confirm that the language and cognitive domains are strictly intertwined (Bates & Dick, 2001) and that cognitive weakness is associated with both receptive and expressive delays in late talkers (Bello et al., 2018; Sansavini, Zuccarini, et al., 2021; Suttora et al., 2020).

Motor scores of *severe* late talkers were also lower, even if not significantly, than those of *moderate* and *mild* late talkers. In addition, motor scores across the three profiles were generally low, highlighting spread motor weaknesses in late talkers. Our findings confirmed the existence of motor vulnerabilities, assessed through a standardized tool, among late talkers, regardless of the severity of their delay, and brought new evidence to those of previous studies that investigated these skills in full-term and preterm children with parental questionnaires highlighting motor weakness in children with language delay (Sansavini, Zuccarini, et al., 2021; Zubrick et al., 2007). Since a growing body of research has underscored that early motor skills represent a prerequisite for language development (Iverson, 2010) and that delay in early motor precursors may have cascading effects on later language performances (LeBarton & Iverson, 2016; Zuccarini et al., 2016, 2017), we cannot exclude that examining motor skills at previous ages and considering specific early motor precursors could highlight earlier motor differences among late talkers' profiles.

Taken together these results highlighted that a set of different communicative, linguistic, and cognitive determinants concurred to explain the heterogeneity of late talkers. Beyond delays in expressive lexical skills, receptive lexical skills, use of pointing, verbal imitation, morphosyntactic, phonological, pragmatic, and cognitive skills deserve to be examined in late talkers at 30 months for describing their profiles.

4.3. Biological and environmental risk factors characterizing late talkers' profiles

4.3.1. Biological risk factors

Biological and environmental factors were mainly similar across the three profiles except for gender. A significantly higher number of male children was included in the *severe* late profile than in the *moderate* and *mild* late profiles. These data confirmed and expanded evidence of previous studies on language delay (Collisson et al., 2016; Reilly et al., 2007; 2010; Zubrick et al., 2007), suggesting that the male gender not only increases the risk of language delay but also its grade of severity and spread. Along these lines, Reilly et al. (2010) showed that the male gender was a predictor of lower outcomes in receptive and expressive language skills, indicating an association between this biological factor and both receptive and expressive skills, as our data have revealed.

Other biological factors did not differ among the three profiles. Preterm birth did not discriminate among late talkers' profiles. It should be noted that the present study investigated for the first time whether birth status (low-risk preterm vs full-term) impacts the severity of language delay in late talkers suggesting that low-risk preterm birth per se does not increase the severity of language delay. Studies with larger samples of late talkers born preterm, with a broader range of neonatal immaturity and perinatal complications, would be necessary for further investigating this issue.

In addition, our findings did not find any significant differences in the prevalence of children with a family history of language delay across the three profiles, with about one out of six children in each profile. Literature on language delay has brought mixed results about this factor with a family history of language delay not always resulting in a significant risk factor for language delay (Fisher, 2017; Sansavini, Zuccarini, et al., 2021). Further studies with larger samples of late talkers should address this issue.

4.3.2. Environmental factors

Concerning environmental risk factors, we did not find low parental education or having parents engaged in unpaid work associated with a specific profile. This finding was in contrast with those of previous studies on late talkers (Dale et al., 2003; Horwitz et al., 2003; Reilly et al., 2010; Sansavini, Zuccarini, et al., 2021; Suttora et al., 2020), and with evidence that low maternal educational often characterized children with more severe weaknesses in language (Desmarais et al., 2010). A possible explanation for this contrasting

result is that the sample was recruited in a region where high education levels are more frequently attained. Indeed, only one-third of the participants had a low parental level, identified by both parents having at most a high school diploma. Also attending a daycare center did not discriminate among the three profiles, probably because most children attended a daycare center with low variability across the sample. Larger samples of late talkers will allow deepening the role of daycare attendance in promoting language development in late talkers in terms of conversational exchanges with peers and adults, as well as the possibility to socialize and interact with others.

4.4. Limitations and strengths of the study

The findings of the current study showed some limitations. We included in the sample only low-risk preterm children who usually are less immature and with less severe pre- and perinatal complications. Although this represented an element of novelty with respect to previous studies (Chilosi et al., 2019; Desmarais et al., 2010), this limited the generalization of our results about the effect of preterm birth and the associated perinatal conditions as risk factors discriminating among late talkers' profiles. Including late talkers born preterm also at lower gestational ages range would contribute to getting a more complete picture of late talkers in the whole preterm population. A second limitation is that we determined late talkers' profiles on a single age point, i.e., at 30 months. As late talkers may already be identified by 24 months (Rescorla, 1989), future studies could examine whether different language profiles can be identified even at an earlier age, their development trajectories over time, and their association with different language outcomes. A third limitation concerns using a single question in a parental questionnaire for assessing phonological accuracy. Albeit literature highlighted that measures obtained through a parent report are robust as those collected through a direct assessment (Sachse & Von Suchodoletz, 2008), our conclusions about this ability might have been impacted by the method we chose for assessing it. The use of spontaneous speech or structured word/non word imitation tasks, besides parental questionnaires, might be helpful to better understand the heterogeneity of late talkers. Moreover, comparing their performance with those of age-matched typically developing peers might provide more information on late talkers' phonological processes and fragilities (Hodges et al., 2017).

Despite these limits, the current study shows multiple strengths. It brought new data for explaining the heterogeneity of late talkers, a topic that has been partially overlooked by literature and deserves more attention. Furthermore, we investigated a wide range of communicative, linguistic, cognitive, and motor skills as potential determinants of the heterogeneity of late talkers, assessing them through parental questionnaires and structured tasks and considering several biological and environmental risk factors in low-risk and full-term late talkers, an investigation that had not been done before.

5. Conclusions and clinical implications

Our findings brought new evidence about the heterogeneity among late talkers. We identified three different profiles based on their receptive and expressive vocabulary size, each characterized by specific communicative, linguistic, and cognitive abilities.

Some clinical implications for the assessment and intervention of late talkers can be drawn from these results. Receptive and expressive lexical skills resulted fundamental in differentiating late talkers' profiles; in addition, frequency of pointing, verbal imitation, grammar, pragmatic, global language and cognitive skills differentiated these profiles, suggesting the relevance of examining all these competencies in late talkers. These findings might also contribute shedding light on potential early predictors of developmental language disorders. Evidence from a recent review (Sansavini, Favilla, et al., 2021), underscored that, at 30 months, poor communicative skills, limited receptive and expressive lexical skills, and impaired syntactic comprehension and production are early predictors of developmental language disorders. Further research could investigate the role of some indexes, besides receptive and expressive vocabulary size, such as the frequency of pointing and verbal imitation in the communication domain, noun and predicate production and responsiveness and assertiveness in the language domain, as contributing to predict developmental language disorders. A deeper investigation of phonological accuracy might also contribute to a further understanding of interindividual variability and persistent linguistic difficulties in this population.

Our findings may also inform on how implementing interventions tailored to specific children's profiles. According to the literature, the presence of a widespread delay in receptive and expressive skills, as well as the presence of additional weaknesses in other competencies and associated risk factors, may be reliable predictors of persistent language delay (Ellis & Thal, 2008; Fisher, 2017) and increase the need for early interventions (Ellis & Thal, 2008). Considering this evidence, we can hypothesize that a timely intervention for late talkers should be preferred to the "wait and see" approach. Recent studies have shown that parent-coaching interventions, based on dialogic book reading and focused stimulation strategies, positively affected child's language development in late talkers at 31 months of age (Zuccarini et al., 2020), as a cascading result of the improvement of parental contingency in communication and dialogic reading abilities (Suttora et al., 2021). There is also evidence that intervention on late talkers aged between 21 and 41 months, conducted by a speech therapist, in a one-to-one session, may be effective in increasing their expressive vocabulary growth (Alt et al., 2014; Munro et al., 2021). Future studies should clarify which types of intervention may be more effective in specific subgroups of late talkers, i.e., those children with an expressive lexical delay or a receptive-expressive lexical delay. Interventions should indeed be customized on late talkers' profiles. *Severe* late talkers would probably need to begin a language and speech intervention supported by a speech therapist earlier, along with a parent-coaching intervention addressed to all late talkers, and focused primarily on language comprehension (Law et al., 2017). At the same time, programs for enhancing educators' use of vocabulary-teaching strategies during a shared book reading should be implemented. Research has shown that programs for enhancing educators' use of vocabulary-teaching strategies during shared book reading improved children's participation in conversations with their educators (Namasivayam et al., 2015) as well as their quality and complexity of language (Rezzonico et al., 2015) at preschool age. Therefore, these programs could

contribute to enhancing language skills of late talkers attending daycare centers.

Finally, a noteworthy consideration is provided by recent research that has underscored that late talkers may also show behavioral problems (Lu et al., 2022) and more severe temper tantrums (Manning et al., 2019). These further critical issues may increase the language difficulties of late talkers and determine sequelae also in other domains, as learning, behavior, and socialization (Sansavini, Zuccarini, et al., 2021). Therefore, future studies should further investigate the relationship between language profiles and mental health in late talkers.

Funding

CRediT authorship contribution statement

Conceptualization, Methodology: A.S., A.G., M.Z.; Data collection: M.Z.; Medical aspects of methodology and medical data collection and supervision: A.A. and L.C.; Data coding: M.Z.; Data curation: M.Z. and C.S.; Data analysis: M.Z., D.G., A.G., A.S., and C. S.; Writing - original draft: M.Z., A.S. and A.G; Writing - review & editing: A.S., A.G., M. Z., D.G., C.S., A.A., L.C., A.B. and M.C.C.; Funding acquisition: A.S. and A.G.; Project administration and Supervision: A.S. All authors have read and agreed to the published version of the manuscript.

Declaration of Competing Interest

The authors declare that they have no competing interests.

Acknowledgments

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jcomdis.2023.106336.

References

Alt, M., Meyers, C., Oglivie, T., Nicholas, K., & Arizmendi, G. (2014). Cross-situational statistically based word learning intervention for late-talking toddlers. *Journal of Communication Disorders, 52*, 207–220. https://doi.org/10.1016/j.jcomdis.2014.07.002

Bacher, J., Wenzig, K., & Vogler, M. (2004). *SPSS twostep cluster - a first evaluation* (2., corr. ed.). Arbeitsund Diskussionspapiere /Universität Erlangen-Nürnberg, Sozialwissenschaftliches Institut, Lehrstuhl Für Soziologie.

Bates, E., & Dick, F. (2001). Language and the developing brain. *NAMTA Journal, 26*(2), 8–60.

Bates, E., & Goodman, J. C. (1997). On the inseparability of grammar and the lexicon: evidence from acquisition, aphasia and real-time processing. *Language and Cognitive Processes, 12*(5–6), 507–584. https://doi.org/10.1080/016909697386628

Bello, A., Caselli, M.C., Pettenati, P., & Stefanini, S. (2012). *PiNG. parole in gioco: Una prova per la comprensione e produzione lessicale per la prima infanzia* (Firenze: Giunti OS (ed.)).

Bello, A., Onofrio, D., Remi, L., & Caselli, M. C. (2018). Prediction and persistence of late talking: A study of Italian toddlers at 29 and 34 months. *Research in Developmental Disabilities, 75*, 40–48. https://doi.org/10.1016/j.ridd.2018.02.006

Bishop, D. V. M., Snowling, M. J., Thompson, P. A., Greenhalgh, T., Adams, C., Archibald, L., Baird, G., Bauer, A., Bellair, J., Boyle, C., Brownlie, E., Carter, G., Clark, B., Clegg, J., Cohen, N., Conti-Ramsden, G., Dockrell, J., Dunn, J., Ebbels, S., … Whitehouse, A. (2016). CATALISE: A multinational and multidisciplinary Delphi consensus study. Identifying language impairments in children. *PloS one, 11*(7), 1–26. https://doi.org/10.1371/journal.pone.0158753

Bonifacio, S., Girolametto, L., Bulligan, M., Callegari, M., Vignola, S., & Zocconi, E. (2007). Assertive and responsive conversational skills of Italian-speaking late talkers. *International Journal of Language and Communication Disorders, 42*(5), 607–623. https://doi.org/10.1080/13682820601084386

Bonifacio, S., Girolametto, L., & Montico, M. (2013). Le abilità socioconversazionali del bambino. *Questionario e dati normativi dai 12 ai 36 mesi d'età.* Milano: Franco Angeli.

Buschmann, A., Joss, B., Rupp, A., Dockter, S., Blaschtikowitz, H., Heggen, I., & Pietz, J. (2008). Children with developmental language delay at 24 months of age: Results of a diagnostic work-up. *Developmental Medicine and Child Neurology, 50*(3), 223–229. https://doi.org/10.1111/j.1469-8749.2008.02034.x

Capirci, O., & Volterra, V. (2008). Gesture and speech. *Gesture, 8*(1), 22–44. https://doi.org/10.1075/gest.8.1.04cap

Carson, C. P., Klee, T., Carson, D. K., & Hime, L. K. (2003). Phonological profiles of 2-year-olds with delayed language development: Predicting clinical outcomes at age 3. *American Journal of Speech-Language Pathology, 12*(1), 28–39. https://doi.org/10.1044/1058-0360(2003/050)

Caselli, M. C., Bello, A., Rinaldi, P., Stefanini, S., & Pasqualetti, P. (2015). Il Primo Vocabolario del Bambino: Gesti, Parole e Frasi. *Forme lunghe e forme brevi del questionario e valori di riferimento per la fascia 8-36 mesi.* Franco Angeli.

Caselli, M. C., Casadio, P., & Bates, E. (1999). A comparison of the transition from first words to grammar in English and Italian. *Journal of Child Language, 26*(1), 69–111. https://doi.org/10.1017/S0305000998003687

Caselli, M. C., Rinaldi, P., Stefanini, S., & Volterra, V. (2012). Early Action and Gesture "Vocabulary" and Its Relation With Word Comprehension and Production. *Child Development, 83*(2), 526–542. https://doi.org/10.1111/j.1467-8624.2011.01727.x

Charkaluk, M. L., Rousseau, J., Benhammou, V., Datin-Dorrière, V., Flamant, C., Gire, C., Kern, S., Pierrat, V., Kaminski, M., & Marret, S. (2019). Association of Language Skills with Other Developmental Domains in Extremely, Very, and Moderately Preterm Children: EPIPAGE 2 Cohort Study. *Journal of Pediatrics, 208*, 114–120. https://doi.org/10.1016/j.jpeds.2018.12.007. e5.

Cheong, J. L., Doyle, L. W., Burnett, A. C., Lee, K. J., Walsh, J. M., Potter, C. R., Treyvaud, K., Thompson, D. K., Olsen, J. E., Anderson, P. J., & Spittle, A. J. (2017). Association between moderate and late preterm birth and neurodevelopment and social-emotional development at age 2 years. *JAMA Pediatrics*, (4), 171. https://doi.org/10.1001/jamapediatrics.2016.4805

Chiat, S., & Roy, P. (2007). The preschool repetition test: An evaluation of performance in typically developing and clinically referred children. *Journal of Speech, Language, and Hearing Research, 50*(2), 429–443. https://doi.org/10.1044/1092-4388(2007/030)

Chilosi, A. M., Pfanner, L., Pecini, C., Salvadorini, R., Casalini, C., Brizzolara, D., & Cipriani, P. (2019). Which linguistic measures distinguish transient from persistent language problems in Late Talkers from 2 to 4 years? A study on Italian speaking children. *Research in Developmental Disabilities, 89*, 59–68. https://doi.org/10.1016/j.ridd.2019.03.005

Chiu, T., Fang, D., Chen, J., Wang, Y., & Jeris, C. (2001). A robust and scalable clustering algorithm for mixed type attributes in large database environment. In *Proceedings of the 7th ACM SIGKDD International Conference on Knowledge Discovery and Data Mining* (pp. 263–268).

Collisson, B. A., Graham, S. A., Preston, J. L., Rose, M. S., McDonald, S., & Tough, S. (2016). Risk and protective factors for late talking: An epidemiologic investigation. *Journal of Pediatrics, 172*, 168–174. https://doi.org/10.1016/j.jpeds.2016.02.020. e1.

Conti-Ramsden, G., Mok, P. L. H., Pickles, A., & Durkin, K. (2013). Adolescents with a history of specific language impairment (SLI): Strengths and difficulties in social, emotional and behavioral functioning. *Research in Developmental Disabilities, 34*(11), 4161–4169. https://doi.org/10.1016/j.ridd.2013.08.043

Dale, P. S., & Hayiou-Thomas, M. E (2013). Outcomes for late talkers: A twin study. In L. A. Rescorla, & P. S. Dale (Eds.), *Late talkers: Language development, interventions, and outcomes* (pp. 241–257). Paul H. Brookes Publishing Co.

Dale, P. S., Price, T. S., Bishop, D. V. M., & Plomin, R. (2003). Outcomes of early language delay: I. predicting persistent and transient language difficulties at 3 and 4 years. *Journal of Speech, Language, and Hearing Research, 46*(3), 544–560. https://doi.org/10.1044/1092-4388(2003/044)

Desmarais, C., Sylvestre, A., Meyer, F., Bairati, I., & Rouleau, N. (2008). Systematic review of the literature on characteristics of late-talking toddlers. *International Journal of Language and Communication Disorders, 43*(4), 361–389. https://doi.org/10.1080/13682820701546854. Taylor and Francis Ltd.

Desmarais, C., Sylvestre, A., Meyer, F., Bairati, I., & Rouleau, N. (2010). Three profiles of language abilities in toddlers with an expressive vocabulary delay: variations on a theme. *Journal of Speech, Language, and Hearing Research, 53*(3), 699–709. https://doi.org/10.1044/1092-4388(2009/07-0245)

Dicataldo, R., & Roch, M. (2020). Are the effects of variation in quantity of daily bilingual exposure and socioeconomic status on language and cognitive abilities independent in preschool children? *International Journal of Environmental Research and Public Health, 17*(12), 4570. https://doi.org/10.3390/ijerph17124570

Dohmen, A., Bishop, D. V. M., Chiat, S., & Roy, P. (2016). Body movement imitation and early language as predictors of later social communication and language outcomes: A longitudinal study. *Autism and Developmental Language Impairments, 1*, 1–15. https://doi.org/10.1177/2396941516656636

Eadie, P., Levickis, P., McKean, C., Westrupp, E., Bavin, E. L., Ware, R. S., Gerner, B., & Reilly, S. (2022). Developing preschool language surveillance models - cumulative and clustering patterns of early life factors in the early language in Victoria study cohort. *Frontiers in Pediatrics, 10*, 1–18. https://doi.org/10.3389/fped.2022.826817

Ellis, E. M., & Thal, D. J. (2008). Early language delay and risk for language impairment. *American Speech-Language-Hearing Association*, 93–100. https://doi.org/10.1044/lle15.3.93

Fenson, L., Marchman, V. A., Thal, D. J., Dale, P., & Reznick, J. S. (2007). *The macarthur-bates communicative development inventories: User's guide and technical manual*. Paul Brookes.

Ferri, R., Orsini, A., Rea, M., Stoppa, E., & Mascellani, F. (2015). Bayley scales of infant and toddler development. *Manuale dell'adattamento italiano* (3rd ed.). Giunti, O.S.: Italian adaptation.

Finlay, J. C. S., & McPhillips, M. (2013). Comorbid motor deficits in a clinical sample of children with specific language impairment. *Research in Developmental Disabilities, 34*(9), 2533–2542. https://doi.org/10.1016/j.ridd.2013.05.015

Fisher, E. L. (2017). A systematic review and meta-analysis of predictors of expressive-language outcomes among late talkers. *Journal of Speech, Language, and Hearing Research, 60*, 2935–2948. https://doi.org/10.23641/asha

Gathercole, S. E. (2006). Nonword repetition and word learning: The nature of the relationship. *Applied Psycholinguistics, 27*(4), 513–543. https://doi.org/10.1017/s0142716406060383

Hammer, C. S., Morgan, P., Farkas, G., Hillemeier, M., Bitetti, D., & Maczuga, S. (2017). Late talkers: A population-based study of risk factors and school readiness consequences. *Journal of Speech, Language, and Hearing Research, 60*(3), 607–626. https://doi.org/10.1044/2016_JSLHR-L-15-0417

Hawa, V. V., & Spanoudis, G. (2014). Toddlers with delayed expressive language: An overview of the characteristics, risk factors and language outcomes. *Research in Developmental Disabilities, 35*(2), 400–407. https://doi.org/10.1016/j.ridd.2013.10.027

Hodges, R., Baker, E., Munro, N., & McGregor, K. K. (2017). Responses made by late talkers and typically developing toddlers during speech assessments. *International Journal of Speech-Language Pathology, 19*(6), 587–600. https://doi.org/10.1080/17549507.2016.1221452

Hoff, E. (2003). The specificity of environmental influence: socioeconomic status affects early vocabulary development via maternal speech. *Child Development, 74*(5), 1368–1378. https://doi.org/10.1111/1467-8624.00612

Horwitz, S. M. C., Irwin, J. R., Briggs-Gowan, M. J., Bosson Heenan, J. M., Mendoza, J., & Carter, A. S. (2003). Language delay in a community cohort of young children. *Journal of the American Academy of Child and Adolescent Psychiatry, 42*(8), 932–940. https://doi.org/10.1097/01.CHI.0000046889.27264.5E

Iverson, J. M. (2010). Developing language in a developing body: The relationship between motor development and language development. *Journal of Child Language, 37*(2), 229–261. https://doi.org/10.1017/S0305000909990432

Iverson, J. M., & Braddock, B. A. (2011). Gesture and motor skill in relation to language in children with language impairment. *Journal of Speech, Language, and Hearing Research, 54*, 72–86. https://doi.org/10.1044/1092-4388(2010/08-0197)

Klee, T., Carson, D. K., Gavin, W. J., Hall, L., Kent, A., & Reece, S. (1998). Concurrent and predictive validity of an early language screening program. *Journal of Speech, Language, and Hearing Research, 41*(3), 627–641. https://doi.org/10.1044/jslhr.4103.627

Korpilahti, P., Kaljonen, A., & Jansson-Verkasalo, E. (2016). Identification of biological and environmental risk factors for language delay: The Let's Talk STEPS study. *Infant Behavior and Development, 42*, 27–35. https://doi.org/10.1016/j.infbeh.2015.08.008

Kuhl, P. K. (2010). Brain mechanisms in early language acquisition. *Neuron, 6*(5), 713–727. https://doi.org/10.1016/j.neuron.2010.08.038

Law, J., Dennis, J. A., & Charlton, J. J. V. (2017). Speech and language therapy interventions for children with primary speech and/or language disorders. *Cochrane Database of Systematic Reviews, 1*. https://doi.org/10.1002/14651858.CD012490

LeBarton, E. S., & Iverson, J. M. (2016). Associations between gross motor and communicative development in at-risk infants. *Infant Behavior and Development, 44*, 59–67. https://doi.org/10.1016/j.infbeh.2016.05.003

Lu, H. H., Tsai, J. D., & Tsao, F. M. (2022). Temporal stability of parent-reported behavior problems in late talkers over 2 years: A prospective case-control study from toddlerhood to preschool age. *Journal of Neurodevelopmental Disorders, 14*(1), 1–9. https://doi.org/10.1186/s11689-022-09445-x

Lüke, C., Rohlfing, K. J., Grimminger, A., Liszkowski, U., & Ritterfeld, U. (2017). In infants' hands: Identification of preverbal infants at risk for primary language delay. *Child Development, 88*(2), 484–492. https://doi.org/10.1111/cdev.12610

Manning, B. L., Roberts, M. Y., Estabrook, R., Petitclerc, A., Burns, J. L., Briggs-Gowan, M., Wakschlag, L. S., & Norton, E. S. (2019). Relations between toddler expressive language and temper tantrums in a community sample. *Journal of Applied Developmental Psychology, 65*(1–10), Article 101070. https://doi.org/10.1016/j.appdev.2019.101070

Marini, A., Ruffino, M., Sali, M. E., & Molteni, M. (2017). The role of phonological working memory and environmental factors in lexical development in italian-speaking late talkers: A one-year follow-up study. *Journal of Speech, Language, and Hearing Research, 60*, 3462–3473. https://doi.org/10.1044/2017_JSLHR-L-15-0415

Mirak, J., & Rescorla, L. (1998). Phonetic skills and vocabulary size in late talkers: Concurrent and predictive relationships. *Applied Psycholinguistics, 19*(1), 1–17. https://doi.org/10.1017/s0142716400010559

Moyle, J., Stokes, S. F., & Klee, T. (2011). Early language delay and specific language impairment. *Developmental Disabilities Research Reviews, 17*(2), 160–169. https://doi.org/10.1002/ddrr.1110

Munro, N., Baker, E., Masso, S., Carson, L., Lee, T., Wong, A. MY., & Stokes, S. F. (2021). Vocabulary acquisition and usage for late talkers treatment: Effect on expressive vocabulary and phonology. *Journal of Speech, Language, and Hearing Research, 64*, 2682–2697. https://doi.org/10.23641/asha

Namasivayam, A. M., Hipfner-Boucher, K., Milburn, T., Weitzman, E., Greenberg, J., Pelletier, J., & Girolametto, L. (2015). Effects of coaching on educators' vocabulary-teaching strategies during shared reading. *International Journal of Speech-Language Pathology, 17*(4), 346–356. https://doi.org/10.3109/17549507.2014.979871

Neam, S. Y., Baker, E., Hodges, R., & Munro, N. (2020). Speech production abilities of 4- to 5-year-old children with and without a history of late talking: The tricky tyrannosaurus. *International Journal of Speech-Language Pathology, 22*(2), 184–195. https://doi.org/10.1080/17549507.2019.1638968

O'Neill, H., & Chiat, S. (2015). What our hands say: exploring gesture use in subgroups of children with language delay. *Journal of Speech, Language, and Hearing Research, 58*, 1319–1325. https://doi.org/10.1044/2015_JSLHR-L-14-0187

Paul, R., & Alforde, S. (1993). Grammatical morpheme acquisition in 4-year-olds with normal, impaired, and late-developing language. *Journal of Speech and Hearing Research, 36*(6), 1271–1275. https://doi.org/10.1044/jshr.3606.1271

Paul, R., & Jennings, P. (1992). Phonological behavior in toddlers with slow expressive language development. *Journal of Speech and Hearing Research, 35*(1), 99–107. https://doi.org/10.1044/jshr.3501.99

Paul, R., Laszio, C. M., McFarland, L. S., & Midford, N. (1993). Language outcomes in late-talkers: Kindergarten. *American Journal of Speech-Language Pathology, 3*, 5–22.

Pauls, L. J., & Archibald, L. M. (2016). Executive functions in children with specific language impairment: A meta-analysis. *Journal of Speech, Language, and Hearing Research, 59*, 1074–1086. https://doi.org/10.1044/2016_JSLHR-L-15-0174

Pérez-Pereira, M., Fernández, P., Gómez-Taibo, M. L., & Resches, M. (2014). Language development of low risk preterm infants up to the age of 30months. *Early Human Development, 90*(10), 649–656. https://doi.org/10.1016/j.earlhumdev.2014.08.004

Petinou, K., & Spanoudis, G. (2014). Early language delay phenotypes and correlation with later linguistic abilities. *Folia Phoniatrica et Logopaedica, 66*(1–2), 67–76. https://doi.org/10.1159/000365848

Reilly, S., Wake, M., Bavin, E. L., Prior, M., Williams, J., Bretherton, L., Eadie, P., Barrett, Y., & Ukoumunne, O. C. (2007). Predicting language at 2 years of age: A prospective community study. *Pediatrics, 120*(6). https://doi.org/10.1542/peds.2007-0045

Reilly, S., Wake, M., Ukoumunne, O. C., Bavin, E., Prior, M., Cini, E., Conway, L., Eadie, P., & Bretherton, L. (2010). Predicting language outcomes at 4 years of age: Findings from early language in Victoria study. *Pediatrics, 126*(6). https://doi.org/10.1542/peds.2010-0254

Rescorla, L. (1989). The language development survey: A screening tool for delayed language in toddlers. *Journal of Speech and Hearing Disorders, 54*(4), 587–599. https://doi.org/10.1044/jshd.5404.587

Rescorla, L. (2011). Late talkers: Do good predictors of outcome exist? *Developmental Disabilities Research Reviews, 17*(2), 141–150. https://doi.org/10.1002/ddrr.1108

Rescorla, L., Dahlsgaard, K., & Roberts, J. (2000). Late-talking toddlers: MLU and IPSyn outcomes at 3;0 and 4;0. *Journal of Child Language, 27*(3), 643–664. https://doi.org/10.1017/S0305000900004232

Rescorla, L., & Dale, P. (2013). *Late talkers: Language development, interventions, and outcomes*. Brookes Pulishing.

Rescorla, L., & Goossens, M. (1992). Symbolic play development in toddlers with expressive specific language impairment (SLI-E). *Journal of Speech and Hearing Research, 35*(6), 1290–1302. https://doi.org/10.1044/jshr.3506.1290

Rescorla, L., & Merrin, L. (1998). Communicative intent in late-talking toddlers. *Applied Psycholinguistics, 19*(3), 393–414. https://doi.org/10.1017/s0142716400010237

Rezzonico, S., Hipfner-Boucher, K., Milburn, T., Weitzman, E., Greenberg, J., Pelletier, J., & Girolametto, L. (2015). Improving preschool educators' interactive shared book reading: effects of coaching in professional development. *American Journal of Speech-Language Pathology, 24*, 717–732. https://doi.org/10.1044/2015_AJSLP-14-0188

Roos, E. M., & Weismer, S. E. (2008). Language outcomes of late talking toddlers at preschool and beyond. *Perspectives on Language Learning and Education, 15*(3), 119–126. https://doi.org/10.1044/lle15.3.119

Rossetti, L. (1990). *Infant toddler language scales*. East Moline, IL: Linguisystems.

Rudolph, J. M., & Leonard, L. B. (2016). Early Language Milestones and Specific Language Impairment. *Journal of Early Intervention, 38*(1), 41–58. https://doi.org/10.1177/1053815116633861

Sachse, S., & Von Suchodoletz, W (2008). Early identification of language delay by direct language assessment or parent report? *Journal of Developmental and Behavioral Pediatrics, 29*(1), 34–41. https://doi.org/10.1097/DBP.0b013e318146902a

Sansavini, A., Bello, A., Guarini, A., Savini, S., Stefanini, S., & Caselli, M. C. (2010). Early development of gestures, object-related-actions, word comprehension and word production, and their relationships in Italian infants. *Gesture, 10*(1), 52–85. https://doi.org/10.1075/gest.10.1.04san

Sansavini, A., Favilla, M. E., Guasti, M. T., Marini, A., Millepiedi, S., Di Martino, M. V., Vecchi, S., Battajon, N., Bertolo, L., Capirci, O., Carretti, B., Colatei, M. P., Frioni, C., Marotta, L., Massa, S., Michelazzo, L., Pecini, C., Piazzalunga, S., Pieretti, M., … Lorusso, M. L. (2021). Developmental language disorder: Early predictors, age for the diagnosis, and diagnostic tools. A scoping review. *Brain Sciences, 11*(5), 1–38. https://doi.org/10.3390/brainsci11050654

Sansavini, A., Guarini, A., & Caselli, M. C. (2011). Preterm birth: Neuropsychological profiles and atypical developmental pathways. *Developmental Disabilities Research Reviews, 17*, 102–113. https://doi.org/10.1002/ddrr.1105

Sansavini, A., Guarini, A., Justice, L. M., Savini, S., Broccoli, S., Alessandroni, R., & Faldella, G. (2010). Does preterm birth increase a child's risk for language impairment? *Early Human Development, 86*(12), 765–772. https://doi.org/10.1016/j.earlhumdev.2010.08.014

Sansavini, A., Guarini, A., Zuccarini, M., Lee, J. Z., Faldella, G., & Iverson, J. M. (2019). Low rates of pointing in 18-month-olds at risk for autism spectrum disorder and extremely preterm infants: A common index of language delay? *Frontiers in Psychology, 10*, 1–12. https://doi.org/10.3389/fpsyg.2019.02131

Sansavini, A., Zuccarini, M., Gibertoni, D., Bello, A., Caselli, M. C., Corvaglia, L., & Guarini, A. (2021). Language profiles and their relation to cognitive and motor skills at 30 months of age: An online investigation of low-risk preterm and full-term children. *Journal of Speech, Language, and Hearing Research, 64*(7), 2715–2733. https://doi.org/10.1044/2021_JSLHR-20-00636

Save the Children (2019). *Il miglior inizio*. https://s3.savethechildren.it/public/files/uploads/pubblicazioni/il-miglior-inizio-disuguaglianze-e-opportunita-nei-primi-anni-di-vita.pdf.

Stoel-Gammon, C. (2011). Relationships between lexical and phonological development in young children. *Journal of Child Language, 38*(1), 1–34. https://doi.org/10.1017/S0305000910000425

Stokes, S. F., & Klee, T. (2009). The diagnostic accuracy of a new test of early nonword repetition for differentiating late talking and typically developing children. *Journal of Speech, Language, and Hearing Research, 52*(4), 872–882. https://doi.org/10.1044/1092-4388(2009/08-0030)

Suttora, C., Guarini, A., Zuccarini, M., Aceti, A., Corvaglia, L., & Sansavini, A. (2020). Speech and language skills of low-risk preterm and full-term late talkers: The role of child factors and parent input. *International Journal of Environmental Research and Public Health, 17*(20), 1–22. https://doi.org/10.3390/ijerph17207684

Suttora, C., Zuccarini, M., Aceti, A., Corvaglia, L., Guarini, A., & Sansavini, A. (2021). The effects of a parent-implemented language intervention on late-talkers' expressive skills: The mediational role of parental speech contingency and dialogic reading abilities. *Frontiers in Psychology, 12*, 1–14. https://doi.org/10.3389/fpsyg.2021.723366

Thal, D. J., Marchman, V., & Tomblin, B. J. (2013). Late-talking toddlers: Characterization and prediction of continued delay. *In Late talkers: Language development, interventios, and outcomes*, 169–201.

Thal, D. J., & Tobias, S. (1992). Communicative gestures in children with delayed onset of oral expressive vocabulary. *Journal of Speech and Hearing Research, 35*(6), 1281–1289. https://doi.org/10.1044/jshr.3506.1289

Thal, D. J., Tobias, S., & Morrison, D. (1991). Language and gesture in late talkers: A 1-year follow-up. *Journal of Speech and Hearing Research, 34*(3), 604–612. https://doi.org/10.1044/jshr.3403.604

Vuksanovic, J. R. (2015). Relationship between social interaction bids and language in late talking children. *International Journal of Speech-Language Pathology, 17*(6), 527–536. https://doi.org/10.3109/17549507.2015.1010579

Zambrana, I. M., Pons, F., Eadie, P., & Ystrom, E. (2014). Trajectories of language delay from age 3 to 5: Persistence, recovery and late onset. *International Journal of Language and Communication Disorders, 49*(3), 304–316. https://doi.org/10.1111/1460-6984.12073

Zubrick, S. R., Taylor, C. L., Rice, M. L., & Slegers, D. W. (2007). Late language emergence at 24 months: An epidemiological study of prevalence, predictors, and covariates. *Journal of Speech, Language, and Hearing Research, 50*(6), 1562–1592. https://doi.org/10.1044/1092-4388(2007/106)

Zuccarini, M., Guarini, A., Savini, S., Iverson, J. M., Aureli, T., Alessandroni, R., Faldella, G., & Sansavini, A. (2017). Object exploration in extremely preterm infants between 6 and 9 months and relation to cognitive and language development at 24 months. *Research in Developmental Disabilities, 68*, 140–152. https://doi.org/10.1016/j.ridd.2017.06.002

Zuccarini, M., Sansavini, A., Iverson, J. M., Savini, S., Guarini, A., Alessandroni, R., Faldella, G., & Aureli, T. (2016). Object engagement and manipulation in extremely preterm and full term infants at 6 months of age. *Research in Developmental Disabilities, 55*, 173–184. https://doi.org/10.1016/j.ridd.2016.04.001

Zuccarini, M., Suttora, C., Bello, A., Aceti, A., Corvaglia, L., Caselli, M. C., Guarini, A., & Sansavini, A. (2020). A parent-implemented language intervention for late talkers: An exploratory study on low-risk preterm and full-term children. *International Journal of Environmental Research and Public Health, 17*(23), 1–20. https://doi.org/10.3390/ijerph17239123