Noun and predicate comprehension/production and gestures in extremely preterm children at two years of age: Are they delayed?

Alessandra Sansavini a,*, Arianna Bello b, Annalisa Guarini a, Silvia Savini a, Rosina Alessandroni c, Giacomo Faldella c, Cristina Caselli d

a Department of Psychology, University of Bologna, Italy
b Department of Neurosciences, University of Parma, Italy
c Neonatology and Neonatal Intensive Care Unit – S. Orsola-Malpighi Hospital, Department of Medical and Surgical Sciences, University of Bologna, Italy
d Institute of Cognitive Sciences and Technologies, National Research Council, Italy

A R T I C L E   I N F O

Article history:
Received 28 May 2014
Received in revised form 7 June 2015
Accepted 16 June 2015
Available online 4 July 2015

Keywords:
Extremely preterm children
Lexical comprehension
Lexical production
Nouns
Predicates
Gestures
Early indexes of language delay

A B S T R A C T

Extremely low gestational age (ELGA, GA < 28 weeks) preterm children are at high risk for linguistic impairments; however, their lexical comprehension and production as well as lexical categories in their early language acquisition have not been specifically examined via direct tools. Our study examines lexical comprehension and production as well as gestural production in ELGA children by focusing on noun and predicate acquisition. Forty monolingual ELGA children (mean GA of 26.7 weeks) and 40 full-term (FT) children were assessed at two years of corrected chronological age (CCA) using a test of noun and predicate comprehension and production (PiNG) and the Italian MB-CDI. Noun comprehension and production were delayed in ELGA compared with FT children, as documented by the low number of correct responses and the large number of errors, i.e., incorrect responses and no-response items, and by the types of incorrect responses, i.e., fewer semantically related responses, in noun production. Regarding predicate comprehension and production, a higher frequency of no responses was reported by ELGA children and these children also presented a lower frequency of bimodal spoken-gestural responses in predicate production than FT children. A delayed vocabulary size as demonstrated by the MB-CDI, was exhibited by one-fourth of the ELGA children, who were also unable to complete the predicate subtest.

These findings highlight that noun comprehension and production are delayed in ELGA children at two years of CCA and are the most important indexes for the direct evaluation of their lexical abilities and delay. The types of incorrect responses and bimodal spoken-gestural responses were proven to be useful indexes for evaluating the noun and predicate level of acquisition and to plan early focused interventions.

Learning outcomes: After reading this manuscript, the reader will understand (a) the differences in noun and predicate comprehension and production between ELGA and FT children and the indexes of lexical delays exhibited by ELGA children at 2;0 (CCA); (b) the relevance of evaluating errors (incorrect response and no response), the types of incorrect responses (semantically related and unrelated) and the modality of the responses
(unimodal spoken and bimodal spoken-gestural) in noun and predicate production to understand the difficulties experienced by ELGA children in representing and expressing meanings; and (c) the need to plan specific interventions to support spoken and gestural modalities in lexical comprehension and production in ELGA children by focusing on noun and predicate acquisition.

© 2015 Elsevier Inc. All rights reserved.

1. Introduction

The survival rate of preterm children [i.e., with a gestational age (GA) < 37 weeks] and extremely low gestational age (ELGA; GA < 28 weeks) children, who comprise approximately 5% of the entire preterm population and have the highest risk of impairments, has significantly increased in the last fifteen years, which raises questions regarding their developmental sequelae (Saigal & Doyle, 2008). Impairments at the preschool and school ages in one or more domains, such as the cognitive, motor and linguistic domains, have been identified in 20–50% of the preterm population, and a higher incidence is observed in ELGA children (Marlow, Wolke, Bracewell, Samara, & EPICure Study Group, 2005; Woodward et al., 2009). Delayed growth curve trajectories in motor, linguistic and cognitive domains have been obtained for ELGA children from the first year of life to the third year of life (Sansavini et al., 2014).

With regard to the linguistic domain, the majority of studies have focused on the preschool and school ages, particularly including samples of very preterm children (GA < 32 weeks). The results of these studies reveal that the scores for receptive and expressive lexicon and receptive grammar were 0.38–0.77 SD less than the scores obtained for the control samples (for a meta-analysis, refer to Barre, Morgan, Doyle, & Anderson, 2011), and an increase in language delay was observed for one in four preterm children at 2:6 to one in three at 3:6 (Sansavini, Guarini, et al., 2010).

Concerning early linguistic abilities, the majority of studies have been performed using samples of preterm children with an extensive range of gestational ages and have primarily focused on expressive abilities. Lags in the expressive lexicon of very preterm children at 2:0 (corrected chronological age = CCA) have been reported by several studies using the MacArthur-Bates Communicative Development Inventory (MB-CDI) parental questionnaire, i.e., an indirect assessment tool (Foster-Cohen, Edgin, Champion, & Woodward, 2007; Kern & Gayraud, 2007; Sansavini, Guarini, Savini, et al., 2011; Stolt et al., 2007). However, few studies have confirmed these lags in very preterm children via direct tools, such as a structured language test (Jansson-Verkasalo et al., 2004; Stolt et al., 2009) or spontaneous speech (Fasolo, D’Odorico, Costantini, & Cassibba, 2010), administered to very preterm children at 2:0 (CCA). In the latter studies, the MB-CDI was also employed, but these lags were not highlighted by this parental questionnaire.

Conversely, early lexical comprehension and gestural communication associated with spoken production, which are important indexes of language development in the second year of life (Caselli, Rinaldi, Stefanini, & Volterra, 2012), have rarely been investigated in the preterm population. A few studies have highlighted a slower development of these abilities in very preterm children in the second year of life compared with full-term (FT) children using the indirect assessment tool MB-CDI at CCA (Sansavini, Guarini, Savini, et al., 2011; Stolt et al., 2009; Stolt et al., 2014) or at chronological age – CA (Cattani et al., 2010). However, only one study has examined the use of gestures by direct observation and discovered similar types and numbers of gestures between very preterm children and FT children, with the exception of fewer gesture-word combinations at 1;6 and 2;0 years of CCA (Suttora & Salerni, 2012). The partially contrasting results of these studies may be partly due to methodological differences among the employed tools. The use of direct assessment tools, in addition to the indirect assessment tool MB-CDI, to examine lexical comprehension and production and gestural production appears important for obtaining a detailed view of preterm children’s language development at 2:0 years of CCA (Sansavini, Guarini, & Caselli, 2011).

Using a direct assessment tool, this study investigates early receptive and expressive lexicon acquisition at two years of CCA in ELGA children, who, among preterm children, are at higher risk for language delays. Their acquisition of nouns and predicates and their associated spontaneous gestural production were investigated to understand the verbal and gestural modalities used by these children to access the lexicon as a function of the acquired lexical category. The indirect assessment tool MB-CDI was also employed to obtain a global measure of the lexical repertoire and the language delay of these children.

1.1. Early lexical comprehension and production in typically developing and preterm children

The second year of life is a critical period for language acquisition because an increase in the lexical repertoire—first in comprehension, and then in production—is usually observed in typical development with a greater repertoire of comprehended words compared with produced words (Bello, Giannantoni, Pettenati, Stefanini, & Caselli, 2012; Caselli et al., 2012; Gershkof-Stowe & Hahn, 2013). This increase in the lexical repertoire is characterized by quantitative and qualitative changes. Nouns are acquired before predicates and are the most common lexical category until the third year of life, whereas the acquisition of predicates gradually increases with increases in the lexical repertoire (Caselli et al., 1995; Fenson, Marchman, Thal, Reznick, & Bates, 2007; Sansavini, Bello, et al., 2010; Waxman, Fu, Arunachalam, Leddon, & Geraghty, 2013).
The asymmetry in the acquisition of nouns and predicates reflects a different lexical organization of these categories, which may be dependent on cognitive and linguistic factors (Hall & Waxman, 2004). Nouns are associated with objects by predominantly employing extra-linguistic indexes, such as the socio-communicative context and the use of gaze following, actions and gestures such as pointing (Caselli et al., 2012). Predicates, such as verbs and adjectives, are associated with actions and properties of objects, respectively, by employing morpho-syntactic and extra-linguistic indexes.

Early lexical comprehension and production and lexical composition in preterm children have been mainly investigated using indirect assessment tools. Several studies have investigated the expressive lexicon via the use of the indirect assessment tool MB-CDI in very preterm children from two years onward, which revealed that they had a smaller lexical size than FT children at 2;0 years of CCA (Sansavini, Guarini, & Savini, 2011; Sansavini, Guarini, Savini, et al., 2011; Stolt et al., 2007). This difference was more evident when very preterm children with neurological damage (Foster-Cohen et al., 2007; Stolt et al., 2007) or mild cognitive delays (Foster-Cohen et al., 2007; Sansavini, Guarini, & Savini, 2011) were retained in the sample; this study found a significantly smaller vocabulary size and a less frequent use of decontextualized words and morphological word endings in extremely preterm (ELGA; GA < 28 weeks) compared with very preterm (VLGA; GA = 28–32 weeks) and FT children (Foster-Cohen et al., 2007; Kern & Gayraud, 2007) at 2;0 (CCA).

Conversely, few studies have investigated early lexical comprehension in the preterm population. A few longitudinal studies, performed between 0;9 and 1;6 by employing the indirect assessment tool MB-CDI, showed that very preterm infants compared with FT infants presented slower development in lexical comprehension at their CCA (Sansavini, Guarini, Savini, et al., 2011; Stolt et al., 2009) or CA (Cattani et al., 2010). Another study, which employed the Reynell test, revealed lower linguistic ability at 2;0 (CCA), as determined by their receptive and expressive scores, in very preterm infants compared with FT infants (Stolt et al., 2009). However, lexical comprehension has never been specifically examined in ELGA children.

With regard to lexical composition, few studies have examined it in the preterm population and only using the indirect assessment tool MB-CDI. The analysis of the expressive vocabulary showed that very preterm children at 2;0 years of CCA knew fewer nouns and predicates (verbs and adjectives) in various mother tongues, such as Finnish (Stolt et al., 2007), French (Kern & Gayraud, 2007), and Italian (Sansavini, Guarini, & Savini, 2011), compared with FT. With regard to receptive vocabulary, fewer nouns and predicates were learned by very preterm infants compared with FT infants between 0;9 and 1;3 (CCA) (Stolt et al., 2009) and at 1;6 (CCA) (Sansavini, Guarini, Savini, et al., 2011). However, the MB-CDI does not provide information regarding the frequency of the use of words for each lexical category; therefore, its use does not address the issue regarding the modalities of the acquisition of nouns and predicates in preterm infants.

These findings suggest the existence of some delays in the early language development of children who are born very preterm with regard to expressive and receptive skills. Although they also highlight the association between lower gestational age and the risk of language delay in this population of infants, this issue warrants further investigation in ELGA children, who are at higher risk for language delays. Particular attention should be paid to receptive skills and lexical composition, which have scarcely been investigated in preterm children and not yet examined in ELGA children. Receptive skills can inform us regarding the severity of the linguistic delays in these children, whereas lexical composition can examine how vocabulary is acquired and whether certain lexical categories exhibit a higher degree of impairment. Studies on early lexical comprehension and production and lexical composition using direct assessment tools in ELGA children are thus needed.

1.2. Spoken and gestural modalities in the early lexical acquisition of typically developing and preterm children

Observational studies of typically developing (TD) children between 1;0 and 1;4 indicate that they primarily convey meanings by deictic (e.g., pointing) and representational gestures (e.g., gestures that replicate action schemes that are usually observed or performed by children with objects, such as bringing a fist to the ear to communicate the word TELEPHONE or the phrase TO PHONE) and by combining gestures and spoken production. As the age gradually increases to 1;8, the spoken modality increases in terms of types and tokens and becomes dominant with respect to the gestural modality (Capirci & Volterra, 1996; Longobardi, Rossi-Arnaud, & Spataro, 2012; Stefanini, Bello, Iverson, Caselli & Volterra, 2009). Bimodal spoken-gesture combinations continue to be employed to convey information, as indicated by observational and experimental studies (Capirci, Iverson, Pizzuto, & Volterra, 1996; Longobardi, Rossi-Arnaud, & Sfatato, 2012; Stefanini, Bello, Iverson, Caselli & Volterra, 2009). For instance, in a cross-sectional study on TD children between the ages of two and seven, Stefanini et al. (2009) showed that two- and three-year-old children used bimodal expressions (i.e., combinations of pointing or representational gestures and words) more frequently than unimodal spoken expressions in a naming task (i.e., a preliminary version of the Picture Naming Game – PiNG – by Bello, Caselli, Pettenati, & Stefanini, 2010, described in the method of this study). Gesture production declined as a function of increasing age—older than 4;0—and increased spoken lexical competence.

With regard to preterm children, few studies have investigated their gestural abilities, and these studies primarily involved the use of indirect assessment tools, i.e., the MB-CDI parental questionnaire. Less-advanced gestural abilities in terms of the total number of produced gestures were identified in very preterm infants from 1;0 to 1;6 (CCA: Ortiz-Manilla, Choudhury, Leevers, & Benasich, 2008; Sansavini, Guarini, Savini, et al., 2011; or CA: Cattani et al., 2010) compared with FT infants. In addition to the score of total gestures, one of these studies distinguished between gestures (i.e., early gestures, which consist of deictic, conventional and social game gestures) and action gestures (i.e., late gestures, which are representational gestures, including actions on objects, pretending play actions and imitating adults’ actions) and showed
that the main difference between very preterm and FT infants involved action gestures, which were significantly less-produced by very preterm infants at 1:6 years of CCA (Sansavini, Guarini, Savini, et al., 2011). A recent study (Stolt et al., 2014) performed using a small sample of very preterm children (38% of the children had major brain abnormalities and 16% of the children had neurological impairment) discovered a lower number of early and late gestures in very preterm children compared with FT children between 0:9 and 1:3 (CCA), and a greater difference was observed for late gestures. These findings were significant even when preterm children with neurological impairment were excluded from the analyses. Another study, which was based on direct observations of mother–child interactions in a small sample of very preterm children, revealed that the number of produced gestures at 1:0, 1:6 and 2:0 (CCA) was similar to the number of gestures produced by FT infants with a prevalence of deictic gestures and some representational gestures; however, a significantly smaller number of gesture-word combinations was observed in very preterm children at 1:6 and 2:0 (CCA) compared with FT children (Suttora & Salerni, 2012). This study provided evidence of the weakness of resorting to bimodal combinations to convey meanings in this population. However, no study has investigated how preterm children and, specifically, ELGA children use gestures to access the lexicon and express meanings. This issue could be important to understanding whether ELGA children at 2:0 years of CCA, similarly to TD children, resort to a combination of gestures and words to access the lexicon or whether they are unable to use gestures as complement to their expression.

1.3. This study

Despite the relevance of examining early lexical comprehension, gestural abilities, and lexical production for studying early language development, no previous study, to the best of our knowledge, has focused on these abilities using direct assessment tools in the early years of life in ELGA children, who are a preterm group at higher risk of impairment in motor, cognitive and language development in infancy (Sansavini et al., 2014) and at school age (Johnson et al., 2009).

This study investigated the lexical abilities of ELGA children at 2:0 years of CCA compared with FT children using a noun and predicate comprehension and production structured test—the PiNG (Bello et al., 2012)—which considers both spoken and gestural responses.

The first aim of the study was to analyze the impact of an extremely preterm birth on response accuracy in a noun and predicate comprehension and production test using a FT control group for comparison purposes. The relevance of assessing the receptive and expressive lexicon at 2:0 has been highlighted by studies of late-talker children, which have indicated that slower developmental rates in lexical comprehension in this developmental period may be predictive of a language impairment (LI) at the preschool age and may distinguish LI children from children who recover (late-bloomers) and eventually generate a normal linguistic profile (Desmarais, Sylvestre, Meyer, Bairati, & Rouleau, 2008; Thal, Marchman, & Tomblin, 2013).

To obtain an in-depth understanding of the strategies employed by children in their verbal responses, correct responses and errors, i.e., incorrect responses and no responses, were considered. This study hypothesized that ELGA children would show a lower accuracy compared with FT children, i.e., a smaller number of correct responses and a larger number of incorrect responses and no responses, in terms of both lexical comprehension and production abilities. The types of incorrect responses—semantically related and unrelated—in noun and predicate production were also analyzed. A method of accessing the lexicon consists of resorting to a semantic network, which helps to obtain the exact word or a word that is semantically linked to the word (Caramazza, 1997; Levelt, 2001). TD children develop semantic networks during the second year of life (Bello et al., 2010). This study hypothesized that ELGA children would not have developed semantic networks by this time and would thus frequently produce incorrect semantically unrelated responses.

With respect to lexical categories, a lower accuracy was expected for both nouns and predicates, and even more difficulty was expected in the understanding and the production of predicates since these require more advanced cognitive mechanisms and the use of extra-linguistic and morpho-syntactic indexes (Waxman et al., 2013).

The second aim was to analyze how modalities of expression (unimodal spoken, bimodal spoken–gestural and unimodal gestural) and types of gestures (deictic and representational) are used by the ELGA and FT groups to convey meanings during the noun and predicate production test. In contrast with TD children, who frequently resort to bimodal expressions (i.e., combinations of gestures and words) in a naming task during this developmental period (Stefanini et al., 2009), we hypothesize that ELGA children would make fewer gestural attempts to recover meanings with a lower use of bimodal expressions and representational gestures, which reflects their difficulty in representing, organizing and accessing meanings.

To obtain a global evaluation of children’s linguistic competence, their vocabulary size and lexical composition were also examined using the indirect assessment tool the Italian MB-CDI short form. Some studies have demonstrated that the use of multiple tools, such as standardized tests, direct observations and transcriptions, as well as parental questionnaires, may contribute to a more extensive evaluation of language and a more accurate identification of language delays (Bello et al., 2012; D’Odorico, Majorano, Fasolo, Salerni, & Suttora, 2011; Stolt et al., 2009). The MB-CDI short form is a very useful tool for identifying language delays and for obtaining an estimate of the expressive lexical size and composition in a population with typical or atypical development (Bello et al., 2012; Caselli, Pasqualletti, & Stefanini, 2007; Fenson et al., 2007; Sansavini, Guarini, Savini, et al., 2011). The use of the MB-CDI may contribute to a definition of the incidence of lexical delay in ELGA children compared with FT children since it considers parental observation in daily contexts.
2. Method

2.1. Participants

Forty monolingual Italian ELGA children, who were born between 2004 and 2008, were recruited at birth from the Neonatal Intensive Care Unit (NICU) of Bologna University, which is one of the main tertiary-care level units equipped with assisted ventilation in the Italian region Emilia-Romagna. Cranial ultrasound scan (US) was carried out for all neonates within the first 4 days of life and then repeated weekly during the first month of life. Those neonates with abnormal US in the first month of life were re-examined weekly until normalization, and then two times per month until discharge. After discharge, all preterm infants returned for re-examination with the cranial US at the presumed date of birth and again at 3 months (CCA); they then entered into a follow-up program at the Day-Hospital of the Unit Neonatology (Bologna University). ELGA children were recruited for this study if they met three primary criteria at birth and at the follow-up controls until 24 months of CCA: (a) GA < 28 weeks, (b) absence of major neurological damage [i.e., periventricular leukomalacia (PVL), intra-ventricular hemorrhage (IVH) > II grade, and hydrocephalus], and congenital malformations, and (c) no indication of visual or hearing impairment [retinopathy of prematurity (ROP) > II grade and hearing loss]. The ELGA children (20 males and 20 females) had a mean gestational age of 26.7 weeks (SD = 1.2, range 24–28 weeks) and a mean birth weight of 841 g (SD = 224; range 475–1370 g).

At ascertainment, all ELGA children had some history of medical complications. These complications, ascertained during the hospital stay, were as follows: small size for gestational age (SGA, n = 9; 22%); respiratory distress syndrome (RDS) (n = 21; 52%), which requires mechanical ventilation; bronchopulmonary dysplasia (BPD), which is defined as the need for supplemental oxygen at 36 weeks of postconceptual age (n = 18; 45%); IVH of grade I or II (n = 2; 5%); ROP of grade I or II (n = 10; 25%); and hyperbilirubinemia treated with phototherapy (n = 28; 70%). In addition, 24 infants (60%) had persistent hyperechogenicity (HE) of white matter (≥14 days), as indicated by the cranial US; however, none of these infants had developed PVL because the HE of white matter had been completely resolved at three months in all cases.

The sample of ELGA children represents the general range of socioeconomic status (SES) strata, as estimated from the mothers’ highest level of educational attainment: two mothers (5%) had achieved the primary level (completed basic education), 23 mothers (57%) had achieved the secondary level (completed high school), and 15 mothers (37%) had achieved the college level (university/Master’s degree or higher degree).

Forty monolingual Italian FT children (21 males and 19 females), who were born in the same years as the ELGA children, were recruited to serve as the reference group. In accordance with the recruitment criteria, all of the FT infants should have experienced normal birth (GA > 37 weeks) and have no history of major neurological damage and/or congenital malformations, no visual or hearing impairments and exhibit an absence of hypoxic-ischemic anoxia. The FT children enrolled in this study had a mean gestational age of 39.5 weeks (SD = 1.2, range 37–42 weeks) and a mean birth weight of 3475 g (SD = 478; range 2500–4600 g). As with the ELGA children, these infants’ backgrounds spanned the low to high levels of SES, as determined based on the mothers’ highest level of education: four mothers (10%) had attained the primary education level, 15 mothers (38%) had attained the secondary level, and 18 mothers (45%) had attained the college level (university/Master’s degree or higher); data on this variable were missing for three children (7%).

No significant differences in the gender distribution were observed between the ELGA and FT samples with \( \chi^2(1, N = 80) = 0.05 \) and \( p = 0.823 \), and no significant differences were obtained in the maternal level of education, with \( \chi^2(2, N = 77) = 2.51 \) and \( p = 0.285 \). The distribution of the socioeconomic status (SES) strata in our samples of monolingual Italian children, as estimated from the mothers’ highest level of educational attainment, reflects the general range of the SES strata of children born of Italian mothers in the Italian region Emilia-Romagna, where the study was conducted.

The assessment of the ELGA children’s lexical and cognitive abilities was performed at their CCA to consider their level of neurobiological maturation. The mean age of the ELGA infants at the time of evaluation was 2;0.4 of CCA (SD = 13 days, range 1;11.13 to 2;1.8), and the mean age of the FT infants was 2;0.5 (SD = 14 days, range 1;10.27 to 2;1.14). The two groups did not significantly differ in age at the evaluation: \( t(78) = -0.473; p = 0.637 \). The ELGA children’s developmental quotient (DQ) mean score (M = 91.8, SD = 17.5), which was assessed by the Griffiths Mental Development Scales (Griffiths, 1996), was within the normal range according to the available normative values, even if below the mean (DQ, M = 100.5, SD = 11.8; Griffiths, 1996). Six ELGA children (15%) had a DQ < −2 SD (i.e., <76.8) that indicated a psychomotor impairment. When the six children with psychomotor impairment were excluded, the mean DQ (M = 97.8, SD = 9.98) of the ELGA children was within the normal range and below the mean of the available normative values (Griffiths, 1996), as for the entire ELGA sample. The presence of some children with a psychomotor impairment is consistent with the findings of studies that focused on the ELGA population (Marlow et al., 2005). All of the FT children presented a normal cognitive development, as reported by concordant reports from their pediatricians, teachers and parents.

The study satisfied the ethics guidelines for human subject protections, including adherence to the Italian legal requirements, and received formal approval from the Research Ethics Committee of the Department of Psychology at the University of Bologna. All of the parents of the ELGA and FT children provided informed written consent for participation in the study, data analysis and anonymous data publication.
2.2. Procedure

All of the children were assessed and audio-videotaped for subsequent transcription in a quiet room at the NICU of the hospital by the same trained psychologist. Prior to the test, the child was introduced to the room with his/her mother and left to play with toys such he/she became familiar with the environment and the psychologist. Once the child was familiarized, the psychologist began the test. The mother was told to remain inside the room but not to intervene during the test. The lexical comprehension and production abilities of the children were assessed via the direct tool Picture Naming Game (PiNG) (Bello et al., 2012), which was administered in two separate sessions (noun and predicate subtests) to prevent fatigue and possible bias in favor of or against specific items. The two evaluation sessions lasted about 20–25 min each, they were not restricted in time and short breaks were possible if needed by the child. If a child did not cooperate with the procedure of the task (e.g., he/she played with the materials presented by the psychologist without following the task), the task was considered as uncompleted and the data of the child were not considered for the analyses. The children’s vocabulary size was evaluated via the indirect tool Italian MB-CDI (Words and Sentences) short form (Caselli et al., 2007), which was completed by the parents during the week that corresponded to their child’s 2;0-birthday (CCA). The MB-CDI was completed by all of the parents of the ELGA children and by all of the parents of the FT children with the exception of one child.

2.3. Materials

Picture Naming Game (PiNG). This lexical test (Bello et al., 2012), which is validated for children aged 1;7 to 3;1, consists of four subtests: Noun Comprehension (NC), Noun Production (NP), Predicate Comprehension (PC) and Predicate Production (PP). The version of the PiNG employed in this study consisted of 24 lexical targets and two training items in the noun subtests, which represented objects/tools, and 22 lexical targets and two training items in the predicate subtests (thirteen representing actions, i.e., verbs, seven representing properties of objects, i.e., adjectives, and two representing spatial relationships among objects, i.e., locative adverbs). In the comprehension subtests (NC and PC), a photograph of the lexical target was presented by two photographs of distracters; the adult asked the child to point to or touch the photograph that corresponded to the labeled word. For example, in the NC subtest, the observer asked “Where is the cat?” and presented photographs of a cat, a dog and a television. In the PC subtest, the observer asked “Who is drinking?” and presented photographs of a child drinking, a child eating and a child grasping. The spatial arrangement of the photographs was randomized. In the production subtests (NP and PP), a single photograph of the lexical target was presented, and the adult asked “What is this?” for noun production (in the previous example, dog). For the PP tests, the adult asked “What is he/she doing?” for an action word (in the previous example, eating), “What is this like?” for a descriptive word (small), or “Where is it?” for a locative word (inside). If the child did not answer or provided an incorrect response, the adult repeated the question. For a more detailed description of the instrument and procedure, refer to Bello et al. (2012).

Italian MB-CDI (Words and Sentences) short form. This questionnaire (Caselli et al., 2007), which was designed for use with children aged 1;6 to 3;0, consists of a vocabulary list of 100 words across different categories (ten social words, forty-six nouns, thirty predicates, and fourteen function words), an item that asked the parents whether their children combine words, and a checklist of 12 pairs of sentences written both in a telegraphic and a complete style with function words. The vocabulary checklist and the item concerning the word combination completed by the parents were analyzed in this study.

2.4. Coding at the PiNG test

All communicative exchanges between the child and the psychologist from the moment a picture was placed in front of the child to the moment the child produced the response were transcribed. With regard to the comprehension subtests (NC and PC), the first response was analyzed. With regard to the production subtests (NP and PP), when a child provided an incorrect response or no response on the first attempt, he/she was given a second chance. In these cases, a “best response” criterion was adopted, i.e., if the child provided a correct response on the second attempt, he/she was given credit for providing a correct response. If neither response was correct, the first response was considered.

The children’s response accuracy and errors in both the comprehension (NC and PC) and production (NP and PP) subtests were analyzed. With regard to the production subtests (NP and PP), the types of incorrect responses, the spoken and gestural modalities of expression and the types of spontaneously produced gestures were also analyzed.

Response accuracy and errors in comprehension and production subtests. According to Bello et al. (2010, 2012), three types of responses were identified: correct, incorrect and no response. With regard to comprehension, the response was coded as correct if the child showed, indicated or took the photograph that corresponded to the target labeled by the adult, as incorrect if the child selected another target, and as no response if the child did not provide an answer. With regard to production, a response was coded as correct if the child provided the expected word for the photograph, intelligible phonologically altered forms (e.g., “cheta” instead of “forketta” [FORK]) or onomatopoeia (e.g., “bumma” instead of “cade” [IT FALLS]) corresponding to the expected word. Incorrect responses were responses in which the expected word for the photograph was not provided. Responses were coded as no response when a child declared that he/she did not know the word that corresponds to the presented photograph or did not provide an answer.

Types of incorrect responses for noun and predicate production subtests. The classification of incorrect responses was performed according to previous studies (Bello et al., 2010; Lucariello, Kyritzis, & Nelson, 1992). Incorrect responses
consisted of semantically related words, semantically unrelated words and unintelligible responses. Semantically related words are related to the expected word in the lexical category (e.g., “mare” [SEA] instead of “spiaggia” [BEACH]) or functional association (e.g., “pronto” [HALLO] instead of “telefona” [HE PHONES]). Semantically unrelated words have no semantic relationship with the expected target (e.g., “mano” [HAND] instead of “tavolo” [TABLE]). Unintelligible responses are productions with such an altered phonological form that they could not be recognized by the coder (e.g., “deo” instead of “camion” [LORRY]).

**Modality of expression and gestures produced in noun and predicate production subtests.** According to Stefanini et al. (2009), the modality of expression is coded as unimodal spoken, bimodal spoken-gestural or unimodal gestural. Unimodal spoken includes responses that are only produced in the spoken modality. Bimodal responses are produced by associating spoken and gestural modalities. Gestures associated with spoken responses can be deictic (POINTING and SHOW, e.g., the child said “cane” [DOG] POINTING to the dog) and representational (e.g., the child said “bum”—onomatopoeia meaning [IT FALLS]—and made the gesture of FALLING DOWN with his hand). Responses were coded as unimodal gestural when they conveyed a meaning that was only produced via the gestural modality (i.e., by representational gestures, e.g., the child made the gesture of COMBINING his/her hand with his/her hand). If the child used two consecutive modalities to express the same meaning (e.g., a bimodal response—POINTING to a swimmer saying “nuota” [HE SWIMS]—followed immediately by a unimodal gestural response—producing the gesture of SWIMMING with his hands/arms), both modalities were coded for that response (e.g., in the above example a bimodal response and a unimodal gestural response were coded).

Because our objective was to determine which modality the children used to express meaning, no responses, i.e., responses that did not convey any meaning, were not considered for the analysis of modality of expression.

**Reliability.** The data obtained for all of the ELGA and FT children (i.e., 100% of all trials) were independently coded from the tapes by two coders (the first and second authors). The reliability between the two coders (for all spoken and gestural productions and the modality of expression—spoken, bimodal and gestural) was assessed for all of the participants. The agreement between coders was 97% and 92% for the comprehension subtest and production subtest, respectively, 98% for the modality of expression, and 92% for gestures. Instances of disagreement, which primarily concerned unintelligible responses, were identified, and a third coder was asked to code the responses by selecting one of the two classifications proposed by the first two coders.

### 2.5. Coding for the Italian MB-CDI short form

A score of 1 was given for each item (word) produced by the child. The total number of words (i.e., lexical size) that were produced by the child and the presence/absence of word combinations were analyzed. The 10th percentile cut-point of the MB-CDI total words, in reference to the Italian normative values (Caselli et al., 2007), was employed to identify children that exhibit delays in expressive lexicon.

### 2.6. Statistical analyses

All of the statistical analyses were conducted using SPSS 19.0 for Windows with an alpha level of 0.05. Analyses of the PiNG noun and predicate comprehension and production subtests were performed on children who were able to complete the respective subtests (i.e., to complete all of the items of a subtest by giving one of the three types of possible response: correct, incorrect and no response).

Concerning the noun comprehension and production subtests, thirty-five ELGA (87%) and all FT (100%) children were able to complete the subtests (Fisher’s exact test: $p = 0.055$, tendency). The five ELGA children who were unable to complete the noun subtests (i.e., who did not cooperate with the procedure of the task) presented delays in lexical size, i.e., $<10$th percentile for the MB-CDI, and two of them had also a psychomotor impairment. Concerning the predicate comprehension and production subtests, a significantly lower number of ELGA ($n = 26$; 65%) compared with FT ($n = 37$; 92%) children were able to perform the subtests, $\chi^2(1, N = 80) = 9.04, p = 0.003$. Among the seventeen children unable to complete the predicate subtests, thirteen (eleven ELGA and two FT children) presented delays in lexical size in the MB-CDI, and five ELGA children of them had also a psychomotor impairment.

The normality and homogeneity of variance were assessed by applying the Kolmogorov–Smirnov test. Two repeated-measure multivariate analyses of variance (RM-MANOVAs) were employed to assess the effect of the group as a between-subject factor (ELGA vs. FT children), and the effect of the task (comprehension vs. production) and of the type of response (correct, incorrect and no response) as within-subject factors for noun and predicate subtests. Multivariate differences were estimated by Pillai’s trace, which is recommended because it is robust to violations of normality and homogeneity of dispersion. The Mann–Whitney test was employed to examine the differences between groups in terms of types of incorrect responses, modality of expression and spontaneous gestures in the PiNG noun and predicate production subtests because these variables were not always normally distributed in one or either group.

Independent $t$-tests and chi square analyses were used to explore the differences between the ELGA and FT groups in terms of the lexical size in the Italian MB-CDI and in lexical (i.e., above or below the 10th percentile) and grammatical delays (i.e., use or absence of combining words), respectively.

To ascertain that significant results were not biased by children with psychomotor impairment who completed the noun ($n = 4$) and the predicate ($n = 1$) subtests, all of the analyses were repeated, and these children were excluded.
3. Results

3.1. Response accuracy and errors in PING noun comprehension and production subtests

An overview of the data is presented in Table 1 (mean, SD, range) according to group, task and type of response, and the results of the RM-MANOVA are reported in Table 2.

The RM-MANOVA yielded a significant effect of Task, with a slightly higher number of accomplished items in comprehension ($M = 24$) compared with production ($M = 23.7$) and type of response. The number of correct responses ($M = 13.3$) was higher than the number of incorrect responses ($M = 6.5$; Bonferroni post hoc, $p < 0.001$) and no responses ($M = 4.1$; Bonferroni post hoc, $p < 0.001$), and the number of incorrect responses was higher than the number of no responses (Bonferroni post hoc, $p = 0.001$). The interactions group $\times$ type of response, task $\times$ type of response and group $\times$ task $\times$ type of response were significant (refer to Fig. 1 and Table 2). To clarify this triple interaction, an RM-MANOVA with group as the between-subject factor and task as the within-subject factor was performed for each type of response (correct, incorrect, and no response).

A smaller number of correct responses was obtained for ELGA ($M = 11.8$) children compared with FT children ($M = 14.7$; group effect: $F(1,73) = 11.1, p < 0.001, \eta^2_p = 0.13$), and a larger number of correct responses was obtained in comprehension ($M = 18.3$) than in production ($M = 8.3$; task effect, multivariate test: $F(1,73) = 498.3, p < 0.001, \eta^2_p = 0.87$), but the interaction between these variables was not significant. As shown in Fig. 1, which reports the data in percentages, a higher percentage of correct responses was observed in comprehension (70% in ELGA children and 83% in FT children) compared with production (29% in ELGA children and 40% in FT children) in both groups.

A larger number of incorrect responses was observed in production ($M = 8.4$) compared with comprehension ($M = 4.6$; task effect, multivariate test: $F(1,73) = 47.8, p < 0.001, \eta^2_p = 0.39$). No significant effect of group was obtained, but the group $\times$ task interaction was significant ($F(1,73) = 8.5, p = 0.005, \eta^2_p = 0.10$). As shown in Fig. 1, ELGA children produced a higher percentage of incorrect responses in comprehension ($M = 5.5$; 23%) compared with their FT peers ($M = 3.7$; 16%), whereas an opposite trend was observed for production (ELGAs: $M = 7.7$; 32%; FTs: $M = 9.1$; 38%).

A larger number of no responses was observed in ELGA ($M = 5.5$) compared with FT children ($M = 2.7$; group effect: $F(1,73) = 11.8, p < 0.001, \eta^2_p = 0.14$), and a higher frequency of no responses was obtained in production ($M = 7.1$) compared with comprehension ($M = 1.1$; task effect, multivariate test: $F(1,73) = 82.9, p < 0.001, \eta^2_p = 0.53$). The group $\times$ task interaction was significant ($F(1,73) = 4.4, p = 0.039, \eta^2_p = 0.06$) because the number of no responses showed a greater increase in ELGA children than in FT children from comprehension (ELGAs: $M = 1.8$; 8%; FTs: $M = 0.4$; 2%, refer Fig. 1) to production (ELGAs: $M = 9.1$; 38%; FTs: $M = 5$; 21%, see Fig. 1).

These results remained significant even when the preterm children with psychomotor impairment ($n = 4$), who were able to complete the noun subtests, were excluded from the analyses.

3.2. Response accuracy and errors in PING comprehension and production predicate subtests

An overview of the data is presented in Table 1 (mean, SD, range) according to group, task and type of response, and the results of the RM-MANOVA are listed in Table 2.

The RM-MANOVA yielded the main effect of task, with a slightly higher number of accomplished items in comprehension ($M = 21.9$) compared with production ($M = 21.2$) and type of response. The numbers of correct responses ($M = 8.3$) and incorrect responses ($M = 8.2$) were higher than the number of no responses ($M = 5.1$, Bonferroni post hoc for both comparisons, $p < 0.001$). The interactions group $\times$ type of response, task $\times$ type of response and group $\times$ task $\times$ type of response were significant.

Table 1

<table>
<thead>
<tr>
<th>Responses</th>
<th>Noun comprehension</th>
<th>Noun production</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELGA ($N = 35$)</td>
<td>FT ($N = 40$)</td>
</tr>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Correct</td>
<td>16.7</td>
<td>4.6</td>
</tr>
<tr>
<td>Incorrect</td>
<td>5.5</td>
<td>2.9</td>
</tr>
<tr>
<td>No response</td>
<td>1.8</td>
<td>2.0</td>
</tr>
<tr>
<td></td>
<td>Predictive comprehension</td>
<td>Predicate production</td>
</tr>
<tr>
<td></td>
<td>ELGA ($N = 35$)</td>
<td>FT ($N = 40$)</td>
</tr>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
</tr>
<tr>
<td>Correct</td>
<td>11.7</td>
<td>3.6</td>
</tr>
<tr>
<td>Incorrect</td>
<td>6.8</td>
<td>2.3</td>
</tr>
<tr>
<td>No response</td>
<td>3.3</td>
<td>3.3</td>
</tr>
</tbody>
</table>
Table 2
Summary of F, degrees of freedom, p and partial eta-squared ($\eta^2_p$) values of the two RM-MANOVAs for the noun and predicate PiNG subtests, which consider group (ELGA vs. FT children), task (comprehension vs. production) and type of response (correct vs. incorrect vs. no response). Significant results are shown in bold.

<table>
<thead>
<tr>
<th>Noun subtest</th>
<th>F</th>
<th>df</th>
<th>p</th>
<th>$\eta^2_p$</th>
<th>Predicate subtest</th>
<th>F</th>
<th>df</th>
<th>p</th>
<th>$\eta^2_p$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group</td>
<td>0.047</td>
<td>1.73</td>
<td>0.828</td>
<td>.001</td>
<td></td>
<td>0.847</td>
<td>1.61</td>
<td>0.361</td>
<td>.014</td>
</tr>
<tr>
<td>Task</td>
<td>10.67</td>
<td>1.73</td>
<td><strong>0.002</strong></td>
<td>.128</td>
<td></td>
<td>9.17</td>
<td>1.61</td>
<td><strong>0.004</strong></td>
<td>.131</td>
</tr>
<tr>
<td>Type of response</td>
<td>76.75</td>
<td>2.72</td>
<td><strong>&lt;0.001</strong></td>
<td>.681</td>
<td></td>
<td>12.77</td>
<td>2.60</td>
<td><strong>&lt;0.001</strong></td>
<td>.299</td>
</tr>
<tr>
<td>Group × Type of response</td>
<td>6.81</td>
<td>2.72</td>
<td><strong>0.002</strong></td>
<td>.159</td>
<td></td>
<td>5.02</td>
<td>2.60</td>
<td><strong>0.010</strong></td>
<td>.143</td>
</tr>
<tr>
<td>Task × Type of response</td>
<td>266.01</td>
<td>2.72</td>
<td><strong>&lt;0.001</strong></td>
<td>.881</td>
<td></td>
<td>238.45</td>
<td>2.60</td>
<td><strong>&lt;0.001</strong></td>
<td>.888</td>
</tr>
<tr>
<td>Group × Task × Type of response</td>
<td>4.23</td>
<td>2.72</td>
<td><strong>0.018</strong></td>
<td>.105</td>
<td></td>
<td>6.87</td>
<td>2.60</td>
<td><strong>0.002</strong></td>
<td>.187</td>
</tr>
</tbody>
</table>

Fig. 1. Mean percentage of correct (C), incorrect (INC) and no responses (NR) in the noun comprehension and production PiNG subtests produced by extremely preterm – ELGA (GA ≤ 28 weeks, N = 35) and full-term – FT (N = 40) children at 2;0 (corrected chronological age – CCA – for ELGA children).

response were significant (refer to Fig. 2 and Table 2). To clarify this triple interaction, an RM-MANOVA with group as the between-subject factor and task as the within-subject factor was performed for each type of response (correct, incorrect, and no response).

A larger number of correct responses was obtained in comprehension (M = 12.7) compared with production (M = 3.8; task effect, multivariate test: $F(1,61) = 455.5$, $p < 0.001$, $\eta^2_p = 0.88$), whereas group and group × task interactions were not significant. As shown in Fig. 2, in which the data are reported in percentages, the majority of the responses in comprehension were correct in both samples (ELGAs: M = 11.7; 53%; FTs: M = 13.7; 62%), whereas few responses in production were correct in both samples (ELGAs: M = 3.6; 16%; FTs: M = 4; 19%).

A larger number of incorrect responses was obtained in production (M = 9.9) compared with comprehension (M = 6.5; task effect, multivariate test: $F(1,61) = 31.5$, $p < 0.001$, $\eta^2_p = 0.34$). Group did not show a significant effect, but the group × task interaction was significant ($F(1,61) = 11.3$, $p = 0.001$, $\eta^2_p = 0.16$). ELGA children produced fewer incorrect responses (M = 8.2; 37%) in production compared with FT children (M = 11.6; 53%), whereas both groups of children produced a similar number of incorrect responses in comprehension (ELGAs: M = 6.8; 31%; FTs: M = 6.1; 28%, refer to Fig. 2).

A larger number of no responses was obtained in ELGA (M = 6.4) compared with FT children (M = 3.8; group effect: $F(1,61) = 10.8$, $p = 0.002$, $\eta^2_p = 0.15$), and a higher frequency of no responses was obtained in production (M = 7.5) compared with comprehension (M = 2.7; task effect, multivariate test: $F(1,61) = 52.8$, $p < 0.001$, $\eta^2_p = 0.46$). The group × task interaction was significant ($F(1,61) = 5.5$, $p = 0.022$, $\eta^2_p = 0.08$) because the number of no responses showed a greater
increase in ELGA compared with FT children from comprehension (ELGAs: $M = 3.3$; 15%; FTs: $M = 2.1$; 10%; refer to Fig. 2) to production (ELGAs: $M = 9.6$; 44%; FTs: $M = 5.4$; 25%; refer to Fig. 2).

These results remained significant even when the preterm child with psychomotor impairment, who was able to complete the predicate subtests, was excluded from the analyses.

### 3.3. Types of incorrect responses in the PiNG noun and predicate production subtests

Concerning the types of incorrect responses in noun production, the ELGA children produced fewer semantically related responses ($M = 2.7$) than the FT children ($M = 3.7$; $p = 0.032$; refer to Table 3), whereas no significant differences were observed in semantically unrelated and unintelligible responses between the two samples (refer to Table 3). In predicate production, semantically unrelated responses were less frequently produced by the ELGA sample ($M = 4.2$) than the FT sample ($M = 6.5$; $p = 0.010$; refer to Table 3), whereas no significant differences were observed in the semantically related and unintelligible responses between the two samples (refer to Table 3).

These results remained significant even when preterm children with psychomotor impairment, who were able to complete the noun ($n = 4$) and predicate subtests ($n = 1$), were excluded from the analyses.

<table>
<thead>
<tr>
<th>Noun production</th>
<th>ELGA ($N = 35$)</th>
<th>FT ($N = 40$)</th>
<th>Mann–Whitney test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>Range</td>
</tr>
<tr>
<td>Semantically related responses</td>
<td>2.7</td>
<td>2.1</td>
<td>0–8</td>
</tr>
<tr>
<td>Semantically unrelated responses</td>
<td>2.7</td>
<td>2.4</td>
<td>0–9</td>
</tr>
<tr>
<td>Unintelligible responses</td>
<td>2.2</td>
<td>2.5</td>
<td>0–12</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predicate production</th>
<th>ELGA ($N = 26$)</th>
<th>FT ($N = 37$)</th>
<th>Mann–Whitney test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$M$</td>
<td>$SD$</td>
<td>Range</td>
</tr>
<tr>
<td>Semantically related responses</td>
<td>2.6</td>
<td>2.0</td>
<td>0–7</td>
</tr>
<tr>
<td>Semantically unrelated responses</td>
<td>4.2</td>
<td>2.7</td>
<td>0–11</td>
</tr>
<tr>
<td>Unintelligible responses</td>
<td>1.3</td>
<td>2.0</td>
<td>0–17</td>
</tr>
</tbody>
</table>

---

**Fig. 2.** Mean percentage of correct (C), incorrect (INC) and no responses (NR) in the predicate comprehension and production PiNG subtests produced by extremely preterm – ELGA (GA ≤ 28 weeks, $N = 26$) and full-term – FT ($N = 37$) children at 2:0 (corrected chronological age – CCA – for ELGA children).
3.4. Modalities of expression and gestures produced in the PiNG noun and predicate production subtests

In the noun production subtest, the ELGA and FT children primarily produced unimodal spoken (ELGAs: $M = 6.9$; FTs: $M = 9.6$) and bimodal spoken-gestural responses (ELGAs: $M = 7.9$; FTs: $M = 9.4$), whereas few unimodal gestural responses were observed (ELGAs: $M = 0.3$; FTs: $M = 0.4$); no significant differences between the two samples were observed (refer to Table 4). The gestures produced by both samples in bimodal productions were mainly deictic (ELGAs: $M = 7.3$; FTs: $M = 8.3$), but a few representational gestures were also observed (ELGAs: $M = 0.4$; FTs: $M = 0.8$, refer to Table 4).

In the predicate subtest, both samples primarily produced unimodal spoken (ELGAs: $M = 7.4$; FTs: $M = 8.4$) and bimodal spoken-gestural responses (ELGAs: $M = 4.8$; FTs: $M = 7.6$), whereas unimodal gestural responses were infrequent (ELGAs: $M = 0.6$; FTs: $M = 0.8$). Fewer bimodal responses were obtained in ELGA with respect to FT children ($p = 0.021$; refer to Table 4). The gestures in bimodal responses produced by both samples were mainly deictic (ELGAs: $M = 4.3$; FTs: $M = 6.1$), but some representational gestures were also observed, with a lower production in ELGA ($M = 0.5$) compared with FT children ($M = 1.2$; $p = 0.048$; refer to Table 4).

When the preterm child with psychomotor impairment, who was able to complete the predicate subtests, was excluded from the analyses, the significant results obtained between the groups in terms of bimodal responses remained significant, in contrast with the results for representational gestures.

3.5. Lexical production for the Italian MB-CDI short form

The mean vocabulary size exhibited by the ELGA children ($M = 46.5$ words, $SD = 33.4$, range 2–100), which was evaluated using the Italian MB-CDI short form, fell within a normal range with respect to the normative values at 2;0 for Italian monolingual typically developing (TD) children (50th percentile = 46 words; Caselli et al., 2007) and did not significantly differ ($t = −1.4$, $p = 0.154$) from the mean vocabulary size exhibited by the FT children ($M = 56.2$, $SD = 26.1$, range 8–96).

However, the number of children with a lexical size below the 10th percentile ($\leq 15$ words; Caselli et al., 2007) was significantly higher in the ELGA group ($n = 11$; 27%) compared with the FT group ($n = 2$; 5%; $\chi^2(1, N = 79) = 7.19$, $p = 0.007$). Similarly, the number of children who were unable to combine two words was significantly higher in the ELGA ($n = 9$; 23%) compared with the FT group ($n = 1$; 3%), as shown by Fisher’s exact test ($p = 0.014$).

With regard to lexical composition, nouns were the most frequent lexical category in both samples, but a smaller number was found for ELGA children ($M = 23.5$, $SD = 16.6$, range 0–46) compared with FT children ($M = 30.1$, $SD = 13.6$, range 3–46; $t = −1.9$, $p = 0.058$). Predicates were less frequently produced by both samples (ELGAs: $M = 8.0$, $SD = 7.5$, range 0–21; FTs: $M = 10.5$, $SD = 7.1$, range 0–27; $t = −1.5$, $p = 0.140$).

4. Discussion

This study provides the first investigation of both lexical comprehension and production at 2;0 years of CCA using a direct assessment tool, the PiNG test, with a particular focus on nouns and predicates and considering both verbal and gestural responses in ELGA children. In the PiNG test, the response accuracy and errors, the types of incorrect responses, the modalities of expression and the spontaneous gestures were analyzed to acquire detailed knowledge of the lexical processes.

<table>
<thead>
<tr>
<th>Noun production</th>
<th>ELGA (N = 35)</th>
<th>FT (N = 40)</th>
<th>Mann–Whitney test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td>Modality of expression</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unimodal spoken</td>
<td>6.9</td>
<td>5.9</td>
<td>0–20</td>
</tr>
<tr>
<td>Bimodal spoken/gestural</td>
<td>7.9</td>
<td>4.9</td>
<td>1–21</td>
</tr>
<tr>
<td>Unimodal gestural</td>
<td>0.3</td>
<td>0.7</td>
<td>0–3</td>
</tr>
<tr>
<td>Gestures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deictic gestures</td>
<td>7.3</td>
<td>4.9</td>
<td>0–20</td>
</tr>
<tr>
<td>Representational gestures</td>
<td>0.4</td>
<td>0.6</td>
<td>0–3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Predicate production</th>
<th>ELGA (N = 26)</th>
<th>FT (N = 37)</th>
<th>Mann–Whitney test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>Range</td>
</tr>
<tr>
<td>Modality of expression</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unimodal spoken</td>
<td>7.4</td>
<td>5.0</td>
<td>0–19</td>
</tr>
<tr>
<td>Bimodal spoken/gestural</td>
<td>4.8</td>
<td>3.3</td>
<td>0–11</td>
</tr>
<tr>
<td>Unimodal gestural</td>
<td>0.6</td>
<td>0.8</td>
<td>0–3</td>
</tr>
<tr>
<td>Gestures</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deictic gestures</td>
<td>4.3</td>
<td>3.1</td>
<td>0–11</td>
</tr>
<tr>
<td>Representational gestures</td>
<td>0.5</td>
<td>0.9</td>
<td>0–4</td>
</tr>
</tbody>
</table>
associated with nouns and predicates. The children’s vocabulary size and lexical composition were evaluated by the indirect assessment tool Italian MB-CDI to obtain a more complete understanding of the children’s lexical size, composition and language delay.

4.1. Delays in early noun and predicate comprehension and production in extremely preterm children

This study contributes new knowledge regarding the early lexical abilities of ELGA children and demonstrates their delayed development in noun and predicate comprehension and production at 2;0 (CCA), despite the absence of psychomotor impairment in most (85%) of them. Although most (87%) of the ELGA children were able to complete the noun subtests, they produced significantly fewer correct responses in the noun comprehension and production tests compared with the FT children. The ELGA children also showed difficulties in predicate comprehension and production, as documented by two main findings. They demonstrated a significantly higher frequency of no responses in these subtests compared with the FT children. Furthermore, about one third of them was unable to complete the predicate subtests. Our findings also showed that 27% of the ELGA children presented delays in their lexical size in the MB-CDI; among those ELGA children with a lexical delay, about half of them was unable to complete the noun subtests, and all of them were unable to complete the predicate subtests.

The analysis of errors contributes to an understanding of the lexical difficulties of ELGA children. First, with regard to lexical comprehension, in addition to fewer correct responses in noun comprehension, the ELGA children reported more incorrect responses in noun comprehension and a greater frequency of no responses in both noun and predicate comprehension compared with FT children. Noun comprehension should be considered the first main index for evaluating language abilities and delay at 2;0 (CCA) in this population. Difficulty with coping with predicate comprehension appears as an additional index that should be considered. These findings highlight the relevance of evaluating lexical comprehension in ELGA children at 2;0 (CCA) and provide new evidence with respect to previous studies that show the relevance of evaluating lexical comprehension between 1;0 and 1;6 (CCA) in very preterm children (Sansavini, Guarini, Savini, et al., 2011; Stolt et al., 2014).

Second, with regard to lexical production, in addition to fewer correct responses in noun production, the ELGA children produced a greater frequency of no responses in both noun and predicate production compared with the FT children. The considerable number of no responses for unknown lexical targets observed in ELGA children proves that their lexical knowledge, even for nouns, which are acquired at an earlier age compared with predicates, remains limited. Two studies conducted on TD children (Bello et al., 2010) and Down Syndrome (DS) children (Bello, Onofrio, & Caselli, 2014) using the PING test showed that no responses are more frequent when the lexical repertoire is very small. However, for TD children at 2;0, correct and incorrect responses are produced at a higher frequency than no responses. The higher percentage of no responses provided by ELGA children compared with FT children might indicate the delays that they experience in meaning and semantic network construction. This finding is confirmed by the MB-CDI data, which indicate that even if the mean vocabulary size does not differ between the two samples, the lexical repertoire of the ELGA sample includes fewer nouns than the FT sample. Furthermore, the percentage of ELGA children who presented delays in lexicon (<10th percentile, 27%) and had not learned to combine words (23%) was significantly higher compared with that obtained for the FT group, which indicates that the ELGA sample is at a high risk for language delay; this finding extends to ELGA infants results obtained in previous studies conducted on very preterm samples at 2;0 (CCA) (Sansavini, Guarini, & Savini, 2011; Sansavini, Guarini, Savini, et al., 2011).

Third, the analysis of the types of incorrect responses might explain the lexical difficulties exhibited by ELGA children in comparison with FT children. According to Bello et al. (2014) the types of mistakes in a naming task may reveal the complexity and stability of semantic-conceptual representations and networks. ELGA children less frequently provided semantically related responses compared with their FT peers, who tended to seek a referent within the same semantic category. The semantic representation of nouns shown by ELGA children appears thus less developed and inaccurately defined. Considering the fact that concrete nouns are among the first acquired words because they refer to objects that are directly perceived as separate entities and are associated with objects by primarily employing perceptual, motor and socio-communicative extra-linguistic indexes (Gentner & Boroditsky, 2001), the weakness shown by ELGA children in noun comprehension and production emphasizes the relevance of their lexical lag. Conversely, both ELGA and FT children resorted to semantically unrelated responses in the predicate subtest due to the greater complexity of the conceptual and syntactic organization of predicates (Hall & Waxman, 2004), which has not been well mastered by either sample and even more by ELGA children, as indicated by their higher number of no responses. Verbs are more difficult to acquire because they express relational concepts, which vary across different contexts and different languages and require that both linguistic cues (e.g., morphosyntactic indexes) and extra-linguistic cues be learned (Gentner, 2006; Ozcaliskan, Gentner, & Goldin-Meadow, 2012). The relevance of analyzing the type of incorrect responses, i.e., semantically related and unrelated, has been confirmed by some developmental studies that discovered strict relationships between rich semantic representations and accurate naming (Barsalou, 1999; McGregor, Friedman, Reilly, & Newman, 2002) and between mistakes and difficulties in word retrieval, which is linked to the early phases of lexical acquisition and weak semantic representations (Belke, Brysbaert, Meyer, & Ghyselinck, 2005; McGregor, Newman, Reilly, & Capone, 2002).

Noun and predicate comprehension, noun production, the types of incorrect responses—semantically related and unrelated—and the number of no responses for nouns and predicates should thus be considered main indexes for evaluating
language abilities and delay in the ELGA population at 2;0 (CCA). The lexical delays exhibited by ELGA children compared to their FT peers cannot be simply ascribed to a global psychomotor impairment which characterized only 15% of the sample. In fact, most of the ELGA children exhibited global psychomotor development within a normal range, and the results remained significant even when those few ELGA children with a global psychomotor impairment, able to complete the noun and predicate tests, were excluded from the analyses. We hypothesize that the receptive and expressive lexical delays exhibited by ELGA children may be explained by their difficulty in employing both extra-linguistic and linguistic cues to recover and express meanings. For instance, the difficulty associated with maintaining prolonged joint attention on a referent with the adult, which was observed in mother–preterm infant interactions at the end of the first year (Landry, Smith, Miller-Loncar, & Swank, 1997; Sansavini et al., 2015), may delay the acquisition of early lexical categories, such as nouns. Linguistic difficulties may be attributed to the cascade-effect of domain-general difficulties, such as basic perceptual, attention, communicative and phono-articulatory abilities, in the first two years of life, as suggested by longitudinal studies on very preterm (D’Odorico et al., 2011; Rose, Feldman, & Jankowski, 2009; Sansavini, Guarini, Savini, et al., 2011; Van Noort-van der Spek, Franken, Wieringa, & Weisglas-Kuperus, 2010) and extremely preterm children (Sansavini et al., 2014; Van de Weijer-Bergsma, Wijnroks, & Jongmans, 2008).

Besides the linguistic difficulties exhibited by ELGA children, a few similar developmental trends were observed in ELGA and FT children. First, lexical comprehension was more developed than noun and predicate production in both samples. Our findings show that the advantage of comprehension with respect to production is evident not only in TD children, as noted by a previous study that utilized the same direct assessment tool (Bello et al., 2012), but also in ELGA children. An early development of nouns with respect to predicates in terms of comprehension and production was also identified in both samples in this study. This finding highlights that ELGA children present a lexical acquisition trend similar to that obtained for TD children via the direct assessment tool PiNG (Bello et al., 2012), the direct analysis of spontaneous speech (D’Odorico & Fasolo, 2007), and the indirect assessment tool MB-CDI (Caselli et al., 2007; Fenson et al., 2007), as well as to that observed in very preterm children via the indirect assessment tool MB-CDI (Sansavini, Guarini, & Savini, 2011; Sansavini, Guarini, Savini, et al., 2011; Stolt et al., 2009). These findings support the hypothesis that ELGA children exhibit a delay in early lexical acquisition but present developmental stages similar to those experienced by TD children in their early years of life. Because 27% of the ELGA sample showed a lexical delay in the MB-CDI and was unable to complete the predicate subtest, an investigation of whether ELGA children who were delayed at 2;0 recover or maintain this linguistic lag in the third year of life would be important. In a recent study, a stable gap in the linguistic and cognitive development of ELGA children with respect to FT children was observed from the first year of life to the third year of life, but marked inter-individual differences in the lags and rates of change in language development were observed in both groups (Sansavini et al., 2014).

4.2. Use of spoken and gestural modalities in noun and predicate production by extremely preterm children

Another important contribution of this study is an examination of the modalities of expression and the gestures produced to document the acquisition and organization of nouns and predicates exhibited by the ELGA and FT samples. Differences between the two samples were identified in predicate production, and the results revealed that knowledge was conveyed less frequently via the bimodal spoken-gestural modality by ELGA children compared with FT children. Regarding gestures, fewer representational gestures were produced by ELGA children in the predicate production subtest (i.e., in naming actions and object properties).

The spoken and gestural responses in this study are coherent for showing a more advanced acquisition of nouns with respect to predicates in both samples; however, a delay was exhibited by ELGA children with respect to FT children at 2;0 (CCA). ELGA children presented a limited spoken mastery of nouns and a scarce spoken and spoken-gestural mastery of predicates. The lesser use of spoken-gestural responses for predicates exhibited by ELGA children at 2;0 (CCA) is another important index for evaluating their lexical abilities and identifying language delay, which shows that these children are less capable than TD children in resorting to spoken-gestural combinations to express meanings. Studies that employ structured naming tasks with TD children have revealed that speech-gesture combinations are frequently utilized until 2;3 and then gradually decrease in favor of the unimodal spoken modality (Stefanini et al., 2009). In addition, a more frequent use of representational gestures to express predicates with respect to nouns has been cross-linguistically identified in TD children at 2;0, independently of the characteristics of the mother tongue, which confirms an evolutionary basis for the spoken-gestural modality of communication (Pettenati, Sekine, Congestri, & Volterra, 2012). Gestures provide a window into the semantic knowledge of children because they prove the presence of meaning representation in a child’s mind even when the phonological representation linked to it has not been consolidated (Capone, 2007). In TD children, gestures are primarily employed between the second and third years of life until a strict link between meanings and their phonological representations becomes consolidated. Conversely, in atypically developing children, such as Specific Language Impairment (SLI) children, whose phonological representations are weak, gestures and gesture-word combinations are used to formulate, conceptualize and express semantic representations for a longer period of time (Goldin-Meadow & Alibali, 2013; Kita, 2000; Mainela-Arnold, Alibali, Hostetter, & Evans, 2014).

The lesser use of spoken-gestural responses and representational gestures exhibited by ELGA children may be dependent on motor factors as well as cognitive and linguistic factors. The difficulties documented in motor development in the early years of life in preterm children (De-Kievit, Piek, Aarnoudse-Moens, & Oosterlaan, 2009) may delay their environmental exploration and object manipulation, which serves a role in constructing meaning that gradually shifts from actions to
symbols (Capirci, Contaldo, Caselli, & Volterra, 2005; Iverson, 2010). As suggested by some studies conducted on TD and atypically developing children, such as children with Developmental Coordination Disorder (DCD), SLI and Autism Spectrum Disorders (ASD) (for a review, see Leonard & Hill, 2014), the development of motor skills gives infants and children new opportunities to interact with others and increases their use of gestures and social interaction. Conversely, poor or atypical motor development, which is common in the early years of life in children with several neurodevelopmental disorders, can hinder communication and opportunities to explore the world and interact with other people and may cause a cascading effect on language and social communication development.

According to some researchers (Bello et al., 2014; Capone, 2007; Iverson, 2010; Stefanini et al., 2009), representational gestures indicate the activation of motor programs associated with objects, actions or properties of objects, and co-speech gestures recreate a “direct link” with the object or the action to be labeled. Thus, they recreate the context in which the word was initially acquired, especially when the word is not yet fully conceptualized. Recent neurophysiologic evidence on the functioning of the motor system (Rizzolatti & Arbib, 1998) supports this hypothesis of a strict link between motor programs associated with actions and gestures and spoken linguistic representations (Bernardi & Gentilucci, 2006; Capirci, Caselli, & De Angelis, 2010). A study on preterm children (Ruff, McCarton, Kurtzberg, & Vaughan, 1984) showed that lower levels of object manipulation are exhibited by high-risk preterm infants at nine months compared to low-risk preterm and FT children and that object manipulation is related to lower cognitive scores at 24 months. These findings suggest that reduced motor opportunities to gather information regarding the properties of objects in the first year of life may impact subsequent categorization and language processes.

Besides the lesser use of spoken-gestural responses and representational gestures exhibited by ELGA children, our findings show that they present some similarities with respect to FT children in terms of the modality of expression and the use of gestures. Unimodal spoken and bimodal spoken/gestural modalities were primarily employed by both samples, whereas the unimodal gestural modality was rare because both samples exhibited normal hearing and had been exposed to auditory linguistic input from birth. Deictic gestures, that help children share a referent with the adult and maintain their attention on the referent, were associated with speech in the children belonging to both samples to identify the referent in the picture, as observed in previous studies of TD children at the same age with a naming test (Stefanini et al., 2009).

4.3. Clinical implications

Our findings also provide suggestions for clinicians, speech-language pathologists and other professionals who need to examine the lexical abilities of ELGA children, identify early indexes of language delay and plan interventions to support delayed linguistic aspects. First, our findings confirm that both direct assessment tools, such as the PiNG test, and indirect assessment tools, such as the MB-CDI parental questionnaire, should be employed in investigations of lexical comprehension and production. In this study, the PiNG test enabled an accurate examination of comprehension and production abilities by capturing information regarding lexical access and organization of specific lexical categories, as well as the types of incorrect responses and the use of gestures that support lexical access. The MB-CDI short form enabled the identification of children who were delayed in language production and the estimation of their expressive lexical size and composition. Second, based on the data collected from the PiNG test, our findings suggest that specific interventions on lexical comprehension and production should be performed at 2;0 (CCA) with ELGA children, with a focus on nouns and predicates that support for both spoken and gestural responses and on incorrect responses, particularly semantically related responses.

5. Conclusion

Using the direct assessment tool PiNG test, the findings of this study show that ELGA children at 2;0 years of CCA, despite no psychomotor impairment except for 15% of the sample, exhibit lexical delays in the comprehension and production of nouns and have a scarce mastery of predicates compared with their FT peers, which is not compensated by the use of bimodal (gesture-word) expressions. A lesser use of nouns in daily familiar contexts and a delayed vocabulary size in 27% of the ELGA children were identified by the indirect assessment tool MB-CDI. Those ELGA children (27%) exhibiting a very small lexical repertoire were unable to complete the predicate substest.

These findings raise the issue of heterogeneous language outcomes in ELGA children: the majority of the children demonstrate a slower development but present patterns similar to those exhibited by younger TD children, whereas some children exhibit more important delays, which may evolve into severe language impairments. This early assessment via the direct tool PiNG test and the indirect tool MB-CDI provides useful indices for identifying language delay in ELGA children, which may help prevent persistent language impairment and suggest strategies for early intervention programs.

Subsequent studies can investigate the role of extra-linguistic domain-general factors, such as attention, perceptual and motor abilities involved in the process of early lexical comprehension and production. An investigation of whether delays and less-developed verbal and gestural strategies linked to ELGA children at 2;0 are also linked to less immature (i.e., very and moderate) preterm children would be important to understanding the role of the degree of neonatal immaturity on the development of receptive and expressive lexical abilities. Longitudinal observations of these children will also facilitate an understanding of whether the delays highlighted in comprehension and production at 2;0 will be recovered or persist in subsequent years and, in the latter case, whether ELGA children will employ bimodal spoken-gestural expressions and representational gestures to compensate for their language delay, as exhibited by atypically developing children.
Funding


We are grateful to The Fondazione Monte di Parma for a grant to the second author of this manuscript.

We are grateful to Cucciolo Associazione in Bologna dei Genitori dei Bambini nati pretermine (Association in Bologna of parents of preterm children) for funding the clinical activity and psychological research at the Unit of Neonatology of Bologna University.

Conflict of interest

The authors report no conflicts of interest. The authors are the sole persons responsible for the content and writing of the paper.

Acknowledgments

We are grateful to the parents and their infants for their participation in this study. We are grateful to Silvia Vandini for her help with the medical examination of the preterm infants. Elena Pace and Cristina Fabbri, we appreciate your help with the data coding.

Appendix A. Continuing education questions

1. ELGA children presented a significantly lower number of correct responses than FT peers:
   (a) in predicate comprehension and in predicate production sub-tests
   (b) in noun comprehension and in noun production sub-tests
   (c) in noun comprehension and in predicate production sub-tests
   (d) both in noun and predicate comprehension and production sub-tests.

2. Among ELGA children one out of 4:
   (a) had a psychomotor impairment
   (b) was unable to complete the noun sub-tests
   (c) completed only the noun and predicate comprehension sub-tests
   (d) was delayed in lexical size at the MB-CDI

3. ELGA children presented a significantly lower number of spoken-gestural responses:
   (a) in the predicate production sub-test
   (b) in the noun production sub-test
   (c) in both the noun and the predicate production sub-tests
   (d) in both noun and predicate comprehension and production sub-tests

4. ELGA children with respect to FT children presented:
   (a) fewer semantically related responses in predicate production
   (b) fewer semantically related responses in noun production
   (c) more unintelligible responses in noun production
   (d) more semantically unrelated responses in predicate production

5. For ELGA children interventions at 2 years should be planned to support:
   (a) lexical acquisition of nouns and predicates only through the spoken modality
   (b) only lexical acquisition of nouns
   (c) lexical acquisition of nouns and predicates through spoken and gestural modalities
   (d) only lexical acquisition of predicates

References


