

The early lexical development and its predictive value to language skills at 2 years in very-low-birth-weight children

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Abstract

The aim of this longitudinal study was to obtain information on the early lexical development and its predictive value to language skills in very-low-birth-weight (VLBW) children. The MacArthur Communicative Development Inventory was used to collect data of the early receptive and expressive lexicon of the 32 VLBW children. This information was compared to the data of 35 full-term controls. The children's language skills were tested using Reynell Developmental Language Scales at 2 years. The growth of the receptive lexicon was slower, and the language skills poorer in VLBW children. The early receptive lexicon growth was strongly associated with the performance in Reynell's test in VLBW children. The findings indicate that the small receptive lexicon size is an early predictor of delayed language development in VLBW children. The results also emphasise the need to assess the language development of the VLBW children in detail at an early age.

Learning outcomes: The reader becomes aware of the receptive and expressive lexical development of the VLBW children, and learns about the predictive value of early vocabulary growth to the language skills at 2 years of corrected age in this group of children.

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1. Introduction

The incidence of the speech and language problems is higher among prematurely born (born <37 gestational weeks) very-low-birth-weight (VLBW, birth weight <1500 g, and/or born <32 gestational weeks) children than in full-term children (e.g. Wolke & Meyer, 1999; Wolke, Samara, Bracewell & Marlow, 2008). Nevertheless, there are only a few follow-up studies focusing on the early linguistic development of this group. The purpose of the present study was to gain information of the early lexical development of the VLBW children. The precise information of the linguistic development of this group is needed to be able to recognise early those who need support.

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1.1. Early lexicon growth in VLBW children

The few studies related to the early receptive lexicon growth in VLBW children are controversial. Menyuk, Liebergott, Schultz, Chesnick and Ferrier (1991) followed the receptive lexical development of 26 prematurely born children including 12 VLBW children, and compared it to that of 27 full-term controls. The only difference detected in the receptive lexical growth between the groups of 12 VLBW and full-term children was that the former group acquired their first 10 comprehended words significantly later than the latter (Menyuk et al., 1991; compare also Menyuk, Liebergott & Schultz, 1995). However, in this study, the full-term controls attained the milestones for their receptive lexical development late (children as a group had acquired the first 10 comprehended words at 11, the first comprehended 50 words at 14, and the first 100 comprehended words at 17 months of age; Menyuk et al., 1991) if compared to the values presented in the literature. In the normative study of the MacArthur Communicative Development Inventory (CDI; Fenson et al., 1994) children as a group had acquired 67 comprehended words (the mean value, the median 41 words) at 10 months and 191 words (median 169) at 16 months of age (Bates, Dale & Thal, 1995). These values are comparable to that reported for Finnish children (Lyytinen, 1999). Thus, in the study of Menyuk et al. (1991) the slow acquisition of the receptive lexicon in full-term children might have contributed to the findings. Further, Riitesuo (2000) followed the early lexical development of 24 prematurely born children including 21 VLBW children during the first 2 years and reported that 16 of the 24 children had acquired their first 100 comprehended words at 16 months of corrected age. Altogether the findings related to the receptive lexical acquisition of VLBW children are inconsistent.

The findings of the two available longitudinal studies focusing on the expressive lexical development of VLBW children differ (Menyuk et al., 1991; Riitesuo, 2000). Menyuk et al. (1991) reported no difference in the expressive lexical acquisition between the groups of full-term and prematurely born children. However, similarly to the receptive lexicon, this group of full-term controls was also slow in their expressive lexical development (children as a group had acquired the first 10 words at 15 months, and the first 50 words at 19 months of age; Menyuk et al., 1991; compare also Menyuk et al., 1995) if compared to the values presented by Bates et al. (1995); at 12 months mean 10, median 6 words, at 16 months mean 64, median 40 words; also Lyytinen, 1999. Riitesuo (2000) reported that 18 of the 24 prematurely born children produced their first 50 expressed words later than at 18 months of corrected age. Further, Rvachew, Creighton, Feldman and Sauve (2005) found that VLBW children ($n = 13$) with bronchopulmonary dysplasia had significantly smaller expressive lexicon sizes at 18 months of age than healthier preterm ($n = 8$) and full-term children ($n = 10$). The recent cross-sectional studies focusing on the expressive lexicon at 24 months of age in VLBW children (Foster-Cohen, Edgin, Champion, & Woodward, 2007; Kern, 2007; Stolt et al., 2007) also report slightly divergent results. Foster-Cohen et al. (2007) reported there was a linear association between children's gestational age at birth and the later expressive vocabulary size. Kern (2007) found a significant difference in the lexicon size at 24 months between very preterm and full-term children. However, in two recent Finnish studies (Jansson-Verkasalo, 2003; Stolt et al., 2007) there was no statistically significant difference in the expressive lexicon size between VLBW and full-term children at 2 years although the mean value of the lexicon size for the VLBW group was lower than that of the full-term children in both studies. Further, it has also been reported that there might be differences in the composition of the expressive lexicon of the VLBW children when compared to that of the full-term children. Kern (2007) found that very preterm (born <32 weeks of gestation) children as a group had less nouns, predicates and grammatical function words, but more words typical of very early lexical acquisition (i.e. onomatopoeic expressions, names of the people, words related to daily routines) in their expressive lexicons compared to other prematurely born and full-term children at 24 months of age. In a recent study those VLBW children with the mental developmental index >85 in Bayley's test (Bayley, 1993) and large expressive lexicons, had less grammatical function words than full-term children at 2 years of corrected age (Stolt et al., 2007).

1.2. Early morpho-syntactic development in VLBW children

The studies focusing on the language structures report a significant difference between VLBW and full-term children at 2 years of age or earlier. Foster-Cohen et al. (2007), Jansson-Verkasalo (2003) and Kern (2007) found that VLBW children had a significantly shorter mean length of utterance than full-term controls. Jansson-Verkasalo (2003) reported that the VLBW children performed significantly poorer in Reynell Development Language Scales

than their matched controls at 24 months of age, and Casiro et al. (1990) that VLBW children were less likely to understand simple questions or to follow simple commands at 12 months of age than full-term children.

1.3. Lexical growth in full-term children

The full-term children show the first signs of word comprehension at the end of the first year, and the receptive lexicon is rapidly acquired after that (Fenson et al., 1994). The expressive lexical acquisition occurs slowly at the beginning of the second year, but the acquisition rate accelerates at the end of the second year in most children (Fenson et al., 1994). There is a very wide variation in the receptive and expressive lexical development between the normally developing full-term children during the second year (Fenson et al., 1994). During the early lexical development children acquire words belonging to different semantic categories (e.g. nouns, verbs, grammatical function words). The acquisition of the semantic lexical categories has been shown to occur in three developmental waves in relation to the growth of lexicon size (Bates et al., 1994; Caselli et al., 1995; in full-term Finnish children Stolt et al., 2007; Stolt, Haataja, Lapinleimu & Lehtonen, 2008). The very first acquired words are often onomatopoeic expressions or words connected to routine situations. When the lexicon size is roughly 50–200 words, the percentage of nouns is very high, but starts to decrease as children acquire more words in their lexicons. The acquisition of verbs is slower, and children acquire these words steadily parallel to the lexicon size. The acquisition of the grammatical function words (i.e. pronouns, prepositions, question words, quantifiers and connectives) is even slower than that of verbs. Bates et al. (1994) interpret that these developmental changes in the composition of the lexicon reflect a shift in emphasis from reference, to predication and to grammar.

1.4. The predictive value of early lexicon

The early lexical development has been shown to predict later linguistic skills. When the receptive lexicon is considered, Bates, Bretherton, and Snyder (1998) found that the parental reports of the words their child understood at 13 months of age were positively associated with the result of the formal test measuring the receptive lexicon at 28 months. Lyytinen (1999) reported that the receptive lexicon size at 1;2 measured using the Finnish version of the CDI (FinCDI; Lyytinen, 1999) associated significantly with the receptive score of the Reynell Developmental Language Scales (RDLS) at 18 and at 30 months of age. Moreover, Lyytinen, Eklund and Lyytinen (2005) found that the early poor receptive language skills were associated with the reading and spelling skills at 5;5 in children with a genetic risk for dyslexia. Also the early expressive lexicon predicts later linguistic performance. Bornstein and Haynes (1998) measured the vocabulary competence of the 184 full-term children at 20 months using different methods and compared this information to the verbal performance IQ at 48 months, and reported a significant positive correlation between the early vocabulary competence and later verbal IQ (Bornstein & Haynes, 1998). Lyytinen (1999) found a significant, positive correlation between the expressive lexicon size at 14 months and the expressive score in RDLS at 18 and 30 months. Rescorla (2005) reported that the expressive vocabulary score of the structured parental rating method at 2 years was a significant predictor of vocabulary, grammar, verbal memory and reading comprehension at 13 years in full-term children identified as late talkers between ages 24 and 31 months. Furthermore, the recent findings have also suggested that the early grammatical acquisition is strongly tied to the expressive lexicon growth at the end of the second year (e.g. Bates & Goodman, 1997; Stolt, Haataja, Lapinleimu & Lehtonen, in press).

1.5. Aims of the study

The purpose of this longitudinal study was to obtain information about the growth and the compositional development of the receptive and expressive lexicons in VLBW children, and to study the predictive value of the early lexical development to the language skills at 2 years of age.

2. Methods

2.1. Participants

The lexical development of 32 prematurely born VLBW children (20 males, 12 females) was compared to that of 35 full-term controls (18 males, 17 females). All the children born in Turku University Central Hospital between July

2001 and May 2005 and meeting the inclusion criteria of the study (1. birth weight ≤ 1500 g, 2. singleton, 3. mother's first born child, 4. a child of a monolingual Finnish-speaking family, 5. the family lives in Turku University Central hospital catchment area) were invited to participate in the study in the neonatal intensive care unit. Altogether 41 families were invited, 37 families agreed to participate, and the language development of 32 VLBW children (1 child died, 4 children dropped out) was followed up to 2 years. To collect the group of full-term controls, the children born in Turku University Central Hospital between November 2001 and April 2002 and meeting the inclusion criteria for the controls of the study (1. born >37 gestational weeks, 2. no admissions to the neonatal intensive care unit, 3. singleton, 4. mother's first born child, 5. a child of a monolingual Finnish-speaking family) were invited to the study in the maternity ward. Eighty families were invited, 44 families agreed to participate, and the language development of 35 children was followed up to 2 years. The main reason for the low participation percentage was an intensive study protocol. The detail analysis of the lexical development of these 35 full-term children is presented elsewhere (Stolt et al., 2008). The present study is part of a multidisciplinary follow-up study focusing on the development of very-low-birth-weight children (PIPARI study). The study protocol was approved by the Ethical Committee of the Hospital District of Southwest Finland in November 2001.

At 2 years of age 3 out of 32 VLBW children were diagnosed with cerebral palsy (Table 1) and 1 child with a bilateral hearing loss (the hearing thresholds without hearing aids 50 dB). All the full-term children were healthy and developing normally which was verified by clinical examination when the children were 1 year old. There was no significant difference in the gender distribution ($\chi^2(1) = 0.84, p = 0.36$), in the basic education of the mother ($\chi^2(1) = 0.74, p = 0.39$) or the father ($\chi^2(1) = 0.37, p = 0.55$) between the groups. However, the mental developmental index (MDI) of the VLBW children measured using Bayley's test (BSID II; Bayley, 1993) was lower than that of the full-term children ($t(65) = -4.2, p = 0.000$).

2.2. Methods

The standardised Finnish version of the MacArthur Communicative Development Inventory (CDI; Fenson et al., 1994; the Finnish version FinCDI; Lyytinen, 1999) was used to collect the data of the lexical development of both groups at five age points (corrected age was used for VLBW children). CDI is a well-known structured maternal rating instrument modified to be a representative index of early vocabularies. It has been shown to give information parallel to the formal language test (e.g. Fenson et al., 1994). The receptive lexicon information was gathered at 9, 12 and 15

Table 1

Characteristics of the very-low-birth-weight (VLBW, $N = 32$) and full-term (FT, $N = 35$) children and their parents. Means, standard deviations and minimum–maximum values are presented. If median values or percentages are used they are marked separately.

	VLBW		FT	
	<i>M</i> (S.D.)	Range	<i>M</i> (S.D.)	Range
Birth weight (g)	1032 (273)	525–1500	3560 (407)	2790–5040
Gestational age in weeks	28 (2)	23–34	40 (1)	37–42
Apgar 5 min (median)	7	3–9	9	7–10
MDI in BSID	98 (18)	60–124	113 (8)	86–126
Females/males	12 (38%)/20 (62%)		17 (49%)/18 (51%)	
Cerebral palsy	3		–	
Hearing impairment	1		–	
Severe visual impairment	–		–	
MDI <70	1		–	
<i>Mother's education</i>				
<9 years	–		–	
9–12 years	11 (34%)		9 (26%)	
>12 years	20 (63%)		26 (74%)	
<i>Father's education</i>				
<9 years	1		–	
9–12 years	15 (47%)		15 (47%)	
>12 years	15 (47%)		19 (59%)	

The data on parental education was missing in three cases (two fathers, one mother).

months using the infant form of the FinCDI (*Words and gestures*) and the data of expressive lexicon at 9, 12 and 15 months using the infant form, and at 18 and 24 months (corrected age was used for VLBW children) using the toddler form of the FinCDI (*Words and Sentences*). There are 380 items presented in 19 semantic categories in the infant form of the FinCDI. Parents are asked to mark on the form all the words their child understands, but does not say, and those words their child says. The toddler form of the FinCDI consists of 595 items presented in 20 semantic categories. The parents are asked to mark on the form those words their child says. All items, except two, that are included in the infant form are also included in the toddler form of the FinCDI.

The word was accepted as understood if child repeatedly showed a clear, immediate and correct response to the word (Benedict, 1979), and, respectively, the word was accepted as an expressed word if a child used it spontaneously and connected it repeatedly to the same referent (Lyytinen, 1999). These criteria were established at the meeting before the gathering of the lexical data began. Mother–child pairs were met at each five age point when the data was collected. The FinCDI was filled in before the meeting and it was reviewed with the mother during the appointment. At 2 years of age (corrected age was used for VLBW children) the language skills of the children were studied using the standardised Finnish version of the Reynell Developmental Language Scales (RDLS III; Edwards et al., 1997; Korttesmaa, Merikoski, Warma, & Varpela, 2001).

2.3. Analysis

In the analysis the comparisons were made in two stages. First, the values of all VLBW children were compared to those of full-term children. Then, the values of the VLBW children with no major neurological disability (NoDis) were analysed. Major neurological disability was defined as cerebral palsy, mental retardation (IQ < 70, bilateral hearing loss (≥ 40 dB) or severe visual impairment (e.g. Luoma, Herrgård, Martikainen, & Ahonen, 1998; Wolke & Meyer, 1999) diagnosed at two (Table 1). The development of the two groups of VLBW children were analysed separately to get precise information on the lexical development of both groups.

For the analysis of the lexicon growth, the total number of the words marked in the FinCDI at each data collection point as understood and expressed were compared between the groups. To accomplish the composition analysis the number of words in different semantic lexical categories marked in the FinCDI at each data collection point were calculated for each child, for receptive and expressive lexicon separately. The semantic categories were: social terms (i.e. onomatopoeic words, names of the people, routine words), common nouns (names of the people excluded; Bates et al., 1994), verbs (i.e. action words), adjectives (i.e. descriptive words), and grammatical function words (i.e. prepositions, pronouns, quantifiers, question words and connectives; Bates et al., 1994; Caselli et al., 1995). The compositional analysis was done in two stages. First, the raw values of social terms, nouns, verbs, adjectives and grammatical function words in the lexicons of the VLBW children were compared to those of the full-term controls at each age point, for receptive and expressive lexicons separately. Then, the percentages of the words in different lexical semantic categories counted from the total number of words in lexicon, in the vocabularies of similar sizes were compared between VLBW and full-term children (Caselli et al., 1995; Stolt et al., 2007), separately for the receptive and expressive lexicons. This was done because the compositional development has been shown to be tied to the lexicon growth (Bates et al., 1994), and because children at the same age can vary markedly in their lexicon size (Stolt et al., 2007; Thordardottir, Weismer & Evans, 2002). Thus, it was necessary to compare the compositions of the lexicons of similar sizes between VLBW and full-term children to verify that the possible differences in the vocabulary composition are not just due to the difference in the lexicon size. To make the comparisons, the following lexicon size subgroups were used: 1–9, 10–49, 50–99, 100–250 and >250 words in lexicon (Caselli et al., 1995). The first lexicon attained by a child and belonging under each lexicon size subgroup was used for the comparison (compare D’Odorico, Carubbi, Salerni, & Calvo, 2001). Because of the rather long time intervals between the data collection points, we were unable to gather the lexicon from each child for every lexicon size subgroup. The numbers of the children in each subgroup are presented in Table 4 (receptive lexicon) and Table 6 (expressive lexicon). There were no significant differences in the lexicon sizes between the VLBW and full-term children inside vocabulary size subgroups (Wilcoxon’s two sample test: receptive: 1–9 words $W = 185$, $p = 0.77$; 10–49 words $W = 635$, $p = 0.49$; 50–99 words $W = 354$, $p = 0.52$; 100–249 words $W = 434$, $p = 0.97$; >250 words $W = 17$, $p = 0.84$; expressive: 1–9 words $W = 780$, $p = 0.51$; 10–49 words $W = 741$, $p = 0.49$; 50–99 words $W = 104$, $p = 0.23$; 100–249 words $W = 95$, $p = 0.30$; >250 words $W = 213$, $p = 0.07$). The percentages of the words in lexical semantic categories were compared in the lexicons of similar sizes between all VLBW and full-term children only. The percentages of the semantic lexical categories in

the vocabularies of VLBW children with no major neurological disability were not analysed separately due to the small number of the subjects.

2.4. Statistics

The receptive and expressive lexicon sizes between the VLBW and full-term children were compared using the poisson regression analysis, and the generalized estimating equations were used in these analyses. Group, age and interaction between group and age were used as independent variables, and lexicon size as dependent variable. If there was a significant lexicon size by age–interaction, individual age points were analysed separately. If the effect of the group across individual age points was similar, only the result of the repeated-measures analysis was reported. The poisson regression analysis was used because it is better suited for the analysis of count data than linear regression. Generalized estimating equation is an extension of the repeated-measures methods used in normally distributed data. It can also be used in poisson distributed data. The independent samples *t*-test was used to compare the performance in RDSL III and the MDI values in Bayley's test between VLBW and full-term children. Other comparisons between two continuous variables were made using Wilcoxon's two sample test. The Chi square test was used to analyse whether there were significant differences in categorical variables between the VLBW and full-term children. Associations between the receptive and expressive lexicon sizes and the result of the RDLS III were studied using Spearman's correlation coefficients. Differences were considered statistically significant if the *p*-value was below 0.05. All significance tests were two-tailed. Statistical analyses were performed using SPSS for Windows (13.0, SPSS Inc.) or SAS for Windows (9.1, SAS Institute inc.).

3. Results

3.1. The growth of the receptive and expressive lexicon size in VLBW children

When the receptive lexicon sizes of all VLBW children were compared to those of the full-term children (Table 2), the receptive lexicon sizes of VLBW children were significantly smaller at each measured age point ($\chi^2(1) = 7.91$, $p = 0.005$). The receptive lexicons of the full-term children were estimated to be 1.8 times larger than those of all VLBW children (the confidence interval for the estimate 1.3–2.6). The effect of age on the receptive lexicon growth was significant ($\chi^2(2) = 45.91$, $p \leq 0.0001$). The interaction between groups and age on vocabulary growth was not significant ($\chi^2(2) = 4.16$, $p = 0.13$).

Table 2

Receptive and expressive lexicon sizes (mean and standard deviation) and the standard score of the Reynell Development Language Scales for FT children, for all VLBW children and for VLBW children with no major neurological disability (NoDis).

	FT <i>N</i> = 35		All VLBW <i>N</i> = 32		NoDis VLBW <i>n</i> = 27	
	<i>M</i> (S.D.)	Range	<i>M</i> (S.D.)	Range	<i>M</i> (S.D.)	Range
Receptive lexicon						
9 months	33 (42)	1–205	13 (14)	0–55	14 (15)	0–55
12 months	94 (68)	12–262	56 (44)	7–193	60 (45)	8–193
15 months	184 (78)	28–333	130 (79)	13–295	141 (80)	13–295
Expressive lexicon						
9 months	1 (2)	0–14	0 (1)	0–6	0 (1)	0–6
12 months	4 (6)	0–32	5 (7)	0–32	5 (8)	0–32
15 months	17 (18)	0–80	19 (28)	0–136	21 (30)	0–136
18 months	69 (63)	4–261	53 (77)	0–292	60 (82)	0–292
24 months	324 (118)	60–532	198 (167)	8–468	223 (169)	8–468
Reynell						
Total score	109 (13)	83–132	93 (18)	65–134	95 (18)	65–134
Receptive score	110 (15)	81–132	94 (19)	64–137	98 (17)	64–137
Expressive score	107 (12)	83–131	93 (15)	77–122	95 (15)	77–122

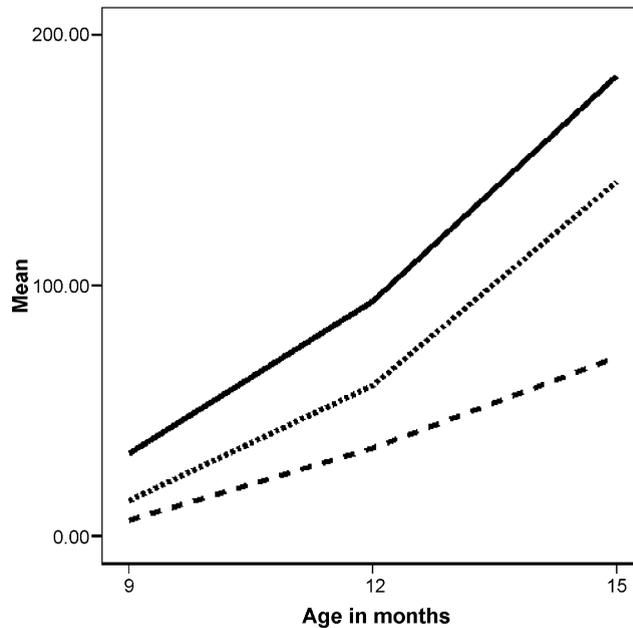


Fig. 1. The growth of the receptive lexicon in very-low-birth-weight children with ($n = 5$, dash line) and without ($n = 27$, dotted line) diagnosed neurological disability and in full-term controls ($N = 35$, solid line) between the ages of 9 and 15 months.

When the receptive lexicon sizes of the VLBW children with no major neurological disability were analysed, the receptive lexicons of VLBW children were significantly smaller than those of the full-term children at each measured age point ($\chi^2(1) = 6.22, p = 0.01$; Table 2, Fig. 1). The receptive lexicon sizes of the full-term children were estimated to be 1.7 times larger (the confidence interval for estimate 1.2–2.4). The effect of age on the receptive lexicon growth was significant ($\chi^2(2) = 39.92, p \leq 0.0001$). The interaction between groups and age was not significant ($\chi^2(2) = 3.95, p = 0.14$).

When the expressive lexicon growth of all VLBW children was compared to that of the full-term children (Table 2), the interaction between the groups and age on vocabulary growth was significant ($\chi^2(4) = 9.77, p = 0.045$). Thus, the effect of the group differed at different age points, and the values of the VLBW and full-term children were analysed separately at each age point. The expressive lexicon size of the VLBW children was significantly smaller than that of the full-term children at 24 months ($\chi^2(1) = 9.74, p = 0.002$). The expressive lexicon size of the full-term children was estimated to be 1.6 times larger than that of VLBW children (confidence interval for estimate 1.2–2.2). At no other age point was a significant difference in the expressive lexicon size detected between all VLBW and full-term children. The effect of age on expressive lexicon growth was significant ($\chi^2(4) = 32.87, p < 0.0001$).

For VLBW children with no major neurological disability, the expressive lexicon sizes of the VLBW children did not differ significantly from those of the full-term children ($\chi^2(1) = 0.11, p = 0.74$; Table 2, Fig. 2). The effect of age on the expressive lexicon growth was significant ($\chi^2(4) = 30.29, p \leq 0.0001$). The interaction between the groups and age in expressive lexicon growth was not significant ($\chi^2(4) = 8.72, p = 0.07$).

3.2. The compositional development of the receptive and expressive lexicon in VLBW children

The comparisons of the compositional development of the receptive lexicon between VLBW and full-term children at each age point are presented in Table 3. The acquisition order of the different semantic lexical categories to the receptive lexicon was generally the same in all VLBW children, and in VLBW children with no major neurological disability, when compared to that of full-term children. The social terms and common nouns were acquired first, then verbs, followed by adjectives and grammatical function words. There were significant differences, however, in the number of words in each lexical semantic category in the vocabularies of all VLBW and VLBW children with no major neurological disability when compared to the lexicons of the full-term children.

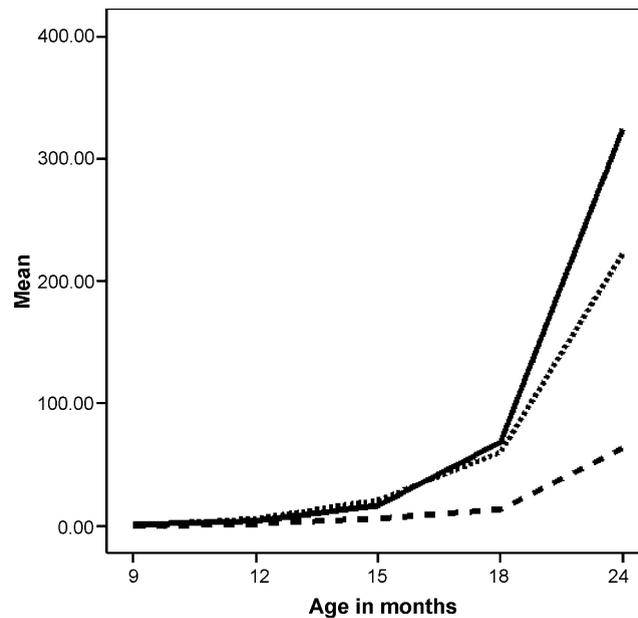


Fig. 2. The growth of the expressive lexicon in very-low-birth-weight children with ($n = 5$, dash line) and without ($n = 27$, dotted line) diagnosed neurological disability and in full-term controls ($N = 35$, solid line) between the ages of 9 and 24 months.

When the percentages of the semantic lexical categories in the receptive lexicons of similar sizes were compared between VLBW and full-term children, most proportions of lexical semantic categories were comparable (Table 4). However, the percentages of the grammatical function words were lower in VLBW than in full-term children in two lexicon size subgroups. In addition, the difference in the percentage of the grammatical function words between the groups was nearly significant in a third vocabulary size subgroup (Table 4).

When the compositional development of the expressive lexicon was analysed, the growth of semantic lexical categories occurred in a parallel manner in all VLBW children, and in those VLBW children with no major

Table 3

The comparison of the composition of the receptive lexicon between all VLBW and FT children, and between VLBW children with no major neurological disability (NODis) and full-term children at 9, 12 and 15 months of age. The raw values (mean and standard deviation) are presented.

	FT <i>M</i> (S.D.)	All VLBW <i>M</i> (S.D.)	Group comparison <i>p</i> -Value	NoDis VLBW <i>M</i> (S.D.)	Group comparison <i>p</i> -Value
At 9 months					
Social terms	10 (7)	6 (5)	0.01	6 (5)	0.03
Common nouns	14 (19)	5 (8)	0.04	6 (8)	0.09
Verbs	5 (10)	1 (2)	0.02	1 (3)	0.06
Adjectives	2 (4)	0 (1)	0.11	1 (1)	0.22
Function words	2 (3)	0 (1)	0.00	1 (1)	0.01
At 12 months					
Social terms	19 (9)	14 (7)	0.02	15 (7)	0.07
Common nouns	45 (35)	29 (24)	0.04	31 (25)	0.11
Verbs	16 (13)	7 (9)	0.00	8 (9)	0.01
Adjectives	5 (6)	2 (2)	0.02	2 (2)	0.07
Function words	6 (5)	2 (3)	0.00	3 (4)	0.00
At 15 months					
Social terms	28 (8)	23 (9)	0.03	24 (8)	0.10
Common nouns	93 (39)	69 (45)	0.03	75 (44)	0.11
Verbs	32 (15)	22 (16)	0.02	23 (16)	0.06
Adjectives	10 (6)	6 (5)	0.00	6 (5)	0.01
Function words	12 (7)	7 (6)	0.00	7 (6)	0.01

Table 4

The comparison of the composition of the receptive lexicons of similar sizes between VLBW and FT children. The values (mean and standard deviation) presented are the percentages counted from the total number of words in the lexicon.

	FT <i>M (S.D.)</i> <i>1–9 words, n = 12</i>	VLBW <i>M (S.D.)</i> <i>1–9 words, n = 19</i>	Group comparison <i>p-Value</i>
Social terms	72 (31)	63 (35)	0.51
Common nouns	11 (16)	29 (35)	0.15
Verbs	5 (10)	5 (9)	0.98
Adjectives	0	1 (4)	0.47
Function words	5 (5)	0	0.01
	FT <i>M (S.D.)</i> <i>10–49 words, n = 24</i>	VLBW <i>M (S.D.)</i> <i>10–49 words, n = 25</i>	Group comparison <i>p-Value</i>
Social terms	43 (14)	49 (21)	0.47
Common nouns	39 (13)	39 (17)	0.82
Verbs	9 (8)	7 (8)	0.60
Adjectives	2 (3)	2 (4)	0.58
Function words	5 (5)	3 (3)	0.03
	FT <i>M (S.D.)</i> <i>50–99 words, n = 17</i>	VLBW <i>M (S.D.)</i> <i>50–99 words, n = 21</i>	Group comparison <i>p-Value</i>
Social terms	23 (6)	25 (6)	0.24
Common nouns	47 (8)	51 (12)	0.13
Verbs	16 (6)	13 (7)	0.07
Adjectives	4 (2)	4 (3)	0.46
Function words	6 (3)	5 (4)	0.11
	FT <i>M (S.D.)</i> <i>100–249 words, n = 29</i>	VLBW <i>M (S.D.)</i> <i>100–249 words, n = 18</i>	Group comparison <i>p-Value</i>
Social terms	17 (3)	17 (4)	0.79
Common nouns	52 (6)	55 (7)	0.17
Verbs	17 (4)	17 (4)	0.84
Adjectives	5 (3)	4 (2)	0.12
Function words	6 (2)	4 (2)	0.05
	FT <i>M (S.D.)</i> <i>>250 words, n = 8</i>	VLBW <i>M (S.D.)</i> <i>>250 words, n = 3</i>	Group comparison <i>p-Value</i>
Social terms	13 (1)	14 (1)	0.62
Common nouns	48 (4)	52 (2)	0.16
Verbs	18 (1)	18 (1)	0.69
Adjectives	7 (1)	6 (0)	0.16
Function words	7 (2)	6 (1)	0.49

neurological disability, as in full-term children (Table 5). However, at 24 months of age, there were significant differences in the number of words in all lexical categories between the groups of all VLBW and full-term children. Also VLBW children with no major neurological disability had less social terms, nouns, verbs and adjectives than full-term controls at 24 months of age.

The comparisons between the compositions of the expressive lexicons of similar sizes in VLBW and full-term children showed that the percentage of nouns was significantly higher in VLBW than in full-term children in small lexicon sizes (1–9 words in the lexicon). No other differences were found when the expressive lexicons of similar sizes were compared between VLBW and full-term children (Table 6).

Table 5

The comparison of the composition of the expressive lexicon between all VLBW and FT children, and between VLBW children with no major neurological disability (NoDis) and full-term children at 9, 12, 15, 18 and 24 months of age. The raw values (mean and standard deviation) are presented.

	FT M (S.D.)	All VLBW M (S.D.)	Group comparison p-Value	NoDis VLBW M (S.D.)	Group comparison p-Value
At 9 months					
Social terms	1 (2)	0 (1)	0.27	0 (1)	0.40
Common nouns	0 (0)	0 (0)	0.74	0 (0)	0.89
Verbs	0 (0)	–	0.36	–	0.40
Adjectives	–	–		–	
Function words	–	–		–	
At 12 months					
Social terms	3 (3)	3 (3)	0.49	3 (3)	0.79
Common nouns	1 (3)	2 (4)	0.21	2 (4)	0.11
Verbs	0 (0)	0 (0)	0.89	0 (0)	0.92
Adjectives	–	–		–	
Function words	0 (0)	0 (0)	0.63	0 (0)	0.73
At 15 months					
Social terms	8 (6)	7 (7)	0.11	7 (7)	0.33
Common nouns	7 (10)	9 (17)	0.41	11 (18)	0.68
Verbs	1 (1)	1 (2)	0.68	1 (2)	0.73
Adjectives	0 (1)	0 (1)	0.78	0 (1)	0.96
Function words	0 (1)	1 (1)	0.44	1 (1)	0.40
At 18 months					
Social terms	17 (7)	13 (11)	0.04	14 (11)	0.17
Common nouns	37 (41)	28 (46)	0.10	32 (49)	0.26
Verbs	6 (8)	5 (11)	0.02	6 (11)	0.08
Adjectives	2 (4)	2 (3)	0.21	2 (4)	0.41
Function words	3 (4)	3 (5)	0.25	3 (5)	0.49
At 24 months					
Social terms	38 (8)	27 (14)	0.00	29 (14)	0.02
Common nouns	162 (53)	97 (82)	0.00	109 (83)	0.02
Verbs	57 (29)	33 (34)	0.00	38 (34)	0.02
Adjectives	21 (12)	12 (12)	0.00	14 (12)	0.02
Function words	24 (12)	15 (15)	0.01	17 (15)	0.06

3.3. Associations between receptive and expressive lexicons

The Spearman's correlation coefficient values for receptive and expressive lexicon sizes at different age points for VLBW children are presented in Table 7.

3.4. The predictive value of the early lexicon to the language skills at 24 months

The VLBW children performed significantly weaker than full-term controls in RDLS III at 2 years of corrected age (see Table 2 for descriptive statistics; All VLBW children: total score $t(65) = -4.4$, $p < 0.0001$, receptive score $t(65) = -3.7$, $p = 0.0005$, expressive score $t(65) = -4.5$, $p < 0.0001$; VLBW children with no major neurological disability: total score $t(60) = -3.52$, $p = 0.0008$, receptive score $t(60) = -2.9$, $p = .005$, expressive score $t(60) = -3.7$, $p < 0.0005$).

The receptive lexicon sizes at 12 and at 15 months of age strongly predicted the performance in RDLS III at 2 years. The expressive lexicon size already predicted the performance in RDLS III at 12 months, but the correlations were stronger at 18 months of age. The parallel results were found in all VLBW children, and in those VLBW children with no major neurological disability (Table 8).

Table 6

The comparison of the composition of the expressive lexicons of similar sizes between VLBW and FT children. The values (the mean and standard deviation) presented are the percentages counted from the total number of words in the lexicon.

	FT <i>M</i> (S.D.) <i>1–9 words, n = 27</i>	VLBW <i>M</i> (S.D.) <i>1–9 words, n = 27</i>	Group comparison <i>p</i> -Value
Social terms	83 (29)	66 (36)	0.07
Common nouns	14 (28)	31 (36)	0.04
Verbs	1 (2)	2 (10)	1.00
Adjectives	0	0	1.00
Function words	0	0	1.00
	FT <i>M</i> (S.D.) <i>10–49 words, n = 27</i>	VLBW <i>M</i> (S.D.) <i>10–49 words, n = 26</i>	Group comparison <i>p</i> -Value
Social terms	54 (16)	50 (17)	0.48
Common nouns	34 (15)	38 (17)	0.60
Verbs	6 (5)	5 (4)	0.36
Adjectives	1 (1)	2 (3)	0.16
Function words	1 (3)	3 (4)	0.15
	FT <i>M</i> (S.D.) <i>50–99 words, n = 14</i>	VLBW <i>M</i> (S.D.) <i>50–99 words, n = 10</i>	Group comparison <i>p</i> -Value
Social terms	29 (6)	28 (6)	0.71
Common nouns	53 (10)	56 (8)	0.44
Verbs	5 (2)	5 (3)	0.71
Adjectives	3 (3)	2 (2)	0.36
Function words	4 (3)	2 (3)	0.27
	FT <i>M</i> (S.D.) <i>100–249 words, n = 15</i>	VLBW <i>M</i> (S.D.) <i>100–249 words, n = 9</i>	Group comparison <i>p</i> -Value
Social terms	16 (4)	18 (6)	0.45
Common nouns	58 (5)	56 (8)	0.23
Verbs	10 (5)	10 (4)	0.84
Adjectives	4 (1)	4 (2)	0.72
Function words	5 (2)	7 (3)	0.58
	FT <i>M</i> (S.D.) <i>>250 words, n = 24</i>	VLBW <i>M</i> (S.D.) <i>>250 words, n = 14</i>	Group comparison <i>p</i> -Value
Social terms	11 (1)	12 (2)	0.10
Common nouns	50 (4)	50 (5)	0.82
Verbs	18 (3)	17 (3)	0.28
Adjectives	7 (1)	6 (2)	0.13
Function words	8 (2)	8 (2)	0.95

3.5. Summary of the results

In the present longitudinal study VLBW children acquired their receptive lexicons at a slower rate with some qualitative differences in the compositional development when compared to full-term controls. There were significant differences in the quantitative growth of expressive lexical development between the groups only if VLBW children with major neurological disability were included in the analysis. Hardly any group differences were detected in the composition of the expressive lexicon when the lexicon size was taken into consideration. VLBW children performed significantly poorer than full-term children in the RDLS III at 24 months of age even if those with major neurological disabilities were excluded. The receptive lexicon size from 12 months onwards strongly predicted the performance in

Table 7

Correlations (r) between receptive and expressive lexicon sizes for very-low-birth-weight children.

All VLBW	Expressive: All VLBW				
	9 months	12 months	15 months	18 months	24 months
Receptive					
9 months	0.43*	0.14	0.04	0.03	0.10
12 months	0.23	0.17	0.10	0.27	0.37
15 months	0.20	0.22	0.23	0.41*	0.56***
Expressive					
9 months		0.38*	0.36	0.37*	0.34
12 months			0.73***	0.64***	0.55**
15 months				0.90***	0.69***
18 months					0.84***
NoDis VLBW	Expressive NoDis: VLBW				
	9 months	12 months	15 months	18 months	24 months
Receptive					
9 months	0.44*	0.10	0.06	0.00	0.06
12 months	0.22	0.07	0.11	0.28	0.39*
15 months	0.16	0.09	0.20	0.38	0.55**
Expressive					
9 months		0.38	0.34	0.35	0.32
12 months			0.73***	0.68***	0.61***
15 months				0.93***	0.75***
18 months					0.86***

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

Table 8

Correlations (r) between the receptive and expressive lexicon sizes and language skills at two in all VLBW and in VLBW children with no neurological disability (NoDis).

Lexicon	All VLBW Reynell expressive score	All VLBW Reynell receptive score	All VLBW Reynell total score	NoDis VLBW Reynell expressive score	NoDis VLBW Reynell receptive score	NoDis VLBW Reynell total score
Receptive						
9 months	0.18	0.37*	0.30	0.12	0.33	0.24
12 months	0.48**	0.69***	0.67***	0.52**	0.70***	0.68***
15 months	0.58***	0.73***	0.73***	0.59**	0.69***	0.71***
Expressive						
9 months	0.12	0.09	0.10	0.05	0.07	0.06
12 months	0.44*	0.40*	0.41*	0.49**	0.43*	0.45*
15 months	0.55*	0.38*	0.44*	0.61***	0.40*	0.49**
18 months	0.68***	0.58***	0.64***	0.70***	0.55**	0.63***
24 months	0.86***	0.73***	0.81***	0.83***	0.70***	0.78***

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

RDL3 III. The early expressive lexicon size also predicted the performance in RDL3 III, but strong associations did not occur before 18 months of age.

4. Discussion

Prematurely born VLBW children acquired their early receptive lexicons at a significantly slower rate than full-term children. One explanation for this finding could be found in the difficulty in the auditory processing skills. Jansson-Verkasalo (2003) found that VLBW children had difficulty in the auditory processing measured using the auditory event related potentials. The mismatch negativity (MMN) amplitudes were smaller in VLBW children than in controls. A weaker object-naming ability at 4 years of age was detected parallel to the diminished MMN amplitudes. Mikkola et al. (2007) reported differences in the auditory event-related potentials between preterm children and their controls at 5 years. The values correlated with the results of the language tests. Thus, VLBW children in the present study might have had weaker auditory processing skills than full-term controls explaining the weaker early receptive lexical acquisition. Further, also qualitative differences were detected in the receptive lexicon growth: the percentage of the grammatical function words was lower in the lexicons of VLBW children compared to the lexicons of the full-term controls. The acquisition of the grammatical function words has been interpreted as a first sign of the emergence of grammar at least in the expressive lexicon (Bates et al., 1994). The grammatical function words take their meaning from the linguistic context, whereas nouns refer to things often visible and easy to grasp. Thus, the mapping between the linguistic symbol (i.e. word) and its referent is less linguistically demanding in nouns than in function words (Gentner & Borodistky, 2001). The smaller number and percentage of these words in the receptive lexicons of VLBW children at an early age may reflect later difficulties in the acquisition of grammatical structures.

The findings related to expressive lexical acquisition were minor if compared to the findings in the receptive lexical development, because VLBW children with no major neurological disability did not differ from the full-term children in their expressive lexicon size. This result is consistent with Jansson-Verkasalo (2003) and Sansavini et al. (2006) who also reported no significant difference in the expressive lexicon size between VLBW and full-term children at 24 and 28 months, respectively. Neither was there a significant difference in the expressive lexicon size between 66 VLBW (12 of the VLBW children in the present sample were included in this larger sample) and 87 full-term children at 2 years of corrected age in our earlier study (Stolt et al., 2007). It may be that the difficulties VLBW children have in their linguistic development are not clearly visible in the early expressive lexical acquisition, but in other language domains, such as receptive language or in grammatical structures. Further, the expressive lexical acquisition occurs slowly at the beginning of the second year, and the very early small expressive lexicons consist mainly of social terms and nouns (Bates et al., 1994). At this early stage of lexical acquisition nouns often refer to visible objects. Thus, at the early stages of lexicon growth the acquisition of nouns is less linguistically demanding than for example the acquisition of grammatical function words that take meaning from language structures (Gentner & Borodistky, 2001). It is possible that the differences in the compositional development of the expressive lexicon become more evident later as the lexicon size grows and the lexicons include more words belonging to different lexical categories (e.g. grammatical functions words, verbs).

Present study gave detailed information of the compositional development of the receptive and expressive lexicons in a longitudinal sample of VLBW children. The findings showed that the shift from reference to predication and to grammar (Bates et al., 1994; Caselli et al., 1995) happened in both lexicons generally in a parallel manner in VLBW children as in full-term controls during the second year. To our knowledge, there are no earlier studies providing detailed information of the compositional development of both lexicons during the second year in VLBW children (see however Menyuk et al., 1995). In our earlier study (Stolt et al., 2007) we analysed the composition of expressive lexicon of a cross-sectional sample of 61 VLBW children (12 of the VLBW children in the present sample were included in this larger sample) and compared it to that of the cross-sectional sample of 84 full-term children. The findings of these two studies are parallel despite of the fact that the samples are different (i.e. longitudinal vs. cross-sectional). These results suggest that the compositional development of early lexicon is tied to the lexicon growth, and not necessarily to the age of a child in VLBW and in full-term children (compare Bates & Goodman, 1997; Stolt et al., 2008).

The language skills of the VLBW children were significantly weaker than those of the full-term children when measured using the formal language test at 2 years. This result is parallel with earlier findings (e.g. Casiro et al.,

1990; Jansson-Verkasalo, 2003; Vohr, Coll & Oh, 1988). Earlier studies, like our study, suggest that the language problems in this group also appear independently of neurological difficulties (Casiro et al., 1990; Landry, Smith & Swank, 2002). Furthermore, in the present study the detected differences in the language skills were not due to the background variables (compare Foster-Cohen et al., 2007) as the parental education did not differ between the groups. The groups were also comparable regarding parity, singleton/multiple birth and linguistic background. However, there was a group difference in the overall cognitive development measured using BSID II. The mental developmental index in BSID II is a composite score including only a few sections measuring language skills, and even fewer measuring receptive language. Therefore, normal cognitive performance measured using MDI does not exclude a language delay (e.g. Siegel, Cooper, Fitzhardinge & Ash, 1995). The problems in the linguistic development may be even more difficult to perceive if they appear in the receptive language. Our findings support this view since in the present study there were 6 VLBW children with MDI score below 85 (standard scores), but 13 with the receptive score below 85 (standard scores) in RDSL III. Our findings propose that the language development of the VLBW children should be carefully followed using appropriate methods to assess both receptive and expressive language in order to find early those requiring support in their linguistic development.

The early lexicon size of the VLBW children was associated with the performance in RDSL III at 2 years. The association between the early receptive lexicon and the language skills was stronger than the association between the early expressive vocabulary and the performance in RDSL III at 24 months of age. The parallel findings have been reported in full-term children. For example Lyytinen (1999) reported an association between the lexicon size at 1;0 and at 1;2 and the performance in RDSL at 18 months, and this association was stronger for receptive than for expressive vocabulary. In the present study VLBW children also acquired their receptive lexicons at a significantly slower rate than full-term controls. These findings propose that the early receptive lexical acquisition is a clinically useful predictor to find those VLBW children with a delayed language development.

The very early receptive lexical acquisition was not associated with the early expressive lexical growth. This finding is parallel with the literature. Bates et al. (1995) reported dissociation between receptive and expressive lexical growth: the receptive lexicon sizes of those children with small expressive lexicons varied from very small to large ones. Bates et al. (1995) proposed that it is possible that different neural systems mediate comprehension and expression, and this is the reason for the dissociation between these two language domains.

In the present study, the structured maternal rating method (FinCDI) was used to measure the early lexical development. This method is used extensively in the field of child language research, and it has been proved to give information parallel to the formal tests (e.g. Fenson et al., 1994; Lyytinen, 1999). The simultaneous correlations between the results of the FinCDI and those of the RDSL III were highly significant in the present study (e.g. Lyytinen, 1999) supporting the view that the structured maternal rating method offers a cost-effective and economic way to screen the early linguistic growth of the VLBW children in the clinical context (Fenson et al., 1994). One has to note however that the toddler form of the FinCDI does not cover the receptive language. Other methods are needed to measure the development in this language domain.

The sample of VLBW children in the present work was representative since all the children born in Turku University Central Hospital filling the intake criteria were invited and very many of the families agreed to participate. Fewer of the invited families agreed to participate in the full-term children's group however. Thus, there may be a possible bias towards the families who are interested in their children's language development especially in the group of full-term children.

4.1. Conclusions

The present study provides detailed information of the quantitative and qualitative development in early lexical acquisition in VLBW children in a controlled longitudinal study. The findings show differences especially in the receptive lexical growth and in the language skills at 2 years. The results propose that the small receptive lexicon size is an early sign of the delayed language development in VLBW children. The findings emphasise the need to assess the language development of the VLBW children in detail at an early age.

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Appendix A. Continuing education questions

1. The growth of the receptive lexicon in VLBW children without major neurological disability:
 - a. happened at the same rate as in full-term children.
 - b. was significantly slower at the beginning but accelerated.
 - c. happened at a significantly slower rate than in full-term children.
 - d. did not differ from that of those VLBW children with major neurological disability.
2. The growth of the expressive lexicon in VLBW children without major neurological disability:
 - a. happened at the same rate as in full-term children.
 - b. was significantly slower at the beginning but did not differ from that of the full-term children at 2 years of corrected age.
 - c. did not differ from that of the full-term children at the beginning of the second year, but at 2 years of corrected age the lexicon size was significantly lower than in full-term children.
 - d. was parallel to that of the VLBW children with major neurological disability.
3. The compositional development of the receptive lexicon in VLBW children:
 - a. happened in a parallel manner as in full-term children when the comparisons were made at each age point the data was gathered.
 - b. VLBW children without major neurological disability had less grammatical function words in their receptive lexicon at each age point, but no other differences were detected.
 - c. happened in a parallel manner as in full-term children when analysed in relation to the lexicon size (i.e. the comparisons were made between those VLBW and full-term children with lexicons of similar size).
 - d. happened otherwise in a parallel manner as in full-term children when analysed in relation to the lexicon size, but there were less grammatical function words in the small receptive lexicon sizes of the VLBW children.
4. The compositional development of the expressive lexicon in VLBW:
 - a. happened in a parallel manner as in full-term children when the comparisons were made at each age point the data was gathered.
 - b. VLBW children had less grammatical function words in their expressive lexicons at each age point, but no other differences were detected.
 - c. happened otherwise in a parallel manner when analysed in relation to the lexicon size, but VLBW children had more nouns in their small expressive lexicons than full-term children.
 - d. happened in a parallel manner as in full-term children when analysed in relation to the lexicon size.
5. The language skills of the total group of the VLBW children measured using Reynell developmental language at 2 years of corrected age:
 - a. were significantly lower than in full-term children.
 - b. did not differ from those of full-term children.
 - c. were significantly better than those of full-term children.
 - d. The receptive score in Reynell's test was significantly lower, but there was no difference in the expressive score between the groups.

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