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The Phonology of Children's Early Words: Trends, Individual Variation, and Parents' Accommodation in Child-Directed Speech

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The mental lexicon is dynamic and changes throughout the lifespan, but how does it begin? Previous research has established that children's first words depend on their communicative needs, but also on their phonetic repertoire and phonological preferences. In this paper, we focus on the phonological characteristics of children's first words, primarily looking at word-initial labials and word length in Norwegian children's first words, as well as at how parents accommodate to child patterns in their speech. Comparing the Norwegian child data with data from children speaking five different languages, we examine how the child's emergent lexicon is on the one hand shaped by the input of the ambient language, but on the other hand limited by more common phonological characteristics of child speech. Based on data from parental reports (CDI), we compared the 50 first words in Norwegian to those in Danish, Swedish, English, and Italian, analyzing two phonological aspects: word initial bilabials and word length in syllables. We found that Norwegian-speaking children follow the children speaking these other languages in having an affinity for word initial bilabials, but that the proportions of mono-, di-, and polysyllables vary depending on the language acquired. Comparisons of the Norwegian child data with samples of adult directed speech (ADS) and child-directed speech (CDS) revealed more word-initial bilabials and shorter words among children than among adults. The CDS was more similar to children's speech than ADS concerning the two phonological aspects dealt with here, which suggests that parents accommodate to children in phonologically detailed ways.

Keywords: phonology, lexicon acquisition, first words, bilabial, word length, Norwegian, communicative development inventories (CDI), CHILDES (Child Language Data Exchange System)

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INTRODUCTION

The phonology of children's first words can be influenced by the ambient language on the one hand and by children's cognitive and motoric abilities, such as memory capacity, vision, proprioceptive feedback from the articulators and motoric dispositions and control on the other (Mulford, 1988; de Boysson-Bardies and Vihman, 1991; MacNeilage and Davis, 2000; McCune and Vihman, 2001; Majorano et al., 2014). Disentangling these factors and their influence on children's lexicons is interesting for both practical and theoretical reasons.

Regarding practical matters, any assessment tool that aims for comparability across languages must take cross-linguistic differences into account (Peña, 2007). The need to establish what is language-specific can be illustrated by results from the development of the Cross-linguistic Lexical Tasks (Haman et al., 2015), an assessment tool developed to identify language impairment in multilingual preschoolers. Here, attempts were made to account for phonological complexity across more than 25 different languages through a set of universal criteria. However, there was no stable relationship between this complexity measure and children's performance on the tasks (Haman et al., 2017; Hansen et al., 2017). Hansen et al. (2017) suggested that the measure failed because it did not take cross-linguistic differences into account.

From a usage-based point of view, the relationship between what is specific to children regardless of the ambient language and what is language-specific is also theoretically interesting, as it can shed light on the role of input in acquisition. Given that we build our mental representations of language directly on tokens of language use, properties of the input such as frequency and phonological salience are crucial (Bybee, 2010). However, as young children are limited by cognitive and motoric abilities still under development, it is not given that they are able to take in, and clearly not to reproduce, all the tokens of language that they are exposed to.

In this paper, we will use data collected from a lexical assessment tool that has been adapted to a wide range of different languages: *The MacArthur-Bates Communicative Development Inventories (CDI)*, developed by Fenson et al. (2007). CDI data from large numbers of children have been used to investigate cross-linguistic patterns in children's lexical development (Bleses et al., 2008; Braginsky et al., 2016) as well as the semantics of children's first words (Caselli et al., 1995; Wehberg et al., 2007; Braginsky et al., under review)[1].

The CDI has also been used to analyse phonological acquisition in French and Danish (Gayraud and Kern, 2007; Wehberg et al., 2007). These studies indicate that the first target words Danish children acquire are predominantly monosyllables, whereas French children acquire a balanced proportion of monosyllabic and disyllabic target words. On the other hand, Gayraud and Kern (2007) and Wehberg et al. (2007) report that a large proportion of the early-acquired target words in both Danish and French have a word initial bilabial. Could it be that word length in syllables depends on the ambient language, but that the affinity toward word initial bilabials has more to do with children's universal cognitive, visual, and motoric abilities?

When Wehberg et al. (2007) compared the proportion of word initial bilabials with proportions of other word initial consonants in Danish children's first words, they saw that 45 percent of the words started with an initial bilabial, and that no other initial consonant was as frequent as any of the bilabial consonants. Gayraud and Kern (2007) showed that at 24 months, 45 percent of French children's targeted nouns started with a bilabial. As for word length in syllables, (Wehberg et al., 2007, p. 370) found that only four of the 50 first words in Danish were 'decidedly polysyllabic' in adult pronunciation, i.e., 92 percent may be produced as monosyllables. On the other hand, Gayraud and Kern (2007) showed that at 24 months, French children aimed at 55 percent monosyllables, and 45 percent disyllables.

Wehberg et al. (2007, p. 377) considered word initial bilabials to be universal to child language, but reported that in other respects, children's words are close to their models. This could imply that they think that word length in syllables in children's words corresponds to the ambient language. Gayraud and Kern (2007) looked at the development of children's acquired target nouns over time. According to their findings, early nouns have much in common with babbling, that is, they are typically short, with initial bilabials and open syllables, whereas the nouns become more similar to the ambient language over time, with a diversification of word initial sounds, syllable types, and word length in syllables.

The results from Gayraud and Kern (2007) and Wehberg et al. (2007) are based on analyses of CDI data from 125 to 183 children, respectively. The number of participants is a strength for both studies, but note that parents are only asked to report on which words their children aim at, not on their actual pronunciations. Thus, the CDI findings above need to be supplemented by data covering children's actual productions.

de Boysson-Bardies and Vihman (1991) analyzed consonants in spontaneous speech data in American, French, Swedish and Japanese children aged 9–19 months. Examining the words that the children attempt at, they found that although there were significant differences between the languages, there was a large proportion of word initial labials in all of the four different languages: French, 60%; English, 49%; Swedish, 41%; Japanese, 41% (de Boysson-Bardies and Vihman, 1991, p. 308). Majorano et al. (2014) reported similar results for Italian infants. These results support the idea that word initial bilabials might be a cross-linguistic characteristic of children's early words.

When it comes to word length in syllables, Vihman and Croft (2007 p. 687) reported that in diary and spontaneous speech data, disyllables seem to be the most common word form of early words across languages (Estonian, Finnish, French, Greek, Hebrew, Hindi, Italian, Japanese, Spanish, Swedish, Welsh). In the Germanic languages English, Dutch, and German, however, children aim mostly at monosyllables. The results from Wehberg et al. (2007) indicate that Danish also belongs to the group of Germanic languages where children acquire mostly monosyllabic target words. According to Vihman and Croft (2007), Swedish is an exception to this pattern, because children acquiring Swedish seem to aim at a balanced proportion of mono- and disyllables. In sum, these findings indicate that children have an affinity toward target words with initial bilabial, but that there are cross-linguistic differences in the number of syllables in the targeted words.

Previous research has demonstrated that CDI data are comparable across languages (Caselli et al., 1995; Bleses et al., 2008; Law and Roy, 2008), but this potential has not been fully exploited for phonological purposes. In addition, we do not know how CDI data compare to spontaneous speech data. Across several languages, including Norwegian, children have been found to have individual sound preferences (McCune

[1]Braginsky, M., Yurovsky, D., Marchman, V., and Frank, M. C. (under review). Consistency and variability in word learning across languages. doi: 10.31234/osf.io/cg6ah

and Vihman, 2001; Vihman and Croft, 2007; Garmann and Torkildsen, 2017). We are therefore interested in studying word initial bilabials and word length in syllables in CDI data in more languages as well as comparing CDI data and spontaneous speech data.

The Current Study

In this study, we use CDI data to identify Norwegian children's first words, and compare our findings with published lists of first words based on CDI surveys from English, Italian, Swedish, and Danish (Caselli et al., 1995; Eriksson and Berglund, 1999; Wehberg et al., 2007), to see whether the same phonological tendencies are found in all these languages. The Norwegian CDI data are compared to spontaneous speech data from Norwegian to look at the relationship between aggregated data and individual children's target words as well as actual pronunciations. We expect Norwegian-speaking children to have a large proportion of target words with initial bilabials, but that the proportions of target words and actual pronunciations with initial bilabials may still vary individually.

Do the cross-linguistic differences in word length result from differences in the ambient languages? Vihman et al. (1994) have investigated content words in mothers' speech in English, French and Swedish, reporting predominantly monosyllabic words (69 percent) among English speaking mothers, but a balanced proportion of mono- and disyllabic words in French and Swedish mothers (Vihman et al., 1994, p. 656 Table 4). (Keren-Portnoy et al. (2009), p. 17) state that Italian CDS contains mostly two- or three-syllable words, and suggest that this may be the reason why Italian children target longer words than English children do.

There is no existing research on the proportions of mono- and disyllabic words in Norwegian. As Danish, Swedish, and Norwegian have a common ancestor, Norwegian may be similar to either Danish or Swedish. It is more likely, however, that Norwegian is more similar to Swedish than to Danish when it comes to word length because Danish has undergone severe phonological reductions involving the loss of syllables (Basbøll, 2005, p. 293). As we know that CDS may deviate from ADS (Snow, 1972; Cruttenden, 1994; Englund, 2005; Englund and Behne, 2005), we will look into the phonological characteristics in Norwegian CDS and ADS to highlight relevant differences. Against this background, we will test the following hypotheses:

1. A high proportion of initial bilabials is a property of early words independent of language, and should thus also characterize Norwegian children's first words.
2. The length of early words will vary across languages, and Norwegian children's first words will be balanced between mono- and disyllabic words.
3. Norwegian adults will adapt their speech with respect to both properties in CDS, but still produce fewer words with initial bilabials and longer words than Norwegian infants.

METHODS

To test our hypotheses, we first made a list of the 50 first targeted words in Norwegian based on CDI norms (Kristoffersen and Simonsen, 2012; Kristoffersen et al., 2013; Simonsen et al., 2014).[2] Then we analyzed the proportions of word initial consonants and mono-, di-, and polysyllables in the 50 first targeted words in Norwegian, and investigated the validity of this method by comparing the figures to cross-sectional analyses of the same two characteristics by vocabulary size. We also reanalyzed the lists of first targeted words for Danish, English, Italian, and Swedish (Caselli et al., 1995; Eriksson and Berglund, 1999; Wehberg et al., 2007) to compare the proportions of bilabials and the proportions of monosyllables, disyllables, and polysyllables in all five languages.

The languages that we analyse here represent the two different phonological groups as defined by Vihman and Croft (2007): the general disyllabic group (Italian), and the more Germanic monosyllabic group (Danish and English). We have also included the language that Vihman and Croft (2007) regard as an exception, namely Swedish. It is particularly interesting to compare the three Scandinavian languages to see whether Swedish is an exception to the Germanic pattern as suggested by Vihman and Croft (2007), or whether there is no such Germanic pattern, and rather, that Danish is the odd language out among the Scandinavian languages.

Following the cross-linguistic analyses, we compared Norwegian CDI data with results from Norwegian children's spontaneous speech, using data from video-recorded play sessions between child and parent(s) (Garmann, 2016)[3]. Then, we compared the children's target words as well as actual productions to CDS from the same corpus as well as ADS from one video-recorded conversation between adults in the Norwegian speech corpus *NoTa–Oslo* (University of Oslo, 2013; Hagen and Simonsen, 2014).

Population Based CDI Data

Following the method in Caselli et al. (1995), we pooled data from 2056 children assessed with the Norwegian infant CDI form (*CDI I Words and Gestures*). These data are cross-sectional, and the children's age range from 8 to 20 months, which is a wider range than the one in Caselli et al. (1995) where the range was 8–16 months. Words were considered to be acquired only if they were checked as produced by the child.

The 50 First Words

A list of the 50 first words in Norwegian was extracted by ranking all the words in the CDI checklist by number of occurrences in the CDI responses, and the words were ranked from most common (1) to least common (50). This means that the first words on the list are the words that Norwegian children are most likely to acquire first. To compare the phonological characteristics of the 50 first words in Norwegian with similar words in other languages, we reanalyzed the first words in English, Italian, Danish, and Swedish as listed in Caselli et al. (1995), Eriksson and Berglund (1999), and Wehberg et al. (2007). Whereas the lists of about 50 first words in Norwegian, Danish,

[2]The Norwegian CDI norms are available on wordbank.stanford.edu (Frank et al., 2017).

[3]The corpus can be accessed on doi.org/10.21415/T5P59D.

English, and Italian are the results of analyses of CDI responses from an age range, 8–16 or 8–20 months, the Swedish list in Eriksson and Berglund (1999) consists of the 44 target words that 80 percent or more of all 16-month-olds are reported to produce. We still think the list is comparable to the other lists, since it is based on CDI results and the 16 months stage is included in our Norwegian sample as well as in the other CDI samples.

We have excluded proper names (the child's or a caregiver's name) as well as words used in games or routines only ('peekaboo' and 'patty cake') from the lists in the phonological analyses, because the phonology of these words are unknown to us as they may vary between individuals. We have included onomatopoeia like animal sounds and car sounds—largely these are quite standardized and function as nouns in child (and child directed) speech. Both content words and function words are included. For our phonological analyses, the English list of 50 first words contains 51 words (as two words are ranked as number 50), the Norwegian list contains 49 words, the Italian list 48 words, the Danish list 47 words, and the Swedish list 42 words when names and words used in games and routines are removed.

We have also analyzed the development of the phonological characteristics (the word initial sound and word length in syllables) in Norwegian. The CDI responses with 1–100 words reported as produced were grouped by vocabulary size: 1–10 words, 11–20 words, and so on up to the CDI responses with 91–100 words checked as produced. The proportion of target words with initial bilabials and the proportions of mono-, di-, and polysyllabic target words were calculated for each child, and mean proportions were then calculated within each vocabulary group.

Norwegian Children's Speech

The Garmann (2016) corpus consists of about 60 video recordings from eight monolingual Norwegian-speaking children, four girls and four boys, aged 1;2–2;1, followed longitudinally over a year. Each video recording covers a 30-min session of child–parent interaction at home. The sessions have been transcribed using Phon (Rose et al., 2006).

For each child, one of the parents was asked to fill in a CDI form on the Internet following each recording session. We wanted to compare the phonological characteristics of the first 50 words to spontaneous speech data from children at a similar stage in lexical development. For this reason, we looked for the video recordings that corresponded to the first month in which the parent reported the child to produce at least 50 words in the CDI. For two of the children, this was impossible to determine due to lacking CDI responses. In addition, one of the boys had a sudden jump from 36 words at age 1;8 to 127 words at age 1;9, and we thought it unsuitable to compare data from any of these recordings to the rest of the recordings, where the corresponding CDIs had 54–64 words. For gender balance, we then excluded one of the girls, leaving two girls and two boys for the analyses: Iben (aged 1;6), Johanna (aged 1;3), Marius (aged 1;7), and Olav (aged 1;8). In total, the four children produced 698 word tokens.

Transcription of Child Data

We performed an orthographic transcription of the child data as well as a narrow phonetic transcription with IPA. In total, six transcribers were involved. To check the validity of the orthographic transcriptions, a random 2-min excerpt from each child was transcribed by an independent transcriber, who had access only to the utterance segmentation from the original transcription. The phonetic transcriptions were validated through the same procedure, allowing the second transcriber to see both segmentation and orthographic transcription, but not the phonetic tier.

Transcription agreement was then calculated with respect to the two phonetic properties investigated. As an example, a production of *ballong* 'balloon' transcribed as [naŋɛh] by the original transcriber, but as [wa.ŋəʰ] by the second transcriber counts as a disagreement about the initial bilabial, but agreement on the number of syllables. In the orthographic transcription, there was a 100% overlap between the transcribers concerning occurrences of initial bilabials, and a 90% agreement on the number of syllables in the utterances transcribed. In the phonetic transcriptions, there was a 99% agreement on initial bilabials (with the one disagreement given as example above), and a 91% agreement on the number of syllables.

Analyses of Child Words

The analyses of target words in children's speech are based on word types for the group as a whole, whereas the analyses of the children's productions are based on word tokens. Both content and function words were included. Most of the children's productions were one-word utterances. Occasionally, the children produced two-word utterances. These were mostly considered as such, but if the prosody indicated that they were produced as unanalyzed units by the child, i.e., there was only one stressed syllable over two words (e.g., Marius: [ɛˈdom] *er tom* 'is empty'), we judged them to constitute single words in the child's vocabulary. In our data set, the group as a whole produced 697 tokens and 101 different target words. The words were analyzed with respect to the word initial sound and the number of syllables in each word, using the same categories as for the CDI data set.

Norwegian CDS and ADS

For analyses of CDS, we used four 30 min' sessions where the parents of Iben, Johanna, Marius, and Olav talked with their children. In total, these four sessions include 6,929 word tokens. Three transcribers in total transcribed the adult utterances orthographically. A fourth transcriber (the first author) transcribed the parents' speech in the first four minutes of each video recording. The transcription agreement, calculated the same way as above, was 92% for the number of syllables and 93% for whether the words had an initial bilabial.

For analyses of ADS, we analyzed the speech of a 28-year-old male from Oslo in conversation with another male. The conversation was taken from the speech corpus *NoTa–Oslo* (University of Oslo, 2013; Hagen and Simonsen, 2014), which consists of interviews of and conversations by speakers of Urban East Norwegian. The corpus is transcribed orthographically.

The conversation lasts for about 40 min, and the 28-year-old's utterances include 4,149 word tokens.

Excerption and Analyses of CDS and ADS Words

There are reasons to believe that children do not give the same attention to all words. Vihman et al. (1994) showed that function words make up maximum 8 percent of the children's words in English, French, and Swedish, and that when it comes to word length and initial consonant, the children's words (including function words) are more similar to content words in CDS than to all of the words in mothers' running speech. They argued that these findings suggest that children attend mostly to content words in the input they receive, and not to unstressed function words. For this reason, we only analyzed the content words in the adult speech, using a wide definition outlined in the **Appendix**. Similarly to Vihman et al. (1994), only CDS from the parents was analyzed, recitations from books were disregarded, and so were imitations of the child's utterances to determine what the child said.

In the CDS recordings, the researcher was involved in the conversations to some degree. For Marius, only the mother was present in addition to the child and the researcher. For Iben, Johanna and Olav, the father was also present. In some of the recordings, visitors or other family members also participated in the conversations. In the analyses of CDS, speech by other speakers, e.g., the researcher or friends, was disregarded. Speech directed toward the researcher (the first author) was also disregarded, as was speech between the parents. If both parents were present, the CDS from both of them was included. We corrected typing errors in the transcriptions, and disregarded fragments. This method resulted in 838 CDS word types from the group as a whole. The ADS recording contained 873 content words types, slightly more than the CDS even though the ADS recording is shorter (40 min vs. 2 h in total for CDS). The phonological analyses were carried out in the same way as for the child data sets.

RESULTS

We initially present the 50 first targeted words in Norwegian, analyse the words with respect to phonological characteristics, and compare the results to reanalyses of the 42–51 first words for English, Italian, Swedish, and Danish in Caselli et al. (1995), Eriksson and Berglund (1999) and Wehberg et al. (2007). Then we take a closer look at Norwegian: First, we investigate the stability of the phonological characteristics by exploring how they vary with vocabulary size. Second, we compare the Norwegian CDI results with targeted words and actual productions in data from spontaneous speech by children. Finally, we look at the role of the ambient speech by comparing children's speech to adults' speech. Exact numbers for the results presented in the figures are published as **Supplementary Material**.

CDI Results

The fifty words that Norwegian children most commonly acquire early are listed in **Table 1**. *Borte!* 'Peek-a-boo!' is only used

TABLE 1 | The 50 first Norwegian target words and the percentage of CDI I responses where the word is checked as produced.

Rank	Word	Phonemic transcription	Translation	% of occ.
1	*mamma*	/²mama/	'mummy'	61.2
2	*hei*	/¹hæi/	'hi'	59.2
3	*brrr (bil-lyd)*	/¹brrr/	car sound	58.2
4	*pappa*	/²papa/	'daddy'	57.5
5	*nam-nam*	/²namnam/	'yummy'	57.3
6	*nei*	/¹næi/	'no'	53.1
7	*ha det*	/¹haːde/	'bye-bye'	52.8
8	*bææ*	/¹bæː/	sheep sound	50.2
9	*takk*	/¹tak/	'thank you'	49.3
10	*voff voff*	/²vovov/	dog sound	45.7
11	*Borte!*	–	peek-a-boo	44.2
12	*ja*	/¹jaː/	'yes'	43.7
13	*møø*	/¹møː/	cow sound	42.3
14	*au*	/¹æʉ/	'ouch'	40.2
15	*ball*	/¹bal/	'ball'	39.8
16	*gakk gakk*	/²gakak/	duck sound	35.0
17	*mjau*	/¹mjæʉ/	cat sound	34.7
18	*bade*	/²baːde/	'take a bath'	31.3
19	*lys*	/¹lʏːs/	'light'	30.6
20	*bil*	/¹biːl/	'car'	30.2
21	*banan*	/ba¹naːn/	'banana'	29.9
22	*se*	/¹seː/	'look'	29.4
23	*baby*	/¹beːbi/ or /¹bæibi/	'baby'	28.5
24	*hysj*	/¹hyʂ/	'shh'	27.3
25	*is*	/¹iːs/	'ice cream'	26.7
26	*sko*	/¹skuː/	'shoe'	25.6
27	*der*	/¹dæːr/	'there'	25.2
28	*katt*	/¹kat/	'cat'	25.0
29	*god natt*	/gu¹nat/	'good night'	24.9
29	*bok*	/¹buːk/	'book'	24.9
29	*grr*	/¹grrr/	lion sound	24.9
32	*bleie*	/²blæie/	'diaper'	24.4
33	*mer*	/¹meːr/	'more'	23.6
34	*smokk*	/¹smuk/	'pacifier'	22.7
34	*melk*	/¹melk/	'milk'	22.7
36	*hest*	/¹hest/	'horse'	22.5
37	*mat*	/¹maːt/	'food'	22.2
38	*eple*	/²eplə/	'apple'	22.2
39	*drikke*	/²drike/	'drink'	21.8
40	*den*	/¹den/	'that'	21.6
41	*hund*	/¹hʉn/	'dog'	21.5
42	*kake*	/²kaːke/	'cake'	21.3
43	*vann*	/¹van/	'water'	20.8
44	*kjeks*	/¹çeks/	'cookie'	20.5
45	*nese*	/²neːse/	'nose'	20.3
46	*borte*	/²buʈə/	'away'	20.2
47	*(leke)bamse*	/²bamse/	'teddy bear'	19.8
48	*øye*	/²øye/	'eye'	19.4
49	*gris*	/¹griːs/	'pig'	18.5
50	*ku*	/¹kʉː/	'cow'	18.2

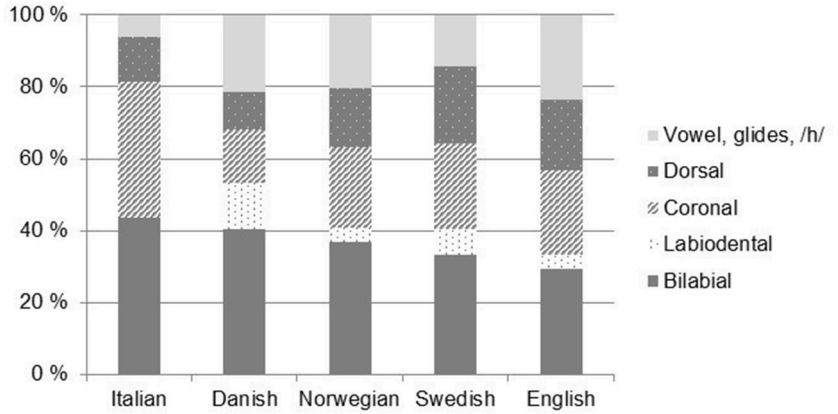

FIGURE 1 | Proportions of place of articulation of the initial sound in the 50 first words in Norwegian compared to Italian, Danish, Swedish, and English based on data from Caselli et al. (1995), Eriksson and Berglund (1999), and Wehberg et al. (2007), sorted by proportion of bilabials.

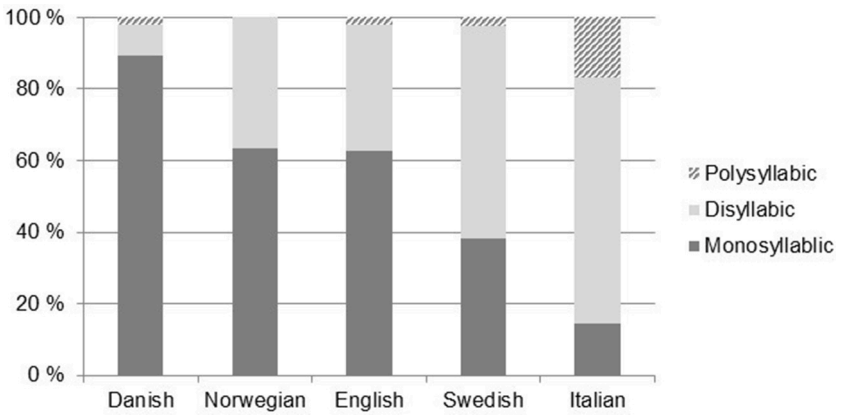

FIGURE 2 | Proportions of mono-, di-, and polysyllabic words among the 50 first target words in Norwegian, compared to percentages in Danish, English, Swedish, and Italian based on data from Caselli et al. (1995), Eriksson and Berglund (1999), and Wehberg et al. (2007), sorted by proportion of monosyllabic words.

in games or routines, and is excluded from the phonological analysis. Among the 49 words left, there are 18 words with initial bilabial, 2 words with initial labio-dental, 11 words with initial coronal, 8 words with initial dorsal, and 10 words with initial vowel, glide or /h/. **Figure 1** shows the proportions of the different places of articulation of word initial consonants in target words in Norwegian compared to Italian, Danish, Swedish, and English. For all the five languages, the largest category of the first words is target words with initial bilabials, ranging between 29 and 44 percent. According to a chi-square test, the differences between the languages are not significant ($\chi^2(4, N = 237) = 2.67, p = 0.61$).

The Norwegian list contains 31 monosyllables, 18 disyllables and no polysyllables. **Figure 2** shows the percentages of monosyllables, disyllables, and polysyllables in Norwegian compared to Danish, English, Swedish, and Italian. The Danish first words list is skewed toward monosyllabic words, whereas the Italian list is skewed toward disyllabic and polysyllabic words. The Norwegian, English, and Swedish lists are balanced between mono- and disyllabic words, although for English and Norwegian, monosyllables are the most frequent, while for Swedish, disyllables are more frequent. A chi-square test shows that there are significant cross-linguistic differences in the proportions of monosyllables in target words ($\chi^2(4, N = 237) = 61.22, p < 0.001$); According to pairwise comparisons of the proportions (see **Table 2**), Danish has significantly more monosyllables than the four other languages, and Italian has significantly fewer monosyllables than Danish, English, and Norwegian. There is no significant difference between English, Norwegian, and Swedish, or between Swedish and Italian.

Figures 3, **4** illustrate that for Norwegian, the phonological characteristics in target words are quite stable during the early lexical development. The distribution between monosyllabic and disyllabic words is quite balanced throughout, and the proportion of word-initial bilabials is quite stable in the area between 30 and 40%. Regarding the first 10 words, the items *mamma* 'mommy' and *pappa* 'daddy' contribute to high percentages of disyllables and word-initial bilabials.

TABLE 2 | Levels of significance (p-values) for pairwise comparisons of the proportions of monosyllables in the first 50 target words of each language according to CDI data.

	Danish	English	Norwegian	Swedish
English	0.029	–	–	–
Norwegian	0.028	1.000	–	–
Swedish	<0.001	0.087	0.087	–
Italian	<0.001	<0.001	<0.001	0.084

Comparisons were performed with Holm corrections.

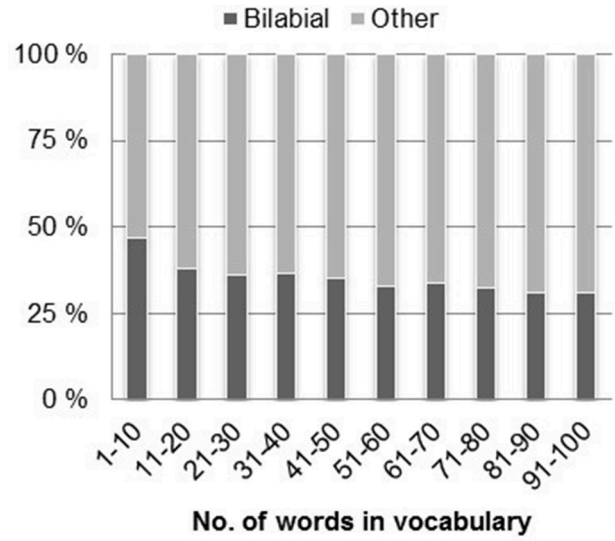

FIGURE 3 | Mean proportions of word initial bilabials by vocabulary size.

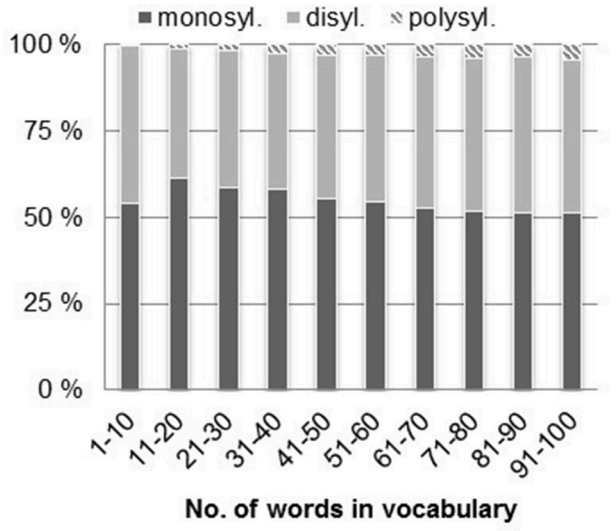

FIGURE 4 | Mean proportions of word length in syllables by vocabulary size.

Children's Speech Compared to CDS and ADS

In this section, we present the proportions of word initial bilabials and the proportions of mono-, di-, and polysyllables in target words and actual productions in Norwegian children's spontaneous speech, and see whether the proportions are reflected in adults' speech directed to children (CDS) and/or in adults' speech directed to other adults (ADS).

When it comes to place of articulation of word initial sounds, 32 percent of the four Norwegian children's 101 target word types have a word initial bilabial. According to a chi-square test, this is not significantly different from the corresponding proportion in the Norwegian CDI based first words list (37 percent) ($\chi^2(1, N = 150) = 0.18$, $p = 0.67$). In the four children's actual productions, 31 percent of the 697 tokens have a word initial bilabial. According to a chi-square test, this is not significantly different from the 32 percent in the target words ($\chi^2(1, N = 798) = 0.003$, $p = 0.96$). However, there is notable variation between the children: Whereas, Iben produces 51 percent of her word tokens with initial bilabials, Johanna does this in only 8 percent of her word tokens.

Turning to the content words of Norwegian adults' speech, 19 percent of the CDS word types have a word initial bilabial. In ADS, the corresponding proportion is 11 percent. As the proportion of targeted word types with initial bilabials in children's spontaneous speech is almost twice as high as in content words in CDS and almost three times as high as in content words in ADS, this suggests that the high proportion of targeted words with word initial bilabials is in fact typical to children's speech. A chi-square test confirms that the differences between the three data sets are significant ($\chi^2(2, N = 1,812) = 38.67$, $p < 0.001$). The fact that content words in CDS have a higher proportion of words with initial bilabials than content words in ADS implies that parents adapt to children's preference for these words.

Concerning word length, our analysis of spontaneous speech data shows that the four Norwegian children in our data set aim at 42 percent monosyllables, 54 percent disyllables, and 4 percent polysyllables in spontaneous speech. Thus, there are fewer monosyllables and more di- and polysyllables in spontaneous speech than in the targeted words in the CDI based first words list (63 percent monosyllables, 37 percent disyllables, and no polysyllables). According to a chi-square test, the difference is significant ($\chi^2(1, N = 140) = 14.71$, $p < 0.001$). In the four children's actual productions, there are 50 percent monosyllables, 45 percent disyllables, and 5 percent polysyllables. According to a chi-square test, this is not significantly different from the proportions in the analysis of the target words [$\chi^2(1, N = 798) = 2.14$, $p = 0.14$]. There is some variation between the children: Johanna produces 33 percent of her word tokens with monosyllables, whereas Olav produces 65 percent monosyllables.

Our analyses of content words in adult speech show that Norwegian CDS has 30 percent monosyllables, 49 percent disyllables, and 22 percent polysyllables, whereas Norwegian ADS contains 25 percent monosyllables, 41 percent disyllables, and 34 percent polysyllables. The proportion of monosyllables is higher in target words and actual productions in children's speech than in content words in CDS, and higher in CDS than

in ADS, whereas polysyllables are more common in ADS than in CDS, and very scarce among the children's word types. A chi-square test confirms that these differences are significant ($\chi^2(4, N = 1,812) = 59.99, p < 0.001$).

DISCUSSION

On the basis of cross-linguistic data from CDI reports, children's speech samples, child directed speech, and adult directed speech we have examined phonological aspects of the child's emergent lexicon. In accordance with previous literature, we found that children speaking English, Italian, Swedish, Danish, and Norwegian have an affinity for word initial bilabials, but that their proportions of mono-, di-, and polysyllables vary. The Norwegian speaking children used more word initial bilabials than adults, as well as a higher proportion of monosyllables, and the parents accommodated when speaking to their children in these two respects. We also found a higher proportion of monosyllables among the target words in the Norwegian CDI data than among the target words in the spontaneous speech data. This difference may be a coincidence, but it could also stem from differences in the age range and vocabulary sizes of the children in the two data sets: The CDI analyses were based on children aged 0;8-1;8, most of whom had a vocabulary smaller than 50 words (Simonsen et al., 2014), whereas the four children from the Garmann corpus were analyzed at the 50 word stage. Thus, the children in these two data sets may be at different stages in their lexical and phonological development.

Our first hypothesis was that the high proportion of initial bilabials in early target words and productions is a property of early words independent of language, and that we would find this pattern also for Norwegian children. This hypothesis was confirmed by analyses of Norwegian, Danish, Swedish, English, and Italian CDI results as well as analyses of targets and actual productions in spontaneous speech in Norwegian. Gayraud and Kern (2007) and Wehberg et al. (2007) claim that the proportion of initial bilabials is high in the list of first target words in Danish and French, and Wehberg et al. (2007) compare their results to similar results for American-English. Since we found no significant cross-linguistic differences in the proportions of initial bilabials in children's target words across Danish, Swedish, English, Italian, and Norwegian, a high proportion of initial bilabials may be a cross-linguistic characteristic of children's speech, at least between these five languages. Actually, this may be an even more universal tendency, as de Boysson-Bardies and Vihman (1991) compared French, English and Swedish with Japanese, and found high proportions of initial bilabials in children's target words in all these languages including the non-Indo-European language Japanese.[4]

The similarities in proportions of word initial bilabials cannot simply reflect that the CDI forms are so similar from language to language; results from spontaneous speech both in this study and in de Boysson-Bardies and Vihman (1991) support the suggestion that a high proportion of initial bilabials is a cross-linguistic characteristic of children's speech as opposed to being input-related. de Boysson-Bardies and Vihman (1991, p. 312–313) argue that the lip closure associated with these sounds is a visual cue, which gives the child an opportunity to observe how they are produced. McCune and Vihman (2001) add that children have better control over the lips and the jaw than over the various parts of the tongue and that the proprioceptive feedback from the lips is easier to interpret than the feedback of lingual consonants, two factors that make bilabials easier to produce than other consonants. MacNeilage and Davis (2000) and Davis et al. (2002) have promoted the argument of motoric control, connecting children's first words to the evolution of language and claiming that the syllabic structure of language develops from the repetitive movements of the jaw and the tongue during the process of digestion. The preference for initial labials may have to do with the relative ease of moving the jaw and the lips compared to moving the tongue. Mulford (1988), on the other hand, accentuates the importance of visual input for the labial cross-linguistic tendency, reporting that blind children produce a lower proportion of labials than sighted children. As our data cannot inform us in this debate, we simply notice that several factors may work in favor of the same result.

Our second hypothesis was that word length in syllables in early target words and productions varies across languages, and that Norwegian children's first words would be balanced between mono- and disyllabic words, similarly to previous findings from Swedish children (Vihman and Croft, 2007). This hypothesis was confirmed by our cross-linguistic comparison of CDI data, as well as by results from analyses of spontaneous speech. We found cross-linguistic differences in the lists of first target words; English and Swedish are balanced, like Norwegian, but Danish is skewed toward monosyllables and Italian is skewed toward di- and polysyllables. Thus, according to both CDI data and analyses of targets and actual productions in spontaneous speech, Norwegian children follow the Swedish pattern, producing a balanced proportion of mono- and disyllabic target words. It seems like Danish, then, is the odd language out among the Scandinavian languages.

From the literature, we expected English and Danish to have particularly high proportions of monosyllables, and Italian to have a particularly high proportion of polysyllables. Our results differ somewhat from our expectations: Even though English children seem to produce more monosyllabic target words than Swedish children, this difference was not significant. It is therefore less clear whether English is so different from other languages when it comes to word length in syllables, at least when we look at CDI data. It would be interesting to compare our results with CDI data from German and Dutch, to see whether Germanic languages are different from other languages in not having dominantly disyllables among the early target words (see Vihman and Croft, 2007, p. 687).

Our third hypothesis was that Norwegian adults would produce fewer words with initial bilabials and longer words than Norwegian infants, but make adaptations with respect to both properties in CDS. The corpus analyses support this hypothesis, as the proportions in CDS were between children's speech and

[4]Note that the figures in de Boysson-Bardies and Vihman (1991) are not directly comparable with ours, as they excluded words with an initial vowel, glide or /h/ in their calculations.

ADS with respect to both properties investigated here. It is well known that adults accommodate their speech in many ways when addressing young children (Snow, 1972; Cruttenden, 1994; Englund, 2005; Englund and Behne, 2005). Our results add to this literature, suggesting that adults accommodate in phonological detail to children when they talk to them (see also Cruttenden, 1994), using fewer polysyllabic words and more words with an initial bilabial than when talking to other adults. This could be a consequence of the children's influence on the conversation topics; *ball* 'ball,' *bil* 'car,' and *banan* 'banana' are all early words that children might want to talk about.

The analyses of Norwegian spontaneous speech indicate that children target fewer polysyllables than adults do. This is similar to the results found in Gayraud and Kern (2007), which show that French 2-year-olds target mono- and disyllables, but not polysyllables, whereas polysyllables first appear at 30 months, and become a substantial category at 46 months. They suggest that this may be due to a lower working memory capacity in younger children. The literature does indeed link the working memory capacity to language acquisition in both children and adults (Baddeley, 2003). A study of 4- and 5-year olds showed that it was easier to remember mono- and disyllabic non-words than polysyllabic non-words, but that disyllables were easier to remember than monosyllables (Gathercole and Baddeley, 1989).

Our analyses of spontaneous speech revealed that the group results mask individual differences for proportions of word initial bilabials and proportions of monosyllables, although to different degrees. Regarding initial bilabials in production, the children ranged from 8% (Johanna) to 51% (Iben). The proportions of monosyllables in their productions ranged from 33% (Johanna) to 65% (Olav). This suggests that children's actual productions might be more affected by their individual phonological preferences, as expressed in, e.g., templates (Vihman and Croft, 2007), than by the adult targets. To learn more about children's phonology, then, we need to take a closer look at individual differences in their actual productions.

CONCLUSION

We set out to investigate one possibly language-dependent property of children's early words, word length in syllables, and one possibly language-independent property, the proportion of word-initial bilabials, investigating child language data from five different languages and comparing children's and adults' speech for Norwegian. We think that our results and the following discussion support the view that children—at least across the languages investigated here—have an affinity toward words with initial bilabials, possibly related to visual cues, proprioception, and motoric control. The length of the words they acquire, on the other hand, depends more on properties of the ambient language. However, Norwegian children appear to overuse not only words with initial bilabials, but also monosyllables, when compared to CDS and ADS. Thus, our findings suggest that although the available target words in the ambient language influence the word length of early target words, factors such as memory capacity may still bias young children toward shorter words.

DATA AVAILABILITY

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

The study was carried out in accordance with the recommendations of the Norwegian Center for Research Data. The parents who filled in CDI questionnaires for their children gave written informed consents on behalf of themselves and the children involved, and so did the parents and any other adult involved in child-parent interaction. Each of these two projects were approved by the Norwegian Center for Research Data.

AUTHOR CONTRIBUTIONS

NGG initiated the project and contributed with child language speech data. HGS and KEK contributed with CDI data. PH and NGG analyzed the speech data together, and PH made decisions on how to study the Norwegian CDI data, carried out the statistical analyses, and created the figures. All authors were involved in writing all parts of the manuscript, often simultaneously. All authors have approved of the final version of the manuscript.

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SUPPLEMENTARY MATERIAL

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fcomm.2019.00010/full#supplementary-material

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

APPENDIX: EXCERPTION OF CONTENT WORDS IN ADULT SPEECH

Table A1 gives a summary of content vs. function words, following Vihman et al. (1994). Different stylistic forms of the same word were disregarded, e.g. *dansa* and *danset* for past tense of *danse* 'dance'. (This was not considered in Vihman et al., 1994). Inflected forms of the same lexeme are regarded as separate word types. Verb particles were treated as part of the verb, which means that verb + particle sequences are also considered separate word types, e.g. *ha på* 'have' + 'on' = 'wear', *ha på deg* 'have' + 'on' + 'you' = 'wear' and *ha det på* 'have' 'it' 'on' = 'wear it'. The definition of content words in Vihman et al. (1994) is wide – 54 percent of the word tokens and 84 percent of the word types in our sample were regarded as content words.

It turned out to be difficult to decide which sequences of verb + preposition/adverb were to be interpreted as verb + particle, and which were to be interpreted as verb followed by a prepositional phrase or an adverb. The following criteria were used:

1. If the verb + preposition/adverb does not take a complement, the sequence is verb + particle. If there is an implicit complement in the utterance, or the sequence does take a complement, supplementary criteria were used:
2. If the verb normally has tonal accent 1, but changes to tonal accent 2 when followed by a preposition or an adverb, the sequence is interpreted as a verb + particle. This is a systematic distinction in Urban East Norwegian, for example: ^{1}*ta på kjolen* which means 'touch the dress' and ^{2}*ta på kjolen* which means 'put on the dress'. This example also illustrates how the meaning is different when the preposition or adverb has grammaticized to a particle and where the word has kept its grammatical meaning.
3. If the preposition or adverb is accented, it cannot be a particle. From this follows that normally the particle is monosyllabic: for example as *med* in *vi kan ta med krakken* 'we can bring the stool'. However, particles may also be polysyllabic as in *se etter* 'look after' and *komme tilbake* 'return': To count as a particle, the preposition or adverb must then be unaccented and the verb + particle unit must have tonal accent 2.
4. Occasionally, there may be an object between the verb and the particle, e.g. *putte den inn* 'put it in'. The object will then be both short and unaccented. All variants of PUTTE + X + INN were counted as exemplars of one type. If the word(s) between the verb and the preposition/adverb is long and/or accented, the preposition/adverb is not considered to be a particle in a unit, e.g. *ser litt annerledes ut* 'looks a bit different', and *sitter helt bom fast* 'is totally stuck', although both *ser ut* 'looks' *and sitter fast* 'is stuck' are verb + particle units. Another type of verbs that may be counted as one or two is verbs followed by a reflexive pronoun. These pronouns are treated as part of the verb, e.g. *lene seg* 'to lean'.

TABLE A1 | Criteria for content and function words, based on Vihman et al. (1994).

Content words	Function words
Nouns	
Main verbs	Copulas. Auxiliaries (e.g., *vil* 'will' and *skal* 'shall'), and catenatives, grammaticized verbs as first verbs in a verb phrase, e.g., *la* in *la den være* 'let I be.'
Adjectives and adverbs	Pragmatic particles (*Hva skal du,* ***'a*** *(da)?'* Where are you going, **then**?')
Conventional interjections (e.g., *ops* 'oups')	
Onomatopoeia (e.g., *vov-vov* for 'dog')	Unconventional onomatopoeia and interjections (e.g., *bam* for 'bang,'), sound effects.
Simple formulaic routines (e.g., *værsågod* for 'here you are')	
	Articles, quantifiers
	Conjunctions, prepositions
	Pro-forms, question words
Locatives as true deictics (e.g., *Se der borte* 'Look over there')	Locatives as introducers or dummy forms (e.g., *Se her, nå skal vi ta på jakka.* 'Here, let's put on a jacket')