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Phonological templates in early words

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Both formalists and functionalists have proposed that universal phonetic or phonological principles govern early word production, yet the wide range of individual differences in this period continues to resist coherent formulation in such terms, even across children acquiring a single language. This study explores the extent of within- and between-language similarities and differences in phonological patterning, with the goal of arriving at a better understanding of the extent to which early word patterns are universal, specific to the ambient language, or individual by child. It is based on analysis of the word forms of 33 children acquiring one of five languages (English, Finnish, French, Italian, Welsh), drawn from language samples taken at the end of the single word period. Segmental inventories were similar across language groups, while the word shapes produced showed an ambient language effect. Individual children responded to the challenges of difficult segments or segmental sequences and long words in different ways, each of them basing their word forms on selected word shapes or 'templates' to which some adult targets are then 'adapted'. We see both similarities and differences in early word forms as rooted in the learning process itself, which provides the basis for emergent phonological organization.

1. Introduction

Both formalists and functionalists have attempted to identify the universal principles governing early word production, beginning with the classic work of Jakobson (1941/68). In current Optimality Theory (OT) accounts it is often maintained that markedness dominates faithfulness at the 'initial state' (Smolensky 1996; Gnanadesikan 2004), although it is generally unclear whether the 'initial state' is meant to refer to the onset of word use – following the Jakobsonian tradition of dismissing the babbling period as irrelevant to language learning – or to a much earlier stage. The statement is a way of expressing the idea that children's first words are typically very simple in structure and content, reflecting the word shapes and segments that are the most widely distributed in the world's languages (the source of markedness principles) rather than the actual segments or

word shapes represented in the adult target for a given word (which would show 'faithfulness'). Similarly, within the framework of prosodic phonology it has been proposed that first words obey the minimal word constraint, such that early words are monosyllabic and minimally bimoraic: either (C)VV or (C)VC (Demuth and Fee 1995 – but see Demuth and Johnson, 2003). From a functionalist point of view, Davis and MacNeilage have suggested – based on the 'frame and content' theory, which posits an early emerging (and phylogenetically plausible) motoric basis for speech – that the CV-associations found in babbling (labial consonants followed most often by central vowels, alveolar consonants by front vowels, and velar consonants by back vowels) dominate early words as well (Davis and MacNeilage 1990, 2000; Davis, MacNeilage and Matyear 2002).

Yet the wide range of individual differences found in early words continues to resist coherent formulation in terms of universal phonological or phonetic principles, even across children acquiring a single language. Furthermore, although there is ample evidence of ambient language influence on early word production and even on prelinguistic vocalizations (Boysson-Bardies et al. 1989; Boysson-Bardies and Vihman 1991) and also clear evidence that early word forms are strongly related to both concurrent and preceding babbling patterns (Vihman et al. 1985), the balance between universal, language-specific and individual child factors in shaping early word forms remains unknown.

We have proposed an alternative view to those summarized above, namely, that the learning mechanism itself, which involves an interaction of production practice with speech perception and segmentation, is what provides the 'universal look' of early word forms (Vihman and Kunnari 2006). We argue that the first words derive from a combination of *implicit (perceptual) experience* with the rhythmic patterning (Ramus 2002) and segmental sequences of the ambient language (Jusczyk 1997), *production practice* through babbling (McCune and Vihman 2001) and *item learning* (Pierrehumbert, 2003). Furthermore, if item learning is taken to be based initially on implicit matching of own vocal patterns to input word forms (DePaolis 2006), it is plausible to consider that early word forms may be represented (*for production*) not in terms of independently known syllables, segments, or distinctive features but as whole 'gestalts' or patterns broadly resembling the adult target.

Note that the extent of specification in the *perceptual representations* tapped by experimental studies remains a subject of lively debate, with some findings appearing to support the idea of underspecified early representations while others contradict this (see, for the former position, Hallé and Boysson-Bardies 1996, Werker and Stager 2000, Vihman et al. 2004 and Swingley 2005, and for the latter, Fennell and Werker 2003, Swingley 2003, Swingley and Aslin 2000, 2002). It appears that representations are task-specific: Priming recognition with

familiar words, for example, results in good infant sensitivity to detail, at least as regards onset consonants, as early as 11 months, while novel word learning fails to show detailed representation even at 14 months. The representations that support word production, similarly, appear to reflect a rough target -to-child-vocal-form match in the early period of context-limited production, while later words, often produced in less routine contexts that present a greater challenge to memory, reflect less accurate representations that are often holistic or 'gestalt-like' rather than 'fully specified' or detailed.

Once a sufficient number of different words have been produced, children – again implicitly – abstract from their own word forms one or more word patterns or 'templates', which incorporate (a) motoric constraints on speech production, (b) accessible features of the ambient language, including word shape, and (c) individual factors relating to a particular child's vocal experience or practice (Vihman and Croft 2007). These templates, which can be seen as the first step in the construction or 'internalization' of a phonological system (Vihman and Velleman 2000), are taken to be the potential source for 'analysing out' a more adult-like set of phonological units, such as syllable onset, nucleus and coda, or /p/, /t/, and /k/, or 'labial' and 'alveolar' (cf. Pierrehumbert's proposal [2003] that the phonological system is 'refined using type statistics over the lexicon' [p. 118]). The key question to be addressed here is whether such a 'whole word' approach can explain both the variability and the underlying regularity seen in the early words of children learning different languages.

This study explores the extent of within- and between-language similarities and differences in phonological patterning, with the goal of arriving at a better understanding of the extent to which early word patterns are universal, specific to the ambient language, or individual by child. We will provide some answers to the following questions:

1. What makes children's early word forms similar?
2. What makes them different – across different children learning the same language and across different languages?
3. What are the challenges for children, and what are the 'opportunities'? In other words, which aspects of adult phonological patterning are difficult for children and which are 'universally' easy?

Some of the first investigators to turn their attention to child phonology advocated the whole word as the starting point for phonology. The main evidence adduced for the view that the first lexical representations are holistic is that

(a) a segment *may vary more* across the forms of one word than another (Ferguson and Farwell 1975);

(b) child words resemble their adult targets only at a *global gestalt* level, not in terms of a segment-by-segment match (Waterson 1971);
(c) a child's word forms may be more *similar as a set* than they are like their adult models on a word-by-word basis (Macken 1979);
(d) *accentual patterning* shapes early word templates, suggesting that child attention is differentially focussed on first vs. second syllable, for example, or on onset vs. medial consonant as a result of perceptual salience due to accent (Vihman et al., 2004; Vihman and Croft 2007).

As noted above, the question as to exactly what 'whole word representation' might mean remains controversial, but the basic idea originally derived from early word data (cf. also Menn 1971, Vihman and Velleman 1989). In this study we return to such data, to test the idea that child words are based on holistic representational templates.

2. Method

We will attempt to address the questions raised about early word forms systematically, on the basis of a reasonably large number of languages, children, and word forms all collected and analysed in a comparable and consistent way, taking exhaustive account of every child variant (within the established limits of the analysis).

2.1. Data sources and sampling procedure

The data derive from 33 children, each acquiring one of five languages (English, Finnish, French, Italian, Welsh); the English data derive from children acquiring either American or British English (five each), to make a total of six 'language groups' (see Table 1). The data are drawn from longitudinal observational studies, with analysis here of one session towards the end of the single word period per child (mean age 18 months),[1] selected to sample as many different word forms as possible. All data were transcribed by native or near-native speakers using the International Phonetic Alphabet (IPA). For reliability, see the sources indicated.

We included a language group only when data were available for at least four different children, with a minimum of 25 different word types per child, whether produced spontaneously or imitated. 'Word shapes' are based on word types but include variants of the same word with differing phonological shapes (the mean is 35 per child overall).

Table 1. Languages, children and sample sizes
The children are ordered within language groups by number of identifiable word shapes.

Language	*Child*	*Age*	*Word shapes*	*Source*
Finnish	Matti	1;6.5	42	Kunnari 2000
	Atte	1;8.0	35	[all Finnish data]
	Eelis	1;10.4	32	
	Mira	1;3.5	32	
	Eliisa	1;3.5	28	
mean		*18.4 mos.*	*34*	
French	Camille	1;5.23	45	Veneziano and Sinclair 2000
	Gaël	1;9.20	45	Veneziano, unpub.
	Laurent	1;5.15	31	Vihman 1993
	Charles	1;3.15	30	Vihman 1996
	Carole	1;2.5	35	Vihman unpub.
	Noël	1;5.2	31	Vihman unpub.
mean		*17.5 mos.*	*36*	
Italian	Anna	1;6.9	53	D'Odorico et al. 2001
	Francesca	1;5.24	43	[all Italian data]
	Marco	1;11.10	40	
	Andrea	2;0.7	28	
	Alessandra	1;7.9	28	
	Luca	2;0.4	27	
	Linda	1;3.2	26	
	Federico	1;6.14	25	
mean		*19.75 mos.*	*34*	
Welsh	Gwyn	1;2.24	46	Vihman, 2000
	Elen	1;5.6	35	[all Welsh data]
	Catrin	1;5.27	30	
	Fflur	1;5.6	28	
mean		*16.75 mos.*	*28*	
English/UK	Jennifer	1;8.23	59	Keren-Portnoy and Vihman (unpub.)
	Rebecca	1;6.27	46	[all UK English data]
	Jude	1;3.11	43	
	Tomos	1;11.10	42	
	Sylvia	1;9.29	29	
mean		*19.8 mos.*	*44*	
English/US	Sean	1;3.22	44	Vihman, unpub.
	Timmy	1;4.22	39	Vihman et al. 1994
	Emily	1;3.29	36	Vihman, unpub.
	Alice	1;4	34	Vihman et al. 1994
	Molly	1;2.20	29	Vihman and Velleman 1989
mean		*16 mos.*	36	

2.2. Analysis

The focus of the data analysis is on the identification of individual child production patterns or word templates. However, we begin by reviewing similarities and differences across the child data from the six groups as regards (a) segmental inventories and (b) prosodic shapes (length in syllables, open vs. closed syllables). We will then consider (c) individual child patterns based on the interaction between prosody and segments.

2.3. Steps in analysis

The same procedure was used for each child in each language sample.

1. List all words used in recording session, with gloss and all variants noted;
2. Group words into 'prosodic shapes', e.g., CV, CVC, C_1VC_1V, longer forms.
3. Distinguish 'accurate' (SELECT) from 'individually adjusted' word forms (ADAPT).

Our criteria for identifying word forms as 'selected' (a relatively accurate match to the adult target form) were lenient, specifically, with regard to any *systematic* omissions below the syllable level. We also allowed for generic child changes, such as systematic segmental substitutions, and also for minor vowel changes. The idea of distinguishing 'selected' from 'adapted' forms is to characterize individual child solutions to the problem of producing adult words whose phonological pattern exceeds their existing resources. *Adapted words* reflect adaptation of the form of adult target to the individual child's word production patterns, which develop out of the earlier, more accurate *selected* forms.

4. Establish the inventory of segments based on *more than one* 'match to target'.
5. Identify child prosody/segment interactions or likely 'templates' (word production patterns).

3. Group results

3.1. Segmental inventories

We present the group results separately for consonants and vowels. Table 2 indicates the number of language groups (out of six) in which more than half the children made match-to-target use of a segment in more than one word form.[2] We can see that these consonants fall into only three manner classes, nasals (in all three positions), stops (initially and medially) and liquids (medial /l/ only). Within this restricted range, the labial and alveolar stops are produced by

Table 2. Consonants. Numbers of languages in which consonants are produced as matches in more than one word by over half of the children (**bold face** indicates all groups).[3]

a. word initial position

stops	**p/b**	**6**	**t/d**	**6**	k/g	4
nasals	m	4	n	3		

b. word medial position

stops	p/b	5	**t/d**	**6**	k/g	3
nasals	m	4	n	2		
liquids			l	2		

c. word final position

nasals			n	3		

almost all language groups in the two positions, medial /l/ and /n/ by only two groups. It is evident that children in all of the language groups are producing a highly restricted set of consonants compared to the adult inventory; the segments produced are, generally speaking, very similar in all of the languages sampled.

Table 3 presents the corresponding results for vowels in accented and unaccented position. Here again the six language groups show relatively similar distributions. The central low vowel [a] is produced by all of the children in more than one word in accented position in all six groups and by all but one in

Table 3. Vowels. Numbers of languages in which vowels are produced in more than one word by over half of the children (**bold face** indicates all groups).

1. accented position

	front unrounded		*back rounded*	
high	i	5	u / ʊ	3
higher mid	e(ɪ)	3	o(ʊ)	5
lower mid	ɛ	1	ɔ	2
low	æ	2	ɑ	6

2. unaccented position

	front unrounded		*back rounded*	
high	i	4	u	1
higher mid	e	1	o	3
low	æ	1	ɑ	5

unaccented position as well. Most of the languages show criterion use of high front unrounded [i] as well in both positions, with back rounded [o(ʊ)] the next most commonly used vowel, occurring in all but one language group in accented position and in three language groups in unaccented position. On this measure the two English groups differ, with a bias toward front unrounded vowels in the US group only.

3.2. Word shapes.

Table 4 indicates the numbers of children who produce words of one, two or more syllables (based on the criteria indicated).[4] Here we see a categorical difference by language group: All of the Finnish, French and Italian children produce disyllables, while only two out of five (Finnish), five out of six (French) and five out of eight (Italian) children in these groups also produce monosyllables. In contrast, all of the Welsh and English children produce monosyllables, although the majority also produce disyllables. Longer forms are produced by a substantial proportion of the children in only one group, Italian. We will return to these differences below.

Table 4. Word shapes. Numbers of children in each language group who produced each word length in more than 10% of their word shapes *and* in a minimum of three words (**bold face** indicates full sample).

	one syllable	*two syllables*	*longer forms*
Finnish	2 / 5	**5 / 5**	1 / 5
French	5 / 6	**6 / 6**	0
Italian	5 / 8	**8 / 8**	4 / 8
Welsh	**4 / 4**	3 / 4	1 / 4
English/UK	**5 / 5**	4 / 5	1 / 5
English/US	**5 / 5**	4 / 5	1 / 5

3.3. Summary

The children produce matches to only a small proportion of the adult segment inventory in any language and the segments they produce are highly similar cross-linguistically. On the other hand, the children are influenced by the structure of the ambient language with respect to the typical lengths of the word forms they produce – although even in a language like Finnish, with its agglutinative morphological structure and typically long child words at a slightly later stage (Savinainen-Makkonen, 2000), early words are restricted to one- and two-syllable forms.

4. Results at the individual child level: interactions between word shapes and segmental constraints

For each language group in turn we will consider, first, the phonetic challenges (and opportunities) presented by the language. We will then illustrate one or more individual child word patterns or 'templates' per group. For this purpose we will observe templates both in the forms that are relatively accurate (*select*) and in those that reflect adjustment to fit into the child's system (*adapt*).

4.1. Finnish

Finnish has a small consonant repertoire and no word-initial clusters; the set of word-final consonants is also highly restricted (alveolars only). On the other hand, short and long segments contrast word medially, whether in accented or unaccented syllable, creating a particular challenge for the child.[5] The rhythmic pattern is consistently trochaic, but with secondary stresses on alternate syllables (Suomi and Ylitalo 2004).

Two patterns account for most of the 'adapted' words used by Finnish children, both disyllabic: <C_1VC_1V> (consonant harmony, or CH), which applies to 19% or more of the word forms of all five children (mean 40%), and <VCV> ('no onset'), used by four of the five children. (For a more exhaustive account, see Vihman and Velleman 2000.) CH has been extensively treated in the child phonology literature (e.g., Stoel-Gammon and Stemberger 1994; Levelt 1994; Vihman 1996) and so will be illustrated only briefly here.

4.1.1. Consonant harmony (CH): Mira

Mira is the Finnish child who makes the most systematic use of CH – eight 'selected' word forms, 13 'adapted', including CH to the lateral [l]:

SELECT		ADAPT	
nenä 'nose'	[nenæ]	*häntä* 'tail'	[nen:æ]
pappa 'grandpa'	[pɑp:ɑ]	*jalka* 'leg, foot'	[lɑlɑ]
tonttu 'goblin'	[təto]	*juna* 'train'	[nunɑ]
tyttö 'girl'	[tytto]	*kala* 'fish'	[ʎɑʎɑ]

4.1.2. 'No onset': Matti

The VCV pattern, which is taken to be 'marked' in OT since the 'optimal' syllable is CV, is less often reported than CH. Matti 'selected' six VCV words and 'adapted' 11 more to fit the pattern.

SELECT		ADAPT	
äiti ‘mother’	[æiti]	*jalka* ‘foot, leg’	[ɑkːɑ]
ankka ‘duck’	[ɑkːɑ]	*katso* ‘look!’	[ɑto][6]
anna ‘give’	[ænːæ]	*kynä* ‘pencil’	[ænæ]
auto ‘car’	[ɑːto]	*purkka* ‘chewing gum’	[ɑkːɑ]
omppu ‘apple’	[ɔpːu]	*vettä* ‘water’	[etːæ]

Here we see that Finnish provides a fair number of VCV models – disyllabic words with vowel onset (24% of all words attempted by 11 Finnish children, including Matti: Vihman and Croft 2007) – but that Matti goes beyond those models, adapting disyllabic words with a C_1–C_2 structure by omitting the onset consonant, even when it is a stop (15% of the words produced by 11 Finnish children were so ‘adapted’: Vihman and Croft 2007). This is a pattern considered rare, even a possible mark of deviance, in children acquiring English (the pattern occurs in 12% of the words attempted by six children learning American English but is observed in only 4% of the words ‘adapted’ to fit their own systems by these same children).

4.2. French

Of the segmental challenges presented by French we note the high number of fricatives, which are common in basic vocabulary. There is also a large set of vowels, including the oral – nasal vowel opposition. Rhythmically, on the other hand, French is regular and consistent in its phrase-final lengthening (resulting in an iambic pattern on disyllabic forms), making it easier for children to adapt their early words to match adult prosody than is the case in either English or Welsh (Vihman et al. 2006). Each of the French children has a distinct word template (or templates).

4.2.1.

Laurent favours medial [l] and adapts words to incorporate this, producing (C)VlV word shapes (Vihman 1993). Notice the avoidance of fricative production here.

SELECT		ADAPT	
allo ‘hello (telephone)’	[ɑlo]	*brosse* ‘brush’	[bəlɑ]
ballon ‘ball’	[pɑlɔ̃)]	*canard* ‘duck’	[kɔ̰ɑ]
voilà ‘here you are’	[wɑlɑ]	*chapeau* ‘hat’	[bolo]

4.2.2.

Camille strongly favours monosyllables of the simple CV shape. She truncates words to achieve CV forms, retaining the best practiced consonant in each case. Thus, the syllable produced in adult forms may but does not always match part of the adult word (cf. *gâteau*, in which the onset consonant produced combines the velar place of the target word-initial consonant and the voicelessness of the medial consonant plus the vowel of the second syllable, and *musique,* in which the onset consonant actually derives by metathesis from the adult word-final consonant along with the vowel of the final syllable. (Veneziano and Sinclair [2000] provide a longitudinal study of Camille with an emphasis on her emergent morphological system.)

SELECT		ADAPT		
chat 'cat'	[ʃɑ]	*chercher* 'look for'	[ʃe]	C1 = C2
cloun 'clown'	[ku]	*canard* 'duck'	[kɑ]	retain C1
pas 'not'	[pɑ]	*gâteau* 'cake'	[ko]	C1 + V2
tiens 'here (you go)'	[tɑ]	*là-bas* 'over there'	[bɑ]	retain C2
		musique 'music'	[ki]	C3 + V2

4.3. Italian

Italian content word forms include relatively few clusters – although geminate consonants do occur in the Padua dialect, the source of these data – and no codas, so that vowels are of relatively high frequency and the Italian inventory includes only the early learned 'peripheral' vowels. On the other hand, it is hard for the Italian child to avoid attempting long words, as they are common even in the basic vocabulary of child directed speech. Drawing examples from just one child's target words, we find *bambola* 'doll', *berretto* 'bonnet', *capelli* 'hair', *cucchiàio* 'spoon', and *maialino* 'piggy'. Producing words of more than two syllables is difficult for children in the single-word stage, even when the adult language provides ample exposure to such forms. Only four of the eight Italian children sampled here produced 10% or more and only two developed long-word-form templates.

4.3.1. Word forms: Francesca

Francesca attempts and actually produces more long words than shorter forms. Most of these long words are 'adapted' – as expected, given the planning and memory challenges presented by such words. (Note that this child has a large production inventory of both consonants and vowels to draw on.) In the session sampled, Francesca uses two different templates for long words.

	SELECT		ADAPT	
1.	< . . . VtV>			
	tanto 'so much'	[tɑt:o]	*coltello* 'knife'	[totɔ]
	testa 'head'	[tɛtɑ]	*aggiustato* 'fixed'	[utɑto]
	il latte 'the milk'	[ilɑte]	*il tappo* 'the lid'	[ipɑto]
	è passato 'all gone'	[epɑtɑto]	*telefono* 'telephone'	[telɛto]
2.	< . . . VjV>			
	biro 'pen'	[bijo]	*balena* 'whale'	[mɑlejɑ]
			bambolina 'dolly'	[mɑmojɑ]
			caramella 'caramel'	[ɑjɑjejɑ]
			paletta 'shovel'	[pɑlejɑ]

The pattern < . . . VtV> is well represented in Francesca's vocabulary (6 'selected', 11 'adapted' – out of 43 word shapes produced). In *coltello* the pattern is used to create a disyllabic harmony form like those that match the target (*tanto, testa*). In the remaining words Francesca builds on target /t/ to create the pattern by omitting a syllable (*aggiustato*, *telefono*) or reordering the consonants (metathesis: *il tappo*).

The < . . . VjV> pattern, on the other hand, is represented by only one 'selected' form but occurs in eight long words, in which the /j/ apparently finds its source in target liquids – although /l/ occurs as such in *balena* and in other such long words as *campanello* 'doorbell' > [tɑpɑɛl:o] and *coccinella* 'ladybug' > [ɑtɑnɛl:ɑ]. Here, as in many of the 'adapted' child words, it would be difficult to derive the child's forms directly from the adult targets by one-to-one substitution rules. Furthermore, the two templates compete, as is evident from the inclusion of *paletta* in the < . . . VjV> pattern despite its final syllable. In fact, particularly in the case of words whose length in syllables exceeds the typical memory span for segmental patterns of one-year-olds with little experience of speech production (Keren-Portnoy et al. in press), there is a haphazard look to the word forms produced, which somewhat unpredictably retain some but not all aspects of the intended target.

4.3.2. 'No onset': Anna

Anna is the Italian child who produces the most VCV forms, with three 'selected' and 8 'adapted'.

SELECT		ADAPT	
Anna	[ɑnːɑ]	*aqua* 'water'	[ɑpɑ]
ecco 'here it is'	[ɛkːo]	*berretto* 'cap'	[eːto]
occhi 'eyes'	[ɔki]	*bocca* 'mouth'	[opɑ]
		dentro 'inside'	[eto]
		rotto 'red'	[oto]
		pioggia 'rain'	[ɔtːɑ]

As can be seen here, geminate consonants are found in all of the 'selected' word targets that take the form VCV in Anna's production – although Anna does not always reproduce sufficient consonant length to meet the transcriber's standard.[7] Of the eight 'adapted' <VCV> forms just four of the targets include geminates, but all have medial clusters of some kind. Interestingly, the identity of the medial consonant produced is not always predictable, with a [p] chosen over [k] by cluster-blending in *aqua* and metathesis in *bocca* (cf. also *mucca* /mukːɑ/ 'cow' > [mupɑ]). The [t] of *pioggia*, on the other hand, appears to be a regular substitution for /dʒ/: cf. *seggiola* 'chair' > [tɛtoɑ].

4.4. Welsh

The segmental inventory of Welsh is rich in consonants even in coda position. Furthermore, voiceless stops are strongly aspirated and are released word-finally. There are many fricatives and both voiced and voiceless sonorants, although the voiceless sonorants are mostly the product of mutation in the framework of particular grammatical constructions and are thus rare in isolated content words; only [ɬ] is frequent in lexical base forms. The dominant 'trochaic' accentual pattern focuses perceptual attention on both the word-medial consonant, which is lengthened under phrasal accent, and the final vowel, which is also lengthened (whereas the vowel of the 'stressed syllable' is short, except in monosyllables, which have contrastive vowel length): See Vihman et al. 2006.

4.4.1. Final [x]: Carys and Fflur

Children learning Welsh tend to produce monosyllables, codas and also VCV patterns. Carys adapts very few words but instead shows a practice effect – and the onset of phonological systematicity – by selecting heavily in favour of monosyllables (82%) and final fricatives, especially velar /x/.

SELECT		ADAPT	
plis 'please'	[pis]	*glas* 'blue'	[gɑx]
pws 'puss'	[pus]	*tractor*	[ɑx]
chwech 'six'	[dɑx]		

In contrast with Carys, Fflur adapts 75% of her words, but similarly favours coda /x/.

SELECT		ADAPT	
drwg 'bad'	[dɑk^{x}]	*boch* 'mouth'	[ʔɑx]
		gwallt 'hair'	[ʔɑx]
		dwr 'water'	[k^{h}ʊx]
		fancw 'over there'	[k^{h}ʊx]

The construction of word templates around coda [x] by two out of four Welsh children invites interpretation. It has long been known, on the one hand, that fricatives tend to be accurately produced first in coda position (Ferguson 1975) and, on the other, that there is some kind of as yet unexplained affinity – possibly based on perceptual factors – between the acquisition of velars and coda position (Menn 1975; Vihman and Hochberg 1986). English generally lacks a phoneme /x/ (Scottish English is exceptional in this regard), but in languages in which it does occur, such as Welsh and also Hebrew, it is learned early in coda position and may even serve as the basis for a word template.[8] Motoric factors may also be involved here: Approximation (without full contact) of the back of the tongue to the palate is arguably easier to control than approximation of the tongue tip or blade, as required for the coronal fricatives, and a tendency for tongue gestures to move from more anterior to more posterior positions over the course of a word's production has also been noted (Ingram 1974; Davis et al. 2002).

4.5. English

English has a comparatively large phoneme inventory, including many fricatives, two affricates and five diphthongs. It also boasts a complex prosodic structure, with two to three consonant clusters common at word onset and over 60% of content words with codas (Vihman, Kay et al. 1994). On the other hand, monosyllables are frequent in input speech to children, as they characterize a sizable proportion of the core vocabulary. In disyllabic words strong word-initial stress is the most common pattern, but in disyllabic phrases stress is typically word-final. The classic 'stress-timed rhythm' was defined on English, with its vowel reduction in unstressed syllables and highly variable rhythms (Ramus, Nespor and Mehler 1999). We noted earlier that the British and American English groups differ with respect to their highest use of the vowel space, with more front vowel production by the American group, more back vowel production by the British group. As it happens, one child each built a template around diphthongal [Vɪ] (US) and [Vʊ] (UK).

4.5.1. Diphthongs and codas: Alice vs. Rebecca

The American child Alice developed a 'palatal pattern' (Vihman et al. 1994). Monosyllables tended to take the form <(C)Vɪ>, while disyllables typically ended in unstressed [i] preceded by a palatalized consonant wherever alveolars occurred in the target (e.g., *bunny* [bʊɲːi]); both mono- and disyllables were generally open.) Out of 34 variant word shapes Alice produced only two with codas, both stops.

SELECT		ADAPT	
bye	[bɑɪ]	*belly*	[vei]
eye	[ʔɑɪ]	*bang*	[pɑ̃i]
baby	[beɪbi]	*clean*	[tiːni]
bottle/boddy	[bɑdi]	*flowers*	[pˑɑːji]

Alice's palatal pattern can be contrasted with the early word forms of Rebecca, who exemplifies 'the UK difference', selecting for monsyllables in <(C)Vʊ> and also adapting words to fit that template. (Alice had two 'selected' words with [Vʊ], *down* [daʊ] and *hello* [loʊ], but no words adapted to give that form.)

SELECT		ADAPT	
ball	[bɑʊː]	*bye*	[bɑʊ]
cow	[dɑʊ]	*two*	[toʊ]
no	[noʊ]		

4.5.2. Monomoraic syllables: Emily and Jude

In contrast with both of these children, one child each acquiring US and UK English produced 'monomoraic' CV syllables almost exclusively, with a preference for monosyllables. Emily, along with another American child, Deborah (Vihman 1996), prefers open forms to closed monosyllables. Like the early words of the French child Camille, these early word forms largely violate the 'minimal word constraint'.[9]

SELECT		ADAPT	
Bambi	[pɑpi]	*all gone* (im.)	[ɑki]
Big Bird	[pepːɪ]	*apple*	[ɑpi]
		beads	[ʔɪbɪ]
		Cookie (Monster)	[hək^{h}i]
		overalls	[ojɪ]
		water	[wɑwi]

Emily's disyllabic template, with the vocalic melody <V…i>, is virtually the same as Alice's. The sequence is common cross-linguistically (for examples, see Davis and MacNeilage 1990, Vihman and Croft 2007), while the reverse – <i…V> or <high…low> – has not been reported.

The British child Jude also produces simple CV forms, whether mono- or disyllabic, and no codas. Like Emily again, he primarily selects for or adapts targets to CH patterns in his disyllables.

SELECT		ADAPT	
baba	[bɑbɑ][10]	*dinner*	[nɪnɛ]
bubble(s)	[bɑbu^{h}]	*football* (im.)	[bɑbɔ]
daddy	[dɑdə]	*in 'ere*	[nənɑː]
Emma	[æmæ]	*noddy*	[nɑnɪ]

5. Discussion

5.1. Similarities and differences across language groups

The restricted but cross-linguistically uniform choice of commonly used segments – stops and nasals, labials and alveolars, and the low vowel [ɑ] – points to a motoric account (and largely agrees with the original predictions of Jakobson, 1941/68). These are the segments of canonical babbling, the sounds used most frequently in the prelinguistic period, in which vocal practice prepares the ground for word production. Similarly, only one- and two-syllable word shapes were used by all the children – with the ambient language biasing the groups towards one or the other. It is this motoric framework that leads to child 'selection' of production-friendly early word targets; it is that selection that provides the basis for the abstracting out of templates, which in turn leads to an increase in (adapted) targeted word forms.

5.2. Challenges and opportunities

5.2.1. Consonant change across the syllables of a multisyllabic word

In all groups there was evidence of 'adapting' words which presented the child with a sequential change in consonant place or manner or both, typically resulting in CH or 'no onset' patterns. Vowel-vowel sequences did not, in general, lead to 'adaptations', although a few cases of vowel harmony were observed in the data base but not exemplified here.

5.2.2. Segmental challenges

The consonants that pose a difficulty to children are those that require finer motoric planning – specifically, fricatives and liquids (Boysson-Bardies & Vihman 1991). Fricatives are reported to be more readily learned word-finally: We found several word templates based on final fricatives (Welsh, UK English) and just one based on a word-medial fricative (French). Similarly, although liquids are generally learned late, some children showed an early production facility with a (word-medial) lateral, and this provided the basis for a French template.

5.2.3. Word shape challenges

Words of more than two syllables were rare in the children's production overall, although one Italian child showed a particular affinity for such words. Some children consistently truncated even disyllables (French: Camille; Welsh: Carys, Fflur).

Coda consonants also constitute a challenge for many of the children – but an 'opportunity' for a few. The French children rarely target coda-final words, although they do occur in the input (ca. 25% of content words: Vihman, Kay et al. 1994). On the other hand, two of the Welsh children seek out word-final consonants. Furthermore, the five (British or American) English-learning children who produce more than one or two coda consonants *attempt* an average of 49% CVC words out of all their word targets, while the five who do not yet produce them target only 32% CVC words.

5.3. Theoretical predictions regarding 'universal' constraints or principles

English has provided the 'model' for child language study in virtually every domain, yet no one language can be 'typical' for acquisition. Thus, monosyllables are not (as sometimes claimed) the most frequent early word form in all languages and word onset is not necessarily the strongest position. Of the theoretical claims mentioned above, most of which originated in the observation of English child data, none are well supported by the data examined here.

Early word forms are neither maximally 'unmarked' at the expense of 'faithfulness' nor the reverse: They are *both* unmarked and 'faithful' (Velleman and Vihman 2006). That is, the relatively simple structure of early child words typically also characterizes the first word targets attempted by children (early words tend to be 'selected' but not yet 'adapted'). The period covered by this study follows that of the earliest words, when the child has developed a small lexicon of frequently used words. At this point – which corresponds to a parental report of some 50 words or more – we begin to see child-specific phonological patterns

or templates. These are manifested both by *focussed targetting* of a particular structural type among adult words (e.g., CVC) and by the child's *adapting* of adult target words of different structures or with different segments or segmental sequences to fit more closely into his or her system. What is striking is the extent to which the children vary – despite the overall cross-linguistic similarity in output forms – in their individual 'solutions' to the challenges posed by adult languages.

Furthermore, when what we might call 'biological accessibility' conflicts with formal markedness, the former 'wins' (Velleman and Vihman 2006). For example, the OT constraint against 'no onset' word shapes is violated in many early word patterns, most likely for reasons having to do with perceptual salience. Finnish and Italian include a number of early word targets with medial geminates, which seem to pull attention away from the onset consonant (Vihman and Croft 2007). In French, the lengthening of the second syllable vowel deflects child attention from the consonant at word onset (Vihman et al. 2004); here again <VCV> templates occur. English is thus again the exception rather than the rule in this respect, and the inclusion of 'no onset' as a 'high ranked' markedness constraint may not be appropriate for child language.

Similarly, the minimal word constraint and the corresponding first stage of the 'prosodic hierarchy', sometimes claimed to be universally observed in phonological acquisition, apply only about half the time in our data. The open syllables of early word forms are often long or diphthongal – but as we saw with Camille, Emily and Jude, some children *adapt* words (by truncation and other processes) to the 'marked' or dispreferred syllable type (C)V.

Finally, CV associations of the kind predicted by the Frame-and-content account can be observed but are far from being the rule in our data, which were transcribed by a number of different teams. Making a rough count of the extent to which the expected CV associations obtain just in the examples chosen for presentation here (not the full data set, which has not been analysed for CV associations), we find that in 58 syllables (out of 137, or 42%) an alveolar is followed by a front vowel (including [æ]), a labial by a central vowel (or [ɑ]) and a velar by a back vowel (excluding [ɑ]). In the remaining 79 syllables with supraglottal consonants at onset these associations fail to obtain. The two most frequently occurring syllables are [pɑ], which shows the expected labial+central-V association, and [to], which does not (13 and 14 occurrences, resp.). The CV association principle thus does not appear to be supported at this developmental point, based on this cursory analysis.

6. Conclusion

This study was intended to explore the extent to which early child word forms fit the universal principles that have been proposed to account for the origins of phonological development; alternatively, we sought to determine whether both the similarities and differences found in early word forms can be explained on the basis of an approach that emphasizes individual item learning followed by the implicit abstracting out of word templates. On the whole, the evidence presented here supports the latter approach. We found that what is 'easy' – or produced commonly in early words –

(a) is motorically accessible;
(b) demands minimal sequential planning (single consonant or repeat of the same consonant in a sequence);
(c) is well practiced ('familiar'), whether from babbling or from previous word production. This refers not only to familiar segments but also to familiar sequences (segments repeatedly produced in the same slot, e.g., C_1–C_2).

Within that common framework for all of the children, which affords a 'universal look' to early word data, the children encountered a range of opportunities and challenges in different languages and in relation to their individual production experiences. Their 'solutions' differed accordingly.

A second goal of the paper was to characterize word templates in a consistent way cross-linguistically, adopting a flexible definition of what 'counts' as a template. For evidence of the existence of a template we categorized child word shapes as 'selected' if they constituted a roughly accurate match to the target but 'adapted' if they departed from the target in some more radical way (often supplemented by evidence from other word forms that the child was motorically capable of producing a closer match). Some of the 'templates' identified by this method were well represented in the child's production and easily characterized, based on relatively stable repeated occurrence (e.g., <VlV> in the case of the French child, Laurent). In other cases, the child's preferred forms were of a rather general shape – as in the case of both Emily and Jude, who produced simple mono- and disyllabic CV forms that observe a harmony constraint.

The children who produced the most words in a session provided the strongest evidence of template use. We take this to suggest that at the point when 25 different word types have just begun to be produced in a half-hour recording session templates are only emergent; one or two months later more easily identifiable templates are found (see Priestly 1977). Within a somewhat longer time period all such idiosyncratic templates are expected to fade away in favour of a more systematic adult-like set of relationships between child forms and adult targets,

mainly reflecting segment substitutions (cf. Macken 1979, who traces just such a developmental path in one Spanish-learning child). This hypothesis remains to be tested on a larger sample of children at a somewhat later age.

Notes

1. Although these data reflect analysis of only one session per child, the method has been applied elsewhere to several weekly sessions (Vihman and Velleman 1989, Vihman, Velleman and McCune 1994).
2. This criterion is admittedly arbitrary, merely a way to sum across children and languages: Correct multiple lexical type use of an identifiable segment by three or more out of five children provides a plausible 'standard' for identifying widely used segments in the single word period.
3. Voiced and voiceless stops are combined here for two reasons: (1) Although all of the data sets were transcribed using IPA, native speaker transcribers of English and Welsh are more likely to use voiced stop symbols to indicate plain unaspirated stops while native speakers of the other languages are more likely to use voiceless stop symbols to indicate the same sound; (2) at this stage, children do not typically distinguish clearly in production between the two voicing categories (Macken 1980).
4. The criterion for reporting word shape statistics refers to individual children within groups rather than summing across children and groups, but the across-group statistic can readily be calculated. The criterion for word shape occurrence is again arbitrary, but results in striking group differences that should prove robust to the application of alternative criteria.
5. As accurate transcription of length in child production of either vowels or consonants is difficult, we exclude considerations of segmental length in categorizing child word forms as 'selected' vs. 'adapted'. For evidence on the acquisition of phonetic and phonological length in consonants see Vihman and Velleman 2000; Kunnari, Nakai and Vihman 2001; Vihman et al. 2006.
6. But note also the C1VC2V variant [kato].
7. I thank Ludovica Serratrice for suggesting that I look for an effect of geminates on Italian children's templates.
8. Anat Ninio provided an anecdotal account of such a case in Hebrew.
9. Coda consonant omission is disregarded in classifying words as 'select' or 'adapt' in cases where the child is not yet producing codas.
10. Welsh for 'baby', often used by English families living in North Wales.

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