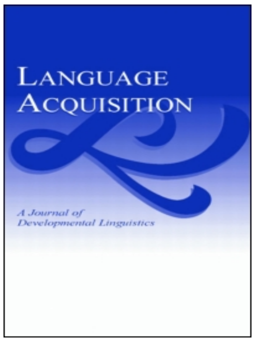

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Nicole Altvater-Mackensen & Paula Fikkert

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Nicole Altvater-Mackensen
Max Planck Institute for Human Cognitive and Brain Sciences

Paula Fikkert
Radboud University Nijmegen

The present article investigates the acquisition of Manner of Articulation (MoA) contrasts in child language production. We analyzed spontaneous longitudinal speech data of four German and six Dutch 1- to 3-year-olds. The data suggest that the acquisition of MoA contrasts is influenced by various co-occurrence constraints at the word level. Interestingly, developmental patterns are very similar across languages. However, children seem to follow different strategies to introduce MoA contrasts: They either introduce MoA contrasts in word-initial position in monosyllables as well as in disyllables, or they introduce MoA contrasts in noninitial position in both types of words. We couch the data in a lexical framework assuming that early lexical representation fits templates that evolve in the course of development.

1. INTRODUCTION

A number of scholars have argued that children do not have adultlike representations in the beginning but instead assume coarsely specified representations to which children add more phonological detail in the course of development (Waterson 1971; Ferguson & Farwell 1975; Macken 1980; Echols 1993; Rice & Avery 1995; Jusczyk 1993; among others). Although this assumption seems to be the minority view in the current language development literature,[1] the

[1]The assumption that early lexical representations do not contain full phonological detail has been severely put into question by numerous studies showing that toddlers are sensitive to even subtle mispronunciations in familiar words (e.g., Swingley & Aslin 2000; Mani & Plunkett 2007; White & Morgan 2008; Swingley 2009). Yet, perception studies also show that not all changes to the phonological makeup of words are detected equally well (e.g., Nazzi 2005; Curtin, Fennell & Escudero 2009; Mani & Plunkett 2010). It has been argued that these asymmetries in perception might indicate that early lexical representations lack certain phonological detail (see Van der Feest 2007; Fikkert 2010; Altvater-Mackensen & Fikkert 2010; Altvater-Mackensen, Van der Feest & Fikkert 2013). However, since this article focuses on production data and cross-linguistic differences, it lies outside its scope to provide a detailed discussion of this debate.

Correspondence should be sent to Nicole Altvater-Mackensen, Research Group Early Social Development, Max Planck Institute for Human Cognitive and Brain Sciences, Stephanstraße 1A, Leipzig, G-04103, Germany. E-mail: altvater@cbs.mpg.de

idea that children's early productions follow specific templates that develop over time has recently been renewed (Vihman & Croft 2007; Fikkert & Levelt 2008). Importantly, these studies do not necessarily imply that children's lexical representations are holistic (as suggested by, e.g., Charles-Luce & Luce 1990; Walley 2005). Rather, they propose that words are represented in terms of phonological segments, but that there are restrictions on their (co-)occurrence. More specifically, Fikkert & Levelt (2008) observe that the realization of different Place of Articulation (PoA) contrasts within one word is highly restricted in the beginning and that the restrictions change systematically in the course of development. In the earliest stage of word production, all consonants of a word share their PoA. In the course of development, children sequentially introduce PoA contrasts in specific positions: While coronals may appear in any position, labials are restricted to word onsets and dorsals are restricted to noninitial positions at first.

Fikkert & Levelt (2008) couch their findings in a lexical framework, assuming that at the earliest stages of development children specify one PoA for the whole word and that PoA contrasts are then introduced in specific word templates. Their observations can be interpreted as evidence that phonological specification is a stepwise process that follows a contrastive hierarchy of phonological markedness (Dresher 2009). Coronals are the most frequent PoA across the world's languages (Greenberg 1966), and they frequently undergo phonological processes such as assimilation (Marslen-Wilson, Nix & Gaskell 1995; Zimmerer, Reetz & Lahiri 2009). They are therefore often assumed to be "unmarked" (e.g., Paradis & Prunet 1991) and might act as *default* PoA in children's early words. The finding that labials come in very early matches with cross-linguistic data: Infants tend to introduce labials first in languages as different as Finnish, Estonian, French, German, Hebrew, and English (Vihman 1996; Vihman & Croft 2007). Furthermore, favoring labials at the beginnings of words is common in development (MacNeilage & Davis 2000; Nazzi, Bertoncini & Bijeljac-Babic 2009). It matches Jakobson's idea that children's first productions tend to have a simple consonant-vowel structure with the consonant being a labial stop and an open vowel because the resulting word would have (a) the most unmarked syllable structure, and (b) the largest possible contrast between a maximally closed consonant and a maximally open vowel (Jakobson 1968).

However, if phonological specification is a stepwise process, we expect similar developmental patterns for other phonological contrasts, like, e.g., Manner of Articulation (MoA). If children indeed do not acquire phonological contrasts "across the board" but one at a time in specific positions, we expect that children show evidence for specific positional restrictions and/or changing co-occurrence constraints in the course of development. MoA contrasts are especially interesting to investigate because they can be described in terms of syllable structure, and their distribution is influenced by principles of sonority. Less-sonorous sounds, like stops or fricatives, tend to occur at onsets and in extrasyllabic positions, while more-sonorous sounds, like nasals or liquids, tend to occur closer to the center of syllables (e.g., Selkirk 1982). Thus, because MoA contrasts are bound by sonority constraints, their acquisition might interact with prosodic structure and follow different lines of development than, e.g., PoA contrasts. It is therefore of special interest to look at the acquisition of MoA contrasts in word context.

Looking at the literature on the acquisition of MoA contrasts in early child language, most studies investigate the acquisition of MoA contrasts at the segment level. A well-known assumption is that stops are the least-marked consonants and are therefore acquired first, while fricatives are more marked and acquired relatively late (e.g., Jakobson 1968). In a survey of the early speech of 55 English-learning infants, Stoel-Gammon (1993) finds that oral stops are the only sound class that is used by all children. Stops, but not fricatives, also frequently occur in babbling (Gildersleeve-Neumann, Davis & MacNeilage 2000). Nasal stops are reported to be acquired early as well, but this seems to be a weaker universal tendency (De Boysson-Bardies & Vihman 1991).

Taking a closer look, the acquisition of MoA contrasts relates to the position of the consonant in question. Fricatives occur in intervocalic or coda position first, while stops and nasals are produced early in onset position (Farwell 1976; Fikkert 1994; Edwards 1996). Interestingly, one of the few studies looking at the acquisition of MoA at the word level finds that not only position within the word is important, but co-occurrence constraints at the word level might also play a role. Reanalyzing the data of 52 typically developing children, Stoel-Gammon (2002) finds that in more than 80% of the earliest 10 words, the initial consonant shares its place and manner features with the final consonant in CVC words or the second consonant in CVCV words respectively. Yet, the nature of the relation between the different MoAs in a word is unclear. Whereas reduplication as well as place harmony is a widely reported phenomenon in child language (e.g., Menn 1971; Vihman 1978; Stemberger & Stoel-Gammon 1991; Pater 2002; Rose & Dos Santos 2006), MoA harmony has scarcely been described along these lines (but see Dinnsen 1998; Rose & Dos Santos 2010). Thus, it is unclear whether Stoel-Gammon's (2002) findings reflect an early stage in which children specify one MoA for the whole word, as proposed by Fikkert & Levelt (2008) for the acquisition of PoA. It also remains open whether there are further co-occurrence constraints at the word level in later stages of acquisition. The question how different MoAs might interact within a word during development is thus not yet answered.

The current study therefore investigates the acquisition of Manner of Articulation contrasts in word context, focusing on the question of whether there are constraints restricting the co-occurrence of different MoAs within one word, and if so, what the nature of the constraints is and how these constraints change in the course of development. If phonological contrasts are specified one at the time, as indicated in the developmental pattern Fikkert & Levelt (2008) described for the acquisition of PoA, we could propose the following predictions for the development of MoA contrasts: First, the consonants in children's early words may share their MoA (as suggested by the data of Stoel-Gammon 2002). Children should then stepwise introduce MoA contrasts and fill in unspecified positions with a *default* MoA. The order and the position in which specific contrasts are specified might thereby follow a universal, a language-specific, or an individual path, as we will discuss later.

More specifically, we investigate the acquisition of plosives, fricatives, nasals, and liquids in monosyllabic CVC and disyllabic CVCV words in German and Dutch. Thus, the contrasts under investigation include (a) the contrast between obstruents and sonorants within the group of consonants, (b) the contrast between plosives and fricatives within the group of obstruents, and (c) the contrast between nasals and liquids within the group of sonorants. These differences might be captured by the phonological features [sonorant], [continuant] and [nasal], as depicted in Figure 1. Note that we excluded glides from the analysis because—unlike obstruents, nasals, and liquids—they are not consonantal. German affricates are neither discussed in detail because they appear very late in the children's productions.

We use monovalent features here to describe the contrasts in question, although they could similarly be described in terms of binary features. However, it appears that monovalent features dovetail with the idea that children introduce phonological detail stepwise. Specification

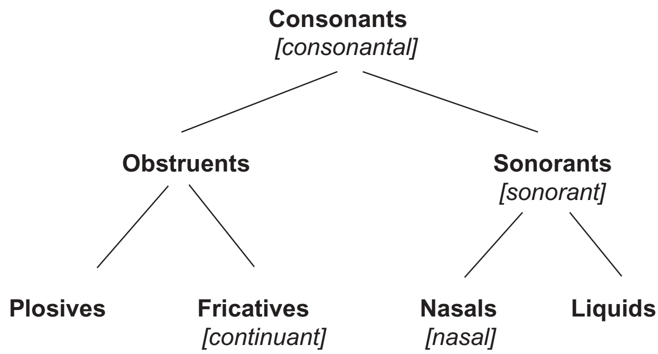

FIGURE 1 Manner of Articulation contrasts under investigation.

of a particular phonological contrast would then entail the representation of a feature for the marked member of a contrast, while the unmarked member might still be left unspecified and act as a *default* realization. For instance, when the child introduces the contrast between plosives and fricatives, fricatives might be marked for being [continuant], while plosives might remain unspecified. Note, however, that this study will focus on the acquisition of the different classes of segments and how they may combine within words, rather than on the acquisition of specific features. We will therefore only briefly touch the question of featural representations in the discussion of the results.

Both languages under investigation, Dutch and German, are closely related and have very similar phonological systems. However, there are some differences that are of potential interest to our research question. First, due to diachronic language changes, words that are monosyllabic in Dutch often contain a word-final schwa in German (compare German /pʊpə/ *Puppe* to Dutch /pɔp/ *pop* 'doll'). Thus, a large number of words that children learn early in development are monosyllabic in Dutch, while they are disyllabic in German, reversing the proportion of CVC and CVCV words in the two languages. Second, the distribution of the different manners of articulation within the word differs across the two languages. Table 1 lists the rank order of the different MoAs under investigation by word position based on word-type frequencies in the lexical database CELEX (Baayen, Piepenbrock & van Rijn 1993). It appears that word-final consonants tend to be sonorants in German, while they tend to be obstruents in Dutch, and that German words are more likely to contain a word-initial fricative than a word-initial plosive, while the reverse holds true for Dutch.

If children indeed use templates to introduce new phonological contrasts one at the time, the previously described differences might cause differences in the developmental path that Dutch and German children follow. There are different developmental scenarios: Children might largely follow a universal, a language-specific, or an individual path in acquiring manner of articulation contrasts. If children follow a universal path, we do not expect differences between German and Dutch children. The acquisition of MoA contrasts might then be driven by, e.g., principles of general markedness (e.g., Jakobson 1968), articulatory constraints (e.g., McAllister Byun 2012), or perceptual factors (e.g., Davis & MacNeilage 2000). Based on earlier results, we might predict that children restrict intervocalic and final positions to fricatives first, while stops and nasal should

TABLE 1
Rank Order of the Different MoAs under Investigation for Word-Initial, -Medial and -Final Position in Dutch and German

Initial		*Medial*		*Final*	
German	*Dutch*	*German*	*Dutch*	*German*	*Dutch*
Fricative	Plosive	Plosive	Plosive	Nasal	Plosive
Plosive	Fricative	Fricative	Fricative	Liquid	Fricative
Liquid	Liquid	Liquid	Liquid	Fricative	Liquid
Nasal	Nasal	Nasal	Nasal	Plosive	Nasal
Affricate		Affricate		Affricate	

be introduced in initial position. We do not, however, have any specific predictions for the co-occurrence of different MoAs within a word.

If children follow a language-specific path, the distribution of the different MoA contrasts in the target language might determine the order and position in which specific MoA contrasts are acquired first. Then, Dutch and German children are expected to differ in their developmental pattern. For instance, German children might show differences between the development of consonants in final and nonfinal position because MoA contrasts are differently distributed across these positions, while the distribution is similar across positions for Dutch children. In particular, the different distribution of sonorants and obstruents in word-final position might lead German children to introduce sonorants and the contrast between liquids and nasals in this position first, while Dutch children might focus on obstruents and the contrast between plosives and fricatives. Furthermore, the higher number of CVC monosyllables might make word-final MoA contrasts more salient for Dutch children, while the higher number of CVCV disyllables might render intervocalic contrasts more salient for German children. Finally, if children introduce phonological detail stepwise in specific word templates and fill in unspecified positions with a *default* MoA, as suggested by Fikkert & Levelt (2008), then the default might differ for Dutch and German depending on what is the most frequent MoA in a specific position.

More generally, comparing the development of CVC and CVCV words might reveal potential differences related to prosodic or phonotactic structure. If position influences the acquisition of MoA contrasts, the developmental path for initial, medial, and final consonants might differ, while they might largely overlap if there are no positional or co-occurrence restrictions. That is, if there are no positional constraints, then initial and noninitial consonants in both CVC and CVCV words should show a similar development. Regardless of word type and syllable position, an acquired MoA contrast should be specified in all positions at the same time. If, however, position within the word influences the acquisition of MoA contrasts, initial and noninitial consonants might develop differently. Depending on the unit on which children base their generalizations, consonants might pattern together differently. For instance, if syllable position is an important factor (see Demuth 1995), we would expect that initial and medial consonants pattern together—they both form syllable onsets—while word-final codas show a different development.[2] Given the

[2]Note that this hypothesis might be an oversimplification. The assumption that word-final consonants are syllabified as codas is not undisputed. Some researchers have argued that word-final consonants form the onset of empty-headed

different sonority restrictions applying within syllables, we would then further predict that sonorants are more likely to be introduced in codas, while obstruents are more likely to be introduced in onset position. However, children might also base generalizations on the position within the word or string of segments more generally; this holds in particular if syllable structure is not part of the lexicon. Perception studies suggest that children pick up most phonological detail from word-initial segments (e.g., Jusczyk, Goodman, & Baumann 1999; Zamuner 2006; but see Swingley 2009, for different findings). Thus, we might expect that initial positions are particularly salient and detail will first be added to initial positions. Medial and final consonants might then behave similar to each other—being both noninitial—but follow a different path than initial consonants.

Taken together, depending on the factors that influence the acquisition of MoA contrasts, we might expect differences between the development of CVC and CVCV words in the two Germanic languages under investigation concerning (a) the order of acquisition of the different manner contrasts, and (b) the position in which contrasts are first produced.

2. METHOD

To track the development of word patterns with respect to MoA contrasts, we analyzed spontaneous longitudinal speech data of 10 children. Our data come from four German children (three female; all children from Grimm 2007) and six Dutch children (three female; all children from the CLPF corpus (http://childes.psy.cmu.edu/browser/index.php?url=PhonBank-Phon/Dutch-CLPF/); Levelt 1994; Fikkert 1994). The children were recorded at their homes during play sessions. Recordings were made every other week for the Dutch children. The German children were recorded every other week in the first months and every month later on. Data were on average collected for a period of about one year, age range was from 1;00 to 2;11. Table 2 summarizes how long and at which age the data for each child were recorded. For more detail on data collection we refer to the corresponding publications.

Based on the phonetic transcriptions of the data provided by Fikkert (1994), Levelt (1994), and Grimm (2007), we selected all monosyllabic and disyllabic content words from the corpora. We restricted the data set to words that did not contain any consonant clusters but had a strict CVC(V) structure. We then made a final selection on the basis of the children's actual productions, i.e., we included all words that the children uttered as monosyllabic CVC or disyllabic CVCV words.[3] We decided to only include those words that had target structure CVC(V) and

syllables in child language because they behave similar to onsets and not to word-internal codas (e.g., Goad 2002). If the C in CVC and CVCV patterns similarly, this could be seen as evidence that the second C in CVC is in fact an onset with an empty nucleus. Furthermore, German and Dutch require a two-positional rhyme (Wiese 1988; Booij 1999). The second consonant in CVCV words might therefore be ambisyllabic in cases where the first vowel is short. Since ambisyllabic consonants are not unambigous onsets, they may behave differently, too. We will come back to these points in the general discussion.

[3]There is one exception to this rule: We also included trochaic disyllables in German and Dutch with a final liquid or glide, which the child produced without the final sonorant. For example, we included a word like German /t͡sɛtəl/ *Zettel* 'note' or Dutch /voΞəl/ *vogel* 'bird,' when the child deleted the final liquid. We did so to enlarge the number of disyllables, especially in Dutch.

TABLE 2
Period of Data Collection for All Children Whose Data Were Included in the Corpus

Name	*Language*	*Age at First Recording*	*Age at Last Recording*	*Number of Recordings*
Elke	Dutch	1;06	2;03	17
Eva	Dutch	1;04	1;11	12
Jarmo	Dutch	1;04	2;02	19
Noortje	Dutch	1;07	2;11	21
Robin	Dutch	1;05	1;11	15
Tom	Dutch	1;01	2;03	21
Hannah	German	1;05	1;11	19
Jule	German	1;05	2;0	18
Niklas	German	1;05	2;01	22
Renee	German	1;00	1;10	28

were also produced as CVC(V) to prevent problems deciding which specific sound was actually substituted or deleted in production. Examples of selected disyllabic words are [dɔnə] for German *Tonne* ‘barrel’ (Niklas 1;08,06) and [pɔfi] for Dutch *koffie* ‘coffee’ (Eva 1;07,22). Examples of selected monosyllabic words are [baːt] for Dutch *paard* ‘horse’ (Tom 1;04,14) and [ba̰m] for German *Baum* ‘tree’ (Renee 1;04,08). We excluded the words for ‘mommy,’ ‘daddy,’ and the children’s names because these words are acquired very early and may have a special status in the children’s speech.

As expected based on the predominant prosodic patterns of the languages, iambs were rare in the children’s productions. In total, we found fewer than 20 iambic words in the whole data set. We therefore decided to focus our analysis on trochaic and monosyllabic words. The resulting corpus consisted of 468 CVC and 1,048 trochaic CVCV words for German, and 2,166 CVC and 1,027 trochaic CVCV words for Dutch. All consonants of the selected words were coded for their Manner of Articulation. Place of Articulation and voicing differences were ignored. All stops were coded as P, fricatives as F, affricates as P_F, nasals as N, liquids as L, and glides as G (for a similar method see Pater & Werle 2003; Fikkert & Levelt 2008). For example, a production like [va͡um] for German *Baum* ‘tree’ (Niklas 1;06,26) would be coded as FVN; a production like [kʉxa] for Dutch *kikker* ‘frog’ (Robin 1;07,27) would be coded as PVFV. As outlined earlier, glides were excluded from further analysis. This resulted in a final corpus containing 2,912 Dutch words and 1,429 German words. For the main analysis we just looked at children’s productions without relating them to the target form. We do, however, report error patterns in a separate section to provide a complete picture of the data.

Following Fikkert & Levelt (2008), we considered a word pattern acquired either when it appeared at least twice within one recording session or when the child produced it in at least two successive sessions. Table 3 gives examples from the German corpus to illustrate the coding procedure. C_1 specifies the initial consonant and C_2 specifies the second consonant of the word, i.e., the final consonant in monosyllabic words and the intervocalic consonant in disyllabic words. Note that the coded patterns reflect the actually produced MoA, not the MoA of the target. Hence, accuracy is not reflected in the initial coding and only accounted for in the separate error analysis.

TABLE 3
Examples of Analyzed Word Patterns from the German Corpus

$C_1 = C_2$	$C_2 = Stop$	$C_2 = Fricative$	$C_2 = Nasal$
C_1 = Stop	PVP(V) [pʰɨpʰɨ] for /pʊpə/ *Puppe* ‘doll’ (Jule 1;05,07)	PVF(V) [pʊs] for /bʊs/ *Bus* ‘bus’ (Niklas 1;08,13)	PVN(V) [ba͡ʊm] for /ba͡ʊm/ *Baum* ‘tree’ (Jule 1;10,14)
C_1 = Fricative	FVP(V) [foːto] for /foːto/ *Foto* ‘picture’ (Niklas 2;00,11)	FVF(V) [βɪç] for /fɪʃ/ *Fisch* ‘fish’ (Renee 1;01,11)	FVN(V) [fɪŋɐ] for /fɪŋɐ/ *Finger* ‘finger’ (Hannah 1;10,19)
C_1 = Nasal	NVP(V) [mati] for /matə/ *Matte* ‘mat’ (Jule 1;07,25)	NVF(V) [mɛsə] for /m͡ʏtsə/ *Mütze* ‘cap’ (Hannah 1;07,08)	NVN(V) [nana] for /naːzə/ *Nase* ‘nose’ (Renee 1;02,22)

3. DATA DESCRIPTION AND DISCUSSION

In the following, we will present the results of the corpus analysis. Results for Dutch and German will be presented separately in sections 3.1 and 3.2 respectively. Each section starts with an overview of the acquisition of MoA contrasts in specific positions. We will then discuss co-occurrence restrictions between the initial and noninitial consonants and propose different developmental stages in the acquisition of MoA. Because affricates and liquids appear late in our data, we will focus this discussion on the appearance of stops, fricatives, and nasals. To provide not only exemplary evidence for the proposed stages, we included tables showing the proportions of words that conform to the different word patterns in each stage (including all MoA contrasts under investigation, i.e., stops, fricatives, affricates, nasals, and liquids). As mentioned in section 2, this analysis only included monosyllabic and trochaic words. This is because iambic words were rare in the children’s productions, making it difficult to abstract away from individual variation. At the end of each section we provide an error analysis that compares produced and targeted manner of articulation to see whether production errors follow specific directions. We will summarize our findings and discuss within- and across-language differences and commonalities in section 3.3.

3.1. Dutch

3.1.1. Development of MoA Contrasts by Position

To disentangle developmental patterns, we first looked at the order of appearance of the different MoAs in initial, medial, and final position separately. For initial position, we collapsed the data for the first consonant of monosyllables and trochees. Medial position refers to the development of the second consonant of trochaic CVCV and final position to the final consonant in monosyllabic CVC. Table 4 summarizes the order of appearance of the different Manners of Articulation per position for each of the six Dutch children. Liquids are not listed in Table 4

TABLE 4
Order of Appearance of Different MoAs per Position (Dutch)

	Elke	*Jarmo*	*Robin*	*Tom*	*Eva*	*Noortje*
Initial	P,F→N	P→F→N	P→F→N	P→F,N	P→N→F	P→N→F
Medial	P,F→N	P→F→N	P→F,N	P, F→N	P,F,N	P→F,N
Final	P,F→N	P,F→N	F→N→P	P→F→N	P,F→N	F,N→P

Note. Arrows separate MoAs that appear subsequently, commas separate MoAs that appear at the same time.

because they appear very late in all positions. As can be seen from the table, all children start with stops in initial position. Most children introduce fricative as second and nasal as third MoA, although some children produce nasals before fricatives in word-initial position (Noortje and Eva). Word-medial onsets show a consistent pattern across children: Stops are the first manner of articulation to appear in word-medial position, followed by fricatives and nasals. Word-final positions show a development similar to word-medial positions. Only Robin and Noortje show a different pattern, introducing fricatives and nasals before stops in final position.

Taken together, this suggests that the order of acquisition is similar across the different positions within the word for Elke, Jarmo, and Tom. For Eva noninitial, i.e., final and medial, positions pattern together, while the word-initial position shows a unique path. For Robin, on the other hand, initial and medial consonants pattern together, while the final position shows a different path. Noortje seems to show a similar behavior to Robin. Thus, it seems that children differ in which positions they collapse.

The finding that children from the same language group show different developmental patterns suggests that the order in which MoA contrasts are acquired is not bound to the distribution of the different MoA contrasts in the target language. Remember from the introduction that in Dutch initial, medial, and final positions show a similar distribution of the different MoA contrasts, with plosives being most frequent, followed by fricative, liquids, and nasals (see Table 1). According to the general distribution, children tended to first produce stops, followed by fricatives in all positions. However, this neither holds for all children nor all positions. Moreover, order of acquisition diverges from the general distribution in that all children acquire nasals before liquids.

3.1.2. Development of MoA Patterns within Words

To get a more detailed understanding of the data, we also tracked the order of appearance of specific word patterns. Instead of presenting the data of all six Dutch children, we will discuss the productions of Tom and Noortje only because their productions are representative for two different strategies that the children use. Four out of six children show the same pattern that Tom does; one other child (Robin) shows the same development as Noortje. We will first discuss Tom's productions.

3.1.3. Introduction of Manner Contrasts in Initial Position

Tom first produces monosyllables that just contain stop consonants (1a). Slightly later, he also produces words starting with a stop and ending in a fricative. The same target word can be produced with either a final stop or a final fricative (1b).

(1)	a.	[paːt]	/paɹt/	*paard* ‘horse’	Tom 1;04,14	PVP
	b.	[pɑs]	/vɔs/	*vos* ‘fox’	Tom 1;05,14	PVF
		[pɔt]	/vɔs/	*vos* ‘fox’	Tom 1;05,14	PVP

In the course of acquisition, Tom’s word patterns become more variable. He produces monosyllables with an initial stop, fricative, and nasal. However, at first, the different initial segments invariably combine with a final fricative (2a), which may indicate that in final position fricatives serve as a default MoA. Only later does Tom also allow variation in the final consonant (2b).

(2)	a.	[daf]	/dœ͡yf/	*duif* ‘dove’	Tom 1;06,25	PVF
		[fɪʃ]	/vɪs/	*vis* ‘fish’	Tom 1;06,25	FVF
		[mœ͡uɸ]	/mœ͡ys/	*muis* ‘mouse’	Tom 1;06,11	NVF
	b.	[χɑt]	/χɑt/	*gat* ‘hole’	Tom 1;07,23	FVP
		[bɔm]	/bom/	*boom* ‘tree’	Tom 1;08,06	PVN
		[ʃʉn]	/zɔn/	*zon* ‘sun’	Tom 1;08,20	FVN

Looking at the development of disyllables, we observe a similar pattern.[4] In the first productions both consonants share their manner of articulation: The first and second consonants are either both stops or both fricatives (3a). Next, Tom combines stops and fricatives within one word (3b). Nasals come in later. As seen for monosyllables, Tom produces nasals in initial position of disyllables before he does so in noninitial position (3c).

(3)	a.	[kɑ͡ukə]	/kœ͡ykə/	*keuken* ‘kitchen’	Tom 1;06,11	PVPV
		[fɔχɔu]	/voχəl/	*vogel* ‘bird’	Tom 1;06,25	FVFV
	b.	[tɛ͡iχə]	/tɛ͡iχəɹ/	*tijger* ‘tiger’	Tom 1;07,09	PVFV
		[fʉtɔ]	/ʋɔrtəl/	*wortel* ‘carrot’	Tom 1;07,09	FVPV
	c.	[mɑ͡usə]	/mœ͡yzə/	*muizen* ‘mice’	Tom1;10,08	NVFV

To illustrate the pattern of development of mono- and disyllables, Table 5 summarizes the appearance of Tom’s first word shapes. Concerning monosyllables, Tom starts with PVP words. It thus seems that he uses the least-marked Manner of Articulation, i.e., a stop, and uses it for both consonants in the word. Analogous to the first stage in development for PoA contrasts described

TABLE 5
Development of Tom’s First Word Patterns in (a) CVC and (b) CVCV Words

Age	*1;04–1;05*	*1;06*	*1;07*	*1;08*	*1;10*
a.	PVP, [PVF]	PVF, FVF, NVF	FVP	PVN, FVN, NVN	
b.		PVPV, FVFV	PVFV, FVPV		NVFV

[4]In the Dutch data CVCV words are generally produced later than CVC words, as expressed in Table 5.

by Fikkert & Levelt (2008), we propose that Tom does not contrast the two consonants in the word, but that one MoA is assigned to both consonants.[5] The next upcoming word pattern is PVF, followed by FVF and NVF. At this stage, he combines different Manners of Articulation in initial position with a "fixed" obstruent—a fricative—in final position. Since variation is only allowed in the initial consonant, it thus appears that Tom introduces manner contrasts in initial position. In the subsequent step, he also produces nasals in final position and combines them with obstruents and nasals in initial position. Co-occurrences of different MoAs within one word seem to no longer be restricted.

The fact that Tom can produce a certain type of Manner of Articulation in initial position (like a nasal in the pattern NVF at 1;6), does not imply that he can also produce this MoA in noninitial position (the reverse pattern FVN only appears at 1;8). Hence, contrasts seem to be introduced in specific positions and do not generalize to all positions automatically. This is also illustrated by the fact that variation in monosyllables precedes those in disyllables. Word patterns are produced in monosyllabic CVC words before they are produced in disyllabic CVCV words (see Table 5). In general, though, CVCV words show a pattern similar to CVC words. In a very early stage, both consonants share their manner of articulation: C_1 and C_2 are either both stops (PVPV) or both fricatives (FVFV). Only later can the consonants differ in manner of articulation.

3.1.3.1. Quantitative data. Table 6a displays the proportion of words that conformed to the different word patterns for all stages, collapsing over the four Dutch children who introduced manner contrasts in initial position. The first column shows the different word patterns that appear in the data. The remaining five columns display the percentage and absolute number of words that conformed to the given word pattern at each proposed developmental stage. Word patterns that should—according to the proposed developmental stages—be introduced in the given stage are marked in bold. Word patterns that should—according to the proposed stages—be part of the inventory, i.e., word patterns that should either be introduced in this specific stage or should have been already acquired in an earlier stage, are marked in gray. We choose this color scheme to make it easier for the reader to spot which cells should contain high numbers of produced words if the proposed stages fit the actual data: Shaded cells should contain a high percentage of produced words, as these word patterns are expected to be acquired, while white cells should contain a low percentage of produced words, as these word patterns are not expected to be acquired yet. Table 6b summarizes for each proposed developmental stage how many words conformed to the word patterns that were supposed to be acquired at this particular stage, at an earlier stage, at the upcoming stage, or at a later stage of development.

The tables show that at Stage 1, children produce a high percentage of words containing two consonants of a similar MoA: roughly three-fourths of all productions are either PVP(V) or FVF(V) words. At Stage 2, almost every second word (roughly 45%) contains a fricative as noninitial consonant. Although the percentage of PVP(V) words is still high, it is reduced relative to Stage 1. In the third stage, more than three-fourths of the words follow the proposed PVX(V)

[5]Note that some researchers have argued that feature spreading is not a possible phonological process in child language, but that children instead copy features (Goad 2001). The assumption that features are shared by all consonants within one word does not necessarily imply that features can spread. Fikkert & Levelt (2008) do not assume a process of place harmony for their initial stage where the PoA feature of the first consonant spreads to the second consonant (or vice versa). Instead they assume that PoA features are initially assigned to the whole word (or to all consonants of a word).

TABLE 6
Percentage of Produced Words That Conformed to the Different Word Patterns in the Proposed Developmental Stages for the Four Dutch Children

6(a) Data for each specific word pattern (P = stop, F = fricative, N = nasal, L = liquid, X = consonantal position that allows variation; vowels are omitted)

C_1C_2	*Stage 1:*	$C_1 = C_2$	*Stage 2:*	*XF*	*Stage 3:*	*PX*	*Stage 4:*	*Free*
PP	**60,53**	**[23]**	39,20	[118]	43,73	[129]	33,20	[256]
PF	5,26	[2]	**37,87**	**[114]**	24,75	[73]	18,42	[142]
PN	0,00	[0]	2,66	[8]	**8,14**	**[24]**	8,04	[62]
PL	0,00	[0]	1,00	[3]	**2,03**	**[6]**	2,98	[23]
FP	5,26	[2]	1,33	[4]	1,02	[3]	**4,15**	**[32]**
FF	**15,79**	**[6]**	7,64	[23]	4,07	[12]	4,67	[36]
FN	0,00	[0]	1,33	[4]	1,02	[3]	**2,33**	**[18]**
FL	0,00	[0]	0,00	[0]	0,68	[2]	**1,82**	**[14]**
NP	2,63	[1]	0,33	[1]	1,69	[5]	**7,65**	**[59]**
NF	0,00	[0]	**6,31**	**[19]**	3,73	[11]	7,91	[61]
NN	**0,00**	**[0]**	0,33	[1]	2,71	[8]	1,69	[13]
NL	0,00	[0]	0,33	[1]	1,36	[4]	**1,56**	**[12]**
LP	0,00	[0]	1,00	[3]	2,03	[6]	**3,11**	**[24]**
LF	5,26	[2]	**0,66**	**[2]**	2,37	[7]	2,20	[17]
LN	5,26	[2]	0,00	[0]	0,00	[0]	**0,13**	**[1]**
LL	**0,00**	**[0]**	0,00	[0]	0,68	[2]	0,13	[1]

6(b) Data collapsed across word patterns that are assumed to be acquired at a particular stage (new), at an earlier stage (earlier), at the next stage (upcoming) or at later stages of development (other)

Pattern	*Stage 1*		*Stage 2*		*Stage 3*		*Stage 4*	
New	76,32	[29]	44,85	[135]	10,17	[30]	20,75	[160]
Earlier	n.a.		47,18	[142]	82,03	[242]	79,25	[611]
Upcoming	10,53	[4]	3,65	[11]	7,80	[23]	n.a.	
Other	13,16	[5]	4,32	[13]	n.a.		n.a.	

Note. Introducing manner contrasts in initial position. Absolute numbers of words that conformed to the different word patterns are given in square brackets.

pattern and start with a stop, while in the last stage the word patterns start to be more evenly distributed. Note that although we propose that children's productions reflect different stages in the acquisition of manner contrasts, stages are not always clear-cut. Rather, stages might overlap so that children might already start to produce some word patterns belonging to upcoming stages of development. Yet, the majority of produced words comply with the acquired template(s). Also, the acquisition of a new word pattern does not imply that the earlier acquired word patterns are no longer in use, as we will see in the error analysis. We will come back to this point in the general discussion.

3.1.3.2. Error analysis. To complete the developmental picture, we will now turn to the error analysis. In total, Tom and the other children who introduced contrasts in initial position

TABLE 7
Errors Produced by the Four Dutch Children Introducing Manner Contrasts in Initial Position Listed by Developmental Stage and Word Pattern

Pattern	*$C_1 = C_2$*		*XF*		*PX*		*Other*	
Stage 1	PP	[PF 5]	PF	[FF 1]				
		[FF 1]						
Stage 2	PP	[FP 1]						
Stage 3	PP	[FP 3]	PF	[PP 1]	PL	[FL 3]	NP	[LP 1]
		[NP 1]	PF	[FF 2]				
		[LP 1]		[LF 1]				
	FF	[LF 1]						
	NN	[GN 1]						
Stage 4	PP	[FP 2]	PF	[PP 2]	PN	[PP 1]	NL	[NP 1]
		[PF 1]		[FF 1]	PL	[PP 1]		[NF 1]
	FF	[FL 1]		[GF 1]		[LL 1]		[NG 1]
	NN	[NP 1]					FP	[PP 1]
							FN	[FL 1]
Total		19		9		6		6

Note. Target form and number of occurrences of a particular error type are given in square brackets.

substituted the manner of articulation of a consonant in 40 cases. Thus, given that these children produced a total of 1,405 words, they made surprisingly few errors. This might indicate that children mainly target those words for production that conform to an acquired template. We will come back to this point in the general discussion. Nevertheless, it is informative to examine if the errors follow specific directions, i.e., if the child adapts words to make it a better fit to a template. Table 7 summarizes the errors by developmental stage and word pattern. Each cell lists the erroneous productions that occurred in a particular stage, i.e., the produced forms that did not conform to the target forms. Targeted pattern and number of occurrences of the particular error are given in square brackets. The first column lists the stages, the second column contains the errors in which children adapted words so that the consonants share their manner of articulation ($C_1 = C_2$), the third column lists errors containing a final fricative (XF), the fourth column lists errors in which the first consonant is a plosive (PX), and the fifth column lists all other types of errors. The word pattern that is supposed to characterize each individual developmental stage is shaded in light gray. We thus expect a higher number of errors in shaded than in unshaded cells.

As can be seen from Table 7, in almost every second erroneous production (19 out of 40) both consonants share their manner of articulation, i.e., words are adapted so that they fit the template of the initial stage ($C_1 = C_2$). Yet these errors do not only occur in the first stage but also in the other stages of development. Thus, children seem to still use the early acquired template in their productions even when they would already have other templates at their disposal. Note, however, that the target structure of most of these words would not conform to the upcoming XF or PX template (with the exception of one LF word produced as FF in Stage 3 and one PF word produced as PP in Stage 4). Moreover, PP productions in Stage 3 might also be the result of adaptations to the PX template. If so, more than every second erroneous production would fit the template expected to be produced in this stage. Still, evidence for the PX and XF templates is less clear. Most of the erroneous productions that conform to these templates are PF forms. The pattern seems to be used mainly in later stages of development to change "harmonic" forms to words in which the two consonants do not share their manner of articulation, hence words that should not need to be altered. Thus, although most erroneous productions conform to the proposed templates (34 out of 40), the error analysis does not provide conclusive evidence for the use of these templates to adapt words in the individual stages.

3.1.4. Introduction of Manner Contrasts in Final Position

Having discussed the first developmental pattern, we will now turn to the data of Robin and Noortje. These two children exhibit a different pattern than Tom and the other children. We will discuss Noortje's productions to exemplify the second developmental pattern found in the data. Noortje shows a similar development to Tom in that she also introduces MoA contrasts step by step and in that she produces monosyllables before disyllables. However, the children's developmental paths show differences regarding the order and the position of appearance of the specific MoAs.

As already seen for Tom, the consonants of Noortje's first productions share their MoA. She first produces monosyllables that just contain stops (4a). In contrast to Tom, she does not introduce fricative but nasal as second manner of articulation (4b).

(4)	a.	[pup]	/pus/	*poes* 'cat'	Noortje 2;02,07	PVP
	b.	[mam]	/man/	*maan* 'moon'	Noortje 2;02,07	NVN

Furthermore, Noortje seems to allow word-internal variation in noninitial rather than initial position first. In her next productions, she restricts the word-initial consonant to stops, while the final consonant may vary and either be a fricative, nasal, or stop (5a). Only in later productions does the initial consonant vary and may also be a nasal and even later a fricative (5b).

(5)	a.	[pɛ˺t]	/bed/	*bed* 'bed'	Noortje 2;03,07	PVP
		[tɑs]	/tas/	*tas* 'bag'	Noortje 2;03,20	PVF
		[pɑ̟m]	/bom/	*boom* 'tree'	Noortje 2;04,04	PVN
	b.	[mœys]	/mœ͡ys/	*muis* 'mouse'	Noortje 2;05,22	NVF
		[χat]	/χɑt/	*gat* 'hole'	Noortje 2;08,01	FVP

A similar developmental path can be observed for disyllables. In the very first disyllables, all consonants are stops (6a). Later Noortje combines different noninitial consonants with a "fixed" initial stop (6b). Finally, the initial consonant may also vary (6c).

(6)	a.	[kɔkɔ]	/voχəl/	*vogel* 'bird'	Noortje 2;01,17	PVPV
	b.	[pama]	/kaməɹ/	*kamer* 'room'	Noortje 2;05,22	PVNV
		[paːfə]	/tafəl/	*tafel* 'table'	Noortje 2;06,05	PVFV
	c.	[mœysə]	/mœ͡yzə/	*muizen* 'mice'	Noortje 2;08,01	NVFV
		[sɔkə]	/sɔkə/	*sokken* 'socks'	Noortje 2;08,28	FVPV

TABLE 8
Development of Noortje's First Word Patterns in (a) CVC and (b) CVCV Words

Age	*2;01–2;02*	*2;03–2;04*	*2;05–2;06*	*2;07–2;08*
a.	PVP, NVN	PVP, PVF, PVN	NVF	FVP
b.	PVPV		PVNV, PVFV	NVFV, FVPV

Table 8 summarizes the order of appearance of the different word shapes for Noortje. When comparing Table 5 and Table 8, it becomes evident that Noortje shows a production pattern different from the pattern observed for Tom. While Tom allows variation in initial position first, Noortje produces varying MoAs in noninitial position first. Hence, the two children seem to use different strategies. Tom focuses on word-initial position and keeps the noninitial position in his productions stable. In contrast, Noortje uses the initial position as a stable anchor point in her productions and varies the Manner of Articulation of the noninitial consonant. In addition, the MoA for the "fixed" position differs for both children. While Noortje restricts the initial consonant to stops, Tom restricts the noninitial consonant to fricatives.

3.1.4.1. Quantitative data. Table 9 displays the proportion of words that conformed to the different word patterns for all stages, collapsing over Noortje's and Robin's productions, i.e., the Dutch children who introduced manner contrasts in noninitial position. The table shows clearly that in Stage 1 the percentage of PVP(V) words is very high and drops in subsequent stages. Other "harmonic" forms in which the first and second consonant share their manner of articulation, though, are rare in the children's productions. Fitting the proposed PX template, the vast majority of words (88%) contain an initial stop but various MoA in noninitial position at Stage 2. Variation in the initial consonant becomes more pronounced at Stage 3. Roughly every third word contains a noninitial fricative in this stage, conforming to the XF template. Yet, the pattern in this stage is less clear-cut than in the previous stage or than has been observed for the other group of children (compare Tables 6 and 9). However, when comparing Tables 6 and 9, it becomes evident that the different word patterns are clearly differently distributed across the developmental stages for the two groups of children. This supports our hypothesis that the two groups of children show two different strategies when introducing manner contrasts in their productions.

3.1.4.2. Error analysis. Noortje and Robin substituted the manner of articulation of a consonant in 46 cases. Again, given that the two children produced a total of 1,507 words, they made surprisingly few errors. The distribution of errors seems similar to what has already been observed for the other group of children (see Table 10). Most erroneous productions across all stages fit the template of the initial stage, i.e., the consonants share their manner of articulation. Although there are a number of errors that fit the XF or PX template, most of these productions already contained an initial stop or noninitial fricative in the targeted form. Thus, although the adaptations fit the proposed templates, a substitution would not have been necessary to adapt the target form to the expected word pattern.

TABLE 9
Proportion of Produced Words That Conformed to the Different Word Patterns in the Proposed Developmental Stages for the Two Dutch Children Introducing Manner Contrasts in Noninitial Position

9(a) Data for each specific word pattern

C_1C_2	*Stage 1:*	$C_1 = C_2$	*Stage 2:*	*PX*	*Stage 3:*	*XF*	*Stage 4:*	*Free*
PP	**85,71**	**[6]**	36,36	[72]	34,77	[153]	28,42	[245]
PF	0,00	[0]	**29,80**	**[59]**	14,32	[63]	9,86	[85]
PN	0,00	[0]	**17,68**	**[35]**	8,86	[39]	8,12	[70]
PL	0,00	[0]	**4,55**	**[9]**	2,50	[11]	3,60	[31]
FP	14,29	[1]	1,01	[2]	5,91	[26]	**9,05**	**[78]**
FF	**0,00**	**[0]**	6,57	[13]	6,36	[28]	3,94	[34]
FN	0,00	[0]	0,51	[1]	1,14	[5]	**6,03**	**[52]**
FL	0,00	[0]	0,51	[1]	1,36	[6]	**5,22**	**[45]**
NP	0,00	[0]	0,00	[0]	9,55	[42]	**12,30**	**[106]**
NF	0,00	[0]	2,02	[4]	**15,00**	**[66]**	8,82	[76]
NN	**0,00**	**[0]**	1,01	[2]	0,23	[1]	1,04	[9]
NL	0,00	[0]	0,00	[0]	0,00	[0]	**1,62**	**[14]**
LP	0,00	[0]	0,00	[0]	0,00	[0]	**1,28**	**[11]**
LF	0,00	[0]	0,00	[0]	**0,00**	**[0]**	0,46	[4]
LN	0,00	[0]	0,00	[0]	0,00	[0]	**0,12**	**[1]**
LL	**0,00**	**[0]**	0,00	[0]	0,00	[0]	0,12	[1]

9(b) Data collapsed across word patterns

Pattern	*Stage 1*		*Stage 2*		*Stage 3*		*Stage 4*	
New	85,71	[6]	52,02	[103]	15,00	[66]	35,61	[307]
Earlier	n.a.		43,94	[87]	67,05	[295]	64,39	[555]
Upcoming	0,00	[0]	2,02	[4]	17,95	[79]	n.a.	
Other	14,29	[1]	2,02	[4]	n.a.		n.a.	

3.1.5. Summary

To summarize, we conclude from our data that the Dutch children introduce manner of articulation contrasts stepwise into their phonological system. In general, the order in which different manners of articulation appear in children's productions may vary across children and across word positions, suggesting that it does neither follow the distribution of the different MoAs in Dutch nor a universal path. This suggests that contrasts are introduced in specific word patterns rather than across the board.

Moreover, children show different individual strategies in introducing MoA contrasts: One group of children, exemplified by Tom's data, introduce contrasts in initial position, keeping the noninitial position restricted to a fricative. The other group of children, exemplified by Noortje's data, introduce contrasts in noninitial position, restricting the initial consonant to a stop. Thereby CVC and CVCV words show a similar developmental pattern. The development of the first and second consonant in monosyllables corresponds to the development of the first and second

TABLE 10
Errors Produced by the Two Dutch Children Introducing Manner Contrasts in Final Position Listed by Developmental Stage and Word Pattern

Pattern	*$C_1 = C_2$*		*PX*		*XF*		*Other*	
Stage 1	PP	[FF 2]						
Stage 2	PP	[LP 1]	PF	[PP 4]				
		[GP 1]						
	FF	[LF 1]						
Stage 3	PP	[NP 1]	PN	[PL 1]	NF	[LF 2]	FP	[GP 5]
		[LP 1]		[PP 1]				[PP 1]
		[GP 1]						
	FF	[LF 4]						
		[GF 1]						
Stage 4	PP	[LP 4]	PN	[PF 1]	PF	[PP 1]	NL	[NP 1]
		[PF 3]	PL	[PP 1]	NF	[PF 1]		[LN 1]
	FF	[PF 1]				[FF 1]	LN	[PN 1]
	LL	[LP 1]			LF	[PF 2]		
Total		22		8		7		9

consonant in trochees respectively, i.e., word-medial consonants do not pattern with word-initial but with word-final consonants. This suggests that the position of a consonant within the word or string of segments—being initial or not—is more important than its syllable position.

Concerning the different MoA contrasts, stops and fricatives appear rather early in the children's productions. This suggests that children first introduce the contrast between continuant and noncontinuant sounds in the group of obstruents. This might be captured by the introduction of the feature [continuant]. When sonorants come in, liquids tend to follow nasals. This suggests that nasals are less marked for the child even though they would have to be characterized by both the feature [sonorant] and [nasal]. This might indicate that children do not necessarily introduce specific manner features but rather tend to acquire classes of segments. However, the primary question of the current study is whether there are co-occurrence constraints between consonants in a word with respect to their MoA. The question whether children rely on specific features when representing MoA contrasts goes beyond the scope of this article and would need a more detailed analysis.

It should be noted that even though the distribution of the different word patterns in the children's productions supports this scenario, the error analysis did not provide conclusive evidence that children adapt words according to a specific word template in each individual stage of development. Rather, children might also adapt words to templates that characterized earlier stages of development. Moreover, the Dutch children made only a few errors, suggesting that in general words that fitted the templates were selectively chosen for production, while other words were avoided. We will come back to this assumption in more detail in the general discussion.

Note that with taking a templatic approach to account for the data, we do not mean to imply that all productions that conform to a given template in Stage 2, e.g., PX, will be altered in Stage 3 to conform to the newly acquired template, e.g., XF. Rather, an acquired template might be used for an extended period in development. Children who allow variation in the noninitial position first, like Tom, pair different MoAs with an initial stop when they first introduce MoA contrasts. When they proceed in development and start to introduce MoA contrasts in initial position, the previous pattern will still be available for production. That is, children might still pair various MoAs in noninitial position with an initial stop. However, they now also add words to their repertoire in which other MoAs than stops appear in initial position. In these new words, the noninitial consonant is fixed to a fricative. This does not mean that all noninitial segments now have to be fricatives. Other noninitial segments might still be paired with an initial stop as in Stage 2. Yet new initial MoAs are introduced in pairing with a noninitial fricative, like new noninitial MoAs had been introduced in pairing with an initial stop.

3.2. German

3.2.1. Development of MoA Contrasts by Position

Having discussed the Dutch data, we will now turn to German. Table 11 summarizes the order of appearance of the first MoAs for the different word positions for each of the four German children.

In general, stop is the first MoA to be produced in initial and medial position. In initial position, all children but Renee introduce nasal as the second manner of articulation. This is a striking difference to the pattern observed for Dutch. Recall from the previous section that the Dutch children tended to introduce fricatives as the second MoA. Similar to the Dutch pattern and in contrast to the other children, Renee introduces fricatives before nasals in initial position. In medial position, Niklas and Jule introduce nasals as the second MoA, while Renee again introduces fricative as the second MoA. Hannah produces both fricatives and liquids as the second MoA in medial position. Final positions show a more diverse pattern, but stops are introduced relatively late, and children either start with the contrast between nasal and liquid (Hannah and Niklas) or they first produce a fricative in final position (Renee and Jule). Taken together, Hannah shows a different developmental pattern for initial, medial, and final consonants. For the other children, initial and medial positions tend to pattern together, while final consonants show a different development.

As already seen in the Dutch data, the order in which MoA contrasts are acquired is not bound to the distribution of the different MoA contrasts in the target language. Remember from the introduction that obstruents are more frequent in initial and medial position in German (with fricatives being most frequent at word beginnings and stops being most frequent in medial position), while sonorants are more frequent in final position (see Table 1). This seems to be reflected in Hannah's

TABLE 11
Order of Appearance of Different MoAs per Position (German)

	Hannah	*Renee*	*Niklas*	*Jule*
Initial	P,N→F→L	P,F→N→L	P→N→F→L	P,N→F→L
Medial	P→F,L→N	P→F→N→L	P→N→F→L	P→N,F→L
Final	N,L→P,F	F→N,L→P	N→L→F→P	F→P→N→L

Note. Arrows separate MoAs that appear subsequently, commas separate MoAs that appear at the same time.

and Niklas's early production of sonorants in word-final position, as well as in the finding that all children produce stops as first MoA in medial position. However, stops—and not fricatives—are also the first MoA to be produced in initial position, and children show substantial differences in which MoA they introduce next. Given that the children show diverse developmental patterns, it seems that the acquisition of MoA does neither follow a universal nor a language-specific path. Rather, children seem to have individual strategies to introduce manner contrasts.

3.2.2. Development of MoA Patterns within Words

To shed more light on the development of MoA contrasts, we tracked the acquisition of specific word shapes in German, too. An interesting difference between the Dutch and the German data that immediately becomes obvious is that disyllables develop earlier than monosyllables in the German children, while the opposite holds true for the Dutch children. This difference seems to reflect the distribution of disyllables and monosyllables in the input: In the German corpus trochees are much more frequent than monosyllables, while in the Dutch corpus the reverse holds true. Concerning the development of word patterns, three out of four children showed a similar behavior.[6] We will present Hannah's data as a representative case to illustrate the developmental pattern of these children. We will then present Jule's development, focusing on the differences between Jule and the other children.

3.2.3. Introduction of Manner Contrasts in Final Position

Hannah first produces trochees that just contain stops (7a). She subsequently introduces stop-initial disyllables that vary in the noninitial consonant. The second consonant may either be a fricative or a stop (7b) and slightly later also a nasal (7c).

(7)	a.	[pʌpa]	/pʊpə/	*Puppe* 'doll'	Hannah 1;05,03	PVPV
	b	[deθa]	/keːzə/	*Käse* 'cheese'	Hannah 1;06,22	PVFV
		[beːbi]	/beːbiː/	*Baby* 'baby'	Hannah 1;06,01	PVPV
	c.	[pinə]	/biːnə/	*Biene* 'bee'	Hannah 1;07,15	PVNV

Hannah produces her first initial fricative in a trochee that also contains a noninitial fricative (8a). Sometime later, nasals appear in initial position (8b), and initial fricatives may combine with stops in noninitial position (8c).

(8)	a.	[vɔfa]	/foːgəl/	*Vogel* 'bird'	Hannah 1;06,29	FVFV
	b.	[nasa]	/naːzə/	*Nase* 'nose'	Hannah 1;08,05	NVFV
		[nakə]	/jakə/	*Jacke* 'coat'	Hannah 1;09,16	NVPV
	c.	[ziːbɐ]	/fiːbɐ/	*Fieber* 'fever'	Hannah 1;09,16	FVPV

[6]Note that it is not obvious from Table 8 that Hannah, Niklas, and Renee show a similar behavior. Only when we look at the development of word patterns, i.e., the combination of different MoAs within one word, do the similarities become evident. This indicates that our method of analysis helps in revealing developmental patterns that would otherwise be overlooked.

When we look at the development of monosyllables, Hannah first produces words in which the consonants share their MoA. All consonants within one word are either nasals or stops (9a). The first contrastive use of MoA within a word takes place in noninitial position: A “fixed” initial stop can combine with a final nasal or a final fricative (9b). The observation that different MoAs are used contrastively in noninitial position first matches the development of disyllables. However, the observation that the first contrast is stop versus nasal contrasts with the development of disyllables in which the first contrast was stop versus fricative.

(9)	a.	[man]	/man/	*Mann* ‘man’	Hannah 1;05,20	NVN
		[bat^{h}]	/bɛt/	*Bett* ‘bed’	Hannah 1;06,22	PVP
	b.	[pan]	/ba͡ɪn/	*Bein* ‘leg’	Hannah 1;06,22	PVN
		[bɯːɸ]	/buːx/	*Buch* ‘book’	Hannah 1;06,22	PVF

In the following stage, Hannah also varies the MoA of the initial consonant. Again, nasals appear earlier in initial position than fricatives (10a/b).

(10)	a.	[ma͡ɪθ]	/ma͡ɪs/	*Mais* ‘corn’	Hannah 1;07,08	NVF
	b.	[çaːf]	/ʃaːf/	*Schaf* ‘sheep’	Hannah 1;09,26	FVF
		[fœt^{h}]	/p͡fe͡ɐt/	*Pferd* ‘horse’	Hannah 1;11,00	FVP

Table 12 summarizes the order of appearance of the different word shapes for Hannah. Hannah shows an early stage in which all consonants of a word share their Manner of Articulation. For monosyllables, she exhibits a stage in which words contain just stops or just nasals. Thus, in monosyllabic words the first contrast produced is nasal versus stop. After this initial stage, she introduces MoA contrasts step by step. In monosyllables, the following patterns are PVN and PVF. A “fixed” initial stop can combine with either a nasal or a fricative, suggesting that MoA contrasts get established in noninitial position. Only later on may the initial consonant vary and be a nasal (NVF at 1;07) or a fricative (FVF at 1;09).

Looking at the development of disyllables, the pattern is slightly different: Hannah exhibits an early stage in which she produces only disyllables containing stops. She then introduces words containing just fricatives or an initial stop combined with a noninitial fricative (PVFV and FVFV at 1;06). Thus, the first contrast established in disyllables is stop versus fricative. Nasals come in later and appear in noninitial position (PVNV at 1;07) before they appear in initial position (NVFV and NVPV at 1;07/1;08).

TABLE 12
Development of Hannah’s First Word Patterns in (a) CVC and (b) CVCV Words

Age	*1;05*	*1;06*	*1;07*	*1;08*	*1;09*	*1;11*
a.	NVN, PVP	PVN, PVF	NVF		FVF	FVP
b.	PVPV	PVFV, FVFV	PVNV	NVFV	NVPV, FVPV	

The fact that Hannah can produce a certain combination of MoAs in one word (like a fricative in the pattern PVFV at 1;06), does not imply that she can also produce the reverse combination (the reverse pattern FVPV only appears at 1;09). Hence, contrasts seem to be introduced in specific word positions instead of across the board. This matches the findings for the Dutch data. This is further illustrated by the observation that variation in monosyllables differs from variation in disyllables. Word patterns containing nasals, for example, are produced in monosyllabic CVC words before they are produced in disyllabic CVCV words.

Similar to the findings in Dutch, CVCV and CVC words show a corresponding behavior concerning the introduction of contrast. In the first stage, both consonants tend to share their MoA. Only later on can the consonants differ in MoA. In monosyllables and disyllables, different manners are first used contrastively in noninitial position, restricting the initial position to a *default* stop. The two word types differ, however, in the kind of contrast that is introduced first. Monosyllables show the first contrast between nasals and stops, while disyllables first display the contrast between stops and fricatives. This suggests that although the position in which a contrast is introduced is similar across word types, medial and final consonants behave differently concerning the actual order in which specific MoA contrasts come in.

3.2.3.1. Quantitative data. Table 13 shows the percentage of words that conformed to the different word patterns for all stages, collapsing over the German children who introduced manner contrasts in noninitial position. Note the huge difference between the proportion of PVP(V) words in Stage 1 compared to Stage 4. It suggests that the children largely produce words that conform to the acquired templates in the beginning and that their productions become more variable over time. It also suggests that the distribution of the different word patterns is not a mere reflection of the distribution in the input, as it is unlikely that children first almost exclusively learn words that consist of stops only and within a couple of weeks acquire a variety of words that include different MoAs. We will come back to this point in the general discussion when discussing the structure of words in the child's lexicon as a possible source of the observed developmental pattern.

In the second stage, children start to produce a high number of words (around 80%) that contain an initial stop but various different noninitial consonants, while in the third stage more than every second word contains a noninitial fricative paired with an initial stop, fricative, or nasal. Thus, the distribution of the different word patterns in children's productions seems to follow the proposed templates PX and XF for these stages. In the fourth stage, the different word patterns are more evenly distributed, although word patterns containing obstruents are still more frequent than word patterns containing sonorants. Note also that the children start to produce affricates (mostly in noninitial position) at this stage.

3.2.3.2. Error analysis. Hannah and the other German children who introduced manner contrasts in noninitial position substituted the manner of articulation of a consonant in 146 cases. This is a much higher error rate than has been observed in the Dutch corpus. It is especially conspicuous that more than one-third of the errors do not fit any of the proposed templates. However, these errors mostly involve the substitution of an affricate (37 out of 55 cases). Remember from the previous section that affricates only appeared in the fourth stage in children's production. Yet, as can be seen from Table 14, even then affricates remain difficult and are frequently replaced by fricatives and less often by stops. This might, however, relate to a phonological change in German: Word-initial labial affricates, such as /pf/ in *Pfanne* 'pan,' tend to be realized as labial fricative /f/ in most German dialects (Grijzenhout & Joppen-Hellwig 2002). It is thus unclear whether

TABLE 13
Percentage of Produced Words That Conformed to the Different Word Patterns in the Proposed Developmental Stages for the Three German Children Introducing Manner Contrasts in Noninitial Position

13(a) Data for each specific word pattern

C_1C_2	*Stage 1:*	$C_1 = C_2$	*Stage 2:*	*PX*	*Stage 3:*	*XF*	*Stage 4:*	*Free*
PP	**91,45**	**[139]**	13,16	[25]	14,36	[26]	19,95	[81]
PF	0,00	[0]	**23,68**	**[45]**	18,23	[33]	9,85	[40]
PP_F	0,00	[0]	**2,63**	**[5]**	0,55	[1]	9,85	[40]
PN	0,00	[0]	**22,11**	**[42]**	5,52	[10]	6,65	[27]
PL	0,00	[0]	**19,47**	**[37]**	9,94	[18]	2,22	[9]
FP	0,66	[1]	0,53	[1]	7,73	[14]	**11,08**	**[45]**
FF	**1,97**	**[3]**	6,32	[12]	21,55	[39]	14,53	[59]
FP_F	0,00	[0]	0,00	[0]	0,00	[0]	**0,99**	**[4]**
FN	0,00	[0]	0,53	[1]	4,42	[8]	**3,69**	**[15]**
FL	0,00	[0]	0,53	[1]	0,55	[1]	**4,43**	**[18]**
P_FP	0,00	[0]	0,00	[0]	0,00	[0]	**3,69**	**[15]**
P_FF	0,00	[0]	0,00	[0]	**0,00**	**[0]**	0,00	[0]
P_FP_F	**0,00**	**[0]**	0,00	[0]	0,00	[0]	0,00	[0]
P_FN	0,00	[0]	0,00	[0]	0,00	[0]	**0,74**	**[3]**
P_FL	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
NP	0,00	[0]	0,53	[1]	0,00	[0]	**1,23**	**[5]**
NF	0,00	[0]	3,16	[6]	**13,81**	**[25]**	0,74	[3]
NP_F	0,00	[0]	1,58	[3]	0,00	[0]	**0,49**	**[2]**
NN	**5,92**	**[9]**	4,21	[8]	2,76	[5]	2,96	[12]
NL	0,00	[0]	1,58	[3]	0,00	[0]	**2,96**	**[12]**
LP	0,00	[0]	0,00	[0]	0,00	[0]	**1,23**	**[5]**
LF	0,00	[0]	0,00	[0]	**0,55**	**[1]**	2,46	[10]
LP_F	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
LN	0,00	[0]	0,00	[0]	0,00	[0]	**0,25**	**[1]**
LL	**0,00**	**[0]**	0,00	[0]	0,00	[0]	0,00	[0]

13(b) Data collapsed across word patterns

Pattern	*Stage 1*		*Stage 2*		*Stage 3*		*Stage 4*	
New	99,34	[151]	67,89	[129]	14,36	[26]	30,79	[125]
Earlier	n.a.		23,68	[45]	72,93	[132]	69,21	[281]
Upcoming	0,00	[0]	3,16	[6]	12,71	[23]	n.a.	
Other	0,66	[1]	5,26	[10]	n.a.		n.a.	

these errors might reflect a diachronic change in the language system rather than inaccurate productions.

More than half of the remaining erroneous productions across all stages fit the template of the initial stage, i.e., the consonants share their manner of articulation. This fits the observation from the Dutch data, although children's tendency to adapt words so that the consonants share their MoA is less strong. Another frequent word pattern resulting from substitution is PF, pairing an

TABLE 14
Errors Produced by the Three German Children Introducing Manner Contrasts in Final Position Listed by Developmental Stage and Word Pattern

Pattern	$C_1 = C_2$		*PX*		*XF*		*Other*	
Stage 1	PP	[PN 1]					FP	[PP 1]
	NN	[NF 7]						
		[FN 2]						
Stage 2	PP	[FP 3]	PF	[PP 4]	NF	[NP_F 1]	PN	[FN 1]
		[PF 2]		[FF 3]			NL	[NP 2]
		[FG 2]					NL	[NG 1]
		[GP 1]						
	FF	[FP 1]						
Stage 3	PP	[PP_F 5]	PL	[FL 2]	PF	[PG 8]	FP	[P_FP 5]
		[P_FP 1]				[FF 7]	FP	[LP 2]
	FF	[FG 2]				[PP_F 1]	FP	[GP 1]
		[LF 1]			NF	[FF 1]	FN	[P_FN 2]
							NP	[PP1]
Stage 4	PP	[FP 17]	PN	[FN 1]	PF	[PG 6]	FP	[P_FP 15]
	FF	[FG 1]				[PP_F 3]		[GP 3]
		[NF 1]				[FF 2]	FP_F	[P_FP_F 3]
		[LF 1]				[FN 1]		[PP_F 1]
	NN	[NL 2]					FN	[P_FN 7]
		[LN 1]						[P_FN 4]
							FL	[GL 1]
							NP	[FP 1]
								[GP 1]
							LP	[FP 1]
								[GP 1]
							LN	[FN 1]
Total		51		10		30		55

initial stop with a final fricative. These productions fit the XF as well as the PX template. The majority of errors that conform to the PX or XF template indeed occur in Stage 2 and 3. Yet, a considerable number of substitutions involving this error type still occur in Stage 4 (13 out of 40 cases). Thus, it again appears that if children use templates to adapt words for production, these templates are not only used in the stage in which they are acquired but also in later stages of development.

3.2.4. Introduction of Manner Contrasts in Initial Position

We will now turn to Jule, who exhibits a different developmental pattern from Hannah, Niklas, and Renee. Looking at disyllables, we find that her first trochees only contain stop consonants (11a). Nasals are introduced as the second manner of articulation. The whole word may contain just nasals, or an initial nasal is paired with a noninitial stop (11b).

(11)	a.	[tɛti]	/tɛdiː/	*Teddy* ‘teddy bear’	Jule 1;06,11	PVPV
	b.	[nœna]	/zɔnə/	*Sonne* ‘sun’	Jule 1;07,25	NVNV
		[mɪpɛ]	/møːvə/	*Möwe* ‘sea mew’	Jule 1;07,25	NVPV

Next, fricatives appear. The produced disyllables contain either just fricatives (12a) or a noninitial fricative co-occurs with an initial stop or nasal (12b). Later on, nasals may also appear in noninitial position (12c).

(12)	a.	[fɪsi]	/fɪʃe/	*Fische* ‘fishes’	Jule 1;08,12	FVFV
	b.	[pʰaːzi]	/gaːbəl/	*Gab*el ‘fork’	Jule 1;08,12	PVFV
		[naːsi]	/naːzə/	*Nase* ‘noise’	Jule 1;08,12	NVFV
	c.	[ba͡ʊmə]	/bɔ͡ɪmə/	*Bäume* ‘trees’	Jule 1;09,24	PVNV
		[zʌna]	/zɔnə/	*Sonne* ‘sun’	Jule 1;10,07	FVNV

Concerning monosyllables, Jule first combines a final fricative with either an initial nasal or an initial stop (13a). She subsequently also produces fricatives in initial position (13b).

(13)	a.	[bʊx]	/buːx/	*Buch* ‘book’	Jule 1;06,26	PVF
		[ma͡ɪs]	/ma͡ɪs/	*Mais* ‘corn’	Jule 1;06,26	NVF
	b.	[fis]	/fɪʃ/	*Fisch* ‘fish’	Jule 1;08,29	FVF

Table 15 summarizes the order of appearance of the different word shapes for Jule. Jule exhibits an early stage for disyllables in which all consonants are stops, or slightly later, nasals. Next, she introduces NVPV forms. Fricatives come in later. Hence, the first contrast established in CVCV words is stop versus nasal. Concerning monosyllables, however, recordings start rather late, and we can only hypothesize that Jule also went through an earlier stage in which monosyllables contain only one Manner of Articulation. The first forms recorded are PVF and NVF. A “fixed” final fricative can combine with either an initial stop or nasal. We might therefore speculate that the first contrastive use of MoA in monosyllables is stop versus nasal in initial position, fricative being a *default* coda. Note that the different stages that we proposed so far seem to be less separated, i.e., overlap more for Jule than for the other children.

Taken together, the data suggest that Jule introduces Manner of Articulation contrasts in initial position in trochees as well as in monosyllables and that the first contrast acquired is stop versus nasal. Assuming that the “harmonic” form PVPV reflects an initial stage in which the consonants of a word share their MoA, it seems that Jule establishes variation in the MoA of the initial consonant first, while she restricts the final consonant to a fricative. The only exception to this

TABLE 15
Development of Jule’s First Word Patterns in (a) CVC and (b) CVCV Words

Age	*1;06*	*1;07*	*1;08*	*1;09*	*1;10*
a.	PVF, NVF		FVF		
b.	PVPV	NVNV, NVPV	FVFV, PVFV, NVFV	PVNV	FVNV

pattern is the form NVPV at 1;07. Thus, Jule shows a pattern opposite to Hannah and the other German children who first introduced MoA contrasts in noninitial position. This suggests that the children use different strategies. While Jule focuses on noninitial position to establish a MoA contrast, the other children introduce manner contrasts in initial position. Looking in more detail at syllable positions and the MoA that can fill them, it seems that word-medial consonants as well as word-final codas are restricted to a default fricative in Jule's data (matching the behavior that we have seen for Noortje and Robin).

3.2.4.1. Quantitative data. Table 16 displays the proportion of words uttered by Jule that conformed to the different word patterns for all stages. As noted before, Jule's productions seem to follow the proposed word templates less well than has been observed for the other German (and Dutch) children. Although every second word contains a word-final fricative in the second stage, fitting the XF template, most of these words also contain a word-initial fricative. It is therefore unclear if they are evidence for a restriction that word-final consonants should be fricatives or if it reflects the requirement of an initial stage in which both consonants of a word should share their manner of articulation. Similarly, almost every second word contains a word-initial stop in the third stage, fitting the PX template, but most of these words also contain a word-final stop. Moreover, Jule also produces a considerable number of FN words in Stage 2 and 3 that fit neither of the proposed templates. Thus, evidence for the different stages in Jule's productions is debatable.

3.2.4.2. Error analysis. The error analysis could potentially shed further light on Jule's development and provide evidence for the use of templates. In total, Jule's data contain 99 erroneous productions. However, as we have already seen for the other children, in the majority of these cases both consonants share their MoA (see Table 17). Thus, they would only provide evidence for the template proposed for the initial stage. In most of these errors, an affricate gets substituted by a stop. Although it fits the observation made for the other German children that a large number of errors involve affricates, the sound serving as substitute differs. While Hannah and the other children substituted affricates by fricatives, Jule tends to substitute affricates by stops.

There are only a few errors that fit the proposed XF or PX template. Neither in the second nor in the third stage can more errors be categorized as conforming to these templates than can be categorized as "other." Thus, again there is only limited and debatable evidence that Jule actually uses specific word patterns in her productions.

3.2.5. Summary

As already seen for the Dutch children, the order in which different manners of articulation appear in children's productions may vary across children and across word positions. Nevertheless, CVC and CVCV words showed a similar development in that initial and noninitial consonants respectively patterned together across the two word types. The strategies to introduce MoA contrasts are similar to the Dutch data: One group of children, exemplified by Hannah's data, introduce contrasts in noninitial position, keeping the initial position restricted to a stop. Jule, on the other hand, seems to introduce contrasts in initial position. Her productions can, however, be less well separated into distinct developmental stages than the productions of the other

TABLE 16
Percentage of Produced Words That Conformed to the Different Word Patterns in the Proposed Developmental Stages for Jule, Who Introduced Manner Contrasts in Initial Position

16(a) Data for each specific word pattern

C_1C_2	*Stage 1:*	$C_1 = C_2$	*Stage 2:*	*XF*	*Stage 3:*	*PX*	*Stage 4:*	*Free*
PP	**100,00**	**[11]**	24,00	[30]	38,77	[88]	33,58	[46]
PF	0,00	[0]	**8,00**	**[10]**	5,29	[12]	9,49	[13]
PP_F	0,00	[0]	0,00	[0]	**0,00**	**[0]**	0,73	[1]
PN	0,00	[0]	0,80	[1]	**3,52**	**[8]**	2,19	[3]
PL	0,00	[0]	0,80	[1]	**0,88**	**[2]**	0,73	[1]
FP	0,00	[0]	4,80	[6]	2,64	[6]	**15,33**	**[21]**
FF	**0,00**	**[0]**	32,80	[41]	25,55	[58]	16,06	[22]
FP_F	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
FN	0,00	[0]	8,80	[11]	7,93	[18]	**10,22**	**[14]**
FL	0,00	[0]	0,00	[0]	0,88	[2]	**0,73**	**[1]**
P_FP	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
P_FF	0,00	[0]	**0,00**	**[0]**	0,00	[0]	0,73	[1]
P_FP_F	**0,00**	**[0]**	0,00	[0]	0,00	[0]	0,00	[0]
P_FN	0,00	[0]	0,00	[0]	2,64	[6]	**0,00**	**[0]**
P_FL	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
NP	0,00	[0]	6,40	[8]	2,64	[6]	**1,46**	**[2]**
NF	0,00	[0]	**9,60**	**[12]**	3,52	[8]	2,19	[3]
NP_F	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
NN	**0,00**	**[0]**	2,40	[3]	1,76	[4]	1,46	[2]
NL	0,00	[0]	0,00	[0]	0,00	[0]	**0,73**	**[1]**
LP	0,00	[0]	1,60	[2]	0,88	[2]	**2,92**	**[4]**
LF	0,00	[0]	**0,00**	**[0]**	3,08	[7]	1,46	[2]
LP_F	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
LN	0,00	[0]	0,00	[0]	0,00	[0]	**0,00**	**[0]**
LL	**0,00**	**[0]**	0,00	[0]	0,00	[0]	0,00	[0]

16(b) Data collapsed across word patterns

Pattern	*Stage 1*		*Stage 2*		*Stage 3*		*Stage 4*	
New	100,00	[11]	17,60	[22]	4,41	[10]	31,39	[43]
Earlier	n.a.		59,20	[74]	77,97	[177]	68,61	[94]
Upcoming	0,00	[0]	1,60	[2]	17,62	[40]	n.a.	
Other	0,00	[0]	21,60	[27]	n.a.		n.a.	

children. The German children also produced considerably more errors than the Dutch children. Although most substitutions are in accordance with the different word templates, they are not selective, i.e., children often adapt words to templates that are not characteristic for the specific stage but conform to an earlier stage of development.

Concerning the different MoA contrasts, children seem to either first introduce the contrast between stops and fricatives or the contrast between stops and nasals. The difference between

TABLE 17
Errors Produced by Jule, the German Child Introducing Manner Contrasts in Initial Position, Listed by Developmental Stage and Word Pattern

Pattern	*$C_1 = C_2$*		*XF*		*PX*		*Other*	
Stage 1								
Stage 2	PP	[PF 1]	PF	[PP 1]	PN	[FN 1]	FP	[FF 1]
		[P_FP 1]		[FP 1]				[LP 1]
	NN	[FN 1]		[FF 1]			NP	[NF 1]
								[NP_F 1]
Stage 3	PP	[PP_F 32]			PF	[FP 1]	FP	[GP 1]
		[PF 5]					FL	[GL 1]
		[FP 1]					NP	[GP 2]
		[P_FP 1]						[NG 1]
	NN	[FN 1]						[NF 1]
		[NP 1]						
Stage 4	PP	[PP_F 27]	P_FF	[FF 1]	PF	[PP 2]	FP	[FG 3]
		[PG 2]				[PP_F 1]		[P_FP 1]
							FN	[P_FN 3]
Total		73		4		5		17

stops and fricatives might be captured by the introduction of the feature [continuant], while the difference between oral and nasal stops might be captured by the feature [nasal]. In both cases, oral stops might then remain the unmarked member of the contrast. However, nasals are not only [nasal] but also [sonorant]. Thus, children would probably have to acquire both features at a time to represent the relevant sound contrasts. Yet, as stated before, we do not want to draw any conclusions on the subsegmental representation of MoA contrasts in this study and leave it for future research to further look into the acquisition of MoA features within word context.

3.3. Language Differences and Commonalities

We will conclude the discussion of our results by summarizing the differences and commonalities within and across languages. To remind the reader of the different developmental patterns, results are pooled in Table 18.

TABLE 18
Developmental Paths in German and Dutch

		Dutch		*German*	
Word type		*Tom*	*Noortje*	*Jule*	*Hannah*
C_1VC_2	First contrast	stop & fric.	stop & nasal	stop & nasal	stop & nasal
	Position of first contrast	C_1	C_2	C_1	C_2
C_1VC_2V	First contrast	stop & fric.	stop & nasal	stop & nasal	stop &fric.
	Position of first contrast	C_1	C_2	C_1	C_2

We found a consistent developmental pattern for mono- and disyllables in German and Dutch, although children used two different strategies: They either introduced contrasts in initial position (pattern of Tom and maybe Jule) or in noninitial position, i.e., final position in monosyllables and word-medial onsets in trochees (pattern of Noortje and Hannah). This holds for both languages despite the differences in distribution of monosyllables and trochees in the two languages. Concerning the influence of syllable structure, it is interesting that word-medial onsets do not pattern with word-initial onsets, but with (word-final) codas. This suggests that syllable position is a less-important factor in the acquisition of MoA than serial position within the word. If syllable position had been a crucial factor, then we would have expected that word-medial onsets pattern with word-initial onsets and not with word-final codas. Note, however, that it has been suggested that word-final codas might not be "true" codas but form the onset of an empty-headed syllable (e.g., Goad 2002). Under such an account, word-medial and word-final consonants might develop similarly, as they both form onsets. However, even if word-final codas would be syllabified as onsets, onsets that are word initial and onsets that are not word initial still seem to develop differently, since initial consonants showed a different developmental pattern from noninitial consonants. Thus, position within the word seems to be an influencing factor even under a different syllabification approach.

An interesting cross-language difference that is displayed in our data concerns the order of acquisition of the different MoA contrasts: All children start with stops. This is not surprising, given that stops are generally considered to be the least marked Manner of Articulation—from a universal point of view (Greenberg 1966; Maddieson 1997), as well as from an acquisition point of view (Jakobson 1968; Stoel-Gammon 2002). However, children differ in what MoA is acquired next. While Noortje and Robin produce nasals before fricatives, the other Dutch children produced fricatives before sonorants. This suggests that the Dutch children either focused on the contrast within the group of obstruents, i.e., the contrast between fricative and stop, or on the contrast between oral and nasal stops (see also Fikkert 1994). The German children show a mixed pattern: Jule acquires nasal as second MoA in all positions; the other children acquire nasal as second MoA in monosyllables, but fricatives before nasals in disyllables. Note that in light of the different developmental paths that the children take, it is unlikely that the order of acquisition follows the distribution of the different MoAs in the target language.

The finding that the Dutch children tend to produce fricatives before nasals seems to contradict earlier results on phonological acquisition in Dutch (i.e., Fikkert 1994; Levelt & Van Oostendorp 2007). However, we speculate that most of the early produced nasals occur in words like *mama* 'mummy' and *nee* 'no.' As both words were excluded in our analysis, this might have led to a difference in developmental order compared to the results of earlier studies. In German, on the other hand, the children tend to focus on the contrast between stop and sonorant first and introduce fricatives later. This is in line with earlier findings reporting that fricatives are produced later than nasals in German (Altvater-Mackensen & Fikkert 2007; Grijzenhout & Joppen-Hellwig 2002).

4. GENERAL DISCUSSION

The acquisition of Manner of Articulation contrasts in four German- and six Dutch-learning children revealed a number of commonalities but also inter- and intralanguage differences. In the remainder of this article, we will reconsider the questions raised in the beginning: First, do we find evidence for the stepwise specification of MoA contrasts, as Fikkert and Levelt (2008) proposed for the acquisition of PoA? Or, to put it differently, do we find evidence that children use specific word templates to add phonological detail to their lexical representations of words in the course of development? Second, if children sequentially introduce MoA contrasts, do the order and the position in which children introduce MoA contrasts follow a specific path? What is the unit on which children base their generalization, i.e., do consonants behave similarly across different positions or is the position within the syllable or word important? And does the distribution in the target language modulate the order in which different MoAs are introduced?

4.1. Stepwise Acquisition of Contrasts

Looking at the results of our corpus study, we see that almost all children exhibit an initial stage in which the consonants of a word share their MoA. For some children, we only found evidence for stop harmony; other children also exhibited fricative and nasal harmony. Remarkably, the first and second consonant are not necessarily identical in place or voicing, suggesting that the identical MoA is not an effect of reduplication or of complete assimilation.[7] This fits Fikkert and Levelt's (2008) proposal that children initially do not specify phonological features for each consonant separately but rather assign phonological features to whole words.

Next, children go through an intermediate stage in which the consonants of a word may differ in MoA. However, word shapes are still highly limited. Only one of the consonants may vary in manner, whereas the other consonant is restricted to a *default* MoA. This suggests that children introduce MoA contrasts in only one position at this stage. We therefore suggested that the children specify the manner of articulation of only one of the consonants at this stage of acquisition. The remaining consonant may be left unspecified for MoA, receiving a default Manner of Articulation in the course of production: a stop for initial positions and a fricative for noninitial positions. Only in the final stage do children allow both consonants of a word to vary in manner of articulation.

In the intermediate stage, we find variation within as well as across language groups. The main commonality concerns the position of the consonant that is restricted in its MoA. In Dutch and German, children either restrict the initial consonant or they restrict the final consonant in monosyllables and the second consonant in trochees respectively. Importantly, what we can conclude from our data is that specification is not an all-or-nothing-phenomenon but that it is bound to specific consonants within the word. The fact that a child can produce a certain MoA in word-initial position does not mean that s/he can produce the same sound in word-medial or word-final position and vice versa. The data further suggest that the introduction of new MoA contrasts is not bound to syllable position: Word-medial and word-initial onsets do not pattern together, but word-medial onsets show a similar behavior to (word-final) codas. This suggests that serial position in the word or string of segments is more important than syllabic position. If children indeed add detail to their lexical representations step by step, then syllable structure does not seem to restrict the specification of MoA in the lexicon. Rather, position of the consonant within the word, i.e., whether the consonant is word initial or not, seems to influence its specification. This might

[7]It would certainly be interesting to further examine possible interactions between different feature classes, such as MoA, PoA, and voicing features. However, it is beyond the scope of this article to provide such an analysis, and we leave this question open for future research.

relate to phonotactic position within the word, as the initial consonant might be defined as being aligned to the left edge of a word boundary. Note, however, that the noninitial consonants in our study were not necessarily aligned to the right edge of a word boundary, as they included word-final consonants in monosyllables and word-medial consonants in disyllables.

Rather than only being influenced by sequential position within the word, the introduction of new contrasts might also relate to prosodic position: Children might keep either the onset of stressed syllables stable and allow variation in the weaker position—i.e., the coda of monosyllables or the onset of the unstressed syllable in trochees—or they might allow variation in the prosodically strong position—i.e., the onset of stressed syllables—keeping the consonant in the weaker position stable. However, to infer that prosodic position rather than sequential position within the word influences the acquisition of MoA, we would have to compare the development of trochees to the development of words with an iambic stress pattern and/or three-syllable words with medial stress. If prosodic position is the crucial factor driving children's acquisition of MoA, we would expect that iambic CVCV words and three-syllable words with medial stress show an acquisition pattern opposite to the pattern found in trochaic CVCV words (as initial and stressed position fall together in trochaic but not in iambic disyllables). If sequential position within the word is more important, we would expect no differences between the different word types. Unfortunately, our corpus did not contain enough data to allow us to investigate words with iambic stress patterns. The distribution in the input reflects the predominant trochaic stress pattern of the two languages: In German and Dutch initial and stressed syllables largely fall together. Children also did not produce enough three-syllable words containing medial stress to allow any firm conclusions, as the initial (unstressed) syllable in these words is most often omitted in early productions. It would therefore be interesting to compare our data to data from a language in which initial and stressed position do not coincide, such as French.

4.2. Strategies to Introduce New Contrasts

Concerning the differences between children, it is not obvious what determines which strategy a child uses to introduce new contrasts. If children indeed specify only one consonant for MoA in the intermediate stage, the onset of stressed syllables would be a good starting point. We might therefore expect that children choose prosodically strong, initial positions to introduce new MoA. Stressed syllables are often articulatorily strengthened and are thus acoustically more salient than unstressed syllables (Lavoie 2001). Hence, children might pick up more information from the signal, which might trigger a more specific representation. Perception studies seem to support this scenario. Dutch- and English-learning infants show sensitivity to one-feature differences in word beginnings before they are able to detect a one-feature change in noninitial position (Vihman et al. 2004; Zamuner 2006; Altvater-Mackensen & Fikkert 2010). Thus, if children rely on acoustically salient and prominent parts of the input to specify their lexical representations, it is expected that they store more information about sounds in prominent positions, i.e., the onset of stressed syllables.

It is more puzzling, however, why some children seem to introduce MoA contrasts in prosodically weak, noninitial positions. Dinnsen & Farris-Tremble (2009) suggested that prosodic strength relations might change during the course of development. They assume that coda and unstressed positions are prosodically strong in early stages of language acquisition and that the strength relation between prosodic positions gets reversed during development. Under this approach one would expect that children will focus on unstressed syllables or coda position first. If for at least some children noninitial positions are prosodically strong in the beginning, we can expect that they focus on these positions first (see also Slobin's [1973] "pay attention to the end of words" bias). Yet, it is unclear why for some children prosodic strength relations should change during development while other children start out with an adultlike strength relation.

Another way to account for the finding that some children introduce new contrasts in prosodically weak positions might be that these children particularly strengthen onsets in stressed syllables. The best possible—i.e., least marked onset—of a syllable is a stop (e.g., Jakobson 1968). The children who introduced contrasts in weak positions in our study kept the consonants in strong positions fixed to a stop, i.e., produced the least marked possible onset. This fits observations that prosodically strong positions do not only resist lenition but might even get strengthened. Compare, for example, the following Spanish examples in (18) for adult speech. In word-medial position /b/ undergoes lenition and becomes [β] (18a). In word-initial position /b/ does not alternate (18b) and /β/ even undergoes fortition and becomes [b] (18c).

(18)	a.	haba	→	ha[β]a	'bean'
	b.	barca	→	[b]arca	'boat'
	c.	vamos	→	[b]amos	'let's go'

A similar phenomenon for child language has been described by Inkelas & Rose (2008). They describe the productions of an American English-learning child who shows a contrast between coronal and velar stops in prosodically weak position but neutralizes the very same contrast in prosodically strong positions. Hence, similar to some children in our data, the productions show the articulation of a contrast in unstressed, but not in stressed, position. Further evidence that children might use different strategies when establishing segmental contrasts in their early productions comes from Stoel-Gammon & Cooper (1984). They describe the phonological development of four English-learning children and report that one child shows a contrastive behavior to the other children in that (a) he has a much larger segmental inventory in final position in his first words, and (b) he assimilates initial consonants to final consonants rather than vice versa. Stoel-Gammon & Cooper (1984) therefore note that for this particular child initial position seems to be the "weakest" position while being the "strongest" position for the other children.

Note that—at least for Dutch—children do not only use different strategies when introducing MoA contrasts. Noortje and Robin, the two Dutch children who introduced MoA contrasts in noninitial position, also produce consonant clusters in word-medial and word-final position before they do so in word-initial position (see Fikkert & Altvater-Mackensen 2013, for more detail). It thus seems that these children have a general tendency to focus on noninitial positions in phonological acquisition. It would be interesting to see if children who focus on noninitial positions versus children focusing on initial positions will also show differences in morphological acquisition. German and Dutch, for example, have rich inflectional morphology marked at the end of words as well as word-final morphophonological alternations. It might be that children who focus on noninitial positions to introduce phonological contrasts will also be more sensitive to these word-final morphological markers. That is, however, only a speculation that would have to be substantiated by more data (but see Grijzenhout & Penke 2005, for a similar argument on the relation between the acquisition of verb morphology and syllable structure).

4.3. The Development of Templates and the Structure of the Lexicon

Regardless of the reason for the differences that we find between individual children, the fact that we find interindividual differences in the acquisition of MoA shows that it does not follow a universal or stable developmental path. In this respect the acquisition of MoA substantially differs from the acquisition of PoA as described by Fikkert & Levelt (2008). Nevertheless, the acquisition of MoA and PoA contrasts follows similar general principles on the word level, i.e., the sequential introduction of new contrasts in limited word patterns. That leads us to follow the ideas of Waterson (1971) and subsequent studies (e.g., Ferguson & Farwell 1975; Macken 1980; Vihman & Croft 2007; Fikkert & Levelt 2008) and to propose that children do not have fully detailed lexical representations in the beginning. Instead early productions seem to conform to a limited number of word templates and become more variable over time. This idea is further substantiated by work on neighborhood density in young children: The first acquired words tend to be close phonological neighbors (Stokes 2010), suggesting that children do expand their lexicon along the lines of a limited number of word patterns or templates.

This, however, raises the question: What triggers the acquisition of a certain word pattern or template? When relating the actual produced form to the target form in the error analysis, we found that misproductions are rare. The finding that children made only few errors suggests that they select those words for production that match the word patterns that they have acquired. Although a selection strategy might account for a stepwise introduction of new contrasts in child speech (e.g., Ferguson & Farwell 1975; Stoel-Gammon & Cooper 1984), it does not motivate the course of development. Next to difficulties to produce certain sounds (e.g., Oller & McNeilage 1983; Kent 1992) or to perceive certain contrasts (e.g., Eilers, Wilson, & Moore 1977; Aslin et al. 1981), another factor driving the formation of a word template might be the frequency with which this specific word pattern occurs within the group of words that the child knows. In other words, learning a high number of PVF(V) words might trigger the acquisition of a PVF(V) word template for production.

To substantiate this idea, we compared the proportion of the specific word patterns that children produced to the words that children probably know, i.e., to the distribution of the specific word patterns in a typical child's lexicon. One way of estimating this distribution is to look at communicative developmental inventories that list the words that children usually know at a certain age. We decided to use communicative developmental inventories rather than the structure of the targeted words because children might know and understand many more words than they actually try to produce. Thus, looking at the structure of words chosen for production can inform us about a selection strategy that the child might use. It does not, however, necessarily also reflect the structure of the lexicon, as the child might know a lot of words with different structures that are not yet targeted for production—for instance, because they do not conform to a given word template.

We therefore analyzed lexical development assessment lists for the two languages under investigation (see Dunphy 2006 for a similar method). We looked at two time points in development, 12 months and 24 months, to estimate the distribution of the specific word patterns at the time that roughly corresponds to the age that children in our study had at the first and the last recording.[8] For German we used the *Fragebogen zur frühkindlichen Entwicklung* (FRAKIS; Szagun, Stumper, & Schramm 2009), for Dutch we used the *Netherland Communicative Developmental Inventory* (N-CDI; Zink & Lejaegere 2002). Using similar criteria as described in section 2, we selected all CVC and CVCV words that were listed in the vocabulary lists and coded the consonants for their Manner of Articulation (again excluding words that contained glides to keep the data comparable). We then calculated the proportion of words that conformed to the different word patterns described before. Table 19 displays the proportions of words that fit the different word patterns for each language in the vocabulary lists for 12- and 24-months-olds.

TABLE 19
Proportion of Words That Conform to the Different Word Patterns in the German and Dutch Child Vocabulary Lists For 12- And 24-Month-Olds

	German				*Dutch*			
C_1C_2	*12 mo*		*24 mo*		*12 mo*		*24 mo*	
PP	13,33	[6]	13,77	[19]	41,38	[12]	23,33	[28]
PF	15,56	[7]	15,22	[21]	10,34	[3]	13,33	[16]
PP_F	4,44	[2]	2,90	[4]	n.a.		n.a.	
PN	6,67	[3]	12,32	[17]	3,45	[1]	10,00	[12]
PL	2,22	[1]	2,17	[3]	3,45	[1]	3,33	[4]
FP	11,11	[5]	5,07	[7]	6,90	[2]	10,83	[13]
FF	20,00	[9]	14,49	[20]	13,79	[4]	10,00	[12]
FP_F	0,00	[0]	0,00	[0]	n.a.		n.a.	
FN	0,00	[0]	7,97	[11]	6,90	[2]	6,67	[8]
FL	4,44	[2]	5,80	[8]	0,00	[0]	1,67	[2]
NP	2,22	[1]	3,62	[5]	3,45	[1]	3,33	[4]
NF	6,67	[3]	5,80	[8]	3,45	[1]	4,17	[5]
NP_F	2,22	[1]	0,72	[1]	n.a.		n.a.	
NN	6,67	[3]	3,62	[5]	3,45	[1]	4,17	[5]
NL	0,00	[0]	0,72	[1]	0,00	[0]	0,00	[0]
P_FP	0,00	[0]	0,72	[1]	n.a.		n.a.	
P_FF	0,00	[0]	0,00	[0]	n.a.		n.a.	
P_FP_F	0,00	[0]	0,00	[0]	n.a.		n.a.	
P_FN	0,00	[0]	1,45	[2]	n.a.		n.a.	
P_FL	0,00	[0]	0,00	[0]	n.a.		n.a.	
LP	2,22	[1]	2,17	[3]	3,45	[1]	4,17	[5]
LF	2,22	[1]	1,45	[2]	0,00	[0]	4,17	[5]
LP_F	0,00	[0]	0,00	[0]	n.a.		n.a.	
LN	0,00	[0]	0,00	[0]	0,00	[0]	0,83	[1]
LL	0,00	[0]	0,00	[0]	0,00	[0]	0,00	[0]
$C_1 = C_2$	40,00	[18]	31,88	[44]	58,62	[17]	37,50	[45]
PX	28,89	[13]	32,61	[45]	17,24	[5]	26,67	[32]
XF	24,44	[11]	22,46	[31]	13,79	[4]	21,67	[26]

Note. Absolute numbers are given in square brackets.

[8]Note that Noortje was a late talker and was therefore also recorded at a later age.

Table 19 collapses the distribution of word patterns across words that children probably know at 12 and 24 months of age. If the development in children's productions is a mere reflection of lexical change, we would expect that the vast majority of words that children know at 12 months of age contain consonants that share their manner of articulation and that the distribution of word patterns significantly changes from 12 to 24 months. However, in general the distribution of the two word patterns does not dramatically change from 12 to 24 months. Admittedly, there is a steep decrease in the proportion of PP words in Dutch children's lexicons, but otherwise the proportion of the single-word patterns changes only slightly. When we collapse the different word patterns that obey the $C_1 = C_2$, XP and XF templates, then it becomes evident that the proportion of words that conform to $C_1 = C_2$ decreases from 12 to 24 months of age, while the proportion of words that conform to the XP and XF pattern tends to increase. This seems to fit the developmental change we see in children's productions. In Dutch, the changes in the distribution of the different word patterns seem to reflect the changes in the produced word patterns. PP is the most frequent word pattern in the Dutch children's lexicon at 12 (and also at 24) months of age, and it is the earliest produced word pattern. Similarly, the number of words containing an initial stop or a final fricative, i.e., conforming to the XF and PF pattern, substantially increases from 12 to 24 months in children's productions as well as in the words children know. Thus, from the Dutch vocabulary list data it is not evident that children use a selection strategy and avoid words for production that they know but that do not conform to a given word template.

However, a closer examination of the German vocabulary data puts into doubt that the changes in the distribution of word patterns that children produce simply follow the changes in the distribution of word patterns that the children know. XP and PF words are already rather frequent in the lexicon of German 12-month-olds, and their proportion does not significantly change from 12 to 24 months of age. In general, the different word patterns seem to be rather evenly distributed in German across the two time points in development. Moreover, the most frequent word pattern in German at 12 months is FF—which is not the word pattern that children introduced in their productions first. Thus, the changes in German children's productions do not seem to be modulated by changes in lexical structure. Rather, it seems that German children target those types of words for production that conform to the acquired template.

Despite such a selection strategy, the frequency of the different patterns seems to match the order of their acquisition: Words in which the consonants share their manner of articulation are most frequent and produced first. For words in which the consonants do not share their Manner of Articulation, it seems that stop-initial words are more frequent than words with initial fricative or nasal. This fits the pattern we found in the child data: For stages in which the initial consonant was fixed and the final consonant allowed variation, the children used a PX template, i.e., restricted the initial consonant to a stop. The *default* MoA for initial position, stop, thus matches the most frequent initial consonant. For noninitial position, however, fricatives seem to be the most frequent Manner of Articulation. This suggests that children also use the most frequent MoA as default when restricting the noninitial position to a fixed MoA and allowing variation in initial position, as seen in words that conform to the XF template. Taken together, this suggests that frequency in the input, i.e., the words that children learn first, might drive the formation of word templates. As stated earlier, this does not imply that the children's productions merely reflect the lexicon structure: If so, we would expect that the distribution of word patterns in child speech conforms to the distribution of word patterns in the vocabulary. Yet, while the distribution of word patterns in the lexicon does not seem to dramatically change from 1 to 2 years of age, the children's productions change from one stage to the other, i.e., the number of words that conformed to certain templates increased in the course of development.

4.4. Conclusion

To summarize, we propose that children's early word productions conform to a limited number of word patterns or templates that evolve in the course of development. Crucially, the acquisition of Manner of Articulation contrasts seems to proceed stepwise in specific positions within the word: Different MoAs may not freely vary and combine within a word in the beginning. Rather, one of the consonants seems to be fixed to a specific MoA, usually an obstruent. Following the argumentation in Fikkert & Levelt (2008), we proposed that children initially only specify the MoA of the varying consonant and that the fixed consonant receives its MoA by default. This suggests that the acquisition of MoA contrast is bound to structures that lie beyond the segmental level. This higher structure might be position within the word or prosodic position. Interestingly, the position of the fixed consonant differs across children, suggesting that children use different learning strategies to introduce MoA contrasts. After all, children seem to learn words and subsequently learn more about the segments that make up those words. Future research might find it useful to further investigate the potential role of the features that make up those segments to get a better understanding of how phonological representations evolve in the course of development.

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