Does Floortje like butterflies more than horses? Influence of a name on consonant cluster acquisition

Joanna Kulig
Leiden University Centre for Linguistics
2009

Research MA thesis

Supervisors:
Dr. Clara Levelt
Prof.dr. Vincent J van Heuven

To Evelien De Later
and
Bob Borges -
Thank you for your invaluable help and support.

Contents

List of tables

List of figures

1. Introduction

The purpose of the current study is to investigate wether the frequency of hearing certain consonant structures has an influence on children's acquisition of the structures in their everyday language.

Levelt & Van de Vijver (1998) hypothesized that developmental orders are language specific: for example, complex codas are not allowed in European Portuguese (Vigário, Freitas & Frota, 2006), whereas in other languages they are very frequently used, e.g. Polish (Sawicka, 1999). They also stated that the reason for the order of acquisition of particular structures is due to the frequency frequency of various syllable structures in the adult speech directed at children.

Kirk and Demuth (2003) tested English-speaking children and found that the pronunciation of coda clusters was much more accurate than onset clusters. They gave several possible explanations, fistly, articulatory difficulties. They claimed that coda clusters are easier to pronounce therefore they are acquired faster and more accurately. Their other explanation was frequency. They noted that in English coda clusters are three times more frequent in child directed speech. In German the situation is similar and the occurrence of coda clusters is also greater than onset clusters (Kehoe & Lleó, 2003). This may be a reasonable explanation of the fact that children acquire the coda clusters before the onset clusters.

But what about Dutch? The situation is a little bit more complicated. Levelt, Schiller, Levelt (2000) have described the acquisition of different syllable types in Dutch and their frequency in child-directed speech. The children in their study acquired more frequent syllable types earlier than less frequent types. From their work, we also learn about the phenomenon of asymmetry in the acquisition of consonant clusters. There are two ways of acquiring clusters – the first is the acquisition of coda clusters followed by acquisition of onset clusters. In the other case, onset clusters are acquired before coda clusters.

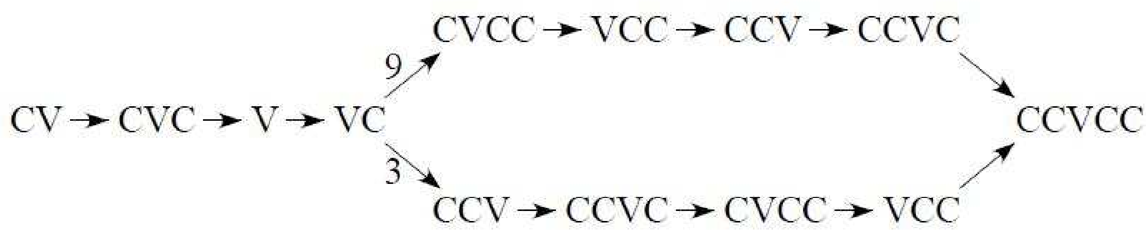


Figure 1 The two developmental paths of consonant cluster acquisition

In Jongstra (2003) investigation of Dutch word-initial clusters, she found that there are two possible factors that might play a role in the word familiarity and cluster frequency. The results showed no significant influence of word familiarity for cluster acquisition, but there was a moderate correlation between scores in perception and cluster frequency.

Moreover, Levelt & Van de Vijver (1998) on a basis of a large corpus of 112,926 primary stressed syllables showed the distribution of various syllable types in Dutch child directed speech presented in Table 1.

Table 1. Frequencies of syllable types in Dutch in child directed speech.

CV	44.81 %	CCVC	1.98 %
CVC	32.05 %	CCV	1.38 %
VC	11.99 %	VCC	0.42 %
V	3.85 %	CCVCC	0.26 %
CVCC	3.25 %		

This research shows that the number of onset and coda clusters used by adults in child-directed speech is almost identical: 3.62% (1.98%+1.38%+0.26%) and 3.93% (3.25%+0.42%+0.26%), respectively. Thus, the frequency of adult speech as the explanation for the variable path of cluster acquisition would not be valid. But what could it be? There may be a certain word or a set of words that are repeatedly spoken in front of a child so that it will become more familiar with one cluster structure, sending the child down one of the acquisition paths, to acquire one of type of cluster before the other. And what would be the most frequent word children hear from their parents? Could the child's own name be a possible explanation?

In this thesis I will investigate if children with onset clusters in their name acquire words with initial clusters before words with final clusters and the reverse for children with names containing coda clusters.

2. The phonology of consonant clusters in Dutch

In this section, I am going to talk about the phonology of consonant clusters in Dutch. I will present the inventory of Dutch conconantal system and the possible consonant combinations that make up the clusters.

2.1 The inventory of Dutch consonants

Dutch is a Germanic language, spoken mainly in The Netherlands, Belgium, South Africa and Suriname. Standard Dutch has 23 consonants (including the rare ones, that occur as allophones or the ones the are of a foreign origin, such as /g/).

Table 2: Dutch consonants (Booij, 1995)

	Bilabial	Labio-dental	Alveolar	Palatal	Velar	Uvular	Glottal
Nasals	m		n		ŋ		
Plosives	p b		t d		k (g)[1]		
Fricatives		f v	s z		ɣ	χ	h
Liquids			r l				
Glides		w		j			

2.2 Onset and coda clusters in Dutch

The basic syllable structure of Dutch is CV (Booij, 1995; Trommelen, 1983), however there are many other possible combinations up to (C)(C)(C)V(C)(C)(C)(C), where the onset can be extended by an extrasyllabic /s/ and the coda by the coronal /s/ and /t/. This chapter will treat consonant clusters in onset and coda position of Dutch words.

2.2.1 The Dutch onset

The onset is not always the essential component of Dutch syllable therefore the syllables may occur without it e.g.

(1) - *os* /ɔs/[2] 'ox'

- *appel* /ɑpəl/ 'apple'

In Dutch consonant onsets are very frequent. There are several types of onsets that are allowed. According to Trommelen (1983), almost all consonants are allowed in Dutch single consonant onsets:[3]

(2) - *tas* /tɑs/ 'bag'
- *paard* /part/ 'horse'
- *kaas* /kas/ 'cheese'
- *boom* /bom/ 'tree'

---

[1] The [g] only occurs in borrowings such as *goal*
[2] The phonetic transcription was taken from http://www.dbnl.org/tekst/paar001abnu01_01/index.htm
[3] With just one exception which is the velar nasal /ŋ/ that does not occur in any kind of onsets in Dutch

Dutch also allows several types of complex onsets, both biconsonantal and triconsonantal onsets are common. The following are a few examples of multi (2-3) consonant onsets[4]:

(3) - kraan /kran/ ‘tap’
- vlinder / vlɪndər/ ‘butterfly’
- straat /strat/ ‘street’

2.2.2 Types of complex onsets

The onsets in Dutch can contain up to three consonants. The bi- or triconsonantal onsets can have various forms, depending on combinations of obstruents and sonorants. The triconsonantal onsets in Dutch always begin with /s/, although one should notice it is considered by some to be an extrasyllabic component of a syllable (e.g., Booij, 1983; Clements & Keyser, 1983; Trommelen, 1983; Hulst, 1984). This issue will be treated in detail in chapter 2.2.2.4.

2.2.2.1 The types of biconsonantal onsets

The basic combinations of sounds occurring in biconsonantal onsets that are allowed in Dutch are (Trommelen, 1983):

- obstruent – obstruent
- obstruent – sonorant

There is also a possibility of occurrance sonorant – sonorant clusters, but they are very rare as they occur only in words of foreign origin e.g.

(4) - *Loire* /lw-/ – French river

Sonorant - obstruent clusters do not occur in Dutch at all as they do not obey the Sonority Sequencing rule which says “Segments can be ranked along a sonority scale in such a way that higher-ranking segments stand closer to the center of the syllable and lower-ranking segments closer to the edges” (Clements, 1987).

A sonority hierarchy is a scale where speech sounds are ranked according to their amplitude. For example, if one says the vowel [a], one will produce it much louder than the plosive [t]. Van der Hulst (1984) distinguished 5 values of sonority:

[4] Complex onsets will be described in a later chapter

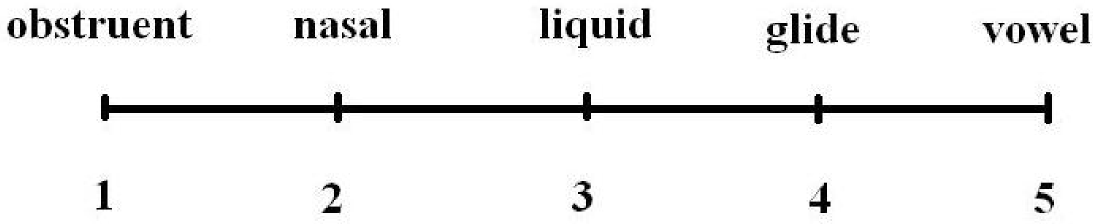


Figure 2: The sonority scale by Van der Hulst (1984)

Selkirk (1984) is more specific about sound types as she also distinguishes obstruents into plosives and fricatives and vowels into high and non-high vowels.

Table 3: The sonority scale by Selkirk (1984)

Sonority	**Type of sounds**		
(lowest)	plosives	obstruents	consonants
	fricatives		
	nasals	sonorants	
	liquids		
	high vowels		vowels
(highest)	non-high vowels		

In Dutch two sonorant clusters may only occur in foreign words or in words beginning with /wr-/ e.g. *wringen* ‘to wring’ although they are usually pronounced as [vr-] which classifies them as an obstruent – sonorant cluster. (Trommelen, 1983)

2.2.2.2 Obstruent – sonorant onset clusters

Obstruent – sonorant onset clusters can be subdivided into three classes (Trommelen 1983):

- obstruent – nasal
- obstruent – liquid
- obstruent – glide

They can occur in combinations with both plosives or fricatives, which is shown in Tables 4 and 5, respectively.

Table 4: Obstruent (plosive) – sonorant type of onset clusters in Dutch

		Liquids		**Nasals**		**Glides**	
		l	**r**	**m**	**n**	**w**	**j**
Plosives	**p**	pl	pr		pn*[5]		pj*
	b	bl	br				
	t		tr			tw*	tj*
	d		dr			dw	
	k	kl	kr		kn	kw	

There are a few examples of words containing a plosive – sonorant onset cluster:

(5) - /plats/ *plaats* 'place'
- /blum/ bloem 'flower'
- /klør/ kleur 'colour'
- /prɛi/ *prei* 'leek'
- /brot/ *brood* 'bread'
- /trɛin/ *trein* 'train'
- /droχ/ *droog* 'dry'
- /kron/ *kroon* 'crown'
- /knop/ *knoop* 'button'

There is another set of obstruent – sonorant clusters, where the obstruent is a fricative:

Table 5: Obstruent (fricative) – sonorant type of onset clusters in Dutch

		Liquids		**Nasals**		**Glides**	
		l	**r**	**m**	**n**	**w**	**j**
Fricatives	**f**	**fl**	**fr**		**fn***[6]		**fj***
	v	**vl**	**vr**				
	s	**sl**		**sm**	**sn**		
	z					**zw**	
	χ	**χl**	**χr**				

The glide /j/ does not occur in clusters frequently - only in a few loanwords, e.g.

(6) - /pjotr/ *Piotr* 'a name'
- /tjalk/ *talc* 'tjalk'
- /fjord/ *fiord* 'fjord'

---

[5] Consonants marked with an asteriks are rare in Dutch
[6] Consonant clusters marked with an asterisk are rare in Dutch

The glide /w/ in the second position of an obstruent - sonorant cluster usually does not follow a fricative, apart from the fricative /z/, as in:

(7) - /zwart/ *zwart* ‘black’

The obstruent - liquid clusters /pn/, /fn/ and /χn/ are also rare in Dutch, they occur in a small set of words, such as:

(8) - /pnœy'matik/ *pneumatiek* ‘pneumatics’
- /fnœykənt/ *fnuikend* ‘fatal’
- /χnom/ *gnoom* ‘gnome’.

Other types of fricative - sonorant clusters, however, occur quite frequently:

(9) - /smak/ *smaak* ‘taste’
- /snɔu/ *snauw* ‘snap’
- /fles/ *fles* ‘bottle’
- /vlur/ *vloer* ‘floor’
- /slaap/ *slaap* ‘sleep’
- /χrot/ *groot* ‘big’
- /frœyt/ *fruit* ‘fruit’
- /vraχ/ *vraag* ‘question’

2.2.2.3 Optimality Theory’s explanation of banning coronal – coronal clusters

In Dutch, obstruent – sonorant clusters obstruents can be followed by a liquid (Trommelen, 1983). However, the clusters */tl/, */dl/ and */zl/, */sr/ and */zr/ do not occur, unlike /sl/. Moreover, /r/ in second position cannot be preceded by a sibilant.

This phenomenon is explained by McCarthy (1988), using Optimality Theory. He says that there is a constraint OCP CORONAL banning the presence of all the clusters (*/tl/, */dl/, */zl/, */sr/[7] and */zr/ also */tn/, */dn/ and */zn/). Clusters of two coronals are also banned, although the clusters /sn/, /sl/, /tr/ and /dr/ are allowed in Dutch, so the constraint OCP CORONAL must be dominated by a faithfulness constraint that causes the clusters /tr/ and /dr/ to surface in the output.

[7] Most speakers of Dutch reduce the /sxr/ onset cluster as in *schrijven* or *schraap*, to [sr]. It could be argued that it would fill the phonological gap next to /sl/, /sn/ etc. However, onset clusters like /sfr/, /sfl/, /sxl/ do not exist, so maybe /sxr/ should not, either. The question is still unsolved.

Table 6: Coronal obstruent-sonorant (coronal - coronal) combinations

		coronal sonorants		
		nasal	**liquids**	
coronal obstruents		**n**	**l**	**r**
	t	*tn[8]	*tl	tr
	d	*dn	*dl	dr
	s	sn	sl	*sr
	z	*zn	*zl	*zr

There are a few examples of coronal – coronal clusters:

(10) - /snar/ *snaar* ‘string’
- /slɔt/ *slot* ‘castle’
- /trœy/ *trui* ‘sweater’
- /droχ/ *droog* ‘dry’

2.2.2.4 The /s/ issue

Some linguists claim (e.g., Booij, 1983; Clements & Keyser, 1983; Trommelen 1983; Van der Hulst 1984) that the phoneme /s/ is not part of the onset, rather it is extrasyllabic. This means that /s/ does not have to obey the constraints applying to syllable onsets. The extrasyllabic status of /s/ can also explain the occurrence of the clusters /sn/ and /sl/.

2.2.2.5 Obstruent – obstruent onset clusters

The Dutch obstruent – obstruent onset clusters can be divided into two subgroups. In both cases /s/ is an essential part of them. The situation is similar to the one in section 2.2.2.4 where obstruent – sonorant clusters also contain /s/, explained by the extrasyllabic property of the phoneme. Trommelen (1983) calls /s/ an extrametrical constituent in order to explain its peculiar distribution. /s/ is the leftmost consonant in clusters and it is the only coronal that may precede /l/, /m/ an /n/. Therefore, as Trommelen (1983) claims, it either simply violates all the constraints or, occurring on different rules, which is claimed here, is considered to be extrametrical and does not have to obey the constraints. Thus, it will be independently motivated.

The first group of obstruent – obstruent initial clusters is a set of clusters that has /s/ and a voiceless obstruent: some of the clusters /sp/, /st/ and /s/ occur frequently in Dutch, e.g.:

(11) - /spɑr/ *spar* ‘spruce’
- /stɑrt/ *start* ‘start’
- /sχap/ *schaap* ‘sheep

[8] Clusters with an asterisk do not occur in standard Dutch

Some obstruent - obstruent clusters, such as /sf/ and /sk/ occur only in a few loanwords:

(12) - /sfɪŋks/ *sfinks* ‘sphinx’
- /ski/ *ski* ‘ski’

The second group of the obstruent – obstruent onset clusters is a number of clusters consisting of a plosive, which is followed by the obstruent /s/. They also only occur in a few loanwords:

(13) - /tsar/ tsaar ‘tsar’
- /psœydo/ pseudo ‘pseudo’
- /ksilofon/ xylofoon ‘xylophone’

2.2.2.6 Triconsonantal onset clusters

There are several types of triconsonantal onset clusters in Dutch, nevertheless the only possible leftmost consonant in the cluster is /s/. The phoneme /s/ can be followed by a cluster of an obstruent and a sonorant (Trommelen, 1983), but not an obstruent - nasal cluster. Furthermore, the phoneme /s/ and the first consonant of the CC-onset must also be a legal onset, e.g. /sp/, /st/ and /sx/. Marginal CC-onset clusters like /sf/ and /sk/ do not occur at the first two places of CCC-clusters, except for some loanwords that start with /skr/, e.g.:

(14) - /skri:n/ ‘screen’
- /skrɪpt/ ‘script’

The possible consonant combinations of three consonant onset clusters are shown in Table 7.

Table 7: Dutch sC_1C_2 onsets

		liquids	
		l	**r**
s	**p**	spl	spr
	t	*stl[9]	str
	x	*sxl	sxr

The obstruents /p/, /t/ and /x/ can be followed by a liquid in CC-onsets. The Dutch-legal sCC onsets are /spr/, /spl/, /str/ and /sχr/, e.g.

(15) - /splɪntər/ *splinter* ‘chip’
- /sprak/ *spraak* ‘speech’
- /strat/ *straat* ‘street’
-/sχreu/ *schreeuw* ‘shout’[10]

[9] The clusters with an asterisk do not exist due to the constrain OCP CORONAL described in chapter 2.2.2.3
[10] See footnote 6

2.2.2.7 Optimality Theory explanation for banning CCC- clusters

There is a constraint banning CCC- clusters - it is assumed to outrank the general faithfulness constraint since there is only a limited number of CCC clusters that are allowed in Dutch. As all Dutch CCC- clusters start with /s/, the extrasyllabic status of the phoneme may account for the grammaticality of /sCC/-clusters. This means that /sCC/-onsets do not violate *CCC because /s/ is not considered to be a part of the syllable, thus the constraint is not applicable.

2.2.3 The Dutch coda

In the syllable structure the least marked syllable rhyme is a single vowel, without a coda. In Dutch an example of such structure can be coda-less word, e.g:

(16) - /stro/ *stro* ‘straw’.

Dutch codas can be either simple or complex. All consonants of the Dutch phoneme inventory, except /h/, can occur in a simple coda (Trommelen, 1983). Nevertheless, because of the final devoicing in Dutch voiced obstruents do not occur in word-final coda-position. Complex coda clusters may consist of up to four consonants as in:

(17) - /hɛrfst/ *herfst* ‘autumn’
- /ɛrnst/ *ernst* ‘seriousness’.

Yet, four consonant clusters occur very rarely. More common are bi- and triconsonantal codas.

2.2.3.1 Two-consonant codas

There are three possible types of CC-codas that occur in Dutch (Trommelen, 1983):

- sonorant – obstruent
- sonorant – sonorant
- obstruent – obstruent.

The CC-codas that start with a sonorant obey the sonority sequencing principle: the consonants that occur in the outermost position of the syllable are less sonorous than sonorants. There are three types of such codas. The first is the sonorant-obstruent combination.

Table 8: sonorant – obstruent codas in Dutch

	p	t	k	f	s	x
m	mp	mt			ms	
n		nt			ns	
ŋ		ŋt[11]	ŋk		ŋs	
l	lp	lt	lk	lf	ls	lx
r	rp	rt	rk	rf	rs	rx

As the table above shows that, not all sonorant – obstruent combinations are possible in Dutch. The liquids /l/ and /r/ can be followed by any obstruent. However, not every nasal – obstruent combination is a legal coda cluster as nasals cannot be followed by a fricative other than /s/. The exceptionality of /s/ as a second consonant can be accounted for by its extrasyllabic nature, described in the previous section. Moreover, nasal – plosive coda clusters share the same place of articulation. An exception is the cluster /mt/. Also here, the exception can be explained by the extrasyllabicity of the final coronal /t/. The following are a few examples of words containing final clusters:

(18)
- /hølp/ *hulp* ‘help’
- /ɑlt/ *alt* ‘contralto’
- /mɛlk/ *melk* ‘milk’
- /sχɛrp/ *scherp* ‘exact’
- /kort/ *koord* ‘cord’
- /vɔrk/ *vork* ‘fork’
- /χɔlf/ *golf* ‘wave’
- /pɔls/ *pols* ‘wrist’
- /vɪlχ/ *wilg* ‘willow’
- /vɛrf/ *verf* ‘paint’
- /kars/ *kaars* ‘candle’
- /bɔrχ/ *borg* ‘deposit’
- /sɔms/ *soms* ‘sometimes’
- /lɛns/ *lens* ‘lens’
- /lɑŋs/ *langs* ‘along’
- /lɑmp/ *lamp* ‘lamp’
- /hɛmt/ *hemd* ‘shirt’
- /kɑnt/ *kant* ‘side’
- /bɑŋk/ *bank* ‘bank’

The coda cluster /mf/, which is only present in Dutch loanwords has not been taken into consideration. (e.g., in *nimf* ‘nymph’ and *triumf* ‘triumph’).

[11] The coda cluster /ŋt/ only occurs in inflected words, such as zingt ‘sing-2/3sg’.

The second class of CC codas are sonorant – sonorant clusters. They also obey the sonority sequencing principle. The first consonant is a liquid and the second consonant is a nasal /n/ or /m/[12]. There are several examples of sonorant – sonorant codas:

(19) - /pɑlm/ *palm* ‘palm’
- /ørn/ *urn* ‘urn’
- /stɔrm/ *storm* ‘storm’.

It should be noted that the sonority distance between these two phonemes is smaller than the minimal sonority distance in onset obstruent – sonorant clusters, whereas nasal-obstruent coda clusters seem to be constrained by the MINIMAL SONORITY DISTANCE.

The third class of CC codas consists of obstruent - obstruent combinations. These codas end with either /s/ or /t/. The consonants have an extrasyllabic status, therefore they are not subject to the SONORITY SEQUENCING PRINCIPLE:

Table 9: C-obstruent coda clusters in Dutch[13]

	/s/	**/t/**
p	ps	pt
t	ts	
k	ks	kt
f		ft
s		st
χ		χt

There are examples of obstruent – obstruent coda clusters:

(20) - /røps/ *rups* ‘caterpillar’
- /trɔts/ *trots* ‘pride’
- /reks/ *reeks* ‘series’
- /stɪpt/ *stipt* ‘punctual’
- /tɑkt/ *takt* ‘tact’
- /sχɑft/ *schaft* ‘break’
- /fest/ *feest* ‘party’
- /rɛχt/ *recht* ‘duty’

[12] According to Optimality Theory the coda cluster */ln/ violates the OCP CORONAL constraint therefore is ill-formed.

[13] The absence of the coda clusters /fs/ and /χs/ in underived words could be accounted for by the violation of the MINIMAL SONORITY DISTANCE constraint.

3. Consonant cluster acquisition

In this chapter I will present the process of consonant cluster acquisition. I will investigate possible strategies employed by children before correct consonant cluster are acquired. I will discuss the processes as they are relevant to the Dutch language.

3.1 General rules of cluster acquisition

Consonant clusters are particularly difficult for children to acquire due to their complex structure. Children tend to acquire less complex phonological structures that can occur at the beginning or the end of a syllable. The process of the acquisition of consonant clusters is one of the most long-lasting aspects of speech acquisition in normally developing children (McLeod, Van Doorn & Reed 2001a).

Usually when children reach 2 years of age they start producing consonant clusters. Earlier attempts result in many various representations of clusters, but mostly by singleton consonants. In the process of attempting consonant clusters many result in non-target productions. There are several paths which the cluster development can take, such as reduction in the number of components of a proper cluster, production of different phonemes instead of the ones in the adult-speech cluster or changes in syllable shape as well as phonemes. Frequently, the outcome of these processes leads to structures that are not permitted in the given language e.g. *blue* is produced as [bwu] (McLeod et al. 2001a).

There are several ways children choose to deal with consonant clusters they cannot produce correctly, illustrated in Table 10. One of them is the strategy not to produce any consonants at all (1). Another one would be to delete the first or second consonant from the cluster, which results in a singleton consonant (2). A singleton consonant can also be the result of coalescence where the reduced cluster becomes a new consonant that still contains features from the original consonants (3). One more strategy that changes a syllable shape – when it becomes different from the target is epenthesis is the insertion of a vowel between the consonants of a cluster (4). Cluster simplification takes place when two elements are produced but one or both of the elements are produced in a non-target manner, which is usually the result of a phonological process that can affect singleton consonants as well (e.g. fronting or stopping) (5). Metathesis, which can be the last strategy before a correct consonant cluster is acquired, is the reversal of adjacent elements and occurs incidentally in the child speech (6) (McLeod et al. 2001a).

Table 10: Possible strategies in the process of acquisition of consonant clusters C1C2.

	Child output	**Example /trein/**
1 Both elements deleted	Ø Ø	[ein]
2 Deletion of 1 element	C_1 Ø	[tein]
	Ø C_2	[rein]
3. Coalescence	C_{other} Ø	[dein]
4 Epenthesis	C_1VC_2	[terein]
5 Cluster simplification	C_1C_{other}	[tlein]
(by substitution)	$C_{other}C_2$	[drein]
	$C_{other}C_{other}$	[dlein]
6 Metathesis	C_2C_1	[rtein][14]
7 Correct	C_1C_2	/trein/

Usually, children begin with reduced forms of consonant clusters, starting off with deletion of one of the elements. After that children may move on to the next step and perform coalescence by inserting consonants other than target consonants, but which share several features with the target ones, e.g. place of articulation. Very often they also insert an additional schwa. When the occurrence of the cluster reduction strategies decreases, a simultaneous increase in use of cluster simplification takes place. The children attempt to pronounce the clusters correctly, but they only manage to produce a near-(target) cluster, e.g. [tl] instead of /tr/. This stage shows the salience of the correlation between the acquisition of the correct number of elements in the cluster and the refinement of all the cluster elements. The changes in the processes of reduction and simplification take place gradually and slowly, thus the correct forms may also coexist with the incorrect ones even for a few months. As the final stage, a child will produce the target consonant cluster correctly in an adult manner at all times (McLeod et al., 2001a, McLeod et al., 2001b).

In another study Greenlee (1974) described three stages of cluster development in normally developing children. She reviewed several publications on the topic and found out that the cluster productions of the tested children who were from six different language backgrounds progressed through the same three stages:

Stage 1: Cluster reduction – by deleting the liquid element (e.g., /kr/ → [k])

Stage 2: Cluster substitution – by producing two elements but with substitution for the liquid element (e.g., /kr/ → [kw])

Stage 3: Correct production – producing the stop + liquid cluster accurately

[14] The example of metathesis in the table above would not occur – it is only for explaining purposes.

3.2 Consonant cluster acquisition in Dutch

The acquisition of consonant clusters is closely linked to the acquisition of syllable structure. Thus, it is possible to track the order of acquisition of the syllable types and apply it onto the consonant cluster acquisition to be able to show which type of the cluster appears first (onset or coda) or if the emerge at the same time.

For the acquisition of Dutch syllables, Fikkert (1994) investigated the development of onsets and of rhymes separately. She used data of language acquisition of 12 monolingual Dutch children. She found out that initially, onsets are obligatory, then optional and finally complex onsets appear. Rhymes consist initially of vowels, then coda consonants are allowed and finally consonant clusters appear in the data.

Fikkert's (1994) study provided insight in the development of onset and rhymes. Then Levelt, Schiller & Levelt (2000) studied the same corpus of data and gave an OT account of the development of the syllable structure as a whole. They discovered that after the first three stages in which CV, CVC, V and VC are acquired, children systematically choose between two different developmental paths when the first consonant cluster emerges. Some children acquire complex onsets before complex codas and some children acquire clusters in the reverse order. Nevertheless, for all children the CCVCC syllable type is acquired as a final structure:

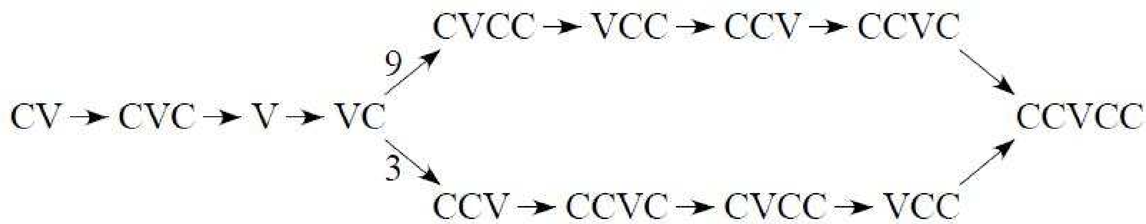


Figure 3 Two developmental paths of consonant cluster acquisition

Interestingly, this order of acquisition corresponds closely to the frequency order of the syllables in Dutch, especially when child directed speech is taken into account (Levelt et al., 2000, Levelt & Van de Vijver, 2004). So, it is very likely that frequency distribution influences the order of cluster development.

4. Input frequency and language acquisition

Input frequency is often described as a case of the environmental influence on the ambient language (e.g., Menn, 1983). This and other environmental influences have been widely investigated in the field of linguistics. Through the cross-linguistic comparison of consonant development, the research showes that there is a strong correlation between ambient language influences and consonant learning.

Pye, Ingram & List (1987) studied the development of initial consonants by Quiche´ Mayan children and compared it with consonant acquisition in English-speaking children. They discovered that Mayan children acquired the affricate /ʧ/ and the lateral /l/ much earlier than the English-speaking children.

The discrepancy prompted the authors to do further research and they found that the reason for the earlier acquisition of the sounds in one language could well be the frequency of occurrence of initial consonants. Pye et al. (1987) concluded that

> ‘children exposed to different types of linguistic input proceed along substantially different paths of phonological development. Ease of articulation seems to play only a partial role in determining the overall developmental route’ (p. 182)’.

This study initiated further research of environmental influences on segment development (Stokes, 2005).

Other researchers who examined the issue of the frequency were Amayreh & Dyson (2000) who compared the frequency of occurrence of consonants produced by Arabic-speaking children and adults with speakers of English. They claimed that the earlier acquisition of /l/ and /j/ in Arabic was a result of the high frequency of occurrence of these segments in the ambient language.

So and Dodd (1995), in their cross-sectional study, investigated the development of phonology in Cantonese-speaking children. They described both the segment and tone development and phonological processes. They found out that the development of consonants, vowels and tones in Cantonese showed input influences: ‘the ambient language influences the implementation of universal tendencies in phonological acquisition’ (p. 473). Their first prediction was that children will be more likely to delete the /k$^{(h)}$/ in /k$^{(h)}$w/ clusters, because fewer words begin with /w/ than with /k/ in children's early vocabularies. However, only two children chose to reduce the cluster this way. The most common realization of /k$^{(h)}$w/ by younger children was [k$^{(h)}$] – a sound that occurs in word onsets in Cantonese more often that /w/. Interestingly, when the /k/ from the reduced cluster was fronted it was sometimes realized as a [p], and the /k/ that was a singleton was fronted to [t]. That means that in the situation where the /w/ was deleted, many children attempted to mark the cluster by substituting the deleted sound with one of the same place of articulation.

Also Stokes & To (2002) in their cross-sectional and longitudinal study of Cantonese-speaking children, noticed their earlier acquisition of affricates and velars than English-speaking children. They suggested that the reason for this may be universal tendencies and ambient language that influenced the segmental development.

The above-mentioned examples of research of ambient language effects are clear proof for influential role of input frequency. Recent work of Plaut & Kello (1999) suggests that frequency of occurrence of consonants may play an important role in learning segments. They have developed a model of phonological learning that contains an articulatory-acoustic feed-forward loop. The strength of the loop is to be dependent on the frequency with which it is activated. The conclusion one could draw would be that the frequency of attempting a particular segment by a child and the articulatory-acoustic properties of that segment are directly proportional, which would suggest considering only the child's lexicon in calculating input effects.

According to Plaut & Kello's (1999) approach, learning of speech production is determined by indirect feedback coming from the comprehension system, namely from its own acoustic, phonological, and semantic consequences of articulations. They established a connectionist model which suggests that frequency of activation, possibly as a function of input, contributes to learning. Neverthless, this speculation still needs to be confirmed.

More and more often the recent work on language acquisition demonstrates a major role for adult speech in acquisition, which directly translates into influence of frequency of language input (e.g., Vihman, 1996). Jusczyk, Luce & Charles-Luce (1994) have compared the phoneme frequencies in adult–adult and adult–child speech and have found very little difference in the measures. This means that frequency of occurrence of initial consonants in adult speech is the variable for ambient frequency.

Schwartz & Terrell (1983) investigated the frequency of novel words presented to one-year-old children. They found that children were learning more frequently presented words better than infrequently presented words. They noted that more frequent presentations may facilitate segmentation of words from fluent speech for inferring word meanings.

There are more and more studies that infer an effect for frequency on individual words based on overall vocabulary size (Goodman, Dale & Li 2007). There is a copious amount of evidence that children whose parents provide more input acquire vocabulary easier and quicker (e.g. Weizman & Snow, 2001).

Kirk and Demuth (2005) investigated the role of frequency in the advantage for word-final cluster acquisition. To do this, they examined the frequency of word-initial and word-final clusters in child-directed speech. They tested English-speaking children in their familiar environment. From the obtained corpus of child-directed speech they extracted all word tokens containing biconsonantal clusters at word edges, yielding a total of 63 686 consonant clusters.

Striking differences in the relative frequencies of word-initial versus word-final consonant clusters were found. Coda clusters accounted for 67%, while onset clusters accounting for only 33% of all consonant clusters. Kirk and Demuth (2005) concluded that it is possible that children are sensitive to the frequency of clusters in word-final position at the phonotactic level. That would mean that children may be aware that two consonants occur at the end of many more words than at the beginning.

Goodman et al. (2008) in their article tried to answer the question 'Does frequency count?'. The answer was definitely yes, although they explained that "the way it counts is not straightforward. It clearly depends on the type of words being acquired (e.g. nouns vs. other lexical categories), the modality of acquisition (production vs. comprehension), and the time line of acquisition (earlier vs. later role of frequency). In addition, frequency is clearly only part of the story. Thus, while it is an important piece of the puzzle of which words children will learn and when. Nonetheless, the way frequency interacts with other variables needs to be further explored" (Goodman et al., 2008:529).

Brown (1997) assumes that we could predict underlying representations of the child's speech if we look at scores in perception tasks. She claims that the types of errors she found signaled that they were already in the phonological system, rather than they were made perceptually. This means that if the distribution of the number of errors in a word pair is even, then the child does not have a contrast in underlying representation. Brown (1997) stated:

> 'This sort of random choice [of a sound to pronounce] is what we would expect if the phonological representations are impoverished: the child hears a cue and must choose between two items that are not distinguished in her lexicon. The child's choice then should vary between the two items and maybe influenced by some non-grammatical factors, such as recency or frequency effects' (1997:113).

In the article, Brown makes a distinction between the Building and the Pruning hypotheses. The first one states that the distinction of phonemic contrasts in a native language develops gradually during the process of acquisition. The second theory states that the distinction takes place from the beginning of language development. In order to find out which hypothesis is more likely, Brown carried out a series of experiments testing the perception of phonemic contrasts of singletons in English. The results supported the Building hypothesis:

> 'In fact the finding that some children are capable of distinguishing all of the contrasts underexamination while others are unable to discriminate any of them is enough to indicate that this capacity is not present from the initial stages of phonological development' (Brown, 1997:109).

4.1 Input frequency in Dutch

In Dutch, the role of frequency may be much stronger than for other languages (Stokes and Surendran, 2005) as Dutch has only sixteen initial consonants. Other languages have many more, e.g. English with twenty four initial consonants. According to Stokes ans Surendran (2005) that would mean that the consonants in the initial onsets are more likely to be more repetitive in the language, thus the frequency of word-initial consonants will determine the direction of consonant acquisition. After having investigated and compared Cantonese, English and Dutch, Stokes also stated that for age of emergence of word onset consonants, it was frequency that was the best predictor for Dutch – 43% of the variance in production accuracy; articulatory complexity accounted for 10% and functional load - 7%.

Nevertheless, there are also other variables that need to be considered to account for why there are differences in development of segments across languages.

5. The experiment

5.1 Participants

The participants of the experiment were 13 children in the age of 18;1 – 27;3 months. All children were monolingual and their mother tongue was Dutch. They were carefully selected as they all had to meet the prerequisite condition which was a consonant cluster in their name. The only exemption from the rule was Tim. Although there is no consonant cluster in his name he was included in the experiment. I based the decision on the fact that he was the twin brother of Floor, so the expected frequency of Tim hearing his sister's name would be very close to the frequency of hearing her name herself. An interview with their mother confirmed my assumption.

5.2 Procedure

In order to state the probability of my hypothesis I came up with the idea of asking the children to produce 20 words containing either onset or coda clusters[15]. This would give me some insight into the relationship between cluster acquisition ans having an onset or coda cluster in the name. I chose 20 nouns, mono- and bisyllabic, with a high likelihood that the children knew them already, e.g. *trein* 'train' or *hond 'dog'*. I decided to depict them in a visual form[16]. Accordingly, 20 pictures (one by one) were presented to each child on the screen of a laptop. I used a power point presentation which consisted of 18 boards with colourful pictures (two of them consisted of 2 items which gives all together 20 words). I also added 2 pictures of well-known cartoon and book characters to attract the children to the experiment and to make the setting more friendly[17].

The pictures were presented in 2 sessions (both preceded by the additional picture of the cartoon character – Winnie the Pooh): the first session was a phase of habituation where I could check if the children were familiar with the words. The second session was the actual picture naming experiment. In the habituation phase children were given a while to attempt to say what they saw in a picture then if they did not succeed they were told the word and asked to repeat. In the second phase the children were supposed to say the words on their own.

There were 2 sets of words - 10 words with onset clusters were mixed with 10 word with coda clusters. The words are listed in Appendix A. I tried to cover all possible combinations of the Dutch clusters. I did not include clusters containing /s/ due to its extrasyllabic status (Booij, 1985; Clements & Keyser, 1983).

I also tried to find mirrored pairs of the clusters, e.g. /tr-/ – /-rt/. It was not always the case due to the phonological restrictions of the language, e.g. the onset cluster /tl-/ – the mirror counterpart of the coda cluster */-lt/, is not possible in Dutch. In such situation I used the closest counterpart, e.g. matching in the place of articulation /br-/ - /-rm/. Nevertheless, I found several matching pairs:

[15] The list of the words is in Appendix 1
[16] A few examples in Appendix 2
[17] See Appendix 2.3

Table 11. Mirror pairs of onset and coda clusters

brood	arm[18]
friet	verf
klok	melk
knoop	bank
kraan	vork
trein	paard

The experiment was carried out in Dutch. It was recorded with a digital voice recorder M-AUDIO microtrack II. A microphone (MicroTrack T-Microphone) was placed about 50 cm from the child's mouth, although sometimes the distance increased when a child got up from a table, but it did not adversely affect the recording quality too much. The laptop was usually placed on a table so the child could sit in front of it in order to and see the pictures properly. The utterances were also transcribed online to adjust any discrepancies and doubts.

The recordings were taken in two places – first in a day care centre, but as it was not a suitable enough place to record speech I decided to visit children in their homes. The change of the place benefited the experiment considerably – it was a familiar environment for children, more quiet and in presence of parents who were very helpful with asking children to speak or come back to the 'game' as we called the experiment.

5.3 Data transcription and analysis

The recordings were analyzed off line by two independent researchers. I used Praat (Boersma & Weenink, 1996) a program for speech analysis, in the cases where it was not immediately clear what the child said. Three children were excluded due to their poor speech skills – they produced either no words with clusters or too few of them to include them in the experiment. I used the data of those who produced more than 60% of words, regardless of their correctness illustrated in Table 12. Children in red rows were excluded post hoc, on the grounds that they failed to produce the required (50%) amount of the target words.

[18] Although it is not a perfect match, it matches in the place of articulation

Table 12: List of participants, their age and production of clusters

no.	name	age (mths)	% of words said	% of correct clusters
1	Christophe	27;2	10	0
2	Mats	24;2	20	25
3	Frederi	24	45	22
4	Stijn	24;1	60	42
5	Floortje	23;2	70	29
6	Kjeld	24;2	70	21
7	Christopher	24;1	75	33
8	Fredericke	27;3	80	69
9	Bram	18;1	80	13
10	Max	27;2	85	94
11	Tim twin	27;2	90	44
12	Floor twin	27;2	95	47
13	Franka	22;2	100	70

The targets were words with either onset or coda clusters pronounced by the children and matching the standard adult pronunciation. Some of the words were spontaneously said correctly in the phase of habituation, some in the experimental phase, some were not pronounced at all. When the child's pronunciation was exactly or closely matching the adult's form it was classified as correct. I considered 'near-the-cluster' variations such as /-rt/ pronounced as /-lt/ as correct, as the form of a CC cluster was retained.

There were 75 word tokens (correctly pronounced) analysed – 27 (36%) were onset clusters and 48 (64%) coda clusters. In the further analysis I excluded a child who produced only 2 correct clusters.

Table 13: Production of onset and coda clusters

no.	name	number of clusters/onset	number of clusters/coda
1	Fredericke	6/11	5/11
2	Bram	2/2	0/2
3	Franka	5/14	9/14
4	Christopher	1/5	4/5
5	Floor twin	1/9	8/9
6	Tim twin	1/8	7/8
7	Stijn	1/5	4/5
8	Floortje	2/4	2/4
9	Max	7/16	9/16
10	Kjeld	3/3	0/3

Each participant contributed 3-16 tokens with the mean of 8,3. The tokens were grouped into two sets – one were the words pronounced by children with an onset cluster in the name, the other – children with a coda cluster in the name. The groups were divided into two subsets to state what percentage of each type of cluster was pronounced by each group of children illustrated in Tables 14 and 15.

Table 14: Production of clusters by children with an onset cluster in the name

no.	name	% correct onset clusters	% correct coda clusters
1	Floor twin	11	89
2	Tim twin	13	87
3	Christopher	20	80
4	Stijn[19]	20	80
5	Franka	36	64
6	Floortje	50	50
7	Fredericke	55	45

Table 15: Production of clusters by children with a coda cluster in the name

no.	name	% correct onset clusters	% correct coda clusters
1	Max	44	56
2	Kjeld[19]	100	0

[19] For the needs of the study I did not consider clusters with /j/as full consonant clusters (/j/ functions as a semi-vowel), thus the name Kjeld is one with a coda cluster, Stijn with an onset cluster.

5.4 Results

In the hypothesis I posited for the study, I ponder over the relation of the frequency of hearing own names and the acquisition of phonological structures, namely consonant clusters. The relation would exist if the children who have onset clusters in their names acquired words that contain onset clusters before the words with coda clusters, and in the same time, the children who have coda clusters in their names would acquire words with coda clusters first. The relation would also exist if the children with onset clusters in their own name acquired onset clusters earlier than children with coda clusters in their name, and the same for children with coda clusters in their name – if they acquire the words with coda clusters earlier than the ones with onset clusters in the name.

I collected the data in a production experiment and this is the outcome: 71% of the children with onsets in their name acquired more coda clusters that onset ones. The distribution of the onset and coda clusters acquisition of the other 29% (blue bars in Table14) was even or almost even – 50%-50% and 55% and 45%, respectively. One child with a coda cluster in its name did not acquire any coda clusters and the other child acquired almost the same number of onset and coda clusters: 44% and 56%, respectively. The results are shown in Figures 4 and 5:

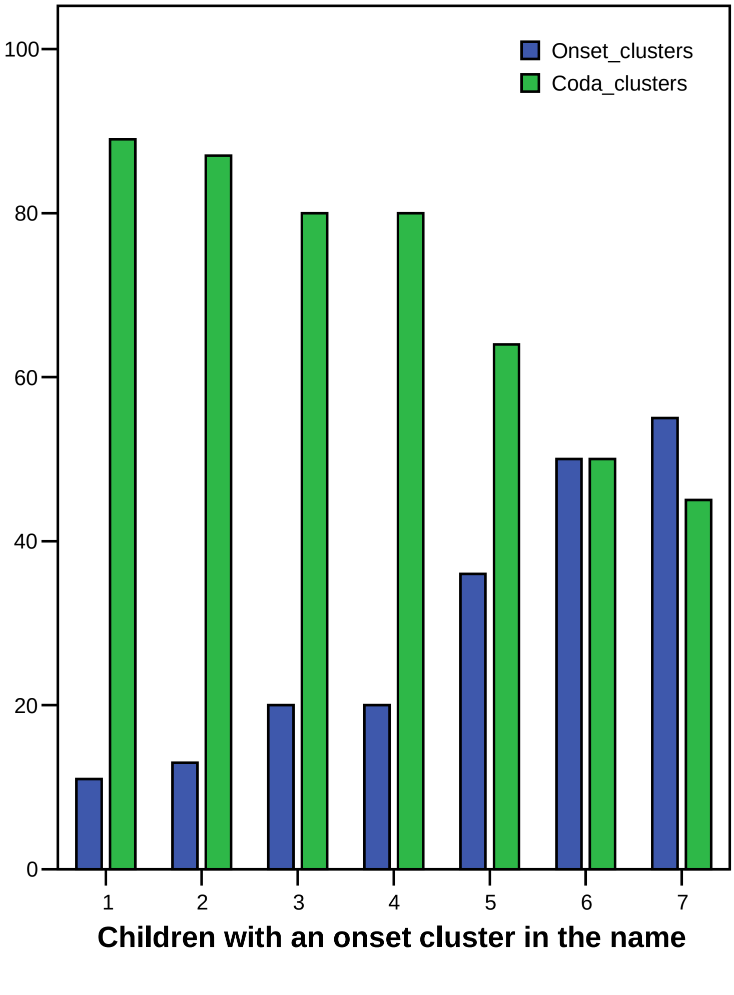


Figure 4. Distribution of the onset and coda clusters produced by children with an onset cluster in the name.

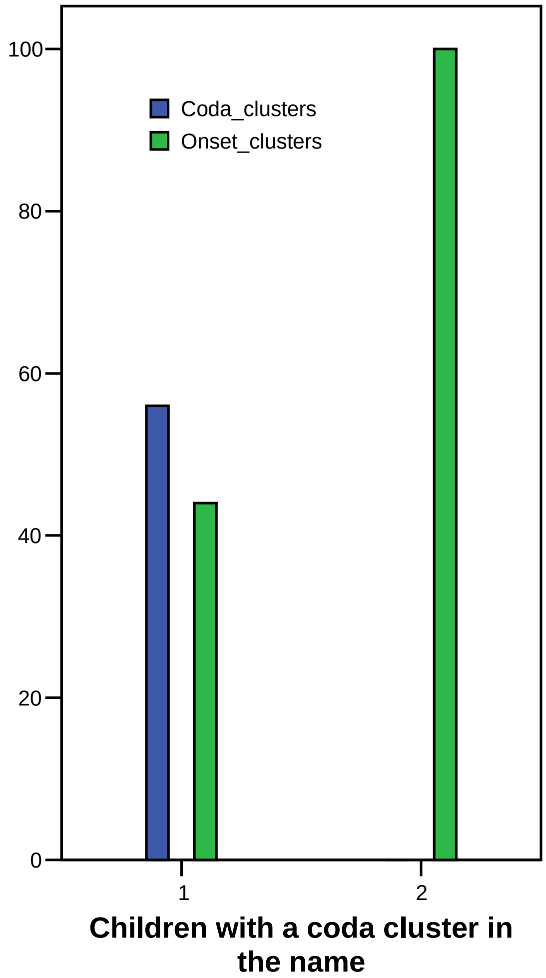


Figure 5. Distribution of the onset and coda clusters produced by children with a coda cluster in the name

As the results show there is no explicit conclusion that could be drawn from the data. Both groups of children – with the onset and coda clusters in the names - seem to acquire the coda clusters first or in a fairly equal distribution with the onset clusters, regardless having the clusters in their own names. There is just one child with an onset cluster in the name and one with a coda cluster who would match the proposed pattern, but the difference in the distribution of both types of clusters in the pronounced words is very small – 45%-55% and 44%-56%, which translates into 1-2 words, and one child whose distribution of clusters was 50%-50%, so it is not possible to unambiguously state the influence of the frequency of hearing consonant clusters in children's names.

A noteworthy phenomenon was also observed in the experiment. The twins Floor and Tim (participants 5 and 6 in Fig.4) obtained almost exactly the same results. They pronounced 95% and 90% of the words respectively and 47% and 44% of them contained correct clusters. It is possible is due to the influence of the same environment in which they were being brought up.

5.4.1 The overview of the statistics of the produced words

I have combined all the utterances produced by the childen in two tables in Appendix 3. As many as 251 utterances were produced all together (including the habituation phase) of which 97 (39%) contained correct clusters. Children attempted to produce – more or less successfully – 133 words with onset clusters (53%) and 118 with coda ones (47%). The percentage of the correctly (vs. incorrectly) produced onset clusters is 29% and coda – 49%. The results are shown in the Table 16:

Table 16. Correct and incorrect cluster production of all utterances

	Correct clusters		Incorrect clusters		Sum	
Onset clusters	39	29%	94	71%	133	53%
Coda clusters	58	49%	60	51%	118	47%
Sum	97	39%	154	61%	251	100%

The most frequent words that children produced were *trein*, *paard*, *eend* and *vlinder*. The least frequent were *hoofd*, *knoop*, *golf* and *geld*. The reason for it must be the input frequency – parents more often say *trein* or *paard* (the words occur in many books and cartoons) than *golf*, *knoop*, *hoofd* or *geld*. It is noticeable in the number of correctly produced clusters, where the words *paard*, *eend* and *trein* also occur, together with *melk*. These 4 words constitute as much as 38% of all correct utterances.

5.4.2 Analysis of the words containing incorrect clusters

There are a few interesting phenomena that may be observed while looking at the words incorrectly produced by the children.

5.4.2.1 Deletion

Some children were not able to produce clusters correctly at all. They used several strategies to deal with the problem, in both onset and coda clusters. One coping strategy is deletion. A few children did not pronounce many clusters and they used only CV monosyllables, e.g. *melk* – [me], *bank* – [ba], *brood* – [bo]. Some of them used CVC, which means that they deleted only one component of the cluster e.g. *paard* – [pat], *fles* – [fes], *vork* – [tok].

5.4.2.2 Substitution

Another common technique was to substitute one or both cluster components by different sound. As I mentioned before I have considered such clusters correct. A very frequent sound that was substituted was /r/. The children pronounced it then as /l/ or /j/, e.g. *trein* – [tlein] or *kraan* – [kjan]. A similar phenomenon also occured in a few cases of words with /l/. The sound was then substituted by /j/, e.g. *fles* – [fjes^j]. Sometimes children decided to replace both components of a cluster, e.g. *paard* – [pats].

Children seemed to have a problem with pronouncing the uvular fricative /χ/ as in *gras* – the children pronounced it as [xras] or [tas].

5.4.2.3 Schwa epenthesis

When they could not manage to produce a cluster, the childrensometimes inserted a schwa /ə/ e.g. *melk* – [meløk], *vork* – [vorək] or *verf* - [verəf]. Schwa insertion is also a common phenomenon among adults so it could be that the schwa was already in the input. Knowing that, I asked some parents to pronounce the words that their children produced with an interconsonantal schwa and interestingly, some of them did not insert the sound. Nevertheless, the parents could have produced the words in a way that was not natural for them, trying to be more correct or it could have been the other parent who was inserting a schwa in their everyday speech.

5.4.2.4 Coalescence

Another interesting phenomenon is coalescence – children substituted a whole cluster with a sound different from the cluster components, but with shared features, e.g. *kraan* – [tan], *nacht* – [nasj]. A great role in the process plays the place of atriculation (PoA). Place of articulation (PoA) plays a great role in this process. Some consonants that are more difficult to pronounce, as shown above, are substituted by easier ones. The choice of the latter is not accidental though, the vowels ‘pull’ the consonants towards their own PoA, for example a labial consonant changes into a dorsal one under the influence of a dorsal (back) vowel.

5.4.2.5 Vowel lengthening

Vowel lengthening is another strategy that children use to facilitate cluster production. They do not pronounce one of the cluster components but mark it with a longer vowel. It is possible that this way make some space for the consonant they will pronounce in future. There were just two occurrences of this phenomenon, namely arm – [a:m] and melk [me:k].

5.4.2.6. Cluster shift

Cluster shift is a fascinating observation that I made during the data analysis. There were two children who produced coda clusters instead of onset clusters. The fact that both children are twins makes it even more remarkable. Moreover, they shifted the clusters in the same word, but interestingly, they produced completely different outputs. The phenomenon concerns the word *gras*. One child pronounced it as [taxs] and the other as [ajs^{j}]. The reason for it may be the parent’s input – they may have a different word for *gras* or it may be another proof that the coda clusters are easier to produce. Those children’s correct cluster production consisted of 87% and 89% coda clusters.

5.5 Control group

To complement the research results I need to take into account a control group of children who do not have clusters in their names, to test how they would produce the clusters. Since such study has already been done (Levelt et al. 2000) I used the results for the purspose of my study. There were 12 children tested and none of them had either onset or coda consonant cluster in the name (Eva, Noortje, Robin, Leonie, Tirza, David, Catootje, Leon, Enzo, Jarmo, Elke, Tom; see also section 3.2). Levelt et al. (2000) have shown that two developmental paths exist in the acquisition of the phonology of Dutch. There is a noticeable tendency for children to acquire coda clusters first, and then onset clusters: 9 of the 12 children acquired coda clusters before onset clusters.

The table below (Table 17), adapted from Levelt et al., shows the inventory of syllable types compiled for the first 15 recordings of the study. In group A are children who acquired coda clusters first, while in group B are children who acquired onset clusters first.

Table 17. The order of acquisition of onset and coda clusters

Group A

	cv	cvc	v	vc	cvcc	vcc	ccv	ccvc	ccvcc
Eva	+	+	+	+	+	+			
Noortje	+	+	+	+	+	+			
Robin	+	+	+	+	+	+			
Leonie	+	+	+	+	+	+	+	+	
Tirza	+	+	+	+	+	+	+	+	
David	+	+	+	+	+	+	+	+	+
Catootje	+	+	+	+	+	+	+	+	+
Leon	+	+	+	+	+	+	+	+	+
Enzo	+	+	+	+	+	+	+	+	+

Group B

	cv	cvc	v	vc	ccv	ccvc	cvcc	vcc	ccvcc
Jarmo	+	+	+	+	+				
Elke	+	+	+	+	+	+			
Tom	+	+	+	+	+	+			

6. Conclusions

Word-final clusters have been reported to develop earlier than word-initial clusters for children learning English (Kirk & Demuth, 2005),German (Lleo & Prinz, 1996), and Dutch (Levelt, et al.,2000). This is opposite to the development of singleton consonants which generally develop in word-initial position first, e.g. /m, n, t/ (Mennen et al., 2006).

In this study I investigated the possible role of frequency in the acquisition of consonant onset and coda clusters. The hypothesis was that the frequency of the input of adult child-directed speech which here was a child's name (repeated by caregivers many times a day and directly to a child) influences the child's ability to acquire certain type of consonant clusters. Ideally Floortje would acquire onset clusters before codas and Max would acquire coda clusters before onset ones.

The evidence collected however, suggests that there is no immediate association between a child's name and the acquisition of consonant clusters in words. So here, the frequency accounts do not seem to provide a satisfactory explanation for the two way developmental path of cluster acquisition.

Nevertheless, the research may be treated as a pilot study and will hopefully stimulate further exploration of the problem.

References

Amayreh, M. M, Dyson, A. T. (2000). Phonetic inventories of young Arabic-speaking children. *Clinical Linguistics and Phonetics*, 14, 193–216.

Boersma P., Weenink D. (1996, 2007) Praat: doing phonetics by computer (Version 5.1.05) [Computer program]. Retrieved September 18, 2007, from http://www.praat.org/

Booij, G. (1995). *The phonology of Dutch*, Oxford: Clarendon Press

Bornstein, M. H., Cote, L. R., Maital, S., Painter, K., Park, S., Pascual, L., Pecheux, M.,Ruel, J., Venuti, P. & Vyt, A. (2004). Cross-linguistic analysis of vocabulary in young children : Spanish, Dutch, French, Hebrew, Italian, Korean and American English. *ChildDevelopment* 75, 1115–39.

Brown, C.A. (1997). *Acquisition of segmental structure: consequences for speech perception and second language acquisition*. Ph.D. dissertation, McGill University.

Clements, G.N. (1987). Phonological feature representation and the description of intrusive stops. *Papers from the Twenty-Third Meeting of the Chicago Linguistic Society*, vol. 2. 29-50. Chicago: Chicago Linguistic Society

Clements, G. N., Keyser S.J., 1983. *CV Phonology: a Generative Theory of the syllable* (Linguistic Inquiry Monograph 9), MIT Press, Cambridge, MA.

Fikkert, P. (1994). *On the acquisition of prosodic structure*. Ph.D. dissertation, University of Leiden.

Gierut, J. (1999). Syllable onsets: clusters and adjuncts in acquisition. *Journal of Speech Language and Hearing Research* 42, 708-26.

Goodman J., Dale, P.S., & Li P. (2008). Does frequency count? Parental input and the acquisition of vocabulary, *Journal of Child Language,* 35, 515-531.

Gussenhoven, C. (1999). Ilustrations of the IPA: Dutch. *In Handbook of the International Phonetic Association* (pp. 74-77). Cambridge: Cambridge University Press.

Jongstra, W. (2003) *Variation in reduction strategies of Dutch word-initial consonant clusters*. Doctoral dissertation, University of Toronto.

Jusczyk, P. W., Luce, P. A. & Charles-Luce, J. (1994). Infants’ sensitivity to phonotactic patterns in the native language. *Journal of Memory and Language* 33, 630-645.

Kager, R.W.J. (1999). *Optimality Theory*. Cambridge: Cambridge University Press.

Kehoe, M. & Lleó, C. 2003. A phonological analysis of schwa in German first language acquisition. *The Canadian Journal of Linguistics* 48. 3-4, 289-327.

Kirk C. & Demuth K. (2005). Asymmetries in the acquisition of word-initial and word-final consonant clusters. *Journal of Child Language* 32, 709-734.

Levelt, C. & van de Vijver R. (1998). *Syllable Types in Cross-Linguistic and Developmental Grammars.* Rutgers Optimality Archive 265.

Levelt C. & Vijver, R. van de (2004). Syllable types in cross-linguistic and developmental grammars. In: Kager R., Pater J. & Zonneveld W. (Eds.) *Constraints in Phonological Acquisition*, 204-218. Cambridge: Cambridge University Press

Levelt C., Schiller N.O. & Levelt W.J. (2000) The acquisition of syllable types. *Language Acquisition* 8, 237-264.

Lleó, C. & M. Prinz. (1996). Consonant clusters in child phonology and the directionality of syllable structure assignment. *Journal of Child Language* 23, 31-56.

McCarthy, J. (1988). Feature Geometry and Dependency: A Review. *Phonetica* 45, 84-108.

McLeod, S., Van Doorn, J. & Reed, V.A.. (2001a). Normal acquisition of Consonant Clusters.Americal *Journal of Speech-Language Pathology* 10, 99-110.

McLeod, S., Van Doorn, J. & Reed V.A.. (2001b). Consonant cluster development in twoyears-olds: General trends and individual difference. *Journal of Speech, Language and Hearing Research* 44, 1144-1172.

Mennen, I., Levelt, C. & Gerrits, E. (in press). Dutch Speech Acquisition. In: S. McLeod (Ed.). *The International Guide to Speech Acquisition*. New York: Thomson Delmar Learning. Chapter 36.

Plaut, D.C. & Kello, C.T. (1999). The emergence of phonology from the interplay of speech comprehension and production: A distributed connectionist approach. In B. MacWhinney (Ed.), *The emergence of language* 381–416. Mahwah, NJ: Erlbaum.

Pye, C., Ingram, D. & List, D. (1987). A comparison of initial consonant acquisition in English and Quiche´. In K.E. Nelson & A. van Kleeck (Eds.), *Children's language*, 175–190. Hillsdale, NJ: Erlbaum.

Sawicka I. (1999) *Struktura grup spółgłoskowych w językach słowiańskich*, [The structure of consonant clusters in the Slavic languages] Monografie Slawistyczne. Ossolineum, Wrocław.

Selkirk, E.O. (1984). On the major class features and syllable theory. In M. Aronoff & R.T. Oehrle (eds.), *Language sound structure: studies in phonology*, presented to Morris Halle by his teacher and students. Cambridge, Mass.: MIT Press. 107- 36.

Shariatmadari D., (2006) Sounds difficult? Why phonological theory needs ‘ease of articulation’, *SOAS Working Papers in Linguistics*. 14, 207-226

So, L. K.H., & Dodd, B.J. (1995). The acquisition of phonology by Cantonese-speaking children. *Journal of Child Language* 22, 473-495.

Stokes, S. & Surendran, D. (2005). Articulatory Complexity, Ambient Frequency and Functional Load as Predictors of Consonant Development in Children, *Journal of Speech, Language, and Hearing Research* .48, 577-591.

Stokes, S. F., To, C. K.-S. (2002). Feature development in Cantonese. *Clinical Linguistics and Phonetics* 16, 443-459.

Tomasello, M. (2003). *Constructing a language: a usage-based theory of language acquisition*.Cambridge, MA: Harvard University Press.

Trommelen, M. (1983). *The syllable in Dutch with special reference to diminutive formation*, Foris, Dordrecht

Hulst H. van der (1984) *Syllable structure and stress in Dutch*, Foris, Dordrecht

Vigário M., Freitas M.J. & Frota, S. (2006) Grammar and frequency effects in the acquisition of prosodic words in European Portuguese. *Language and Speech* 49, 175-203.

Vihman, M.M. (1996). *Phonological development: the origins of language in the child*. Oxford: Blackwell.

Weizman, Z. & Snow, C. (2001) Lexical input as related to children’s vocabulary acquisition: Effects of sophisticated exposure and support for meaning. *Developmental Psychology* 37, 265-267.

Appendix 1

The words with a coda cluster

arm
bank
eend
geld
golf
hoofd
melk
nacht
paard
verf
vork

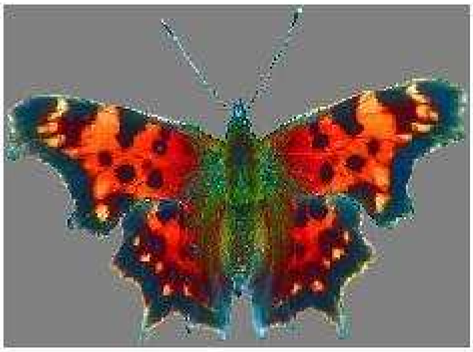
The words with an onset cluster

bloem
brood
fles
friet
gras
klok
knoop
kraan
trein
vlinder

Appendix 2

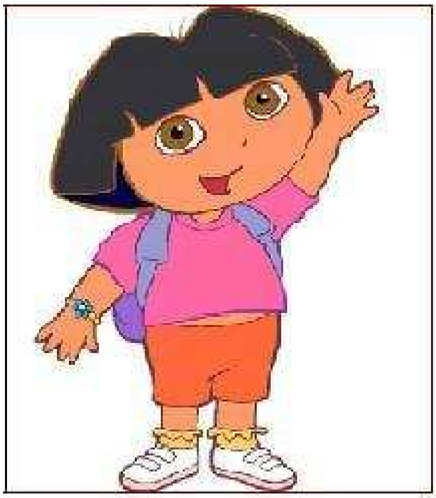
A few examples of pictures used during the experiments:

2.1 Words with onset clusters – *bloemen* ‘flowers’, *vlinder* ‘butterfly’



2.2 Words with coda clusters – *paard* ‘horse’, *hond* ‘dog’

2.3 Pictures of the cartoon/book characters - Dora and Winnie the Pooh



Appendix 3 The frequency of occurence of the words in the study

word	correct utterances
paard	14
melk	8
eend	7
trein	7
arm	6
gras	6
klok	6
kraan	5
nacht	5
bank	4
brood	4
fles	4
geld	4
vlinder	4
hoofd	3
verf	3
friet	2
golf	2
vork	2
bloem	1
knoop	0

word	incorrect utterances
trein	15
bloem	13
vlinder	12
bank	11
fles	11
eend	9
klok	9
kraan	9
brood	8
friet	7
nacht	7
verf	7
knoop	6
vork	6
golf	5
paard	5
gras	4
melk	4
geld	3
arm	2
hoofd	1

word	all utterances
trein	22
paard	19
eend	16
vlinder	16
bank	15
fles	15
klok	15
bloem	14
kraan	14
brood	12
melk	12
nacht	12
gras	10
verf	10
friet	9
arm	8
vork	8
geld	7
golf	7
knoop	6
hoofd	4