Syllable Structure Development in Dutch Monolingual Children

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Table of Contents

Abstract V

1. Introduction 1

1.1 Topic of Investigation and rationale 1

1.2 Research Questions 2

2. Background 3

2.1 Dutch phonological development 3

2.2 Phonological processes 5

2.3 Dutch syllable structure development 6

2.4 Cross-linguistic syllable types 8

2.5 Previous literature on syllable type development 9

2.6 Hypotheses and predictions 12

3. Method 14

3.1 Research model 14

3.2 Inclusion criteria 14

3.3 Low threshold participation 14

3.4 Recruiting participants 16

3.5 Required documents and exclusion criteria based on documents 16

3.5.1 Informed Consent and optional supplement 16

3.5.2 Questionnaire 16

3.5.3 SNEL Screening Instrument 17

3.5.4 Excluded participants 18

3.6 Final number of participants 18

3.7 Socio-demographic variables 19

3.8 Data collection 19

3.9 Transcription 20

3.10 Possible delayed or deviant phonological or language development 22

3.11 Data processing 22

3.12 Analysis 23

4. Results 25

4.1 Development of syllable types mastered 25

4.1.1 Syllable type: CV 25

4.1.2 Syllable type: CVC 26

4.1.3 Syllable type: V 27

4.1.4 Syllable type: VC 29
4.1.5 Ambisyllabic consonants 30
4.1.6 Complex onset 30
4.1.6.1 CCV 30
4.1.6.2 CCVC 31
4.1.7 Complex coda 32
4.1.7.1 VCC 32
4.1.7.2 CVCC 33
4.1.8 CCVCC 34
4.1.9 CCC 35
5. Discussion 36
5.1 Answers to Research Questions 36
5.2 Hypotheses 40
5.3 Consonant Clusters 41
5.3.1 First measure of two productions of complex onsets and complex codas 41
5.3.2 Combined complex syllable type development 43
5.3.3 Calculation of percentage of clusters correct 44
5.4 Differences in number and usable content of recordings 45
5.5 Background information and excluded participants 47
5.6 Recommendations for further research 49
6. Conclusion 50
Literature 51
Appendices 53
Appendix I: ASCII notation 53
Appendix II: Letter to recruit participants 54
Appendix III: Informed Consent form 55
Appendix IV: Optional addition to Informed Consent 58
Appendix V: Questionnaire 59
Appendix VI: Questionnaire SNEL 62
Appendix VII: SNEL calculation test scores 63
Appendix VIII: SNEL forms, English translations 64
Appendix IX: SNEL scores for each participant 65
Appendix X: Socio-demographic information 66
Appendix XI: Ages of the participants and total number of recordings 67
Appendix XII: The ages of the participants for each recording 68

Appendix XIII: Syllabification rules _____ 70

Appendix XIV: Productions of complex onsets and complex codas for each participant _____ 71

External Appendix: Percentages calculated for each syllable type

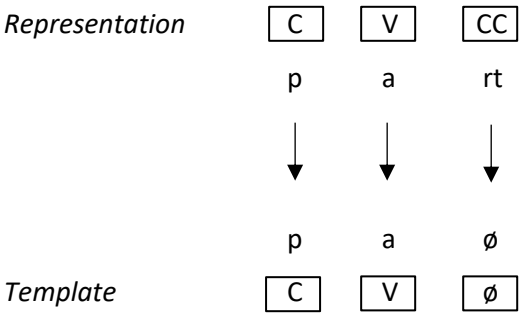
ABSTRACT. This thesis aims to provide ages of acquisition for syllable structure development in Dutch monolingual children. The spontaneous speech of 31 children between the ages of 1;0 and 4;0 was collected over a period of six months. The transcripts of these recordings were used to calculate a percentage of correctly produced syllable types. The combination of these percentages showed a different pattern in the early acquisition of syllable types than found in a previous study by Levelt, Schiller and Levelt (2000). In the current study, children were measured to first acquire the CV syllable type, followed by V, VC and then CVC, whereas earlier research concluded that the CVC syllable type was acquired secondly. For each of these syllable types, as well as for complex syllable types, age ranges were established in which children are expected to have started developing a specific syllable type, and in which they are expected to have acquired a specific syllable type. These results can be used as an additional tool for screening or diagnostics of phonological development in young children.

1. *Introduction*

1.1 Topic of Investigation and rationale

The current study focuses on collecting spontaneous speech data from children between 1;0 and 4;0 years old, aiming to link ages to the development of syllable types. According to Levelt, Schiller and Levelt (2000), who used spontaneous speech data by Fikkert (1994) and Levelt (1994), syllable types are acquired in the following order: CV[1], CVC, V, VC, CCV, VCC, CCVC, CVCC, CCVCC. For example, the word /et@[2]/ 'eating' consists of the syllable types V for /e/ and CV for /t@/. A correct realisation of this target word would therefore require the child having acquired both the CV and V syllable type. The acquisition of syllable types is a part of a child's phonological development. As the syllable type development progresses, a child is able to produce target words increasingly similar to adult speech. When children simplify target words to fit the syllable types they have acquired, the dominating syllable type they use is referred to as the syllable template. When the syllable structure of the target word requires a syllable type that the child has not acquired yet, the realisation of the word will adapt to the child's current syllable template (Jansonius-Schultheiss et al., 2014: 165). This is displayed in Figure 3 with the Dutch word *paard* 'horse'.

Figure 1: Adaptation to a child's syllable template (Jansonius-Schultheiss et al., 2014: 166)[3]



Earlier research on the subject by Levelt, Schiller and Levelt (2000) and by Fikkert (1994) has not been able to link children's ages of acquisition to syllable template development due to large variation between children. The current study includes participants with a wider range in age, as well as a larger group of participants, aiming to uncover patterns in syllable template development that can be linked to age ranges. Uncovered age ranges in which children are measured to have started developing or to have acquired the various syllable types, could furthermore be used in phonological diagnostics and therapy in the clinical setting of a speech language therapist.

[1] C stands for consonant and V for vowel. CC stands for two succeeding consonants, a consonant cluster.
[2] Any examples that are given, or excerpts from transcripts will be notated in ASCII (Appendix I).
[3] Adapted from the source, using ASCII.

1.2 Research Questions

Based on the consulted literature and the conclusion of what kind of additional research would contribute to the available data on the subject of syllable type development, the following research questions were drawn up:

1. Are there any differences between Fikkert (1994) and Levelt, Schiller and Levelt (2000) on the one hand and the current study on the other hand in terms of stages of syllable structure development and development of syllable types?
2. How can the development of syllable types as found by Levelt, Schiller and Levelt (2000) be linked to ages of development, using spontaneous speech data gathered for the current study?
3. How can the acquired normative data on syllable template development be included in speech language therapy and diagnostics in the clinical setting?

This research paper has been organised as follows. In the next chapter, Chapter 2, the reader is provided with theoretical background and relevant literature. Subsequently, in Chapter 3, the methodology of the current research is clarified. Chapter 4 presents the results that were gathered from the spontaneous speech data that was collected. The results and findings are discussed and compared to literature in Chapter 5. A conclusion is provided in Chapter 6.

2. *Background*

2.1 Dutch phonological development

To acquire syllable structure, children must first be able to produce phonemes that are part of their native language. They need to learn which speech sounds distinguish meaning in their native language. The specific phonological rules as well as phonemic contrasts that need to be learned are different for each language. As described by Gillis and Schaerlaekens for example, in Dutch, /d/ and /t/ are phonemes. The minimal pairs *das* 'tie' and *tas* 'bag' carry different meanings solely based on the contrast [voice]. Exposure to a specific language allows children to discover the relevance of every distinguishable phonological opposition (Gillis & Schaerlaekens, 2000: 131, 132). Additional phonological rules, such as limitations at the word level and acceptable consonant clusters are also language specific (Beers, 2003: 246). Typically developing children (TD) raised in a Dutch environment will therefore acquire the Dutch phonological system, of which the consonants are depicted in Table 1. The child will also need to acquire additional phonological and syllabic rules, that are described in Chapter 2.3. The Dutch language includes stops, fricatives, nasals, liquids and glides. As explained by Gillis and De Houwer (1998), the speech sounds [g], [S] and [Z] are mainly found in loanwords such as 'goal', 'choco', and 'jury', respectively. The [g] can also occur as a contextual allophone such as in [zagduk] *zakdoek* 'handkerchief' from /zak/ and /duk/ (1998: 5). In Table 1, only one manner of articulation is shown for the /r/: the alveolar trill [r]. Additionally, the uvular trill [R**]** and the alveolar approximant ["] are also acceptable realisations of phoneme /r/ in Dutch.

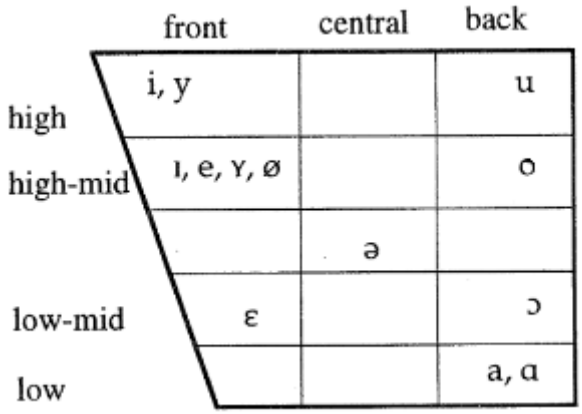
Table 1: Dutch consonant inventory (Gillis and De Houwer, 1998: 5)[4]

	Bilabial	Labiodental	Alveolar	Palatal	Velar	Glottal
Stop	p, b		t, d		k (g)	
Fricative		f, v	s, z	(ʃ, ʒ)	χ, ɣ	h
Nasal	m		n		ŋ	
Liquid			l, r			
Glide		ʋ		j		

Furthermore, in Figure 2, the Dutch vowel space is shown. The different vowels are illustrated by their place of articulation. The Dutch vowel system consists of 13 monophthongs, distinguishing steady-state vowels and the schwa [@], as represented in Figure 2 (Gillis and De Houwer, 1998: 6).

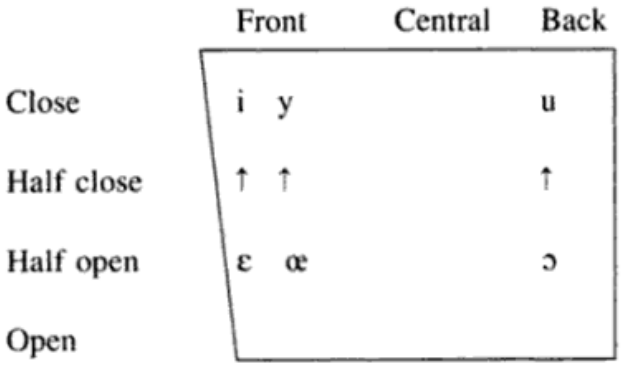
[4] Table 1 and 2, and Figure 2 and 3 are included from various sources. These sources used the International Phonetic Alphabet (IPA) symbols.

Figure 2: Representation of the Dutch vowel space (Gillis and De Houwer, 1998: 6).



The Dutch vowel system additionally includes three diphthongs, /Ei/, /@y/ and /Au/. These diphthongs are produced through a change in the height of their position, as displayed in Figure 3 (Booij, 1995: 5).

Figure 3: Production of diphthongs in Dutch (Booij, 1995: 6).



The various consonants as depicted in Table 1 are acquired in distinct stages, by means of acquiring different contrasts, as found by Beers (1995). The Dutch phonemes consist of different phonological features that contrast with other phonemes. The child acquires a new phonological feature that contrasts with an earlier acquired feature, to expand the child's phonological system. The ages of acquisition, stages of development and the different phonological features are shown in Table 2. In the first contrast stage (A), between the ages of 1;3 and 1;8 years old, TD children acquire the first necessary contrast between 'consonant' and 'vowel'; and the following contrasts [sonorant] versus [obstruent]; and [labial] versus [coronal]. In stage two (B), the existing features contrast with the [dorsal] feature. In stage three (C), the [continuant] feature is introduced as a contrast. Stage four (D) is achieved when the [voice] contrast has been achieved. The fifth (E) and final stage has been mastered when children have acquired the [lateral] and the [rhotic] feature to produce the phonemes /l/ and /r/, respectively.

Table 2: Dutch phonological acquisition of initial and final consonants, and vowels (Beers, 2003: 248)[5]

Groep	C (ini)	kenmerken	C (fin)	kenmerken	V	kenmerken
A **1;3-1;8jr**	p t m n j	[consonantisch] [sonorant] [labiaal] [coronaal]	p	-	i ɪ u ɛ a	[voor], [laag] [gespannen], [rond]
B **1;9-1;11 jr**	k	[dorsaal]	k	[consonantisch] [labiaal] [dorsaal]	O ʌ	
C **2;0-2;2 jr**	s x h	[continuant]	t s x	[coronaal] [continuant]	e o	
D **2;3-2;5 jr**	b f ʊ	[voor] [rond] [stem]	m n	[sonorant]		
E **2;6-2;8 jr**	l r	[lateraal] [rhotic] [nasaal]				
F **2;9-2;11 jr**	d					
G **3;0-3;2 jr**					Y	
verwerving niet bepaald			l r f ŋ		ö y	

2.2 Phonological processes

Children's ongoing phonemic development limits their ability to produce phonological structures necessary to realise adult-like productions. When a child's target word is more difficult than their phonological development allows for in production, the phonological production will be simplified systematically. These simplifications can be defined as various phonological processes that occur in the phonological development of TD children. These processes can be divided into three categories: assimilation processes, such as 'regressive consonant assimilation'; and substitution processes, such as 'fronting' (example: /k/ → /t/), 'stopping' (example: /s/ → /t/) and 'gliding' (example: /l/ → /j/) (Gillis & Schaerlaekens, 2000: 152). The third category consists of processes that adapt the syllable structure, which is the most relevant for the current research. A child might have acquired a rich system of phonemes, but will not be able to realise them in every context (Gillis & Schaerlaekens,

[5] Table 2: the original table included the IPA symbol /w/, instead of the [ʊ]. To avoid confusion, this has been changed into the labiodental [ʋ], which is the general Dutch realisation of the phoneme /w/.

2000: 152, 153). Phonological processes that affect the syllable structure are shown in Table 3:

Table 3: Examples of phonological processes that adapt syllable structure

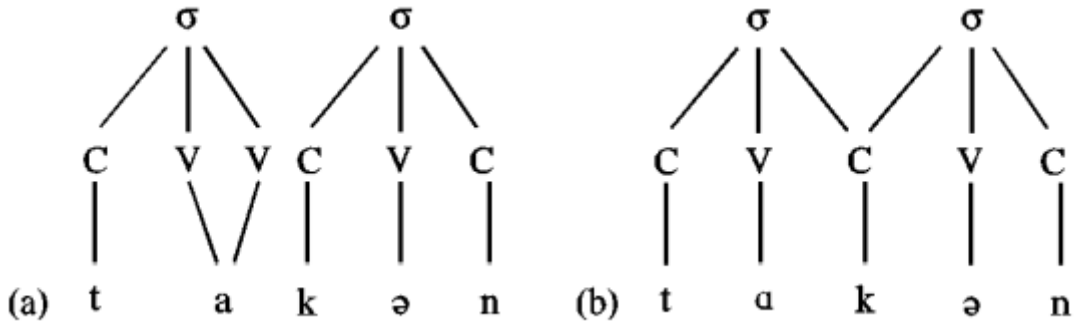
Phonological process	**Target word (Dutch, orthographic)**	**Target word (English translation, orthographic)**	**Target production**	**Realisation**
Cluster reduction	praten	to speak	/prat@/	[pat@]
Final consonant deletion	poes	cat	/pus/	[pu]
Reduplication	auto	car	/Auto/	[toto]
Deletion of unstressed syllables	cadeau	present	/kɑdo/	[do]

These phonological processes are common in young children's speech. However, children may also experience problems with acquiring each of these phonological features and contrasts. When children should physiologically be able to produce phonemes, but consistently substitute or simplify certain phonemes, the phonological development might be delayed or disordered (Stes, 1997; 62). Influenced by problems with their hearing, phonological processing or auditory feedback, normal phonological processes may persist for too long or deviant phonological processes may occur. Depending on the children's intelligibility and personal frustration or problems with communication, their delayed or deviant phonological development can be treated by a speech language therapist, generally implementing the phonological therapy methods *Hodson and Paden* (Hodson & Paden, 1983) or *Metaphon* (Dean et al., 2002). Phonological disorders manifest as a speech disorder, due to the child's lesser intelligibility. However, the cause of a phonological disorder is a language disorder, as phonology is a part of language (Burger, Van de Wetering & Van Weerdenburg, 2012: 45).

2.3 Dutch syllable structure development

Aside from the acquisition of phonemes and their various contrasts, children also need to learn the way words are structured. Syllable structure is also language specific. In Dutch, a vowel length contrast can be identified. This vowel contrast can only occur in closed syllables, as open syllables do not allow short vowels. The consonant after a short vowel is longer than the consonant after a long vowel (Jongman, 1998; 209). This consonant following a short vowel in Dutch is considered an ambisyllabic consonant, which behaves as both the coda (final consonant) for the first syllable *and* the onset (initial consonant) for the second syllable (Jongman, 1998; 215). This is illustrated in Figure 4 with the Dutch words *taken* /tak@n/ 'chores' and /t^k@n/ *takken* 'branches'.

Figure 4: Ambisyllabic consonant following a short vowel (Jongman, 1998; 215)



Furthermore, concerning the acquisition of syllable structure, the first syllable type that Dutch children acquire is the universal core syllable CV (Fikkert, 1994: 53). As described by Levelt, Schiller and Levelt (1999), apart from this core syllable, Dutch syllables can also include a coda and can also lack an onset. Both codas and the onsets can be branching, and therefore allow consonant clusters (Levelt, Schiller & Levelt, 1999: 292).

In the early development of language and phonology, children typically start to babble around the age of seven to eight months. When the babbling phase fails to occur, this has a negative influence on the child's language development, and can therefore have an influence on the child's phonological development (Burger, Van de Wetering & Van Weerdenburg, 2012: 28). Subsequently, the early lingual phase begins. In this phase, children transfer from babbling to utilising phonemes to carry substance. The production of the child's first words normally starts at 1;0 years old (Burger, Van de Wetering & Van Weerdenburg, 2012: 28). According to the phonological development as recorded by Beers (1995), TD children will have started implementing phonemes in meaningful utterances at 1;3 years old (see Table 2). It is therefore possible to start measuring the syllable structure development from the start of the child's first utterances that carry meaning.

Children acquire syllable structure through the acquisition of syllable templates, as discussed in Chapter 1.1. Levelt, Schiller and Levelt (2000) have connected these templates to stages of development in Dutch children, which were calculated using spontaneous speech data collected by Fikkert (1994) and Levelt (1994). The distinguished stages are shown in Table 4.

Table 4: Stages of syllable type development (Levelt, Schiller & Levelt, 2000)

Stage I	CV
Stage II	CVC
Stage III	V & VC
Stage IV	All syllable types

The categorisation of these stages is represented differently than the three stages as concluded by Fikkert (1994), as shown in Table 5. The stages as concluded by Fikkert (1994) could be linked to the stages as found by Levelt, Schiller and Levelt (2000). In both stage I and stage II, they postulate a syllable type with an onset, corresponding to the first stage as found by Fikkert (1994). Stage III by Levelt, Schiller and Levelt (2000) corresponds to stage II from Fikkert (1994), as they both allow empty onsets. Then, stage IV and III, respectively, both allow different segments in the onset position. These stages and other factors regarding syllable type development are discussed in Chapter 2.5.

Table 5: Stages of syllable structure development (Fikkert, 1994)

Stage I	Obligatory onsets
Stage II	Allowing empty onsets
Stage III	Onset position allows different segments

2.4 Cross-linguistic syllable types

The various syllable types that are possible in the Dutch language are not present in every language. As explained by Blevins (1995), and displayed in Table 6, the syllable types of a language can vary. Hua only has the core syllable type CV, while the English language contains every mentioned syllable type. Some languages do not include complex coda's, such as Spanish, while in other languages complex onsets are not present, such as in Finnish. The Dutch language system contains every syllable type that is included in Table 6. Therefore, a child learning Dutch has to acquire a very rich syllable type system.

Table 6: Syllable types present in different languages (Blevins, 1995; 75)

	V	*CV*	*CVC*	*VC*	*CCV*	*CCVC*	*CVCC*	*VCC*	*CCVCC*	*CVCCC*
Hua	no	yes	no	no	no	no	no	no	no	no
Cayuvava	yes	yes	no	no	no	no	no	no	no	no
Cairene	no	yes	yes	no	no	no	no	no	no	no
Mazateco	yes	yes	no	no	yes	no	no	no	no	no
Mokilese	yes	yes	yes	yes	no	no	no	no	no	no
Sedang	no	yes	yes	no	yes	yes	no	no	no	no
Klamath	no	yes	yes	no	no	no	yes	no	no	yes
Spanish	yes	yes	yes	yes	yes	yes	no	no	no	no
Finnish	yes	yes	yes	yes	no	no	yes	yes	no	no
Totonac	no	yes	yes	no	yes	yes	yes	no	yes	yes
English	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

2.5 Previous literature on syllable type development

Fikkert (1994) and Levelt, Schiller and Levelt (2000) refer to different stages of the acquisition of syllable types, as shown in Table 4 and Table 5. These stages were found at different ages in the available data of twelve children, collected by Fikkert and Levelt in 1994. Much variability between children and also within individual children was found. Therefore, Fikkert chose to intensively research each child's syllable structure development and provide general stages of development. These stages of syllable type development are not linked to a chronological age, due to the large variability, as mentioned (Fikkert, 1994: 33).

The spontaneous speech data by Fikkert (1994) and Levelt (1994) was used in the research by Levelt, Schiller and Levelt (2000), to calculate the acquisition order of syllable types.
As shown in Table 7, two different constructions of syllable types are calculated. Children appear to either acquire the complex coda first, as the nine children in Group A, or they acquire the complex onset first, as displayed by Group B (2000: 243).

Table 7: Syllable types from all recording sessions (Levelt, Schiller & Levelt, 2000: 243)

Group A

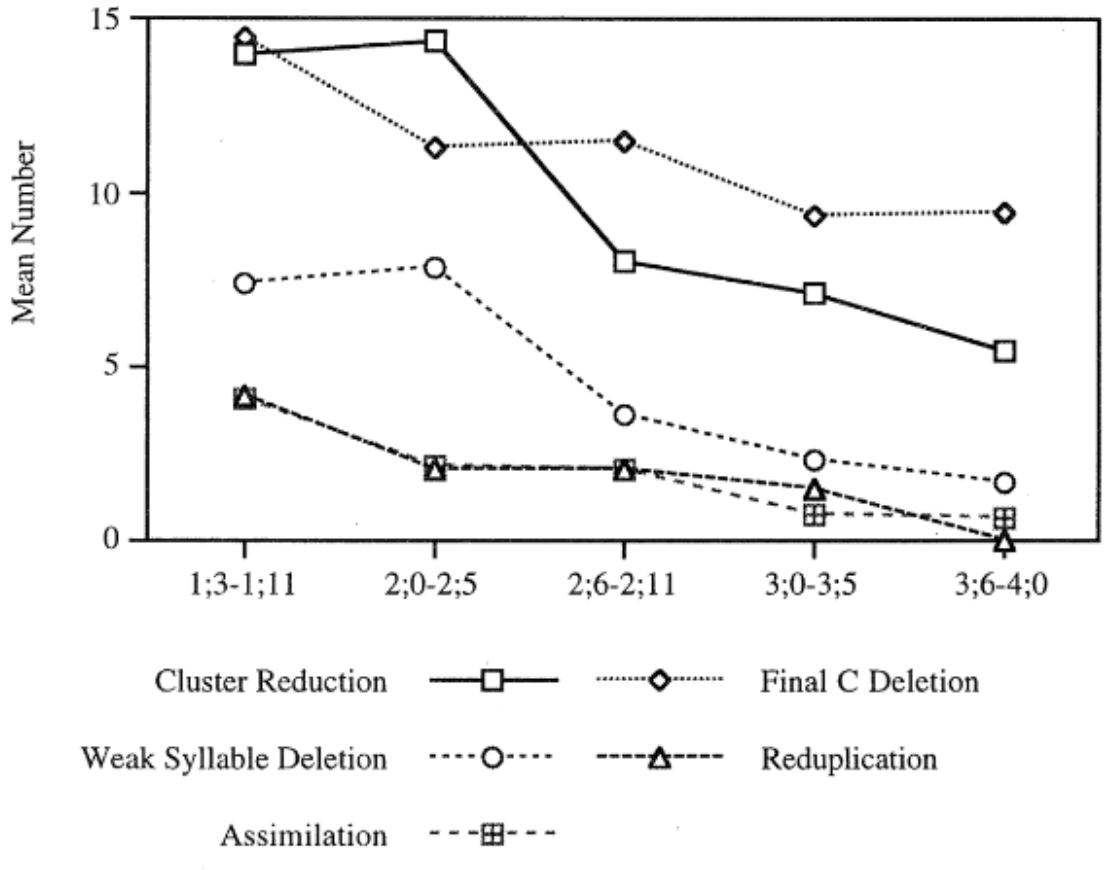
	cv	cvc	v	vc	cvcc	vcc	ccv	ccvc	ccvcc
Eva	+	+	+	+	+	+			
Noortje	+	+	+	+	+	+			
Robin	+	+	+	+	+	+	+	+	
Leonie	+	+	+	+	+	+	+	+	
Tirza	+	+	+	+	+	+	+	+	
David	+	+	+	+	+	+	+	+	+
Catootje	+	+	+	+	+	+	+	+	+
Leon	+	+	+	+	+	+	+	+	+
Enzo	+	+	+	+	+	+	+	+	+

Group B

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

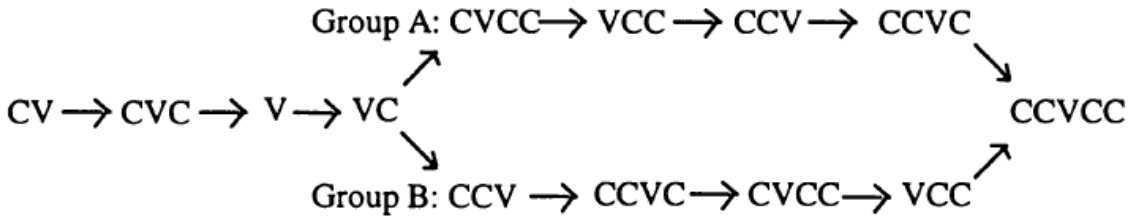
The spontaneous speech data as collected by Fikkert (1994) and Levelt (1994), and used for the research by Levelt, Schiller and Levelt (2000) consisted of a total of twelve children. One of these children was recorded from 1;0 years old. The other eleven children included in the Corpus were recorded at the age of 1;4 or older. The participants were recorded at the age of almost 2;9 years at the latest (Fikkert, 1994: 27). Eight of these twelve children did not acquire the final syllable structure: CCVCC, as in *schelp* 'shell' /sGElp/, for example (Levelt, Schiller & Levelt, 2000: 243). This can be explained, as by the age of three years old, 75% of children have started acquiring clusters, yet not all children older than ten have acquired every cluster (Stes, 1997: 52). Cluster reduction in general still occurs between 2-7 times in a spontaneous speech sample of 100 productions of children between 3;6 and 4;0 years old, as shown in Figure 5 (Jansonius-Schultheiss et al., 2014: 147; Gillis & De Houwer, 1998: 21). Including both a complex onset and a complex coda in one production, as in CCVCC, is even more difficult, as it requires two clusters in one production. Note that many of the selected words in a sample of 100 words will not include a complex onset or coda.

Figure 5: Mean number of syllable structure processes in a spontaneous speech sample of 100 words (Gillis & De Houwer, 1998: 21)



Both Table 7 and Figure 6 show that Schiller, Levelt and Schiller (2000) have concluded that children first acquire the CV syllable template, followed by CVC, V and then VC, after which children start acquiring clusters. Treatment for phonological disorders can be started at two or three years old. It would therefore be very useful to gain more information on the chronological age at which TD children are expected to have acquired these earlier syllable types and additionally, the cluster development. As the purpose of the current study focuses on results that are applicable to diagnostics and treatment of phonological disorders, it is more useful to follow syllable type development and the stages combining these syllable types, as found by Levelt, Schiller and Levelt (2000). In calculating an expected age range for the development of each specific syllable type, a child's utterances could then be compared to general syllable type development. This information would be less specific if only the stages by Fikkert (1994) were used. The current study will therefore mainly compare results to the results as found by Levelt, Schiller and Levelt (2000).

Figure 6: Development of syllable types (Levelt, Schiller & Levelt, 2000; 242)



The purpose of the current study is threefold. Firstly, we would like to know if the findings by Levelt, Schiller and Levelt (2000), concerning the acquisition order of syllable types and the stages of acquisition, can be replicated. To this end, we will collect longitudinal spontaneous speech samples from a larger group of participants (N > 30) with a wider age range (1;0 – 4;0 years old) than the data gathered by Fikkert (1994) and Levelt (1994). This data will provide a time frame in which children are expected to acquire the established syllable types and stages of development.

Secondly, the results of the syllable type acquisition will be linked to ages of development. This will provide insight into the ages at which children have typically acquired specific syllable types. By combining the results with the children's ages of development, this information can be used in diagnostics, to compare a child's syllable type development to that of TD children, as mentioned earlier. This information will also allow for the normative data on syllable type development to be compared to other areas of development, such as language or intelligence. Furthermore, when a child is tested using the Phonological Analysis of Dutch (Fonologische Analyse Nederlands: FAN) (Beers, 1995), the combination of syllable structure processes and syllable type development could provide insight into priorities in treatment.

Finally, we will examine how the results of the current study could contribute to improving treatment of phonological disorders by including syllable type development.

2.6 Hypotheses and predictions

Hypotheses:

1. Dutch acquiring children can be categorised into one of the two following groups (Levelt, Schiller & Levelt, 2000):
    a) The first acquired complex syllable type has a complex onset
    b) The first acquired complex syllable type has a complex coda
2. The wider range of ages and higher number of participants included in the current study will provide clear ages of acquired syllable types.

The first hypothesis can be verified by uncovering a similar pattern as found by Levelt, Schiller and Levelt (2000) in the acquisition of syllable types. The hypothesis can be falsified when a different pattern is found from the data gathered in the current study than the pattern uncovered by Levelt, Schiller and Levelt (2000), as shown in Table 7 and Figure 6.

The second hypothesis can be verified when a clear distinction can be made in syllable type development, linked to age. The hypothesis can be falsified when large variability, as was found by Fikkert (1994), makes it impossible to provide clear age ranges of syllable type acquisition.

3. *Method*

In this chapter, every step in executing the current research will be described. First, the model of the research will be discussed, followed by the selection and recruitment of participants. Furthermore, the documentation, data collection and transcription process will be further explained. Finally, the rules set for the data processing and analysis of the results will be illustrated.

3.1 Research model

To be able to calculate the syllable structure development and compare these results to earlier research, new data has been acquired for the current study. The results have been drawn from spontaneous speech samples from children between 1;0 and 4;0 years old, through audio and video recordings that were collected from May up to and including October 2017. The recordings were then transcribed, and the different syllable structures the child has mastered were determined. By comparing the ages when the different participants have mastered certain syllable structures, an average acquisition of syllable structure is presented. Based on these results, a recommendation for speech language diagnostic and therapy purposes is proposed.

3.2 Inclusion criteria

In order to allow for more detailed analysis of the development of the complex syllable types, the age range in the current study is wider than the Corpus by Fikkert (1994) and Levelt (1994). The participants could take part in the study if the child was between 1;0 and 4;0 years old at the time of the recordings. The minimum age was set at 1;0 years old, to provide insight into the first meaningful utterances the child produces, and therefore the start of the syllable structure development in spontaneous speech. The maximum age was set at 4;0 years old, to include more data about the consonant cluster development.

The final inclusion criterion is that the participants do not need to have produced their first word yet. This allows for the occurrence of the first words to be included in the analysis of the current study.

3.3 Low threshold participation

The main purpose of this study is to calculate an average development of syllable type acquisition in young children in a rather wide age range. To be able to recognise a pattern in the final data, it is important to include a large number of participants, allowed for by the scope of this study. The design of this study therefore focusses on creating a low threshold for parents of participants to

participate in the study. A number of decisions has been made in the design of the study to acquire a vast data set.

Firstly, and most importantly, no visit to the child's household was needed. Parents had been asked to repeatedly record their child for approximately five minutes. The following basic requests for the recordings were sent to each of the participants' parents:

- A video recording is preferable over an audio recording. Less intelligible utterances may be easier to understand due to the visual of both the child's mouth and the material the child is playing with. If a video recording is not possible, an audio recording is also welcome. Switching between video and audio recordings is also perfectly fine.
- Try to repeat the child's utterances as much as possible (especially the less intelligible utterances or when the child is speaking about a subject outside of the here and now).
- To be able to document the exact age of the child at the time of the recording, please state the date at the start of the recording.
- When you are participating in this study with more than one child, please try to make a separate recording for each child.
- Try to record the child with as little background noise as possible. For example, mind any door that is still open, a radio or television that is still turned on, or people speaking in the background.

By leaving the task of recording the children with the parents, the inclusion of participants is not limited to the researcher's own schedule and location. The parents could choose any time that worked best for them, to record the child.

Secondly, the recordings were collected during a period of six months. The parents were asked to make a recording every week or every other week. However, it has been made clear on numerous occasions, that any contribution, such as shorter recordings or a small total number of recordings, was still very welcome. This resulted in a larger number of participants with a variety in frequency; some parents were only able to send a few recordings, and some parents have sent a recording for every (other) week for the total of six months.

Finally, the necessary background information and the data itself have all been obtained through digital contact. The parents were asked to fill out a questionnaire, a screening tool and Informed Consent (see Chapter 3.5). These documents were sent through digital channels, also providing a lower threshold for participation in the study.

3.4 Recruiting participants

After the purpose of the study became evident, a letter was written to provide possible participants with basic information about what was expected from them if they would decide to participate (Appendix II). The participants have been found through personal and professional networks. An appeal for parents to participate in the study was made through social media (Facebook) and people in my personal social network were asked to contact parents with children between 1;0 and 4;0 years old who might be willing to participate. Professional acquaintances through work and study were also appealed to and asked if they knew anyone who might be interested in participating. Initially, this resulted in 35 possible participants. After further contact and providing the parents with more information, a final number of 31 participants have ultimately participated in this study.

3.5 Required documents and exclusion criteria based on documents

When parents had decided to participate in the study, they needed to fill out three documents to provide background information about the child and its development and to give Informed Consent for the use of the recordings for the purpose of this study. These documents are the Informed Consent form, the questionnaire and the SNEL screening instrument. The Informed Consent, the optional supplement of the Informed Consent and the questionnaire have all been approved by the Ethics Committee Faculty of Humanities. For every final participant the Informed Consent, the SNEL and the questionnaire have been collected.

3.5.1 Informed Consent and optional supplement

First and foremost, the parents needed to sign an Informed Consent form (Appendix III), which was accompanied by an optional addition (Appendix IV). Filling out this optional supplement was not obligatory for the participation of the study.

3.5.2 Questionnaire

Secondly, parents needed to fill out a questionnaire to ensure that there were no indicators of a deviant or delayed speech or language development (Appendix V). The children included in this study are between 1;0 and 4;0 years of age, which indicates that they are at the peak of their phonological development during the recordings. Therefore, it was deemed important to check for factors that might indicate a problem with the child's phonological development. One important aspect that was included in the questionnaire is the child's hearing and aspects that could have an influence on the

child's hearing. For example, breathing through the mouth instead of the nose, and habits of sucking on a thumb, finger or pacifier could have a negative influence on swallowing frequency or tonsils and might therefore impact the child's hearing. Children who have a history of hearing problems or ear tubes could be monitored extra closely and if necessary excluded from the study, as these problems could have had a negative influence on the child's speech and/or language development. Between 38-47% of children with phonological disorders have a history of Otitis Media with Effusion or Acute Otitis Media (AOM) (Jansonius-Schultheiss et al. 2014: 63).

Furthermore, another important question that has been included in the questionnaire, as described in Chapter 2.3, is whether the child has babbled in the pre-lingual phase. The stay off of babbling might have had a negative influence on the child's language development (Burger, Van de Wetering & Van Weerdenburg, 2012: 28). Considering that phonological processes still occur in TD children until the age of 4;0 (Jansonius-Schultheiss et al., 2014: 147), it was difficult to extensively screen the participants in the current study for possible phonological disorders without further extensive testing. A typical language development, combined with no indicators of hearing problems makes a budding phonological disorder less probable. However, the spontaneous speech samples have all been checked for a possible deviant or delayed phonological development. In case of doubt about the child's phonological development, this would be a reason to exclude the child from the study, or at least discuss these doubts clearly in the results and discussion of this paper (Chapter 4 and 5). The data of two participants was not included in the final results. Participant 15 was excluded due to very limited productive language at an age of 1;11 years old. In the phonological development of participant 27, some phonological processes were noticed that are not expected at the age of 2;7 years old. To be safe, the results of these two participants are shown in the results section, but are not included in the analysis and in providing age groups of syllable type development.

3.5.3 SNEL Screening Instrument

In addition to the information gathered from the questionnaire, parents have filled out the Dutch standardised screening instrument Spraak en Taalnormen Eerstelijns Gezondheidszorg (SNEL) (Luinge, 2005) (Appendix VI, VII and VIII). This screening tool will indicate whether the language development appears to progress normally. The selection of this screening tool was based on several aspects. Firstly, the tool is approachable for parents. The instrument can be filled out in only a few minutes. Another acceptable screening tool would be the *Lexilijst A and B* (Schlichting and Lutje Spelberg, 2002), which measures the language development through active vocabulary. An additional tool, the *Lexilijst Reception* (Schlichting and Lutje Spelberg, 2007), measures the receptive language development. These instruments, however, are only applicable for children between 1;3 and 2;3

years old and between 1;3 and 2;1 years old, respectively. It also takes approximately 30-45 minutes to fill out the *Lexilijsten.* The SNEL was considered more suitable for this study due to the screening of both language reception and language production in a considerably shorter amount of time. Additionally, the screening tool is applicable to children between 1;0 and 6;0 years old, which includes the complete age group of the participants in the current study.

3.5.4 Excluded participants

None of the participants were definitively excluded from the study based on the provided documents. Incidentally, parents had doubts about their child's speech-language development (P33) or a child had had ear tubes or temporary lesser hearing, combined with a positive score on the SNEL screening tool (P34, P6, P22, P5 and P14). These children were not excluded from the study, but their transcripts were more closely observed for possible problems with speech and/or language (also see Chapter 5.5). None of the children were excluded based on persistent hearing problems, yet several participants had had problems with colds, a sucking habit (pacifier, thumb or fingers) or had a habit of breathing through their mouth.

None of the children had received speech language therapy at the time of the recordings. Yet, for two children, the SNEL score showed a moderate delay (Appendix IX). One child was 13 months and the other 20 months at the time of the measure, and their parents did not express worries about their speech language development. These children's recordings were also more closely observed, to make sure there were no noticeable problems with their speech language development.

3.6 Final number of participants

As none of the participants needed to be excluded after receiving the filled out documents, the total number of participants remained the same. A total of 31 participants have participated in the study. To make sure there would be no gaps in the final data, the age at which recordings of the participants were received have been calculated to show the distribution of the participants in age ranges of six months. This distribution of participants is shown in Table 8. Some children would fit into one age group at the start of the recordings and would fit into the following age group by the time of the last recording. The target number of participants per age group was initially a minimum of five participants. This has been achieved for each group, except for the age group 3;0-3;5 years old.

Table 8: Distribution of final number of participants

Age	Number of participants (N = 31)
1;0 – 1;5	9
1;6 – 1;11	11
2;0 – 2;5	8
2;6 – 2;11	7
3;0 – 3;5	3
3;6 – 3;11	8

3.7 Socio-demographic variables

From the questionnaire certain socio-demographic background information was filled out by the parents of the participants, such as the gender of the child, the family situation, the parents' level of education, the parents' first language etc. (Appendix V).

Some of the collected socio-demographic variables are shown in the table in Appendix X: gender, region, sibling position and the level of education of the participant's mother. The hometowns of the final participants were not limited to a specific area in the Netherlands. The participants live in six different regions of the Netherlands and two even live abroad. The region where most of the participants live is Noord-Brabant, with fifteen participants. The group of participants consists of 13 boys and 18 girls. Most participants were the family's firstborn, but eight were also the second child of the family and three of the participants were third in the sibling position. The participants included one set of twins. Every child's mother had a high level of education, which means that every mother has completed a degree in higher education or university.

3.8 Data collection

The start of the collection of the recordings was set at the first of May 2017. Most parents sent the video's through WhatsApp, but the recordings were also occasionally sent via e-mail or We Transfer. The recordings were saved on a computer under the children's participant numbers and were deleted from the telephone or e-mail.

Every participant's first recording was viewed to be able to provide further advice for the rest of the recordings, if necessary. Apart from the first recording, the videos were not transcribed until after the data collection was completed. Only when parents specifically asked for feedback about the usefulness of the recording, the recording was viewed to provide feedback or confirmation.

The collection of data continued until the end of October 2017. A few parents have chosen to send a recording after the end of October, these recordings were also included in the final data set. The final number of recordings that was received during the data collection is 273 recordings. As discussed in Chapter 3.3, the period of time over which parents have sent recordings and the total

number of recordings differed strongly. The total number of recordings that was received for each participant, as well as the ages of the participants at the time of the first recording and the final recording, is shown in the table in Appendix XI (also see Appendix XII for the ages of the participants at the time of every recording). The shortest period of time has been one day of recording(s). The longest period of time a child has participated was eight months and six days. Most of the recordings that were sent were approximately 5 minutes long. Sometimes parents would send an extra (shorter) recording when a child seemed talkative, or would send more than one recording on one day. The total number of recordings that has been received per participant differs from one recording to 48 recordings. The different types of variation, as mentioned here, have been influenced by many factors, which will further be considered in the discussion in Chapter 5.4.

3.9 Transcription

For each recording, the exact age of the child at the time of the recording was calculated. A transcript of the child's utterances was made for each recording. A few basic rules were set for the transcripts:

I. Every transcript started with the child's age at the time of the recording, followed by the setting in which the recording took place.

II. The child's utterance is notated phonetically in the first column, including any errors, substitutions or deletions. After the utterance, the target word is notated orthographically. Any onomatopoeia productions, such as 'meow' for 'cat' or 'too toot' for 'car', are not included in the transcript. Furthermore, if a child's utterance is incorrect due to limited linguistic development, this is not counted as a mistake. For example: the child (participant 9, age 2;3.10[6]) produces /Pl^k@g/, which is an incorrect adjective in Dutch. The correct form would be /pl^k@R@g/ 'sticky'. In this case, the child is expected to not have acquired the correct form of the adjective, causing the target syllable structure to differ from the adult target realization. This utterance is in this case syllabified as: CCVĊ ĊVC[7] (as further explained in point III and IV), and is counted as a correct realisation.

III. The same production of a target word may only occur three times in the transcript, which is in line with the rules of the FAN by Beers (1995). Different productions may separately be included maximally three times. For example, if a child produces /Auto/ 'car' correctly six times, only three of these productions are included in the transcript.

[6] The form of notation for the participant's age at the time of a specific recording: (year);(month).(day), for example; 2;5.18 is a participant of two years, five months, and eighteen days old at the time of the recording.
[7] An ambisyllabic consonant (see rule IV), is notated as Ċ.

When the child then produces /to/ for *auto* 'car' four more times, the incorrect production of the target word is also included in the transcript three times.

IV. The target word is divided into syllables in the middle column, using syllabification rules as used in the FAN by Beers (1995) (Jansonius-Schultheiss et al., 2014: 129), which can be found in Appendix XIII. One change to these rules was implemented, namely the implementation of ambisyllabic consonants instead of medial consonants, as also discussed in Chapter 2.3. As the participants in the current study were only 1;0 year old when the first recordings are made, their vocabularies are still very limited. The syllabification rules as used in the FAN would syllabify the word /m^ma/ 'mommy' as /m^ = m – a/[8], corresponding to CV = C – V for the current study. The medial /m/ is then not included in the analysis. For the purpose of the current study, it was deemed important to differentiate between the CV and V forms in the word /m^ma/ and /p^pa/ and the CV and V forms in, for example, the word /Auto/. It is important to differentiate between these forms, to make sure that the results of the CV and V syllable type development are calculated correctly. Separate syllable types are included for ambisyllabic consonants, where the word /m^ma/ would be divided as CVĊ ĊV, with the ambisyllabic consonant behaving as both a coda and an onset. These syllable types are calculated separately from the CVC and CV structures.

V. In the case of an incorrect syllable structure, the structure as used in the child's utterance is notated in the middle column, following the target syllable structure. This allows for a fast observation of the mistakes that are made in the syllable structure.

VI. In the third and final column, the phonological processes that adapt syllable structure are notated. In any cases of doubts about the child's phonological development, the phonological processes of substitution and assimilation are also notated.

<u>Examples of the notation of the child's utterance (participant 17, age 1;6.6):</u>

/dIt/ (dicht) (closed)	CVCC → CVC	cluster reduction
/o/ (ook) (also)	VC → V	final consonant deletion

VII. After the transcription, the number of correct realisations of each syllable type is calculated, as well as the number of times the child deployed a certain syllable type to

[8] The medial consonant is expressed with the notation = C – around the medial consonant, in this case the /m/, as is done in FAN transcription (Appendix XIII).

simplify the target realisation. Any phonological substitutions are not counted as a mistake in syllable structure, because the child appears to be aware of the target syllable structure, but is unable to produce the correct phoneme to achieve adult realisation of the target word.

Example of the calculated number of correctly realised syllable types (participant 12, age 2;0.3):

Syllabe Type	Number of target syllable types	Number of correct realisations	Used to adapt syllable structure
CV	83	77	22
CVC	50	42	9
VĊ	0	0	1
ĊV	5	5	0
CVĊ	5	5	0
V	7	6	4
VC	3	2	0
CCVC	9	4	0
CCV	10	1	1
CVCC	6	3	0
CCVCC	1	0	0
VCC	3	0	0

3.10 Possible delayed or deviant phonological or language development

When every recording was transcribed, two children were signalled to possibly have problems with speech or language development. Participant 15 displayed a delayed vocabulary and syntactic development. Participant 27 applied more phonological substitution and assimilation processes than would be expected at the age at the time of the recordings. The parents of these children were informed about the possible delayed or deviant problems with phonological or language development, and were advised to contact a speech language therapist for further assessment and possibly treatment. To make sure the results of these participants with possible problems with language or phonology did not interfere with the results of this study, these two participants are not included in the calculations of an average syllable type development. They will be discussed further in Chapter 5.5 to compare their development to that of the calculated average age groups.

3.11 Data processing

After every recording has been transcribed, the numbers of correctly produced syllable types for each transcript are used to calculate the percentages of correctly produced syllable types. When determining whether the child has mastered a certain syllable type, the same percentages are used as the cut-off points as used in the FAN by Beers (1995) for the analysis of a child's phonological

development. Less than 50% correctly produced syllable types is counted as 'not mastered'. Between 50% and 75% is counted as a syllable type that is currently under development. A number of 75% and higher is counted as a syllable type that is mastered by the child.

In order to create a clear overview of the data, the percentages are calculated for each month of the participants' ages in which recordings were received. For example, a recording made on the day a participant's age was 2;5.20 is presented as a result for age 2;5. The recordings and corresponding transcripts that were made during one month in the child's age are combined for the calculations. For example, participant 9 was recorded repeatedly during the month she was 1;11 years old, at 1;11.4, 1;11.5, 1;11.13, 1;11.15, 1;11.21, 1;11.27 and 1;11.29. The results from these transcripts are combined to calculate one result in percentages of correctly produced syllable types during the time she was 1;11 years old.

A percentage of correctly produced syllable types is only calculated when the child has selected a minimum of three target words including a certain syllable type. If the child has only selected zero, one or two target words with a syllable type, a notation is made in the data that a transcript is available, but that an insufficient number of a certain syllable type was selected (ITW[9]).

For the CV and CVC syllable type, the results are calculated separately for only the CV syllable type and the CVC syllable type, excluding any ambisyllabic syllable types. Additional percentages are calculated for the CV and ĊV syllable types combined, and for the CVC, ĊVC, CVĊ and ĊVĊ combined. These percentages are included in the External Appendix. The percentages for syllable type VC and syllable types including a consonant cluster were only calculated including any ambisyllabic varieties, as the frequent words /m^ma/ 'mommy' and /p^pa/ 'daddy' only contain the ĊV and CVĊ syllable type, and the VC and cluster syllable types are not frequently selected in general. Therefore, more results could be calculated by including the ambisyllabic varieties.

Finally, after the age of 2;6, and in some cases earlier, the number of target syllable types and correct realisations were no longer measured for the syllable types CV, CVC, V and VC. The age depended on how clear it was that the child had no difficulties with these specific syllable types. A percentage was then only measured, when there were doubts about a participant having acquired one of these syllable types and several mistakes were registered.

3.12 Analysis

The analysis of the results is very strictly defined. In Chapter 5 of this paper, this will be discussed further. In Chapter 4, where the results are presented, an overall development pattern will be based

[9] ITW: Insufficient number of Target Words. The child has selected less than three target words with the syllable structure that is discussed.

on the moment where every child has acquired a certain syllable type. The following rules are set, as demonstrated in Chapter 4. Two measures of age groups are displayed. Firstly, the age at which a child is expected to have acquired a specific syllable type. Secondly, an age group for when a child is expected to have started developing a specific syllable type.

The acquisition age group is measured as follows. The first moment where one of the participants achieves at least 75% percentage of correctly producing a syllable type is the first number of the age group. Finally, the last moment where none of the participants score less than 75% on the measured syllable type is counted as the age at which the syllable type is expected to be acquired.

The age group of the syllable type under development is defined as follows. The first moment a participant has scored a percentage between 50% and 100% is the first time where that specific syllable type has been measured to be under development. Then, the month *after* the last moment where a child produces the syllable type less than 50% correctly is used as the second measure. For example, if the last moment where a participant has produced a syllable type correctly less than 50% was measured at 1;9 years old, the final age at which a child is expected to have started developing that specific syllable type is set at 1;10.

However, not every syllable type shows instances where the child has produced less than 50%. In these cases, the end-point where the child is expected to have at least started developing the selected syllable type is set at the age where every participant has produced the specific syllable type correctly 50% or more at least once, including 75% or more correct productions. Given the large variety of the age at which the recordings start, not all, but at least five children must have produced over 50% correctly. By implementing these measures, it is ensured that there are no instances following the ‘under development end-point’ where a participant has produced less than 50% correctly.

4. *Results*

4.1 Development of syllable types mastered

In this chapter, the development of the various syllable types as extracted from the acquired data is described. First, every syllable type is discussed separately and linked to the age of development of each specific syllable type (subchapters 4.1.1 – 4.1.9). The order in which the syllable types are discussed is based on the syllable type development as measured by Levelt, Schiller and Levelt (2000). Subsequently, the data as a whole will be presented to show the connections of the development of the different syllable types.

4.1.1 Syllable type: CV

The number of correct productions of the syllable CV has been calculated for each participant at the ages their recordings were made. Table 9 displays the percentages of correctly produced syllable types for each participant. The participant in this group that is not included in the results, participant 15, displays a delayed development of the CV syllable type in comparison to the participants who showed no problems in language development.

The first point when a participant has mastered the syllable type CV is at 1;1 years old. The last point where any participant scores less than 50% correct on syllable type CV is at the age of 1;4. 1;4 is the last point where a participant has produced the syllable type correctly less than 50%, which makes the age at which children are expected to have started developing this syllable type 1;5. Finally, starting from the age of 1;6, none of the children score less than 75%. These numbers provide a clear age range for the acquisition of the CV syllable structure, which can be set between 1;1 and 1;6 years old. The age groups as defined from these results are displayed in Table 10.

Table 9[12]: Percentages of correctly produced CV syllable types from 1;0-1;10 years old

CV	1;0	1;1	1;2	1;3	1;4	1;5	1;6	1;7	1;8	1;9	1;10
P2					**100%**[10]		**100%**			**85,7%**	
P7	ITW										
P10	ITW		**100%**			**93,3%**					
P17					**33%**	**71%**	**82,9%**	**78,8%**	**76,8%**	**82,2%**	
P21		**100%**	**100%**	**92,9%**	**100%**	**91,7%**	**85,2%**	**92,3%**			
P24		ITW	**66,7%**	**100%**							
P25			ITW								
P34				**100%**	**100%**	**88,9%**					
P36	ITW	ITW									
P3											**91,5%**
P9											
P12							**94,4%**	**82,4%**	**82,5%**	**89%**	**91,3%**
P15[11]						ITW	**25%**	ITW	**44,4%**	**93,3%**	
P19											
P20							ITW	ITW	**75%**		**80,1%**
P29										ITW	**100%**

Table 10: CV syllable type age groups

CV	Age groups
Syllable type under development	1;1 – 1;5
Syllable type acquired	1;1 – 1;6

4.1.2 Syllable type: CVC

The percentage of correct realisations of the syllable type CVC has been depicted in Table 11 for each participant. Participants who were older than 2;7 at the time of the recordings all produced the CVC syllable structure correctly in over 75% of the target words. As can be seen in Table 11, the development of the CVC syllable type does not progress consistently. Several participants, such as participant 17, 21 and 19 appear to have mastered the CVC syllable, followed by a decrease in the percentage of correct productions one or two months after. Possible reasons for these drops are further discussed in Chapter 5.4.

[10] In this table and following tables, green means ≥ 75% correct productions, meaning that the syllable type is mastered. Yellow means ≥ than 50%, yet < 75% correct productions, the syllable type is under development. Red means < 50% correct productions, the syllable type is not mastered.
[11] Participants 15 and 27 will be shown with a grey background in every similar table to follow. Any calculations mentioned in the text or in other tables do not include these two participants.
[12] The complete table of every calculated percentage for each syllable type is included in Appendix VII-XVIII.

Table 11: Percentages of correctly produced CVC syllable types from 1;0-2;7 years old

CVC	1;0	1;1	1;2	1;3	1;4	1;5	1;6	1;7	1;8	1;9	1;10	1;11	2;0	2;1	2;2	2;3	2;4	2;5	2;6	2;7
P2					87,5		80%			81%										
P7	ITW																			
P10	ITW		0%			50%														
P17					42,9%	71,4%	86,7%	72,3%	64,9%	82,6%										
P21		83,3%	55,6%	81,3%	36,4%	54,2%	76%	85,2%												
P24		75%	ITW	ITW																
P25			ITW																	
P34				66,7%	25%	ITW														
P36	ITW	ITW																		
P3											63,3%									
P9												85.7%								
P12							62,5%	58,6%	55%	84,5%	60%	81%	84%		80,7%					
P15						ITW	66,7%	ITW	33,3%	0%		0%								
P19												70%	88,9%	73,3%	28,6%	60%	76,9%			
P20							ITW	33,3%	66,7%		80%	93,3%								
P29										ITW	50%			84,6%						
P6															70,4%	98,3%	100%			
P11																	85,7%	53,7%	87,6%	
P22																80%	86,7%			
P27														60,9%	64,3%	53,8%	74,2%	47,1%		70,4%
P26																				
P31																				
P33																			75%	73,3%

The first moment where a child has mastered the CVC syllable type for the first time occurs very early, at the age of 1;1 years old. The first measure where every child has correctly produced the CVC syllable type more than 75% of the instances, is at the age of 2;8. Furthermore, the last moment where a child produces less than 50% correctly is measured at 2;2, which places the moment where the CVC syllable type is expected to be under development at 2;3. These age ranges are shown in Table 12.

Table 12: CVC syllable type age groups

CVC	Age groups
Syllable type under development	1;1 – 2;3
Syllable type acquired	1;1 – 2;8

4.1.3 Syllable type: V

As the current study requires a minimum of three target words with every specific syllable type, it has become imminent that the frequency of the different syllable types in (child) language differs greatly. The V syllable type occurs very infrequent, as is shown in Table 13. To illustrate, participant 21, at the age of 1;6 produced a total of 64 meaningful utterances, including target words with 27 required CV syllable structures, 25 CVC syllable structures, seven VC structures and even six CCVC syllable structures, yet only one target word including a V syllable structure is selected by the child.

When the participants did select at least three target words with a V syllable structure, none of the participants produced less than 50% correctly.

The first moment where a child has correctly produced at least 75 percent of the V syllable types is at an age of 1;3. Note, however, that no percentages from earlier ages are available in this data, due to limited target words including a V syllable type. The first moment where every participant has correctly produced the V syllable type is at the age of 2;0. After the age of 2;0, none of the participants have correctly produced less than 50% of the V syllable target words. Children would therefore be expected to have acquired the V syllable type between 1;3 and 2;0, as shown in Table 14.

The first measure for the age group that shows when the syllable type V is under development is also set at 1;3. There is no moment in the current data where a child produces less than 50% correctly. Therefore, the cut-off point is measured by the age where at least five children have produced the V syllable structure correctly more than 50% of the target words at least once. In Table 13, this is shown to be at 1;7.

Table 13: Percentages of correctly produced V syllable types from 1;0-2;0 years old

V	1;0	1;1	1;2	1;3	1;4	1;5	1;6	1;7	1;8	1;9	1;10	1;11	2;0
P2					ITW		ITW			100%			
P7	ITW												
P10	ITW		ITW			100%							
P17					ITW	ITW	ITW	100%	100%	100%			
P21		ITW	ITW	ITW	ITW	100%	ITW	ITW					
P24		ITW	ITW	100%									
P25			ITW										
P34				ITW	ITW	ITW							
P36	ITW	ITW											
P3											60%		
P9												100%	
P12							100%	100%	77,3%	77,8%	75%	93,3%	85,7%
P15						ITW	ITW	ITW	ITW	ITW		ITW	
P19												66,7%	ITW
P20							ITW	ITW	ITW		ITW	75%	
P29										ITW	ITW		

Table 14: V syllable type age groups

V	Age groups
Syllable type under development	1;3 – 1;7
Syllable type acquired	1;3 – 2;0

4.1.4 Syllable type: VC

Similar to the V syllable, the VC syllable is selected too infrequently to be able to calculate a percentage of correct productions. Table 15 displays the percentages that could be calculated based on the current data.

The first instance where a participant has mastered the VC syllable type is at an age of 1;4. The age where every child produces at least 75% correctly starts at 2;5. The VC syllable type is therefore acquired between the ages of 1;4 and 2;5, as shown in Table 16.

Furthermore, the age where a child first produces at least 50% of the syllable type VC correctly is at 1;2 years old. None of the calculations reveal a child that has produced the VC structure correctly less than 50% of the target words. The moment when at least five children have started acquiring the VC syllable type is set at 1;10. Therefore, between the ages of 1;2 and 1;10, the VC syllable structure is expected to be under development, at least.

Table 15: Percentages of correctly produced VC syllable types from 1;0-2;7 years old

VC	1;0	1;1	1;2	1;3	1;4	1;5	1;6	1;7	1;8	1;9	1;10	1;11	2;0	2;1	2;2	2;3	2;4	2;5	2;6	2;7
P2					ITW		100%			80%										
P7	ITW																			
P10	ITW		ITW			ITW														
P17					ITW	100%	78,6%	85,2%	92,9%	56,3%										
P21		ITW	60%	50%	100%	66,7%	100%	ITW												
P24		ITW	ITW	ITW																
P25			ITW																	
P34				ITW	ITW	ITW														
P36	ITW	ITW																		
P3											ITW									
P9												90%								
P12							ITW	100%	100%	76,9%	100%	77,8%	66,7%		96%					
P15						ITW	ITW	ITW	ITW	ITW		ITW								
P19												100%	100%	ITW	60%	100%	86,7%			
P20							ITW	ITW	ITW		80%	ITW								
P29										ITW	ITW			ITW						
P6															90%	95%	90%			
P11																	82,6%	85,7%		
P22																75%	55,6%		83,3%	
P27														ITW	ITW	ITW	62,5%	44,4%		42,9%
P26																				
P31																				
P33																			80%	ITW

Table 16: VC syllable type age groups

VC	Age groups
Syllable type under development	1;2 – 1;10
Syllable type acquired	1;4 – 2;5

4.1.5 Ambisyllabic consonants

The acquisition of syllable types including ambisyllabic consonants was calculated separately, as described in Chapter 3.9 and 3.11. In the calculation of the percentage of correctly produced syllable types, the syllable types CV and CVC were first calculated separately, as described in Chapter 4.1.1 and 4.1.2. Especially for the younger children, whose complete transcript often included several productions of /m^ma/ (mommy) and /p^pa/ (daddy), it is important to separate the results of the CV and CVC productions from the combination of CV and ĊV, as well as the combination of CVC, ĊVC and CVĊ. Therefore, the results as discussed in Chapter 4.1.1 and 4.1.2 did not include any syllables containing an ambisyllabic consonant.

As discussed in Chapter 3.11, every syllable structure following CV and CVC, the ambisyllabic variations are included in the calculations of the percentage of correctly produced syllable types. These percentages can be found in the External Appendix.

4.1.6 Complex onset

Both the syllable types CCV and CCVC contain a complex onset, and are measured separately in the results. Levelt, Schiller and Levelt (2000) suggest that children either acquire the complex onset, or the complex coda first. A comparison with the earlier research on these differences are presented in the discussion in Chapter 5.3.1.

4.1.6.1 CCV

From the data as shown in Table 17, the CCV syllable type starts to develop at an age of 1;11. The first instance where a child has mastered the syllable type is at 2;2. The last instance where every child has correctly produced over 75% of the target syllable type CCV is at 3;11. As there is no available data for children after this age, this needs to be interpreted with caution.

Furthermore, the first instance where the CCV syllable type is correctly produced between 50% and 75% is at 1;11 years old. The last moment where a child has produced the CCV syllable type correctly less than 50% is at 2;7 years old, which puts the age of the CCV syllable type being under development at 2;8 years old, as shown in Table 18.

Table 17: Percentages of correctly produced CCV syllable types from 1;10-3;11 years old

CCV	1;10	1;11	2;0	2;1	2;2	2;3	2;4	2;5	2;6	2;7	2;8	2;9	2;10	2;11	3;0	3;1	3;2	3;3	3;4	3;5	3;6	3;7	3;8	3;9	3;10	3;11
P3	37,5%																									
P9		70,6%	64,7%	46,2%	80%	100%																				
P12	0%	0%	10%		26,7%																					
P15		ITW																								
P19		ITW	ITW	ITW	ITW	ITW	0%																			
P20	ITW	9,1%																								
P29	ITW			ITW																						
P6					100%	100%	90,9%	100%	100%	100%																
P11							42,9%	ITW	71,4%	75%			ITW													
P22						ITW	ITW		0%	0%		ITW														
P27				0%	0%	0%	0%	ITW		0%																
P26									ITW	30%					83,3%											
P31									ITW		ITW		100%	83,3%												
P33									66,7%	0%			ITW													
P4																	50%				100%		100%			
P8																		100%	79,5%	100%	100%	100%	100%	100%		
P5																									100%	ITW
P14																							83,3%	80%		ITW
P18																							100%			
P28																									100%	
P32																						62,5%	ITW		50%	
P35																									81,3%	100%

Table 18: CCV syllable types age groups[13]

CCV	Age groups
Syllable type under development	1;11 – 2;8
Syllable type acquired	2;2 – 3;11

4.1.6.2 CCVC

The results from the other complex onset syllable type, CCVC, are shown in Table 19. Particularly Participant 32 shows a low percentage of correct realisations up to a later age. After the age of 2;9, the participants show a decrease in having difficulty producing this syllable type correctly.

[13] An age group that shows a grey colour in this table and similar tables to follow, should be interpreted with caution, as it has been calculated with a limited amount of data.

Table 19: Percentages of correctly produced CCVC syllable types from 1;11-3;10 years old

CCVC	1;11	2;0	2;1	2;2	2;3	2;4	2;5	2;6	2;7	2;8	2;9	2;10	2;11	3;0	3;1	3;2	3;3	3;4	3;5	3;6	3;7	3;8	3;9	3;10
P9	85,7%	80%	53,8%	100%	100%																			
P12	19%	44%		11,8%																				
P15	ITW																							
P19	ITW	ITW	ITW	0%	0%	0%																		
P20	0%																							
P29			0%																					
P6				50%	57,1%	ITW	100%	90%	100%															
P11						28,6%	33,3%	37,5%	50%			92,3%												
P22					ITW	0%		0%	14,3%		33,3%													
P27			0%	0%	0%	ITW	0%		0%															
P26								ITW	58,8%					50%										
P31								75%		ITW		ITW	66,7%											
P33								ITW	100%			100%												
P4																87,5%				66,7%		94,7%		
P8																	100%	92,1%	100%	100%	100%	100%	100%	
P5																								85,7%
P14																						69,2%	100%	
P18																						100%		
P28																								ITW
P32																					0%	33,3%		92,9%
P35																								100%

The age groups that can be calculated from these percentages are provided in Table 20. Children are both expected to have started developing the CCVC syllable type and to have acquired this syllable type at an age of 3;9.

Table 20: CCVC syllable types age groups

CCV	Age groups
Syllable type under development	1;11 – 3;9
Syllable type acquired	1;11 – 3;9

4.1.7 Complex coda

In the Dutch phonological system, both the VCC and CVCC complex coda are possible. The results for these syllable types are presented separately in this subchapter.

4.1.7.1 VCC

The VCC syllable type was found sporadically in the available data (External Appendix). On only ten occasions did a participant select three or more VCC target words, allowing for calculation of a percentage of correct productions. In measuring an age group for this syllable type, these results are not rendered representative for the acquisition of this syllable type, as the current research has not been able to gather ample data. Seven participants selected at least three VCC words on one occasion in the available data. An eighth participant selected three or more VCC words on three

separate occasions in the available transcripts. Therefore, the age groups as provided in Table 21 are to be interpreted with much caution.

Table 21: VCC syllable types age groups

VCC	Age groups
Syllable type under development	1;8 – 3;9
Syllable type acquired	1;8 – no data

4.1.7.2 CVCC

The CVCC syllable type was regularly available in the spontaneous speech of the participants. Therefore, many percentages were calculated for this specific syllable type, as displayed in Table 22.

Table 22: Percentages of correctly produced CVCC syllable types from 1;11-3;10 years old

CVCC	1;11	2;0	2;1	2;2	2;3	2;4	2;5	2;6	2;7	2;8	2;9	2;10	2;11	3;0	3;1	3;2	3;3	3;4	3;5	3;6	3;7	3;8	3;9	3;10
P9	100%	93,8%	100%	88,9%	80%																			
P12	9,1%	50%		50%																				
P15	ITW																							
P19	ITW	ITW	ITW	ITW	ITW	ITW																		
P20	60%																							
P29			0%																					
P6				ITW	83,3%	75%	ITW	ITW	ITW															
P11						0%	50%	35,7%	55,6%			50%												
P22					0%	25%		66,7%	ITW		ITW													
P27			ITW	ITW	ITW	0%	ITW		33,3%															
P26								0%	50%					100%										
P31								85,7%		ITW		ITW	100%											
P33								0%	ITW			76,9%												
P4																80%				100%		100%		
P8																	91,7%	94%	81,3%	100%	90,9%	100%	100%	
P5																								100%
P14																						78,6%	80%	
P18																						100%		
P28																								ITW
P32																					66,7%	75%		60%
P35																								100%

No percentages lower than 50% were found after the age of 2;6, which puts the end point for the age group of the CVCC syllable type being under development at 2;7. The age at which children are expected to have acquired this syllable type, is set at 3;11. As there is no available data for children after this age, this needs to be interpreted with caution. These numbers are shown in Table 23.

Table 23: CVCC syllable types age groups

CVCC	Age groups
Syllable type under development	1;9 – 2;7
Syllable type acquired	1;11 – 3;11

4.1.8 CCVCC

Furthermore, the CCVCC syllable type was calculated. This syllable type does not occur often, yet there were a legitimate number of instances where children selected at least three CCVCC target words, as displayed in Table 24. After the age of 3;4, there were no instances where a child scores less than 75% correct realisations. However, there were too few results at this age to conclude that children are expected to have acquired this syllable type by the age of 3;4. Therefore, in this case, the moment where at least five children have acquired the CCVCC syllable type is used as a measure for age group of having acquired the CCVCC syllable type. This age is therefore set at 3;10, as shown in Table 25. Children are expected to have started acquiring this syllable type after the last instance of a percentage under 50%, which is at 3;0 years old.

Table 24: Percentages of correctly produced CCVCC syllable types from 2;6-3;11 years old

CCVCC	2;6	2;7	2;8	2;9	2;10	2;11	3;0	3;1	3;2	3;3	3;4	3;5	3;6	3;7	3;8	3;9	3;10	3;11
P6	25%	ITW																
P11	ITW	100%			ITW													
P22	ITW	ITW		ITW														
P27		ITW																
P26	ITW	ITW					ITW											
P31	ITW		ITW		ITW	33,3%												
P33	ITW	0%			ITW													
P4									ITW				100%		100%			
P8										ITW	85,7%	ITW	100%	ITW	ITW	ITW		
P5																	ITW	ITW
P14															100%	100%		ITW
P18															ITW			
P28																	ITW	
P32														ITW	ITW		100%	
P35																	ITW	100%

Table 25: CCVCC syllable types age groups

CVCC	Age groups
Syllable type under development	2;7 – 3;0
Syllable type acquired	2;7 – 3;10

4.1.9 CCC

The CCC syllable type could include either a CCC onset or a CCC coda. Due to the limited number of words in the Dutch language containing either CCC syllable type, especially the limited number of target words that are expected for young children to select, these different syllable types were not calculated separately. Even though these syllable types were calculated combined, there were only eight instances where a child selected at least three target words including a CCC syllable type, which allowed for calculation of a percentage of correctly produced CCC syllable types. These results are therefore deemed unreliable.

5. *Discussion*

In this chapter, the results of this thesis are discussed further. First, answers to the research questions are given in section 5.1. Then, in section 5.2, a response to the hypotheses is provided. Subsequently, important aspects of consonant clusters are further discussed. Then, the differences in number and usable content of recordings are examined, followed by a discussion of the background information and the participants who were excluded from the results. Finally, recommendations for further research will be provided.

5.1 Answers to Research Questions

The following research questions were drawn up at the start of this study, in Chapter 1.2:

Research Question 1: Are there any differences between Fikkert (1994) and Levelt, Schiller and Levelt (2000) on the one hand and the current study on the other hand in terms of stages of syllable structure development and development of syllable types?

Firstly, concerning stages of syllable structure development, a difference was found between the previous research by Levelt, Schiller and Levelt (2000), by Fikkert (1994) and in the current study. As shown in Table 4, Levelt, Schiller and Levelt (2000) had concluded that CVC fell under the second stage of development, while the V and VC syllable type fell under the third stage of development. The current study has concluded that the CVC syllable type is fully acquired only after the V and VC syllable types are already acquired.

The stages as set by Fikkert (1994) and shown in Table 5, could correspond to the results as found by the current study. However, in the text it is further explained that in stage one, some children have also inserted an onset to create a CVC structure before the occurrence of V or VC syllable structures. These differences in results can be explained by the differences in method. The current study has calculated the percentage of correct productions of a specific syllable type that was selected as a target word at least three times in the transcript, which provides information about the amount of correctly produced syllable types, and therefore the acquisition pattern. Fikkert (1994) based these stages on the occurrences of CVC simplifications instead of patterns in age where the different syllable types are acquired, yet the results are referred to as the 'acquisition of onsets' (Fikkert, 1994; 56), instead of simplification patterns.

Furthermore, Levelt, Schiller and Levelt (2000) calculated their results, based on a minimum of two productions in the child's transcript (2000; 240). However, V and VC target words are selected

a lot less frequently than the CV and CVC syllable type, for example (see Table 13 and 15). The instance as described in Chapter 4.1.3, where Participant 21 selected 25 CVC target words, and only one V target word, illustrates this. The method of calculating the first time a child has produced a certain syllable type twice, does not necessarily measure that the child has acquired that specific syllable type. Contrariwise, a lack of (at least two) productions does not mean the child has not acquired that specific syllable type, either. Through the calculations as used in the current study, by measuring the instances where a child has selected at least three V or VC target words, very few mistakes are registered (see Table 13 and 15), while the CVC syllable type remains under development for a much longer period of time (Table 11). This order of development can also be found in the age ranges that have been calculated for each syllable type in Chapter 4. A combination of these age ranges is provided in Table 26. This table shows that the age at which the CVC syllable type is under development or has been acquired both end at a later age than the V and VC syllable type. That the first occurrences of a CVC syllable type are found at the early age of CVC, shows that the methods as used by Fikkert (1994) and Levelt, Schiller and Levelt (2000) would indeed show a pattern where the CVC structure is frequently used in production before the V and VC syllable type, that are more frequently found after the age of 1;3 and 1;4 respectively. This does not mean that the CVC syllable type is acquired earlier, but it does show that the stages and syllable types by Fikkert (1994) and Levelt, Schiller and Levelt (2000) illustrate the order of syllable types as used in simplification of target words.

Furthermore, concerning the differences in the syllable type development, differences beside the placing of the CVC syllable type development were found as well, considering the cluster development. Levelt, Schiller and Levelt (2000) concluded that children either acquire the complex onset first or the complex coda. To allow for comparison, an additional measure has been used in Chapter 5.3. This measure shows that the results of the current study do not show the same pattern. This is further explained in Chapter 5.2 and 5.3.

Research Question 2: How can the development of syllable types as found by Levelt, Schiller and Levelt (2000) be linked to ages of development, using spontaneous speech data gathered for the current study?

To allow for a clear comparison between children of a similar age, percentages were calculated for each syllable type at every age available in the transcripts. Based on these percentages, an age range was concluded for each syllable type, based on the rules as described in Chapter 3.12. In Table 26, a combination of the age groups as provided in Chapter 4 is shown. The second column provides age ranges for when the participants have acquired a specific syllable type. The third column provides

age ranges for the age at which participants have started developing a specific syllable type. These ages provide a good insight into when children are expected to have started developing or have acquired a specific syllable type. Some of the age ranges are wider than others. For example, the CVC syllable type shows a variation of 19 months for when this syllable type can be acquired, yet the CV syllable types is acquired over the course of 5 months. For this reason, the ages when a syllable type is under development have been added. When a child is 2;2 years old, for example, a child does not need to have fully acquired the syllable type VC yet. However, the child would be expected to have at least started developing this syllable type. Providing both measures gives insight into the severity of a delayed syllable type development, when used for screening or diagnostic purposes.

Table 26: Age ranges for the development and acquisition of each syllable type

Syllable types	Age groups (syllable type acquired)	Age groups (syllable type under development)
CV	1;1 – 1;6	1;1 – 1;5
V	1;3 – 2;0	1;3 – 1;7
VC	1;4 – 2;5	1;2 – 1;10
CVC	1;1 – 2;8	1;1 – 2;3
CCV	2;2 – 3;11	1;11 – 2;8
CCVC	1;11 – 3;9	1;11 – 3;9
CVCC	1;11 – 3;11	1;9 – 2;7
VCC	1;8 – no data	1;8 – 3;9
CCVCC	2;7 – 3;10	2;7 – 3;0
CCC	3;4 – no data	1;11 – 3;9
Clusters combined	–	1;11 – 3;9

The final row of Table 26, the calculation of the age at which children start correctly producing ‘clusters combined’ is only included in the age groups for syllable types under development, not for syllable types acquired. The age range when clusters in general are expected to be under development is expected to be accurate. It is concluded that the age when clusters are generally expected to have started developing would be between the ages of 1;11 and 3;9. The acquisition of clusters in general is more difficult. As stated earlier, there is too little data available on the syllable types VCC and syllable types including a branched complex onset or coda (CCC). Therefore, a combination that includes a lack of target words in these categories does not represent the

acquisition of clusters as a whole. Furthermore, children older than 3;11 were not included in this study. Participant 32 showed problems with most syllable types until the age of 3;10. After this age, there is no data available on this child's further cluster development. It is likely that the acquisition of clusters in general is still ongoing at the age of 3;11. Therefore, for cluster development, it would be safer to implement the 'under development' age group, as the age group for having acquired complex syllable types should include children of an even older age (also see chapter 5.6).

The separate calculations for complex syllable types also have some gaps, caused by, either too few instances where children selected the complex syllable type at least three times, allowing for calculation of a percentage, or caused by a lack of data from children over the age of 3;11. Therefore, these numbers need to be interpreted with caution. The calculations for CCV, CCVC, CVCC and CCVCC for syllable types under development are expected to be accurate, as these syllable types have started developing earlier than 3;11 and were measured with a sufficient number of productions at various ages.

Research Question 3: How can the acquired normative data on syllable template development be included in speech language therapy and diagnostics in the clinical setting?

The age ranges as provided in Table 26 could be used for screening, diagnostic and treatment purposes. This will be further illustrated by using the results of Participant 15 and 27, in Chapter 5.5. If a child's phonological development is delayed or deviant, this could be recognised in the syllable type development. If a child has not acquired a specific syllable type by the final age of acquisition, or if a child has less than 50% correct when a syllable type is measured to be expected to be under development, the child's syllable type development and therefore aspects of the phonological development are expected to be delayed or deviant. For this purpose, a diagnostic tool could be developed.

Due to the unavailability of data of children above the age of 3;11, we would advise not to include these age groups in any type of screening, diagnostics or treatment options. Instead, it would be safer to use the expected age group for complex syllable types in general to be under development. If a child has not started developing complex syllable types by the age of 3;9 (see Table 27), the cluster development is expected to be delayed.

Table 27: Age ranges for the development and acquisition of each syllable type

Syllable types	Age groups (syllable type acquired)	Age groups (syllable type under development)
CV	1;1 – 1;6	1;1 – 1;5
V	1;3 – 2;0	1;3 – 1;7
VC	1;4 – 2;5	1;2 – 1;10
CVC	1;1 – 2;8	1;1 – 2;3
Clusters combined	–	1;11 – 3;9

The results have shown that the VC syllable type is easier to correctly produce than the CVC syllable type. Therefore, in phonological therapy, when selecting target words, it is possible that VC words are easier for a child to practise. For example, when treating the process of final consonant deletion, it might be easier for the child to use words as *aap* 'monkey' or *eet* 'eat' to practise the occurrence of the final phonemes /p/ or /t/, than it would be to use the word *pop* 'doll' or *mat* 'rug'. This hypothesis would need to be tested in further research.

5.2 Hypotheses

Hypothesis 1: Dutch acquiring children can be categorised into one of the two following groups (Levelt, Schiller & Levelt, 2000):

a) The first acquired complex syllable type has a complex onset
b) The first acquired complex syllable type has a complex coda

Further information is provided in Chapter 5.3.1 on this subject and about Table 28. From the measurements as depicted in Table 28, which shows the first occurrence of two productions of clusters, the age at which a child is measured to have produced a complex onset or coda twice for the first time occurs at almost the same moment for seven of the participants. Participants 21 and 3 are measured to have started implementing the complex onset first, and participants 20 and 22 appear to have started utilising the complex coda first. Therefore, this hypothesis is only partly falsified. Four of the participants are measured to start implementing the complex onset or coda, while the other seven measures showed a pattern where both the complex onset and the complex coda was implemented at basically the same age. However, part of this hypothesis is falsified, as we

have determined that the method as used by Levelt, Schiller and Levelt (2000) shows a simplification pattern of syllable types, not necessarily a syllable type acquisition pattern.

Hypothesis 2: The wider range of ages and higher number of participants included in the current study will provide clear ages of acquired syllable types.

This hypothesis is supported by the results as found in the current study. As provided in Chapter 5.1, an age range has been calculated for each syllable type. Especially for the earlier syllable types CV, V, VC and CVC, these results are expected to be reliable. The clusters were more difficult, as some children are still developing the complex consonants after the age of 3;11.

5.3 Consonant Clusters

As shown in the Chapter 4.16 – 4.1.9, it has proven difficult to calculate definitive percentages of the acquisition of complex syllable types, due to lack of target words with a complex onset and/or a complex coda. To provide alternative numbers for the development of complex syllable types, three additional measurements were included in this study. First, to be able to compare these findings to the results as found by Levelt, Schiller and Levelt (2000), the number of productions of a syllable type is calculated, to find the first captured moment where the participant has produced at least two complex onsets or two complex codas. These numbers, as found in Appendix XIV show the combined number of correct productions and the simplifications including a cluster, measured separately for complex onsets and complex codas. Secondly, the percentages of correctly produced consonant clusters was measured for every complex syllable type combined.

5.3.1 First measure of two productions of complex onsets and complex codas

With the restriction of implementing a minimum of two productions, as was used in the calculations by Levelt, Schiller and Levelt (2000; 240), the first moment the production of a complex onset or complex coda is measured twice in the data of the participant is shown in Table 28 (also see Appendix XIV). The variation that was seen in the attempt to calculate an age group for the complex consonant syllable types development (Chapter 4.1.6 – 4.1.9), is measured again in this table. The age at which the participants start to utilize and simplify syllable structures using consonant clusters, varies. The final participants 4, 8, 5, 14, 18, 28, 32 and 35 were not included in this table, as they all uttered at least two productions in their first recordings and every following recording.

Table 28: The first occurrence of two productions of complex onsets and complex codas[14]

	CCV + CCVC	VCC + CVCC
Participant 2	-[15]	-
Participant 7	-	-
Participant 10	-	-
Participant 17	1;7	1;8
Participant 21	1;7	-
Participant 24	-	-
Participant 25	-	-
Participant 34	-	-
Participant 36	-	-
Participant 3	1;10	-
Participant 9	1;11	1;11
Participant 12	1;8	1;7
Participant 15	-	-
Participant 19	-	-
Participant 20	-	1;10
Participant 29	-	-
Participant 6	2;2	2;3
Participant 11	2;4	2;4
Participant 22	-	2;6
Participant 27	-	-
Participant 26	2;7	2;7
Participant 31	2;6	2;6
Participant 33	2;6	2;10

The ages in Table 28 do not show the moment where a complex onset or coda is acquired, but provide information about the moment when a child first starts to implement clusters. The measurements suggest that this moment occurs between the age of 1;7 and 2;7 for complex onsets and between the age of 1;7 and 2;10 for complex codas. However, the lack of two or more

[14] Note that these calculations also include simplification patterns, where a child utilises a complex syllable structure to simplify a more difficult syllable type.
[15] A dash represents that the participant has not produced two or more complex onset syllable structures throughout the received recordings.

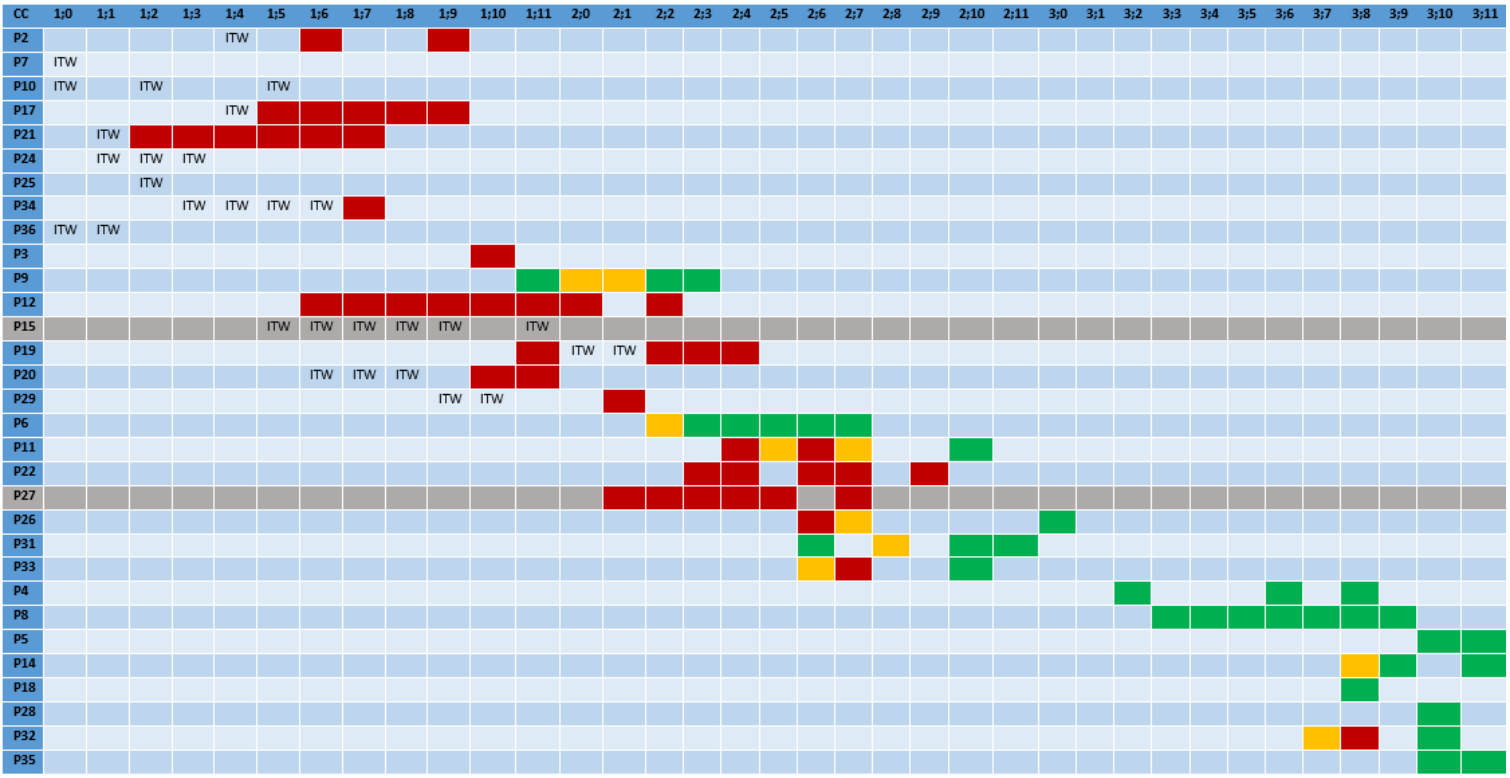
productions of clusters in other participants of the same age, suggests a larger variety. For example, in Table 19, participant 19 is measured to have produced 0% of the CCVC syllable types correctly at the age of 2;2, 2;3 and 2;4. Low percentages are also shown in Table 19 for participant 22 at the age of 2;4 – 2;9 and for participant 29 at the age of 2;1. In both these measurements, not a lack of target words containing clusters, but the inability to correctly produce these clusters is shown to be the case for certain participants. Therefore, the age at which a child starts implementing clusters in their spontaneous speech shows great variety between children.

Furthermore, the measurements as provided in Table 28 show that calculating only the number of occurrences provides results that do not necessarily mean a child has acquired a certain syllable type. For example, participant 12, followed from age 1;6 until 2;2 years old, has not acquired any of the complex consonant syllable types during the length of this study. Yet the calculations, when measuring a first occurrence of at least two productions of a certain syllable type, show an occurrence of both the complex onset and the complex coda at 1;8 and 1;7 years old, respectively. Even when calculated separately, the syllable types CCVC with 4 productions at 1;8, and CVCC, with 2 productions at 1;7, would be counted as acquired in the results of Levelt, Schiller and Levelt (2000). However, at 1;8, participant 12 only correctly produced 25% of the target CCVC words, and at 1;7 had also only correctly produced 25% of the CVCC target words.

5.3.2 Combined complex syllable type development

As a second alternative, a table was made to calculate the development of every consonant cluster combined, to check if these total percentages differ from the image that is gathered for the individual complex syllable types. These percentages can be found in the External Appendix. In Table 29, the general development of complex syllable types combined is illustrated. In this table, a similar pattern is found as in Tables 17, 19 and 22, where Participant 9 and Participant 11 start correctly producing complex syllable types before their age matched peers, while Participant 32 shows a difficulty with clusters at a later age than the others.

Table 29[16]: Pattern of percentages of correctly produced complex syllable types combined



5.3.3 Calculation of percentage of clusters correct

Within the scope of the current study, the main focus in examining the development of syllable structures including clusters was the order in which the different cluster syllable types are acquired. Therefore, in calculating the acquisition of clusters, no differences have been included of how difficult a specific cluster might be for children of a certain age. The calculations were only based on the syllable structure, not including any variety in difficulty of different clusters. For example, as researched by Stes (1997), 75% of three-year-old children are expected to have acquired the complex onset /tw/, while combinations with an /l/, such as the complex onsets /bl/, /fl/ and /pl/ are acquired by 75% of four-year-old children. The acquisition of more complex clusters, such as the complex onsets including an /r/ or an /s/, is still ongoing until the age of nine (Stes, 1997: 52). The Dutch articulation test *Nederlands Articulatieonderzoek (NAO)* (Baarda et al., 2013), employs as a general guideline for the indication of therapeutic intervention, that at least 75% of consonant clusters must be acquired by the age of six years old, excluding three-consonant clusters, in accordance with the results by Stes (1997) (Baarda et al., 2013; 30). Considering that the current study has only included children until the age of 4;0, many cluster combinations would be expected to not have been

[16] The colours in this table correspond to the colours used in the previous similar tables. Red means a percentage of less than 50%, yellow means 50 to 75% correctly produced complex syllable types, and green means the complex syllable types combined were correctly produced at least 75 percent.

acquired yet. Looking at the results as shown in Table 29 however, which combines every target word including a cluster, 13 of the participants have correctly produced at least 75% of the target clusters. Especially after the age of 2;10, many of the participants produce the target clusters correctly very often, also including clusters that Stes (1997) has found to be difficult until a later age. For example, Participant 11 produces the complex onset /sp/ for [spel@] and the complex coda /rt/ for [part] incorrectly at the age of 2;6, followed by several correct productions of these and other clusters at the age of 2;10.

Subsequently, as measured by Beers (1995), the phonological process cluster reduction occurs only 2-7 times in a spontaneous speech sample of 100 words between the age of 3;6 and 4;0, a finding that supports the general results as found in the current study, where many children between 2;10 and 4;0 produce the clusters they have selected correctly. One explanation for these differences could be that the target words that children frequently select in their spontaneous speech at this young age, are correctly produced at an earlier age than words containing clusters that are not selected frequently by young children. Another aspect that is important to address relating to these differences, is that general results for every target cluster combined do not provide any information about which clusters a child has acquired separately, which has been provided by Stes (1997). For example, Participant 11, at the age of 2;4, correctly produces the complex onset /kl/ for [klEin] *small* or [klar] *done* on three occasions. In the same transcript, the complex onset /sl/ as in [slap] *sleep* is incorrectly produced six times. This pattern, where the complex onset /kl/ is acquired before the complex onset /sl/ correlates with the pattern as found by Stes (1997). As shown by this example, it is very difficult to try and compare the very different results as found by Stes (1997), Beers (1995) and as found in the current study, due to the different aspects that are focused on. Therefore, the main comparison that is made in the current study, is with the work of Levelt, Schiller and Levelt (2000), who have also focused on the specific aspect of (complex) syllable structures.

5.4 Differences in number and usable content of recordings

As shown in Chapter 3.8, the number of received recordings for each participant and the age range in which recordings were made varied. Furthermore, some children were recorded repeatedly during one month of their age, while another was only recorded once. This has an influence on the number of utterances that each calculation for percentages of correctly produced syllable types is based on. For example, 199 words are included for Participant 12 at the age of 1;9, gathered from recordings at the ages 1;9.0, 1;9.4, 1;9,15, 1;9.19 and 1;9.27. Participant 2, at the age of 1;9.22, was recorded once during the age of 1;9, providing a total of 55 target words during this recording. The more recordings, and therefore the more data is available for each participant, the more accurate the calculations of

percentage of correctly produced syllable types will be. In a larger study, it would be preferable to compare transcripts of the same length to each other. Specifically, comparing the same number of target words including a certain syllable type would be ideal. Considering that the current data is gathered through the spontaneous speech of children, it would be necessary to include a larger number of participants and a larger dataset to be able to realise this objective. Otherwise, as is found in the results of the current study, certain syllable types will not be selected enough in the spontaneous speech sample.

In some cases, the number of recordings was influenced by the child's age. Some of the children just turned one year old in September or October 2017, allowing a very short window for gathering recordings. Other participants turned four years old during the period of time in which recordings were collected. As the data of children older than 4;0 were not included in the current study, this also limited the time frame for recording these participants.

Parents of the participants also shared other reasons why some children were recorded less frequently. The youngest age group of one-year-old children were difficult to record during times when they were producing meaningful and intelligible utterances. A recording where the child produces few meaningful words also influences the number of recordings that have provided data with certain syllable types that were produced less than three times, and were therefore not calculable. Furthermore, parents explained that it sometimes proved difficult to create a moment to record one child, without siblings speaking in the background or including themselves in the conversation. Parents also reported that some children reacted differently when they could see they were being recorded. They would refuse to talk, or they would be preoccupied with the recording instead of the conversation or activity at hand. This contributed to some recordings being made with only audio instead of a preferable video recording, but it also contributed to some participants being recorded less frequently.

In Appendix XI, the distribution of the ages of the participants is provided. Every group consisted of at least 7 participants, except for the age group of 3;0 years old up to and including 3;5 years old, which only consists of three participants. In the various tables that show the percentages of syllables the participants correctly produced, fewer results are seen in this underrepresented age group. However, the acquisition of the first syllable types that a child develops, namely CV, V, VC and CVC, are calculated with the age groups until 2;7 (Tables 9, 11, 13 and 15). The lack of children in the age group from 3;0 to 3;6 does not influence these results, as the participants are calculated to have acquired these syllable types at the age of 2;8 at the latest. For the acquisition of complex syllable types, it would have been preferable to have included more children in the aforementioned age group. However, the group of children between 3;6 and 4;0 did include eight participants, and therefore provides information on the development of complex syllable types after 3;6 years old. The

results suggest that the complex syllable types are still under development in this last age group. Consequently, the lack of results of the fifth age group included in this study appears to be the least influential on the validity of the results, as the age of 3;0 to 3;6 is shown to be the age where the acquisition of the earliest syllable type is finalised, while the cluster development is still ongoing.

Additionally, another aspect that has possibly had an influence on the results is the variation of the content of each recording. Some recordings included many repetitive words, especially with young children who have a smaller vocabulary than older children. A specific activity or certain playing material might have influenced the child to produce specific words repeatedly, or to produce phonologically difficult words repeatedly, causing the percentage of correctly produced syllable type to drop. For example, Participant 11 is playing with toy bunnies and is feeding them carrots. The child produces the word *worteltjes* 'small carrots', a word containing three CVC syllable types, as /Worc@s/ or /Woc@s/ several times. Every production, depending on the production, one or two target CVC structures are incorrectly produced. This is one of the words that influenced the percentage of correctly produced CVC structures to drop to 53,7%, while this participant scored 85,7% one month before and 87,6% one month after. Obviously these difficult words are also correct measurements for the child's ability to correctly produce a certain syllable type. Participant 11 included a total of 67 target CVC words, of which 36 were correctly produced, and the drop of the CVC structure is not only due to this example. However, when calculating these percentages, the selected target words and the variety in target words does play a role in the outcome. As mentioned before, it is therefore very important to include an adequate number of utterances.

5.5 Background information and excluded participants

The gender of the participants, regions in which they are growing up and the sibling position all varied amongst the participants. The mother of every participant, however, received a high level of education. This might have had an influence on the results. It would be advisable to gather additional data from children with mothers who have received a low or middle level of education.

As described in Chapter 3.5.2, two of the participants were excluded from the results, Participant 15 and Participant 27. In every table, the results of these participants have been coloured grey. This provides insight into the applicability of syllable type calculations for children with possible speech or language problems. Both participants showed problems with various syllable types at a later age than the average calculated age groups, or did not produce enough utterances to measure a percentage. Their results have been displayed in Table 30 for Participant 15 and in Table 31 for participant 27. These results show that a syllable type measure could be a good screening for possible problems with language (P15) or phonology (P27).

Table 30: Results for P15 in comparison to age groups[17]

Syllable types	Age groups (acquired)	Age groups (under development)	Results P15 (acquired)	Results P15 (under development)
CV	1;1 – 1;6	1;1 – 1;5	1;9	1;9
V	1;3 – 2;0	1;3 – 1;7	ITW up until 1;11	ITW up until 1;11
VC	1;4 – 2;5	1;2 – 1;10	ITW up until 1;11	ITW up until 1;11
CVC	1;1 – 2;8	1;1 – 2;3	Not acquired at 1;11	1;6
Clusters combined	-	1;11 – 3;9	ITW up until 1;11	ITW up until 1;11

Table 31: Results for P27 in comparison to age groups

Syllable types	Age groups (acquired)	Age groups (under development)	Results P27 (acquired)	Results P27 (under development)
CV	1;1 – 1;6	1;1 – 1;5	-	-
V	1;3 – 2;0	1;3 – 1;7	-	-
VC	1;4 – 2;5	1;2 – 1;10	Not acquired at 2;7	2;4
CVC	1;1 – 2;8	1;1 – 2;3	Not acquired at 2;7	2;1
Clusters combined	-	1;11 – 3;9	Not acquired at 2;7	Not under development at 2;7

Furthermore, the speech of one child, whose parents explained that they had some doubts about the child's phonological development, was examined more closely, to make sure this would not influence the results. The child appeared to catch up on the phonological development very well, without receiving therapy, which is why the child has been included in the results. However, it is still possible that this child's possibly slightly deviant phonological development could have an impact on the results. In Table 11, this participant (33) is the last one to produce less than 75% correctly, albeit only by a few percent (73,3%). Participant 11, who did not have any previous notable problems with

[17] The results were only calculated if the child was recorded during the target age group of when the syllable type is expected to be under development, unless the child still showed problems with the syllable type at a later age.

speech, language or hearing, scored 53,3% at an age of only two months younger. In the other calculations, Participant 33 fits in with the general pattern. Similarly, with young children, such as in the current study, it is still possible that some of the participants will prove to have problems with speech and/or language at a later age. Additionally, much variation can occur between the phonological development of participants.

Furthermore, five of the participants have had a history of temporary problems with their hearing. In their transcripts, there were no noticeable problems with speech and/or language development, there were no current problems with their hearing, and they all scored very good on the SNEL. However, it is still possible that a history of lesser hearing has had an influence on their phonological development and therefore, on the results. Only in the calculations for the VC syllable type, in Table 15, this might have had a slight influence. Participant 22 scores 55,6% at age 2;4, while the other latest instance of the VC syllable type being under development is Participant 19 at age 2;2 with 60%. The other tables show no noticeable influences by the participants with a history of hearing problems.

5.6 Recommendations for further research

To realise a screening or diagnostic tool for syllable type development as an indicator for phonological or language problems, a data set of young children who have just been diagnosed, but who have not received treatment yet, would be necessary. These results could then be compared to the average development as calculated in the current study, such as the examples of the results for Participant 15 and 27 (Table 30 and 31).

Furthermore, as explained in Chapter 5.1, we cannot be certain that the calculations for the acquired complex syllable types are accurate, as there were no children included in this study that were older than 3;11. Additional information about whether children above the age of 3;11 have indeed acquired the complex syllable types is necessary to be able to include these age groups in any form of screening or diagnostics.

Finally, further research would be necessary to measure whether children prefer the VC syllable type to the CVC syllable type when receiving therapy for the development of final consonants, as discussed in Chapter 5.1.

6. *Conclusion*

Using spontaneous speech data gathered from 31 participants, the current study has succeeded in its main goal to provide age ranges for syllable type development in monolingual Dutch children. Using the transcripts of every recording, a percentage of the correctly produced syllable types was calculated for each syllable type. This was used to show whether a child, at a specific age, had acquired a syllable type, whether the syllable type was still under development, or whether the syllable type had not started to develop yet. These numbers allowed for the calculation of age ranges for the acquisition of each syllable type. One age group was provided that showed the expected ages of syllable types to be under development. Another age group was provided that showed the age range of the acquisition of the various syllable types.

By combining and comparing the results of the participants, we have found a different order of syllable type acquisition than the available results by Levelt, Schiller and Levelt (2000) and Fikkert (1994). Based on the presence of syllable types, rather than a percentage of correctly produced syllable types, both Levelt, Schiller and Levelt (2000) and Fikkert (1994) concluded that the CVC syllable type was acquired before the V and VC syllable type. In the current study, participants are measured to have acquired the CVC syllable type after the V and VC syllable type. The results suggest that children have fewer problems with V and VC. Very few mistakes are registered for the V and VC syllable types. Moreover, the correct production of the CVC syllable type remains more difficult until a later age.

The acquisition of clusters was partly measured. For some complex syllable types, the participants did not select enough target words to allow for calculating a percentage of correctly produced syllable types. For the clusters combined, however, we have calculated that children are expected to have started developing clusters between the ages of 1;11 and 3;9. No evidence was found for a pattern where every participant would acquire the complex onset or the complex coda first, as was found in previous research by Levelt, Schiller and Levelt (2000).

The age ranges that have been provided can be used for diagnostic purposes, for example to measure if a child's syllable type acquisition is developing normally or if there is a suspected problem with the child's phonological development. Further research could focus on creating a diagnostic tool for measuring syllable type development, and on further gathering data on complex syllable type development for children between 3;0 and 3;11 and also above the age of 3;11. This would complete the gaps in the data of the current study on complex syllable type acquisition.

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Appendices

Appendix I: ASCII notation (Jansonius-Schultheiss et al., 2014: 125)

ASCII

ASCII, met voorbeelden van de bedoelde klanken

Vocalen	voorbeeld	Consonanten	voorbeeld
/I/	d*i*k	/p/	*p*ak
/E/	m*e*t	/b/	*b*ak
/O/	p*o*p	/t/	*t*ak
/Y/	b*u*s	/d/	*d*ak
/^/	d*a*t	/k/	*k*oek
/i/	k*ie*r	/f/	*f*iets
/y/	m*uu*r	/v/	*v*ies
/u/	b*oe*k	/s/	*s*oep
/e/	v*ee*l	/z/	*z*ee
/q/	r*eu*s	/x/	la*ch*en
/o/	b*oo*s	/G/	*g*a
/a/	k*aa*s	/m/	*m*os
/Ei/	t*ij*d	/n/	*n*eus
/@y/	*ui*t	/N/	la*ng*
/Au/	k*ou*s	/l/	*l*os
/@/	d*e*	/r/ of /R/	*r*aam
		/j/	*j*aar
		/c/	bie*tj*e
		/W/	*w*aar
		/h/	*h*elp
		/S/	*sj*aal
		/Z/ *	*g*iraf

Als een medeklinker niet herkenbaar is, dan is de notatie een Q voor een medeklinker
Als een klinker niet herkenbaar is, dan is de notatie een V voor de klinker (V = vocaal)

Bij transcriptie in ASCII ten behoeve van een fonologische analyse gaat het primair om de fonemen die geuit zijn. Dit betekent dat distorsies die fonetisch van aard zijn niet worden getranscribeerd. Een sigmatismus interdentalis, of nasale emissie op de p hoeven niet te worden getranscribeerd. De s-interdentaal wordt als /s/ getranscribeerd, de p met nasale emissie als /p/, ten behoeve van een fonologische analyse.

Appendix II: Letter to recruit participants

Beste ouder(s)/verzorger(s),

Momenteel ben ik bezig met mijn masteronderzoek voor de master General Linguistics met als richting Klinische Linguïstiek, aan de Universiteit van Amsterdam. Voor mijn onderzoek ben ik op zoek naar ouders van kinderen van één tot vier jaar die het leuk zouden vinden om met hun kind mee te werken aan mijn onderzoek.

Wat houdt het onderzoek in?

Het onderzoek zal zich richten op de ontwikkeling van de syllabestructuur bij Nederlandstalige kinderen. Dit houdt in dat ik ga kijken naar de opbouw en de uitspraak van de woorden die ze gebruiken. Door in kaart te brengen hoe deze ontwikkeling bij kinderen met een normale spraaktaalontwikkeling verloopt, kan vergeleken worden wanneer kinderen een afwijkende of vertraagde ontwikkeling doormaken. Indien u dit leuk zou vinden, kunt u het uiteindelijke onderzoek toegestuurd krijgen.

Wat wordt er van u gevraagd?

In een periode tussen mei t/m oktober 2017 wordt van u gevraagd de spraak van uw kind regelmatig vijf minuten op te nemen, bijvoorbeeld in een gesprekje of tijdens het samen spelen (dit mag ofwel een video-opname of alleen een geluidsopname zijn). Voorafgaand aan uw medewerking wordt samen afgesproken wat voor u haalbaar zou zijn. Het gaat om iedere week of iedere twee weken één opname, herhaald tussen de één en zes maanden. Door de spraak van uw kind langer te volgen, kan ik een goed beeld krijgen van de ontwikkeling. Indien uw kind al bijna vier is of nog net geen één, dan is dit ook geen probleem. Iedere maand die binnen de genoemde leeftijd valt, is een waardevolle bijdrage.

Bij voorbaat dank voor uw overweging van mijn vraag. Ik hoor het erg graag wanneer u bereid zou zijn om mee te werken aan mijn onderzoek. Voor vragen of verdere informatie kunt u via onderstaande gegevens contact opnemen.

Vriendelijke groet,

Nanette Boxma
nanette.boxma@gmail.com / 06-14823896

Appendix III: Informed Consent form

Informatiebrochure

Betreft: Medewerking masteronderzoek N. Boxma, student General Linguistics, Universiteit van Amsterdam.

Beste ouder/verzorger,

Samen met uw kind gaat u deelnemen aan het onderzoek 'Ontwikkeling van de syllabestructuur van Nederlandstalige kinderen' door masterstudent N. Boxma aan de Universiteit van Amsterdam. Dit onderzoek wordt uitgevoerd onder begeleiding van Prof. Dr. J. Schaeffer en Dr. S. Hamann als verantwoordelijke onderzoekers. Voordat het onderzoek begint, is het belangrijk dat u kennis neemt van de procedures die in dit onderzoek worden gevolgd. Leest u het onderstaande daarom zorgvuldig door.

Doel van het onderzoek

Het onderzoek zal zich richten op de ontwikkeling van de syllabestructuur bij Nederlandstalige Kinderen met een normale spraaktaalontwikkeling. Dit houdt in dat ik ga kijken naar de opbouw en de uitspraak van de woorden die ze gebruiken. Deze informatie kan vergeleken worden met de syllabestructuur van kinderen die een afwijkende of vertraagde spraaktaalontwikkeling doormaken, om te bepalen in hoeverre de ontwikkeling van de syllabestructuur vertraagd of afwijkend verloopt.

Wie kan er aan dit onderzoek meedoen

Voor dit onderzoek worden ouders met kinderen tussen de 1;0 en 4;0 jaar oud uitgenodigd. Voorafgaand aan het onderzoek wordt u een aantal vragen gesteld over de ontwikkeling van uw kind. U wordt gevraagd om zowel de screeningsvragenlijst SNEL in te vullen en een aanvullende vragenlijst. Gezien de aard van het onderzoek is het met name van belang dat er geen problemen bekend zijn met het gehoor of de spraaktaalontwikkeling. Hiernaast worden enkele vragen gesteld over de taal die thuis gesproken wordt en de (taal)achtergrond van de ouders. Uw kind kan meedoen aan het onderzoek als het kind ééntalig Nederlands wordt opgevoed.

Instructie en procedure

In een periode tussen mei t/m oktober 2017 wordt van u gevraagd de spraak van uw kind regelmatig vijf minuten op te nemen, bijvoorbeeld in een gesprekje of tijdens het samen spelen (dit mag ofwel een video-opname of alleen een geluidsopname zijn). Voorafgaand aan uw medewerking wordt samen afgesproken wat voor u haalbaar zou zijn. Het gaat om iedere week of iedere twee weken één opname, herhaald tussen de één en zes maanden. De afgesproken frequentie en duur van deelname kan op ieder moment gewijzigd worden. Het is voor dit onderzoek niet nodig dat de onderzoeker aanwezig is bij de opnames. Er wordt niet van u verwacht dat de opnames ieder moment op dezelfde dag of tijdens dezelfde activiteit zullen worden gemaakt. Enkele tips voor optimale opnames worden aanvullend toegestuurd.

Vrijwilligheid

Samen met uw kind doet u vrijwillig mee aan dit onderzoek. U kunt dan ook op elk moment gedurende het onderzoek uw deelname stopzetten, tot 8 dagen na het versturen van de laatste opname. Dit zal geen gevolgen voor u hebben en u bent in geen geval verplicht de hierboven beschreven procedures af te ronden. Als u uw deelname staakt of intrekt, worden alle verzamelde gegevens definitief verwijderd.

Vertrouwelijkheid van de onderzoeksgegevens

De gegevens die in dit onderzoek verzameld worden, worden gebruikt ten behoeve van het masteronderzoek van N. Boxma. Hierbij wordt geen gebruik gemaakt van persoonsgegevens van uw kind en de anonimiteit blijft onder alle omstandigheden gewaarborgd. De verzamelde onderzoeksgegevens zullen gecodeerd opgeslagen worden, apart van de persoonlijke gegevens van uw kind. Alleen de onderzoeker, N. Boxma, heeft toegang tot deze gegevens en de codering. De verzamelde video- en/of audio-opnamen zullen nooit zonder uw schriftelijke toestemming voor publiek gespeeld worden. U ontvangt een apart formulier waarop u desgewenst deze toestemming kunt verlenen.

Resultaten

Als u daar prijs op stelt, ontvangt u te zijner tijd een kopie van het onderzoeksverslag.
Wanneer uit de vragenlijst, de screeningsvragenlijst SNEL of uit de opnames zelf informatie komt die mogelijk wijst op een afwijkende of vertraagde spraaktaalontwikkeling, dan wordt u hier persoonlijk over geïnformeerd door N. Boxma en wordt u geadviseerd over eventuele vervolgstappen.

Nadere inlichtingen

Als u nog verdere informatie wilt over dit onderzoek, dan kunt u zich wenden tot de onderzoeker N. Boxma (telefoon: 0614823896; e-mail: nanette.boxma@gmail.com; Achter ’t Zand 55, 4103XN Culemborg). Hiernaast kunt u zich wenden tot de verantwoordelijke onderzoekers/begeleiders: Prof. Dr. J. Scheaffer (telefoon: 0205252083; e-mail: j.c.schaeffer@uva.nl) en Dr. S. Hamann (telefoon: 0205252194; e-mail: s.r.hamann@uva.nl).

Met eventuele klachten over dit onderzoek kunt u zich wenden tot de secretaris van de Commissie Ethiek van de Faculteit Geesteswetenschappen van de Universiteit van Amsterdam, commissieethiek-fgw@uva.nl (telefoon: 020-525 3054; Kloveniersburgwal 48, 1012 CX Amsterdam).

Informed consent (onderzoek bij kinderen)

Betreft: 'Ontwikkeling van de syllabestructuur van Nederlandstalige kinderen' door N. Boxma

'Ik verklaar hierbij op voor mij duidelijke wijze te zijn ingelicht over de aard en methode van het onderzoek, zoals uiteengezet in bovenstaande informatiebrochure. Mijn vragen zijn naar tevredenheid beantwoord.

Ik verklaar bevoegd te zijn om voor deelname van het kind aan het bedoelde onderzoek te tekenen.

Ik stem geheel vrijwillig in met deelname van het onder mijn gezag vallende kind aan dit onderzoek. Ik behoud daarbij het recht deze instemming tot 8 dagen na het onderzoek weer in te trekken zonder dat ik daarvoor een reden behoef op te geven en besef dat het kind op elk moment mag stoppen met het experiment. Indien ik mijn deelname staak of mij terugtrek uit het onderzoek, zullen de verzamelde gegevens worden verwijderd. De onderzoeksresultaten van het onder mijn gezag vallende kind zullen volledig geanonimiseerd gebruikt worden in uitwerkingen van het onderzoek van N. Boxma. De persoonsgegevens van het kind zullen niet door derden worden ingezien zonder mijn uitdrukkelijke toestemming.

Ik geef hierbij toestemming tot het geanonimiseerd verwerken (uitschrijven, analyseren en uitwerken ten behoeve van het masteronderzoek) van de spontane spraak van het onder mijn gezag vallende kind middels de aangeleverde video/audio fragmenten.

Als ik nog verdere informatie over het onderzoek zou willen krijgen, nu of in de toekomst, kan ik me wenden tot de onderzoeker N.Boxma (tel: 0614823896 of e-mail: nanette.boxma@gmail.com) of tot de verantwoordelijke onderzoekers/begeleiders: Prof. Dr. J. Scheaffer (telefoon: 0205252083; e-mail: j.c.schaeffer@uva.nl) en Dr. S. Hamann (telefoon: 0205252194; e-mail: s.r.hamann@uva.nl). Met eventuele klachten over dit onderzoek kan ik me wenden tot de secretaris van de Commissie Ethiek van de Faculteit Geesteswetenschappen van de Universiteit van Amsterdam, commissieethiek-fgw@uva.nl (telefoon: 020-525 3054; Kloveniersburgwal 48, 1012 CX Amsterdam).'

Aldus in tweevoud getekend:

……
Naam proefpersoon (kind)

…… ……
Naam gezaghebbende Handtekening

'Ik heb toelichting verstrekt op het onderzoek. Ik verklaar mij bereid nog opkomende vragen over het onderzoek naar vermogen te beantwoorden.'

…… ……

Naam onderzoeker Handtekening

…… Datum

Appendix IV: Optional addition to Informed Consent

Optionele aanvulling informed consent

Betreft: Medewerking masteronderzoek N. Boxma, student General Linguistics,
Universiteit van Amsterdam.
Onderwerp onderzoek: Ontwikkeling van de syllabestructuur van Nederlandstalige kinderen.

Voor deelname aan dit onderzoek is het invullen van dit formulier niet noodzakelijk. Deze aanvulling is volledig optioneel.

Kruis aan indien van toepassing:

☐ Hierbij geef ik toestemming om de transcripten (uitgeschreven spontane spraak) en de biografische- en achtergrondgegevens, zoals verkregen middels de ingevulde vragenlijst en de SNEL, geanonimiseerd beschikbaar te stellen voor overig aanvullend onderzoek door:

☐ N. Boxma ☐ derden

☐ Hierbij geef ik toestemming voor het geanonimiseerd gebruiken van de aangeleverde video/audiomateriaal van mijn kind ten behoeve van academische en educatieve doeleinden door:

☐ N. Boxma ☐ derden

Aldus in tweevoud getekend:

……
Naam proefpersoon (kind)

…… ……
Naam gezaghebbende Handtekening

_____

…… ……

Naam onderzoeker Handtekening

…… Datum

Appendix V: Questionnaire

Medewerking masteronderzoek N. Boxma, student General Linguistics, Universiteit van Amsterdam.

Onderwerp: Ontwikkeling van de syllabestructuur van Nederlandstalige kinderen.

1. Gegevens kind

Naam: ..... jongen / meisje

Geboortedatum: .. / .. / .... Maakt deel uit van een tweeling/meerling? Ja / Nee

Adres: .....

Postcode en woonplaats: .....

Geboorteland: .....

Welke taal wordt thuis het meest gesproken? ☐ Nederlands ☐ Anders, namelijk: .....

.....

Op welke schooltype zit het kind? ..... ☐ Niet van toepassing

Zijn er bijzonderheden in de ontwikkeling/de gezondheid van het kind? .....

.....

.....

2. Gegevens ouder(s)/verzorger(s)

Telefoonnummer: .....

E-mailadres: .....

Gezinssamenstelling/bijzonderheden (inclusief leeftijden broers/zussen): .....

.....

Hoogst genoten opleidingsniveau, afgerond met diploma:

Vader/verzorger:

☐ geen of basisonderwijs ☐ vmbo/mavo/lbo/mbo 1 ☐ mbo2 t/m 4/havo/vwo ☐ hbo/wo

Moeder/verzorger:

☐ geen of basisonderwijs ☐ vmbo/mavo/lbo/mbo 1 ☐ mbo2 t/m 4/havo/vwo ☐ hbo/wo

Geboorteland moeder/verzorger: .....

Moedertaal moeder/verzorger: .....

Geboorteland vader/verzorger: .....

Moedertaal vader/verzorger: .....

3. Spraaktaalontwikkeling

Heeft u twijfels of bemerkt u bijzonderheden over het verloop van de spraaktaalontwikkeling?

.....

.....

.....

Is er sprake van therapie/begeleiding op het gebied van spraak of taal?

☐ Nee ☐ Ja, namelijk: .....

.....

Maakte uw kind als baby veel geluidjes? Ja / nee / twijfel

Brabbelde uw kind? Ja / nee / twijfel

Wanneer kwam het eerste woordje? .....

Is uw kind voor vreemden verstaanbaar? .....

.....

4. Overig

Heeft u twijfels over het gehoor van uw kind? Ja/nee

.....

Is het gehoor in het verleden beoordeeld? Ja/nee Indien ja, wanneer? .....

.....

Zijn er andere bekende KNO problemen, zoals regelmatige verkoudheden of vergrootte/verwijderde neus/keelamandelen?

Ja/nee .....

Heeft uw kind buisjes gehad? Ja/nee

Indien ja, hoe vaak en wanneer? .....

.....

Ademt uw kind door de mond? Ja/nee/twijfel

Is er sprake van duimzuigen/vingerzuigen/speenzuigen?

Overige opmerkingen/bijzonderheden: .....

.....

.....

.....

.....

.....

Appendix VI: Questionnaire (Dutch) Spraak en Taalnormen Eerstelijns Gezondheidszorg (SNEL)

(Luinge, 2005: 114)

Naam:
Leeftijd in maanden:

Vragen voor kinderen van 12 tot 72 maanden	Ja = 1 Nee = 0
1. Begrijpt uw kind opdrachtjes van 2 woorden? (bijv. "jas aan", "papa boek")	...
2. Kan uw kind 1 of meer lichaamsdelen aanwijzen (bijv. "Waar zit je neus?"	...
3. Zegt uw kind in totaal ongeveer 10 woordjes?	...
4. Begrijpt uw kind zinnetjes van 3 woorden (bijv. "op de stoel", "in de tuin")	...
5. Kan uw kind twee woordjes combineren zoals "papa boek" of "kijk poes"?	...
6. Kan uw kind zinnetjes van 3 woorden maken? (bijv. "popje muts opheb-ben", "auto in garage")	...
7. Zet uw kind 3 tot 4 woorden achter elkaar? (bijv. "ik koekje wil hebben", "wij gaan ook zingen")	...
8. Kunt u ongeveer de helft van uw kind verstaan?	...
9. Vertelt uw kind weleens spontaan een verhaaltje? (bijv. over wat uw kind die dag heeft gedaan)	...
10. Kan uw kind een verhaaltje navertellen bij een aantal plaatjes?	...
11. Kunt u ongeveer driekwart van uw kind verstaan?	...
12. Maakt uw kind ook heel lange zinnen? (bijv. "Als ik later groot ben, dan wil ik graag kok worden.")	...
13. Kunt u bijna alles van uw kind verstaan?	...
14. Praat uw kind als een volwassene qua taalgebruik, vindt u?	...
SNEL-score	...

Appendix VII: SNEL calculation test scores (Luinge, 2005: 115)

Leeftijd[1]	Leeftijd in maanden	SNEL-score[2]	10e percentiel
...	12–17	...	0
...	18–19	...	1
...	20–21	...	2
...	22–24	...	3
...	25–26	...	4
...	27–29	...	5
...	30–32	...	6
...	33–36	...	7
...	37–41	...	8
...	42–46	...	9
...	47–54	...	10
...	55–64	...	11
...	65–82	...	12

SNEL-score kleiner dan 10e percentiel	⇒ Ernstige achterstand
SNEL-score gelijk aan 10e percentiel	⇒ Matige achterstand
SNEL-score groter dan 10e percentiel	⇒ Geen achterstand

[1]Leeftijd in maanden invullen bij de juiste leeftijdscategorie
[2]SNEL-score invullen bij de juiste leeftijdscategorie

Appendix VIII: SNEL forms, English translations (Luinge, 2005: 106, 107)

Name: Age in months:	
Questions for children from 12 to 72 months of age	Yes = 1 No = 0
1. Does your child comprehend tasks of 2 words? (e.g., "sit down")	...
2. Is your child able to point at one or more body parts? (e.g., "Where is your nose?")	...
3. Does your child say about 10 words in sum?	...
4. Does your child comprehend sentences of 3 words? (e.g., "on the chair")	...
5. Can your child combine two words such as "papa book" or "look cat"?	...
6. Can your child make sentences of 3 words? (e.g., "car in garage")	...
7. Places your child 3 or 4 words in succession? (e.g., "I wanna have biscuit")	...
8. Do you understand about a half of your child's speech?	...
9. Does your child sometimes tell a story spontaneously? (e.g., something about school)	...
10. Can your child repeat a story by some pictures?	...
11. Do you understand about three-quarter of your child's speech?	...
12. Does your child make long sentences? (e.g., "when the sun sets, it gets dark")	...
13. Do you understand about everything of your child's speech?	...
14. Does your child talk like an adult (qua language use)?	...
SNEL-score	...

Age[1]	Age in months	SNEL-score[2]	10th percentile
...	12–17	...	0
...	18–19	...	1
...	20–21	...	2
...	22–24	...	3
...	25–26	...	4
...	27–29	...	5
...	30–32	...	6
...	33–36	...	7
...	37–41	...	8
...	42–46	...	9
...	47–54	...	10
...	55–64	...	11
...	65–82	...	12

SNEL-score smaller than 10th percentile	⇒ Serious delay
SNEL-score equal to 10th percentile	⇒ Moderate delay
SNEL-score larger than 10th percentile	⇒ No delay

[1]Fill in age (in months) matching next to age category
[2]Fill in SNEL-score next to appropriate age category

Appendix IX: SNEL scores for each participant

Participants	SNEL-score	Age in months	Result
Participant 2	7	16	No delay
Participant 7	2	13	No delay
Participant 10	3	12	No delay
Participant 17	4	16	No delay
Participant 21	0	13	Moderate delay
Participant 24	3	12	No delay
Participant 25	1	12	No delay
Participant 34	4	15	No delay
Participant 36	3	15	No delay
Participant 3	6	22	No delay
Participant 9	11	22	No delay
Participant 12	5	18	No delay
Participant 15*	2	18	No delay
Participant 19	5	23	No delay
Participant 20	4	20	No delay
Participant 29	2	20	Moderate delay
Participant 6	13	25	No delay
Participant 11	11	28	No delay
Participant 22	12	27	No delay
Participant 27*	7	25	No delay
Participant 26	13	31	No delay
Participant 31	12	31	No delay
Participant 33	9	28	No delay
Participant 4	14	39	No delay
Participant 8	13	39	No delay
Participant 5	14	45	No delay
Participant 14	13	44	No delay
Participant 18	13	42	No delay
Participant 28	13	46	No delay
Participant 32	13	43	No delay
Participant 35	13	46	No delay

Appendix X: Socio-demographic information

Participants (N = 31)	Gender	Region	Sibling position	Level of education mother[18]
Participant 2	M	Noord-Brabant	First	High
Participant 7	M	Zuid-Holland	First	High
Participant 10	F	Gelderland	Third	High
Participant 17	F	Noord-Brabant	First	High
Participant 21	F	Noord-Brabant	First	High
Participant 24	F	Abroad	First, twin	High
Participant 25	M	Abroad	First, twin	High
Participant 34	F	Noord-Brabant	Second	High
Participant 36	F	Noord-Holland	First	High
Participant 3	F	Noord-Brabant	Third	High
Participant 9	F	Noord-Brabant	Second	High
Participant 12	F	Noord-Brabant	First	High
Participant 15*	M	Noord-Holland	Second	High
Participant 19	F	Noord-Brabant	Second	High
Participant 20	F	Limburg	First	High
Participant 29	M	Zuid-Holland	Second	High
Participant 6	F	Noord-Brabant	Second	High
Participant 11	F	Gelderland	First	High
Participant 22	M	Noord-Brabant	First	High
Participant 27*	F	Gelderland	First	High
Participant 26	M	Zuid-Holland	Second	High
Participant 31	F	Zuid-Holland	Third	High
Participant 33	M	Noord-Holland	First	High
Participant 4	M	Groningen	First	High
Participant 8	F	Noord-Brabant	First	High
Participant 5	M	Noord-Brabant	First	High
Participant 14	F	Noord-Holland	First	High
Participant 18	M	Noord-Brabant	Second	High
Participant 28	M	Zuid-Holland	First	High
Participant 32	M	Noord-Brabant	First	High
Participant 35	F	Noord-Brabant	First	High

[18] Based on the Dutch educational system, low is: “vmbo/mavo/lbo/mbo 1”, middle is: “mbo 2/3/4, havo, vwo” and high is: hbo/wo.

Appendix XI: Ages of the participants at the time of the recordings and total number of recordings

Participants[19] (N = 31)	Age at first recording	Age at final recording	Number of recordings (N = 273)
Participant 2	1;4.10	1;9.22	5
Participant 7	1;0.28	1;0.29	2
Participant 10	1;0.12	1;5.12	6
Participant 17	1;4.26	1;9.20	30
Participant 21	1;1.13	1;7.4	15
Participant 24	1;1.23	1;3.4	6
Participant 25	1;2.11	1;2.12	2
Participant 34	1;3.25	1;8.3	8
Participant 36	1;0.13	1;1.10	6
Participant 3	1;10.12	1;10.30	2
Participant 9	1;11.4	2;3.28	15
Participant 12	1;6.5	2;2.11	48
Participant 15*	1;5.23	1;11.16	7
Participant 19	1;11.5	2;4.27	11
Participant 20	1;6.25	1;11.18	9
Participant 29	1;9.1	2;1.26	4
Participant 6	2;2.10	2;7.21	9
Participant 11	2;4.4	2;10.2	10
Participant 22	2;3.14	2;9.7	7
Participant 27*	2;1.17	2;7.8	12
Participant 26	2;6.16	3;0.1	9
Participant 31	2;6.26	2;11.29	6
Participant 33	2;6.8	2;10.3	5
Participant 4	3;2.30	3;8.7	4
Participant 8	3;3.18	3;9.3	17
Participant 5	3;10.20	3;11.24	3
Participant 14	3;8.2	3;11.1	5
Participant 18	3;8.14	3;8.20	2
Participant 28	3;10.24	-	1
Participant 32	3;7.15	3;10.29	4
Participant 35	3;10.10	3;11.17	3

Total: 273 Recordings

[19] After transcription, the phonological or language development of the children with an asterix behind their participant number, appeared to be somewhat delayed, as discussed in Chapter 3.5.2.

Appendix XII: The ages of the participants for each recording

Red: no meaningful utterances/recording not usable
Blue: transcribed usable recording

Ages group 1;0 – 1;5 (46)

Participant 2	1;4.10				
Participant 7	1;0.28	1;0.29			
Participant 10	1;0.12	1;0.18 (2)	1;2.6	1;5.11	1;5.12
Participant 17	1;4.26	1;5.4	1;5.11	1;5.18	1;5.24 (2)
Participant 21	1;1.13	1;1.24	1;2.0	1;2.12	1;2.20
	1;3.2	1;3.12	1;3.18	1;4.8	1;4.15
	1;5.13	1;5.23			
Participant 24	1;1.23	1;2.11	1;2.12	1;3.4 (3)	
Participant 25	1;2.11	1;2.12			
Participant 34	1;3,25	1;4.4	1;4.11	1;5.24 (2)	
Participant 36	1;0.13 (3)	1;0.18 (2)	1;1.10		

Ages group 1;6 – 1;11 (104)

Participant 2	1;6.10 (3)	1;9.22			
Participant 3	1;10.12	1;10.30			
Participant 9	1;11.4	1;11.5	1;11.13	1;11.15	1;11.21
	1;11.27	1;11.29			
Participant 12	1;6.5	1;6.11	1;6.18 (2)	1;6.25	1;7.4
	1;7.11 (2)	1;7.14	1;7.15	1;7.24	1;8.3
	1;8.6	1;8.16	1;8.23	1;9.0 (3)	1;9.4
	1;9.15 (2)	1;9.19 (2)	1;9.27 (2)	1;10.4 (2)	1;10.9 (2)
	1;10.16 (2)	1;10.22	1;11.5 (3)	1;11.12	1;11.23 (2)
	1;11.28 (2)				
Participant 15	1;5.23	1;6.11	1;6.26	1;7.13	1;8.22
	1;9.22	1;11.16			
Participant 17	1;6.0	1;6.6	1;6.14 (2)	1;6.22	1;6.24
	1;7.1	1;7.6	1;7.14	1;7.19 (4)	1;7.28 (3)
	1;8.4	1;8.9	1;8.17	1;8.23	1;8.29
	1;9.7	1;9.14	1;9.20		
Participant 19	1;11.5	1;11.18			
Participant 20	1;6.25 (2)	1;7.24	1;8.28	1;10.16 (3)	1;11.14
	1;11.18				
Participant 21	1;6.13	1;6.27	1;7.4		
Participant 29	1;9.1 (2)	1;10.4			
Participant 34	1;6.17	1;7.10	1;8.3		

Ages group 2;0 – 2;5 (42)

Participant 6	2;2.10	2;3.2	2;3.14	2;4.1	2;4.23 (2)
	2;5.5				
Participant 9	2;0.9	2;0.25 (2)	2;1.20	2;2.8	2;2.21
	2;3.10	2;3.28			
Participant 11	2;4.4	2;4.20	2;5.13		
Participant 12	2;0.3 (2)	2;2.10 (2)	2;2.11 (4)		
Participant 19	2;0.5	2;0.15	2;1.3	2;1.23	2;2.19
	2;2.23	2;3.23	2;3.28	2;4.27	

Participant 22	2;3.14 (2)	2;4.4			
Participant 27	2;1.17	2;1.20	2;2.17 (2)	2;3.4	2;4.0
	2;4.20 (2)	2;5.19	2;5.23		
Participant 29	2;1.26				

Ages group 2;6 – 2;11 (34)

Participant 6	2;6.6	2;7.21			
Participant 11	2;6.2 (2)	2;6.20	2;7.0	2;7.12	2;7.27
	2;10.2				
Participant 22	2;6.9 (2)	2;7.5	2;9.7		
Participant 26	2;6.16	2;7.5 (2)	2;7.7 (2)	2;7.13 (3)	
Participant 27	2;7.6	2;7.8			
Participant 31	2;6.26 (2)	2;8.28	2;10.26	2;11.29 (2)	
Participant 33	2;6.8	2;6.13	2;7.21	2;10.3 (2)	

Ages group 3;0 – 3;5 (11)

Participant 4	3;2.30 (2)				
Participant 8	3;3.18	3;3.19	3;3.27	3;4.5	3;4.11
	3;4.18	3;4.23	3;5.25		
Participant 26	3;0.1				

Ages group 3;6 – 3;11 (29)

Participant 4	3;6.22	3;8.7			
Participant 5	3;10.20	3;11.4	3;11.24		
Participant 8	3;6.4	3;6.8	3;6.22	3;7.18 (2)	3;7.17
	3;8.6	3;8.12	3;9.3		
Participant 14	3;8.2	3;8.20	3;9.5	3;9.22	3;11.1
Participant 18	3;8.14	3;8.20			
Participant 28	3;10.24				
Participant 32	3;7.15	3;8.22	3;10.1	3;10.29	
Participant 35	3;10.10	3;10.24	3;11.17		

Other received recordings (not included in the study or total number of recordings)

Participant 14	4;0.1
Participant 18	4;1.9
Participant 35	4;0.18

Appendix XIII: Syllabification rules (Beers, 1995; Jansonius-Schultheiss et al., 2014: 129)

Verdeling in syllabes, ten behoeve van de FAN-analyse

Syllabificatieregels (= verdelen in lettergrepen)
Bij de indeling van woorden in syllabes worden de grenzen in eerste instantie morfologisch bepaald. Dus: de grens van de syllabe valt samen met een morfeem: voet-bal, er-in, grap-je. Verder gelden de volgende regels voor het syllabificeren van de woorden (bij de voorbeelden is orthografisch gespeld):

1 Eén consonant staat tussen twee vocalen (xVCVx)

a eerste vocaal is lang: xV – CVx . Bijvoorbeeld beetər → bee-tər of kaadoo → kaa-doo
b eerste vocaal is een sjwa xə-CVx. Bijvoorbeeld gədaan → gə-daan
c eerste vocaal is kort xV-C-Vx; de C is nu mediaal; notatie met behulp van = Bijvoorbeeld pakkə → pa=k-ə
(korte vocalen zijn: e (van bel), i (van vis), u (van mus), a (van bal), o (van som))

2 Twee consonanten staan tussen twee vocalen (xVCCVx)

Voor de syllabificatie geldt dat het begin van een syllabe zoveel mogelijk gevuld moet worden met clusters die toegestaan zijn in het Nederlands (= Maximaal Onset Principe, MOP)

a Na een korte vocaal valt de syllabegrens meestal binnen het cluster, aangezien een korte vocaal in het Nederlands altijd gevolgd wordt door een C. De eerste consonant van het cluster behoort dus bij de eerste syllabe. Volgens het MOP mag de volgende syllabe niet met een lege onset beginnen, en wordt de onset gevuld met de tweede C van het cluster
Bijvoorbeeld infoo → in-foo ;Bijvoorbeeld atlas → at-las; Bijvoorbeeld herdər → her-dər; Bijvoorbeeld jangkə → jang-kə
b Na een korte vocaal ontstaat een mediaal cluster, als volgens de MOP beide consonanten van het cluster een onset vormen die is toegestaan in het Nederlands, en tegelijkertijd een eindcluster van de eerste syllabe kunnen vormen. Dit gebeurt m.n. in het geval van sp-clusters
Bijvoorbeeld haspəl → ha-spəl Bijvoorbeeld kosmos → ko-smos
c Na een sjwa wordt het cluster een initiaal cluster van de tweede syllabe, omdat deze hoofdklemtoon heeft
Bijvoorbeeld bəsguit → bə-sguit
d Na een lange vocaal wordt het cluster een initiaal cluster van de tweede syllabe volgens MOP
Bijvoorbeeld luistər → lui-stər

3 Drie of vier consonanten staan tussen twee vocalen (xVCCCVx of xVCCCCVx)

Opnieuw wordt de positie van de syllabegrens bepaald door het MOP, zie boven bij 2)
Bijvoorbeeld sirkwie → sir-kwie Bijvoorbeeld ortnər → ort-nər Bijvoorbeeld venstər → ven-stər

4 Verkleinwoorden

sgermpjə → sgerm-pjə
drangkjə → drang-kjə ng = 1 klank
mootortjə → moo-tor-tjə
slaatjə → slaa-tjə
sgaapjə → sgaa-pjə
pinnetjə → pi=n-ə-tjə

Appendix XIV: The productions of complex onsets and complex codas for each participant

Participant 2	CCV + CCVC	VCC + CVCC
1;4	0	1
1;6	1	0
1;9	0	0

Participant 7	CCV + CCVC	VCC + CVCC
1;0	0	0

Participant 10	CCV + CCVC	VCC + CVCC
1;0	0	0
1;2	0	0
1;5	0	0

Participant 17	CCV + CCVC	VCC + CVCC
1;4	0	0
1;5	0	0
1;6	0	0
1;7	2	0
1;8	2	6
1;9	1	4

Participant 21	CCV + CCVC	VCC + CVCC
1;1	0	0
1;2	0	1
1;3	0	1
1;4	0	0
1;5	0	0
1;6	0	0
1;7	2	1

Participant 24	CCV + CCVC	VCC + CVCC
1;1	0	0
1;2	0	0
1;3	0	0

Participant 25	CCV + CCVC	VCC + CVCC
1;2	0	0

Participant 34	CCV + CCVC	VCC + CVCC
1;3	0	0
1;4	0	0
1;5	0	0
1;6	1	0
1;7	0	0
1;8	0	0

Participant 36	*CCV + CCVC*	*VCC + CVCC*
1;0	0	0
1;1	0	0

Participant 3	CCV + CCVC	VCC + CVCC
1;10	4	0

Participant 9	CCV + CCVC	VCC + CVCC
1;11	25	6
2;0	28	17
2;1	13	8
2;2	11	9
2;3	23	4

Participant 12	CCV + CCVC	VCC + CVCC
1;6	0	0
1;7	0	2
1;8	4	1
1;9	4	7
1;10	4	0
1;11	5	2
2;0	6	3
2;2	6	7

Participant 15	CCV + CCVC	VCC + CVCC
1;5	0	0
1;6	0	0
1;7	0	0
1;8	0	0
1;9	0	0
1;11	0	0

Participant 19	CCV + CCVC	VCC + CVCC
1;11	0	0
2;0	0	0
2;1	0	0
2;2	0	1
2;3	0	0
2;4	0	0

Participant 20	CCV + CCVC	VCC + CVCC
1;6	0	0
1;7	0	0
1;8	0	0
1;10	0	2
1;11	1	4

Participant 29	CCV + CCVC	VCC + CVCC
1;9	0	0
1;10	0	0
2;1	0	0

Participant 6	CCV + CCVC	VCC + CVCC
2;2	8	0
2;3	10	5
2;4	12	3
2;5	10	0
2;6	16	5
2;7	8	1

Participant 11	CCV + CCVC	VCC + CVCC
2;4	16	3
2;5	2	5
2;6	13	7
2;7	23	7
2;10	13	2

Participant 22	CCV + CCVC	VCC + CVCC
2;3	0	0
2;4	0	1
2;6	0	4
2;7	1	3
2;9	1	4

Participant 27	CCV + CCVC	VCC + CVCC
2;1	0	0
2;2	0	0
2;3	1	0
2;4	0	0
2;5	0	0
2;7	0	1

Participant 26	CCV + CCVC	VCC + CVCC
2;6	0	0
2;7	13	6
3;0	7	4

Participant 31	CCV + CCVC	VCC + CVCC
2;6	5	6
2;8	4	3
2;10	4	4
2;11	8	8

Participant 33	CCV + CCVC	VCC + CVCC
2;6	2	0
2;7	6	1
2;10	14	10

Participant 4	CCV + CCVC	VCC + CVCC
3;2	9	5
3;6	13	4
3;8	22	15

Participant 8	CCV + CCVC	VCC + CVCC
3;3	27	11
3;4	66	34
3;5	25	15
3;6	27	24
3;7	38	12
3;8	26	5
3;9	9	6

Participant 5	CCV + CCVC	VCC + CVCC
3;10	16	3
3;11	2	10

Participant 14	CCV + CCVC	VCC + CVCC
3;8	14	12
3;9	19	4
3;11	9	8

Participant 18	CCV + CCVC	VCC + CVCC
3;8	10	7

Participant 28	CCV + CCVC	VCC + CVCC
3;10	4	3

Participant 32	CCV + CCVC	VCC + CVCC
3;7	5	2
3;8	10	6
3;10	15	4

Participant 35	CCV + CCVC	VCC + CVCC
3;10	25	10
3;11	18	18