The development of the speech production mechanism in young children : evidence from the acquisition of onset clusters in Dutch

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English summary

This thesis is about child speech, about the system behind child speech production and about the development and maturation of this system, also referred to as the child speech production mechanism. I investigated its development by looking at the production and at the perception of onset clusters in Dutch toddlers.

The leading question in this thesis is, which part of the speech production mechanism remains "under construction", when a child reduces an onset cluster word (which results in an error with respect to the adult target form). Stated differently, which part of the speech production mechanism is still incomplete, when a toddler produces 'tein', while pointing to a train ('trein'). To obtain an answer to this question I carried out a number of different studies, which are described in chapters 2 to 5 in this thesis.

The study in **Chapter 2** concerns mainly the question whether reduced cluster words are fully reduced or whether in some way they exhibit acoustic traces of the omitted second consonant. For this purpose I analyzed the acoustic characteristics of (minimal) pairs of toddler utterances that differed in the presence or absence of an onset cluster in their target forms. I looked at minimal pairs of onset cluster words vs. singleton target words starting with /Cr/-/C/ and /kn/-/k/, like *brood* /bʀo:t/ 'bread' – *boot* /bo:t/ 'boat' and *knip* /knɪp/ 'cut' – *kip* /kɪp/ 'chicken'. The results in Chapter 2 showed evidence for acoustic traces of the omitted consonants.

Even though Dutch children's target /r/ sound in the complex cluster /Cr/ were not perceived by adults, the children tended to realize a rising F2 in the vowel onset, which might be reminiscent of the rising F3 that we see in adult speech. As for target /kn/ words in which the nasal sound was neither perceived by adults, I found that the subsequent vowel did show a moving formant pattern,

and perhaps a lower center of gravity. In sum, the data of two-year-old Dutch children showed small acoustic traces of some typical auditory cues of the target consonant in the subsequent vowel. The fact that there is an acoustic trace in the child reduced cluster might suggest that the lexical representation of the cluster word a /CCV/ rather than a /CV/ form.

In **Chapter 3** I have presented a detailed analysis of the acquisition of /Cr/ clusters, by means of descriptive and qualitative analyses of longitudinal data of five children. Seven developmental stages were discovered, but not all children pass through all seven stages, and stages can be overlapping. All children start with the complete and traceless omission of target C_2 (stage 1), like in this utterance of the word "crocodile" by Cato in het fifth session [kɔkɪdju], at the age of two years. The locus of this omission was suggested to be at the level of phonological encoding, where the syllable spellout only recognizes singleton onsets. The next stages consist of an acoustic trace (stage 2) or a substituent vowel following C_1.(stage 3), an example of which would be Cato's [kuokodɪu] in her 8th session, at the age of two years and two months. This stage usually is followed by epenthesis, like in Tirza's utterance of the word 'stairs' *trap* as [tərɑp] in her 16th session at age two years and three months. Here the epenthesis is interpreted as the acoustic effect of immature coordination of the two consonant articulations. A consonant substitution of /r/ in the C_2 position of the onset (stage 5) followed by a realization of epenthesis plus substitution (stage 6) and finally the realization of a mature or not yet entirely mature /r/ (stage 7) are the next stages in the development. An example of stage 7 would be Cato's crocodile uttered as [kʀo:kodɪl] in her 11th session, at the age of two years and four months.

In **Chapter 4** too I looked at the development of cluster words realization. However where in Chapter 3 I used spontaneous speech data, here elicited speech data was used. The experiment involved picture naming (PN), word

repetition (WR) and non-word repetition (NWR), performed by four children, where the target forms were real words or nonwords with onset cluster.

The analyses revealed a developmental shift (for three children), from an initial state to a final state. In the initial state performance on NWR outranks performance on both WR and PN, while in the final state performance on all tasks is similar, it has improved and this is especially visible in the PN and WR.

In children's cluster productions, it was observed that the /sC/ and /C/ + liquid clusters show a different timing in development, for two children correct /C/ + liquid clusters appeared first, for one child correct /sC/ cluster appeared first. For one of the four children, Lars the results were unclear. This followed the literature, suggesting an extra-syllabic position for /sC/ clusters and an onset syllable position for the /C/ + liquid cluster. The different syllabic positions clarify the different timing in development.

Lars exhibited performance, which is comparable and poor on all tasks and contrary to the other children this remained the case until the final recordings.

The initial poor performance on the WR and the PN tasks (with respect to the NWR) can be interpreted either as a problem with lexical access (lexical representation) or with phonological encoding. Perception data is needed to tear the two apart.
As soon as the problem experienced in the initial state is solved (either by a better lexical representation or a better phonological encoding), the lexical route could boost the production performance. With respect to the different performance patterns of C + liquid and /sC/ clusters, I cannot draw any clear conclusions about the locus of the problem. Finally, given the persistently poor performance of Lars, I concluded that his speech production mechanism (at least with respect to consonant clusters) was not functioning well. It is very possible that multiple layers of his production mechanism did not function well.

In **Chapter 5** I questioned how detailed the representation of onset clusters is in the child mental lexicon. Do children exhibit different looking behavior when they perceive correctly produced onset clusters as opposed to reduced onset clusters? If so, do they exhibit different looking behavior where C1 is the omitted element, or where C2 is the omitted element? Therefore I examined the perception of correct vs. reduced /sC/ clusters like in the word *stoel* /stul/ 'chair' and /C/ + liquid clusters like in the words *trein* /tʀɛin/ 'train' and *bloem* /blum/ 'flower' clusters by two-year-olds. The results pointed out that two-year-olds exhibit awareness of /sC/ cluster reduction but not of /C/ + liquid cluster reduction. In other words, children looked longer at the picture of a chair (*stoel*) when they perceived the reduced form *toel* as compared to the correct form *stoel*, while they looked equally long at the picture of a train while perceiving correctly and incorrectly produced *trein* and *tein*.

A possible interpretation of the obtained results suggest that the longer looking times at *toel* could evidence for a more stable mental representation of correct /sC/ cluster words as opposed to /C/+ liquid words, in line with the literature on perception of mispronounced words (Swingley & Aslin, 2000, White & Morgan, 2008).

However, my research points to a more probable interpretation of the results, which states that the longer looking times point to a learning effect. The results suggested that in children who have not acquired /sC/ clusters yet this learning effect appears to be stronger than in children who have acquired /sC/ clusters. Children were aware of the difference between 'stoel' and 'toel', while they uttered 'toel' themselves. This might be a sign that they were learning the correct form. In this way the results are asymmetrical. The asymmetry consists in the fact that on the one hand the children who (on the basis of their production) seemed to have stored /CCV/ forms in the mental lexicon, did not show awareness of cluster reduction in perception, while on the other hand, the

children who seemed to have stored /CV/ forms (also on the basis of their production), did exhibit an awareness of cluster reduction in perception.

In **Chapter 6** a discussion of the results obtained in Chapters 2 to 5 is offered. First I discussed the nature of the child speech production mechanism in its initial state. However in this thesis the age of interest is when onset clusters are being acquired and I assume that at this age, the speech production mechanism has got the characteristics of the adult mechanism, being formed by a lexical level, phonological level, phonetic level and the articulation level as a final result. In this thesis I offer an account for the maturation of the speech production mechanism according to which it matures in a top-down fashion. As it was said, the levels are already available so what matures, is the representation, which is formed at each of these levels. If we take the development of the production of /Cr/ clusters for instance, we see how first limitations come from the syllable spell out (which is part of the phonological encoding), later they come from the phonological encoding, followed by limitations of the phonetic encoding, when its coordination fails until finally the forms at all levels have matured and an adult-like 'trein' can be uttered.