EARLY L1 CLUSTERS AND HOW THEY RELATE TO UNIVERSAL PHONOTACTIC CONSTRAINTS

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ABSTRACT
This paper investigates the ways in which universal phonotactic constraints describing consonant clusters are reflected in early first language acquisition. I looked for first appearances of clusters in children’s speech. Data from a number of typologically different languages has been considered. The predictions as to which clusters were expected to appear in the young phonologies stemmed from universal phonotactic constraints. These constraints have the nature of preferences and were formulated within the phonotactic model of the beats-and-binding phonology, in the naturalist framework. A general tendency for cluster reduction in child language is shaped by such constraints. Thus, it is possible to predict the phonotactic behaviour of a language system in flux, e.g. in L1 acquisition (or in L2 acquisition, phonostylistics, aphasia). On the other hand, systems in flux belong to the areas of external evidence against which the model of phonotactics proposed in the paper may be verified.

1. INTRODUCTION
Consonant clusters are rare in the world’s languages. The ground for this is the universal preference for the CV-structure which is in turn derived from higher order semiotic and functional principles of, respectively, figure-and-ground and perceptibility and pronunciability (cf. [2]). In particular, a good phonetic contrast which is both easy to hear and pronounce is best realized by a consonant+vowel syntagma. There are languages, however, among them also some major world’s languages with respect to the number of speakers, which do allow for clusters of consonants. Though they differ from language to language, clusters share certain universal traits which either guarantee their survival in a language or let them be similarly treated by children, aphasics, learners of foreign languages or everyday casual talkers. Those universal traits are expressible in terms of phonotactic preferences which derive the preferred clusters for all positions. Their function is, on the one hand, to counteract the CV-only preference and, on the other, to counteract the creation of dysfunctional clusters.

In this paper I examine the functionality of the phonotactic preferences in young children’s speech. Section 2 will be devoted to the preferences, section 3 will present the data and section 4 will provide discussion and evaluation of the study.

2. PHONOTACTIC PREFERENCES
2.1. The model
The model of phonotactics which I employ in this paper has been formulated within the Beats and Binding Phonology (B&B Phonology in short), constructed according to the assumptions and principles of Natural Phonology (cf. e.g. [4], [5]).

2.2. Beats and bindings
The smallest units in the B&B Phonology are beats (symbolized as ●) and nonbeats (symbolized as O). The relation that typically obtains between the two is that of binding (symbolized as O → ●). Phonemically, O → ● is typically represented by a C V syntagma, thus:

Figure 1. A O → ● binding.

A CV-realization of the O → ● binding is the universally preferred one and derives directly from the figure-and-ground principle, clarity of perception and ease of articulation functions of phonology, and the principle of least effort. The CV-preference, if alone, would prevent the occurrence of any consonant clusters at all. Clusters, in order to survive, must be sustained by some force counteracting the overwhelming tendency to reduce towards CVs. This force is sonority.

2.3. The Optimal Sonority Distance Principle (OSDP)
The Optimal Sonority Distance Principle (OSDP) defines the way in which phonemic segments should order themselves in a successful sequence: the relations between sonority distances between pairs of neighbouring phonemes should be optimally balanced. I.e., an optimal relation should obtain between the distances in pairs of consonants measured in sonority and their distances to the neighbouring vowels. “Optimal” means different things depending on the context. Below I shall specify the optimal sonority relations for double and triple clusters in all positions in a word. They take the form of well-formedness conditions holding for: initial and final doubles, initial and final triples, medial doubles and medial triples. Those well-formedness conditions have the status of preferences (cf. [3]) since the more a given condition is observed the better the output cluster will be. They refer to the sonority values of the scale below:

<table>
<thead>
<tr>
<th>Vs</th>
<th>semi-Vs</th>
<th>liquids</th>
<th>nasals</th>
<th>fricatives</th>
<th>affricates</th>
<th>plosives</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
</tr>
</tbody>
</table>

Figure 2. The sonority hierarchy.

2.4. The preferences
2.4.1. Initial and final doubles. For word-initial and final double clusters, the distance between the two consonants should be bigger
than or equal to the distance between a beat and a nonbeat bound to it.

Figure 3. A preference describing initial and final doubles.

2.4.2. Initial and final triples. For word-initial and final triple clusters, the distance between the first (counting from the beat) and the second consonant should be bigger than or equal to the distance between this first consonant and the beat, and bigger than the distance between the second and the third consonant.

Figure 5. A preference describing initial and final triples.

Good doubles are included in the good triples; so, there is no good triple without a good double. In other words, a good triple implies a good double.

2.4.3. Medial doubles. For a word-medial double cluster, the distance between the two consonants should be smaller than between each of the consonants and its respective neighbouring beat.

Figure 7. A preference describing medial doubles.

2.4.4. Medial triples. For a word-medial triple cluster, the distance between the first and the second consonant should be smaller than between the first consonant and the beat to which it is bound, whereas the distance between the second and the third consonant should be smaller than between the third consonant and the beat to which it is bound.

Figure 9. A preference describing medial triples.
2.5. Relations among the preferences
There are two sets of predictions concerning the relations among the phonotactic preferences specified above. The first set concerns the implications which obtain in pairs of clusters. There are the following implications between triples and doubles (read: a preferred medial triple implies a preferred medial double, etc.).

\[
\begin{align*}
&VCCV >> VCCV \\
&CVCV >> CCCV \\
&VCCC >> VCC
\end{align*}
\]

The second set of predictions refers to the relation between medial vs. periferal clusters. Preferred medials may be the only clusters whereas dispreferred medials (at least developmentally) imply the occurrence (development) of preferred initials and finals.

\[
VC(C)CV \ast VC(C)CV >> (CCC)C & VCC(C)
\]

2.6. Hypotheses concerning L1 acquisition of clusters
On the basis of the above preferences and relations among them, certain expectations can be formulated with reference to the acquisition of clusters by children. (1) Firstly, the earliest clusters to appear should be from among the preferred ones, while the dispreferred ones should undergo the so-called L1 cluster reduction. (2) Secondly, less complex clusters should appear before the more complex ones. (3) Thirdly, the first clusters should be medial, arising as a result of combining the sequences VC and CV. Only then should initial and final clusters be able to dissociate (unless a medial is a preferred one and there is no need to).

To test the above predictions, data from typologically different languages is needed. Of this work-in-progress research I present here a selection of observations from three languages: Polish, English and Italian.

3. THE DATA

3.1. Polish
The data I quote here comes from three girls, two of them observed by means of a diary study (age spans: M. 0;11-2;8 and K. 2;0-2;6), the third one recorded and transcribed (Z. 1;7-2;1)\textsuperscript{7}.

<table>
<thead>
<tr>
<th></th>
<th>M.</th>
<th>K.</th>
<th>Z.</th>
</tr>
</thead>
<tbody>
<tr>
<td>first cluster</td>
<td>VCCV</td>
<td>CCCV</td>
<td>25%</td>
</tr>
<tr>
<td>pref</td>
<td>5</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>VCCV</td>
<td>25</td>
<td>15</td>
<td>60%</td>
</tr>
<tr>
<td>pref</td>
<td>14</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>VCC</td>
<td>7</td>
<td>1</td>
<td>15%</td>
</tr>
<tr>
<td>pref</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
</tbody>
</table>

Table 1. Clusters in Polish L1.

In M.'s speech, the first cluster was a dispreferred medial [\textsuperscript{-}\textsuperscript{g}\textsuperscript{g}\textsuperscript{-}] (a potential preferred final). This was the only cluster from 0;11 to 1;8. From 1;9 to 1;10 three more (non-medial) clusters appeared. Then, a rapid growth of medials 1;10 - 2;1 took place, with only infrequent non-medials. In the time span 2;1 - 2;8 medials still predominate, while initials begin to be more frequent.

In K.'s speech, the first cluster was also a dispreferred medial [\textsuperscript{-}\textsuperscript{g}\textsuperscript{d}\textsuperscript{d}\textsuperscript{-}] (a potential preferred final). Early medials, while almost alone, were mostly of the dispreferred types. They improved when initials and finals started to appear. Also Z. shows the predominance of medial clusters over initial ones, and these in turn over the final ones.

Replacements showing precedence of medials: M. sv\textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}se \rightarrow f\textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}se; M. \textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}jk\textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}\textsuperscript{ka} \rightarrow \textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}jk\textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}\textsuperscript{ka}; M. \textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}kt\textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}\textsuperscript{ka} \rightarrow \textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}kt\textsuperscript{-}\textsuperscript{g}\textsuperscript{t}\textsuperscript{e}\textsuperscript{ka}.

Substitutions showing improvement according to the preferences: kf\textsuperscript{-}\textsuperscript{g}\textsuperscript{d} \rightarrow f\textsuperscript{-}\textsuperscript{g}\textsuperscript{d}, an improvement within the preference stated in Fig. 5.; lv. \rightarrow vl., gv. \rightarrow gj., changes from dispreferred to preferred according to the preference stated in Fig. 5.; kr\textsuperscript{-}\textsuperscript{d}\textsuperscript{r}\textsuperscript{t} \rightarrow kr\textsuperscript{-}\textsuperscript{d}\textsuperscript{r}\textsuperscript{t}av\textsuperscript{-}\textsuperscript{d}\textsuperscript{r}\textsuperscript{t} (kf. \rightarrow kr., -dr. \rightarrow -dv.), an change from dispreferred to preferred of both an initial and medial cluster according to the preferences stated respectively in Fig. 5. and in Fig. 7.

3.2. English
The data comes from [6], which is a systematic study of babbling and early words in five infants from ca 7-36 months of age.

<table>
<thead>
<tr>
<th></th>
<th>babbling (0;8\rightarrow)</th>
<th>early words (1;3\rightarrow)</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial</td>
<td>30%</td>
<td>45% (esp. stop+glide)</td>
</tr>
<tr>
<td>medial</td>
<td>56%</td>
<td>22% (esp. nasal+stop)</td>
</tr>
<tr>
<td>final</td>
<td>13%</td>
<td>33% (esp. nasal+stop, stop+fricative)</td>
</tr>
<tr>
<td>generally preferred</td>
<td>stop+nasal</td>
<td>stop, nasal, fricative, liquid (both orders)</td>
</tr>
<tr>
<td>constituents</td>
<td>nasal+stop+glide</td>
<td>nasal+stop+glide</td>
</tr>
</tbody>
</table>

Table 2. Clusters in English L1.

Table 2 demonstrates different tendencies for clusters in babbling
and in early words. The data also showed that monosyllables were preferred among early words, that increased cluster complexity co-occurred with decreased cluster productions, that cluster elements were derived primarily from the singleton phonetic inventory, that contiguous segments in babbling clusters varied by manner more often than place and that the majority of clusters in both babbling and words were homorganic. As far as the influence of the ambient language on clusters was concerned, no strong influence was evidenced in babbling, whereas it evidently showed in early words. Moreover, the cluster types in words demonstrated continuity and expansion of the types in babbling.

3.3. Italian
The data below comes from one child (a hoy C.) in an age span 2;0 - 2;6, and was collected for the purposes of the already mentioned project (cf. note 7). The analysis was performed by Sabrina Noccetti.

C. showed a definite preference for a structure CVCCV, which started to appear systematically at 2;3, after VCV and CVVC (sporadically VCCV) had developed. For example, cesca (francesca), ostre-giostre. As the main cluster reduction strategy C. employed assimilation resulting in gemination: altri → atti, questo → etto, aspetta → appetta, tanti → tatti, banka → bakkì, talpa → tappa, orso → ossa, torna → tonna etc. All geminates are preferred medials, according to the preference stated in Fig. 7. Other reductions also occurred, e.g. reductions via a preferred initial: dentro - tro → dento, reba - bra → ba, sopra - pra → sopa, or reductions leaving only a medial cluster of a word, and thus pointing to its precedence, e.g., brutto → butto, spengo → pengo, scuola → cola, etola, scrittò → itto.

4. DISCUSSION
Of the three major predictions specified in 2.6., the third one appears to be fully confirmed by the above data. The earliest clusters were indeed medial and they prevailed for a substantial period in the discussed children’s speech. Their precedence was also supported by reductions of other clusters but medial within a word.

The English data distinguished between the tendency for medials (of the dispreferred types) in babbling which gave rise to initials of the most preferred type (stop+glide) in first words. The order ‘medials before initials’ is compatible with the order in Polish and Italian. It may be that the English children developed initials earlier due to the demonstrated preference for monosyllables in early words.

The second prediction concerned the expected growing complexity of clusters. The data confirmed this prediction as well. Clusters grew more complex not only in terms of number of segments involved (there were very few more complex ones than doubles in the data), but also in terms of articulatory variety of the segments themselves. The English data was systematically analyzed in this respect and showed the homorganicity of clusters, and this tendency is also discernible in Polish, e.g. in nasal+stop clusters, and in Italian geminates.

The first hypothesis of 2.6., predicting the universal ‘goodness’ of the early clusters, was only partly confirmed. The Italian geminates produced the best possible medials. Many of the Polish medials were of the dispreferred types at first and improved only when the peripherals started to develop. In the English data the medials were predominantly bad at the start, but as such created material for good initials (esp. stop+glide) and finals (esp. nasal+stop). Thus, first (medial) clusters are random combinations of simpler structures VC and CV, which constitute a necessary stage in the creation of the preferred types of initials and finals. However, the phonotactic preferences did manifest themselves explicitly in the improvements of the target clusters according to the well-formedness conditions. Also, the early clusters (esp. in the English babbling) varied by manner rather than place, which points to the developing perceptual sensitivity in children which is the basis of the phonotactic preferences.

ACKNOWLEDGMENTS
I thank the colleagues from the INTO-CHILDES discussion list who answered my query about clusters so helpfully and constructively.

NOTES
1. Cf., e.g., [1]: 13f, [4]: 63ff for a summary of evidence.
2. They are formulated by means of ‘greater than’ and ‘less than’ symbols.
3. Cf. [4]: 87 and other pages for discussion of the notion of sonority.
4. Since the same cluster cannot be both a preferred initial and a preferred final, these are largely independent. However, either may occur (develop) in a language depending on other factors. For instance, initials may occur due to the prominence of a word-initial position. finals may occur due to a need for morphological suffixes.
5. The data will gradually expand to include, among others, German, Finnish, Dutch, Estonian, Estree, Quichua.
6. The data were conducted by myself and report on the speech development of my two daughters.
7. This data comes from the International Project on the Acquisition of Pre- and Protomorphology, supervised by W.U. Dressler (University of Vienna). The Project includes ca 24 languages; I have collected part of the Polish data.
8. I’m grateful to Sabrina Noccetti, who recorded and transcribed C.’s speech, for having analyzed the data from a phonological perspective and letting me use her results.
9. The preference for homorganicity is also discernible in the data quoted by Vihman (cf. [7]: 31f): clusters preserved most often by the investigated Slovenian, Estonian, Czech, Spanish and English children were nasal+stop, fricative+stop, stop+fricative, and lateral+stop.

REFERENCES