LabPhon

Phonetics in Phonology

Outline

• Positional Neutralisation:
  • Fronting
  • The Continuity Assumption
  • Lateral Neutralisation

• Interaction of Phonetics and Phonology:
  • Liquids in First Language Acquisition Data
  • The Direction of Substitutions
Bij Noordwijk zwom een nat konijn
Temidden van een school tonijn
“Tja”, sprak het beest,
“Dat tomt ervan als men de ta niet zeggen tan”

Kees Stip

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**Fronting Data**

Inkelas & Rose (2003): E. (1;9 - 2;1)

- *cup* realised as $[t^h\Lambda p]$
- *go* realised as $[do:]$
- *again* realised as $[\varepsilon’dm]$

velar fronting to coronal in onsets of prosodically strong positions only
Fronting Data

However:

- back realised as [bæk]
- bagel realised as ['bejgu]
- conductor realised as [tʌn’dəktə]

prosodically strong positions:
in word-initial and stressed onsets

Fronting

Strange process: sounds are affected in strong positions

In adult languages sounds are always affected in dependent positions

Cross-linguistic observation:
prosodically prominent positions are privileged
The Continuity Assumption

Continuity Assumption:
(Macnamara, 1982; Pinker, 1984)

the process of language acquisition is continuous, i.e. the formal properties of the grammar do not change

Fronting is not attested in adult languages

The Continuity Assumption

Fronting is not attested in adult languages
Positional neutralisation in adult languages affects weak, rather than strong positions.

This undermines any grammatical-only approach to the process of fronting
Questions

- Why are velars, rather than coronals, neutralised?
- Why only in strong, rather than weak, positions?
- Why is the process unique to children?

1. First Factor Fronting

Inkelas & Rose (2003):

Fronting is a **grammaticalised artefact** of the physiological difficulty of the articulation of velar consonants in prosodically strong positions at early stages of children’s development.
1. First Factor Fronting
Fletcher (1973); Kent (1981); Crelin (1987):

In young children, **the size of the tongue is much bigger**, relative to the rest of the vocal tract, than it is in adults, while the palate is proportionally shorter.

The tongue of a two-year-old fills the supralaryngeal cavity almost entirely.

2. Second Factor Fronting
Fougeron and Keating (1996); Fougeron (1999):

**Consonants in strong positions** show **larger amplitude in their articulatory gestures** than those in other positions.

This difference in gesture magnitude appears to disproportionately affect velars, yielding a greater, more forward linguo-palatal contact for velars in strong positions than in other positions.
Children are extremely faithful to target stressed syllables

The greater emphasis on the dorsal articulator expands tongue contact into the coronal region, yielding the coronal release
Inkelas & Rose (2003):
E.’s early, articulatory driven implementation of strengthened onset velars as phonetically coronal was quickly phonologized by E.

E: Babbling stage: [k] in strong positions
E: (1;9) - (2;1): phonologized fronting
E: Transitional stage (2;1 - 2;3) nonsense words
   [ɡæk] [kæk] [kæŋ]
E: (2;3) - …: no fronting

Variation between fronting and non-fronting children

Children’s grammars react differently to physiological constraints on acquisition

- Hale & Reiss (1998): children’s grammars are adult-like; Deviant processes are the direct consequence of a general lack of articulatory control at early ages.

- Inkelas & Rose (2003) do not agree: child-only processes like fronting reveal a great deal of articulatory control. The extremely systematic and well-controlled articulations reflect grammatical organization.
Discussion

Acquisition in OT:

Reranking constraints
Demoting markedness constraints; Promoting correspondence/faithfulness constraints
or:

Grammar of a child has same ranking as adult language

Conclusion

Physiological explanation:
fronting is due to large tongue and short palate

Phonological explanation:
fronting is extremely systematic and caused by faithfulness to strong positions
causing greater emphasis on the dorsal articulator in these positions
Conflicting phonologically based and phonetically based constraints in the analysis of /l/-substitutions

Paper available on http://www.let.rug.nl/~gilbers/papers

Outline

• **How:** FLA as a conflict between different types of markedness and correspondence constraints

• **Thesis:** An adequate account of the data is only possible if phonologically based and phonetically based constraints interact.

OT seems to be the perfect tool to bridge the gap between phonological and phonetic accounts
/l/-substitutes

/l/ $\rightarrow$ [l]; [ɾ]; [w]; [j]; [n]; [h]

Feature Changes /l/ $\rightarrow$ [w]

<table>
<thead>
<tr>
<th>/l/</th>
<th>$\rightarrow$</th>
<th>[w]</th>
</tr>
</thead>
<tbody>
<tr>
<td>+son</td>
<td>+son</td>
<td></td>
</tr>
<tr>
<td>+cons</td>
<td>-cons</td>
<td></td>
</tr>
<tr>
<td>+cont</td>
<td>+cont</td>
<td></td>
</tr>
<tr>
<td>+lat</td>
<td>-lat</td>
<td></td>
</tr>
<tr>
<td>-lab</td>
<td>+lab</td>
<td></td>
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<tr>
<td>+ant</td>
<td>-ant</td>
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<tr>
<td>+cor</td>
<td>-cor</td>
<td></td>
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<tr>
<td>-high</td>
<td>+high</td>
<td></td>
</tr>
<tr>
<td>-back</td>
<td>+back</td>
<td></td>
</tr>
<tr>
<td>-round</td>
<td>+round</td>
<td></td>
</tr>
</tbody>
</table>
What's wrong with the phonologically-based account of the gliding process?

The Naturalness of a Common Process

- McCarthy (1988, p.86): A common process (...) is accomplished by an elementary operation of the theory. [An uncommon process is far more complex to state].

- Gliding is a widely attested phonological process, but it has to be accounted for phonologically as a very marked process, because almost all features change value.
**Phonological Analysis**

- Gliding process: /l/ → [w]

- D. Gilbers (1992), Phonological Networks, a theory of segment representation, PhD Thesis, Groningen University:

- Minimal Change in the phonological **Control Component**

- … leads to a series of articulatory feature changes in the **Phonetic Component** (Domino-effect)

**Neurolinguistic Evidence**


- Broca’s (phonetically-based disorders) vs. Conduction Aphasics (phonologically-based disorders)

- Gliding explained as a phonological process
Acoustic Evidence


- Gliding explained as a phonetic process

What is the phonetically-based account of gliding?

/l/ → [w]

+son +son
+cons -cons
+cont +cont
+lat -lat
-lab +lab
+ant -ant
+cor -cor
-high +high
-back +back
-round +round
Liquids and Glides Perceptively
(Ainsworth and Paliwal, 1984)

Typical set of responses obtained from listening to glide/liquid-vowel synthetic stimuli (simplified)

<table>
<thead>
<tr>
<th>3160 Hz</th>
<th>w w w l l l l j j j j</th>
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<tr>
<td>↑</td>
<td>w w w l l l l j j j j</td>
</tr>
<tr>
<td>F3 locus freq.</td>
<td>w w w r r r l j j j j</td>
</tr>
<tr>
<td>↓</td>
<td>w w w r r r j j j j j</td>
</tr>
<tr>
<td>1540 Hz</td>
<td>w w r r r r j j j j j</td>
</tr>
<tr>
<td>760 Hz</td>
<td>← F2 locus freq. → 2380 Hz</td>
</tr>
</tbody>
</table>

Sonorant Consonants
Acoustically

- Lehiste (1964): F1 and F2 of [l] and [w] coincide to a large extent. F2 for [w] is somewhat lower than F2 of [l]. F2 of [j] is somewhat higher than F2 of [l].

- Ac. Corresp. Constraint: MinDF2
  Minimal Distance IO Second Formant Value forces substitutes for liquids to be glides
/l/-substitutes (1)

**Target:**
- klok /klɔk/ ‘clock’

**Realisation:**
- [krɔk]

(2:1)

Minimal distance acoustically (cf. Coleman, 1998) and (Liberman et al, 1956)

/l/-substitutes (2)

**Target:**
- lief /lif/ ‘dear’
- lekkers /lɛksərs/ ‘tasty’
- roe /ru/ ‘birch’

**Realisation:**
- [wif]
- [hɛkə]
- [hu]

(2:2)

Minimal distance acoustically (cf. Coleman, 1998) and (Liberman et al, 1956):

Deletion of suprasegmental features in a feature geometry

/l/-substitutes (3)

<table>
<thead>
<tr>
<th>Target</th>
<th>Realisation</th>
</tr>
</thead>
<tbody>
<tr>
<td>slapen /slapən/</td>
<td>[sjapən]</td>
</tr>
<tr>
<td>geel /xeəl/</td>
<td>[χəw]</td>
</tr>
<tr>
<td>geeuw /xeəw/</td>
<td>[χəw]</td>
</tr>
</tbody>
</table>

Minimal distance length transitions (Lehiste, 1964)

Minimal perceptual distance [l]:[j] (Ainsworth and Paliwal, 1984)

/l/-vocalisation (phonetically-based)

Positional markedness

Nasal-Liquid Alternation: /n/ → [l]

knopje ‘little button’
/knɔpjo/ → [klɔpjo]

snoep ‘candy’ /snup/ → [slup]
Liquid - Nasal Alternation:  
/l/ → [n]

slurf ‘trunk’  
/slærfl/ → [sناةناة]  

The substitutions are bidirectional

Spectral Zeros

[ana]
[la] and [n] coincide in having spectral zeros between the F2 and F3 (cf. Kent et al 1996)

• [l] and [n] coincide in having spectral zeros between the F2 and F3 (cf. Kent et al 1996)

• Ac.Corrsp.Constraint: Max IO Sp0

Max IO Spectral Zeros forces [n] to be the substitute for /l/ and v.v.
Sonority Hierarchy (cf. Jespersen, 1904)

- Least sonorant: obstruents \(/p,t,k../\)
  \(/f,s,x../\)
  nasals \(/n,m../\)
  liquids \(/l,r../\)
  glides \(/j,w../\)
  vowels \(/i,u../\)
  \(/e,o../\)

- Most sonorant: \(/a/\)

Sonority & Markedness

Least marked: vowels and obstruents
Most marked: liquids
(OT constraint: \textbf{SonMark})

glides; liquids; nasals
vowels; obstruents
Sonority & Markedness

Least marked: vowels and obstruents
Most marked: liquids
(OT constraint: SonMark)

Splitting up Constraint Son Mark:

*liquids >> *glides; *nas >> *vowels; *obstr


If a constraint is split up, other constraints can intervene between the members of the split up constraint, but the sequence of the members cannot be altered

Interference of Positional Markedness

- /l/ → [n] and /n/ → [l] in satellite position
- /l/ → [n] (but not v.v.) in margin core pos.

onset

margin

pre-margin margin core satellite
Positional Markedness

Hnuc (Prince & Smolensky, 1993): a >> .. >> l,r >> .. >> p,t

Hmar: p,t >> .. >> l,r >> .. >> a

Hsat: l,r >> n,m ; w,j >> .. >> p,t ; a

Interference of Positional Markedness

- Phonological Markedness Constraint:
  Hsat: Liq >> Nas ; Glide (cf. Hnuc & Hons)
### OT tableau /snup/

<table>
<thead>
<tr>
<th>/snup/</th>
<th>Max-IORoot</th>
<th>Sp0’s</th>
<th>Hsat</th>
<th>SonM/*liq</th>
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<tr>
<td>[sup]</td>
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<tr>
<td>[slœrf]</td>
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<td>*!</td>
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<td>[sjœrf]</td>
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<td>*!</td>
<td>sn</td>
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<td>[swœrf]</td>
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<td>*!</td>
<td>sw</td>
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<td>✧[snœrf]</td>
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<td>[stœrf]</td>
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<td>[jɛkə]</td>
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Future Research

- All influences on FLA (incl. minimal distance scales) formulated as constraints
- More data
- ‘Computational OT’ (Karttunen, 1998): give constraints; give data; give options \(\rightarrow\) calculate weights
- Statistics

Phonological applications of Harmonic Grammar led Alan Prince and myself to a remarkable discovery: in a broad set of cases, at least, the relative strengths of constraints need not be specified numerically. For if the numerically weighted constraints needed in these cases are ranked from strongest to weakest, it turns out that each constraint is stronger than all the weaker constraints combined. That is, the numerical strengths are so arranged that each constraint can never be overruled by weaker constraints, no matter how many. This has led to a non-numerical successor to harmonic grammar, Optimality Theory (Prince and Smolensky, 1993), in which constraints are arranged in strict dominance hierarchies, each constraint strictly stronger than all the lower ranked constraints (even when combined).’ (italics by Smolensky).