Polish nasal vowels are autosegmental
Word game evidence

Joanna Zaleska\textsuperscript{1} Andrew Nevins\textsuperscript{2}

\textsuperscript{1}Universität Leipzig

\textsuperscript{2}University College London

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Introduction

- Aim: present the results of three language game experiments designed to shed light on the underlying representation of nasal vowels in Polish

- Claims:
  - Polish nasal vowels are not derived from a sequence of an oral vowel and a nasal consonant
  - They are represented either as underlyingly nasal vowels or as oral vowel plus a floating nasal autosegment
Outline

1. Polish nasal vowels
2. Experiments: overview
3. Di-segmental or not?
4. Are word-initial nasal vowels really disallowed?
5. Monosegmental or autosegmental?
6. Conclusions
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Polish vowels

- Oral vowels: a ɛ i ɔ u ɨ
- Two mid nasal vowels, spelled a and ɛ
- Phonetically polysegmental, consisting of an oral vocalic part, analogous to /ɔ/ and /ɛ/, and a nasal part
- Nasal vowels appear in genuinely native words
(1) Before fricatives and word-finally: realized as nasalized diphthongs [ɔ̃w] and [ɛ̃w]

\[ wąs \quad [vɔ̃ws] \quad \text{‘moustache’} \]
\[ kęs \quad [kɛ̃ws] \quad \text{‘bite’} \]
\[ wstąpiżka \quad [fstɔ̃wʃka] \quad \text{‘ribbon’ (dim.)} \]
\[ idą \quad [idɔ̃w] \quad \text{‘they go’} \]

(2) Before stops and affricates: realized as oral vowels + homorganic nasal stops

\[ dąb \quad [dɔmp] \quad \text{‘oak’} \]
\[ ręka \quad [rɛŋka] \quad \text{‘hand’} \]
\[ wstędze \quad [fstɛnɛʑɛ] \quad \text{‘ribbon’ (dat.)} \]

They never appear before sonorants or word-initially.
Word-final ɛ’s tend to lose nasality.
Nasal vowels: behaviour

Units

- Nasal Vowel Deletion in verbal stems (Bethin 1988: 35)
- Nasal Backing (Bethin 1988: 39-43)

Other arguments:

- ę’s failure to cause palatalization (Bloch-Rozmej 1997)
- phonotactic restrictions on nasal vowels
Nasal vowels: behaviour

Sequences of segments

- Nasal Assimilation (Bethin 1988: 43-46)
- Nasal Gliding (Bethin 1988: 46-50)
- Innovative Derived Imperfective Lowering (Rubach 1986: 134)
- Vowel-Zero alternations (trigger and input; Rubach 1984: 131)

Other arguments:

- phonostylistic evidence (Rubach 1977)
Proposed underlying representations

(3) Proposed representations for nasal vowels

a. disegmental
\[
\sigma
\]
\[
R
\]
\[
N
\]
\[
\nu
\]
\[
\varepsilon
\]
\[
S
\]

b. monosegmental
\[
\sigma
\]
\[
R
\]
\[
N
\]
\[
\tilde{\nu}
\]
\[
\varepsilon
\]
\[
S
\]

c. autosegmental
\[
\sigma
\]
\[
R
\]
\[
N
\]
\[
\nu
\]
\[
\varepsilon
\]
\[
S
\]

([+nasal])

(Bethin 1988, Gussmann 2007)
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The idea

- Transformational games (or *ludlings*; Laycock 1972) that delete, replace or invert segments to allow inspection of otherwise undetected moments in the phonological derivation

- Based on a similar study on nasal vowels in Brazilian Portuguese (Guimarães & Nevins 2013)
Procedure: training

Only words with oral vowels used

- Stage 1: dividing words into syllables and clapping for each syllable
- Stage 2: clapping for each syllable in a given word, repeating only vowels
- Stage 3: game-specific
Experiments: overview

Procedure: production

- stimuli recorded by a female native speaker of Polish with 44.1 kHz and 16 bit (mono) using Tascam DR-40 linear PCM recorder
- stimuli presented acoustically over headphones
  - alert signal
  - 0.5 seconds silent pause
  - auditory presentation of the stimulus
  - 2.5-3 seconds silent pause
  - alert signal . . .
- 2-3 blocks
- 8-12 minutes
- verbal responses recorded; later transcribed and coded
- demographics questionnaire
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Coda deletion game: rules

Rule
Delete the coda segment(s) in every syllable
(Guimarães & Nevins 2013)

Example
*marmur* [mar.mur] ‘marble’ ⇒ [mamu]

Aim
To decide between the disegmental representation vs. autosegmental/monosegmental representation of nasal vowels
## Coda deletion game: possible outcomes

### Possible outcomes for *kąsek* [kɔ̃.sɛk] ‘morsel’

<table>
<thead>
<tr>
<th>Type</th>
<th>Structure</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>a. disegmental</td>
<td><img src="image" alt="Disegmental Structure" /></td>
<td><img src="image" alt="Disegmental Example" /></td>
</tr>
<tr>
<td>b. monosegmental</td>
<td><img src="image" alt="Monosegmental Structure" /></td>
<td><img src="image" alt="Monosegmental Example" /></td>
</tr>
<tr>
<td>c. autosegmental</td>
<td><img src="image" alt="Autosegmental Structure" /></td>
<td><img src="image" alt="Autosegmental Example" /></td>
</tr>
</tbody>
</table>
Coda deletion game: stimulus design

20 disyllabic (C)C\u0107(C)CV(C)C words - all singular nouns in nominative case.

- 10 words with a, 10 words with e
- 6 a’s followed by a [-continuant], 4 a’s followed by a [+continuant]
- 4 e’s followed by a [-continuant], 6 e’s followed by a [+continuant]
Coda deletion game: stimulus design

80 filler items:
- oral vowels only but otherwise the same characteristics as the experimental words
- four filler words for each experimental item, matching it in terms of the type of sound following the first vowel (continuant vs. noncontinuant obstruent) and the quality of the second vowel

All words randomized using a blocking procedure (5 blocks of 20 items).
Coda deletion game: participants

- 20 non-paid participants (10 female, 10 male)
- all native speakers of Polish
- aged 21-56 (mean age 32.6)
Coda deletion game: results

Overall results

- Oral: 34 (8.5%)
- Nasal: 359 (89.75%)
- Missing: 7 (1.75%)

n=20
Coda deletion game: results

- Nasality was retained in 89.75% of the cases (Brazilian Portuguese: 90% of vowels in a coda-deletion game realized as oral, see Guimarães & Nevins 2013)
- No further differences found between factors (type of nasal vowel, sound following the nasal vowel)
Coda deletion game: conclusion

Nasal vowels are not disegmental

a. disegmental

b. monosegmental

c. autosegmental

Zaleska and Nevins (Leipzig & UCL)
Outline

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Pig Latin game: rules

Rule
Take the word-initial onset and move it to the end of the word. Then suffix an /u/.

(based on the English game)

Example

droga [drɔga] ‘road’ ⇒ [ɔgadru]

Aim
To check whether the lack of word-initial nasal vowels is a systematic or accidental gap.
Are word-initial nasal vowels really disallowed?

Pig Latin game: possible outcomes

Possible outcomes for *waʃy* [νɔ̃šiνu] ‘moustache’

a. Systematic gap [ɔsɪνu]?

```
   σ   σ   σ
  /     /     /
 R   R   R
 /     /     /
N  N  N
 /     /     /
*ǔ   s   i   v   u
```

monosegmental?

b. Accidental gap [ɔ́šiνu]

```
   σ   σ   σ
  /     /     /
 R   R   R
 /     /     /
N  N  N
 /     /     /
 ɔ́  s   i   v   u
```

autosegmental

monosegmental
Are word-initial nasal vowels really disallowed?

Pig Latin game: stimulus design

20 disyllabic (C)CṼCV words - all nouns in nominative case.

- 10 words with ę, 10 words with ą
- 5 ę’s and 5 ą’s followed by a [-continuant],
  5 ę’s and 5 ą’s followed by a [+continuant]
- each of the 5 words ended in a different oral vowel:
  /a/, /ɛ/, /i/, /ɔ/ or /ɨ/
Are word-initial nasal vowels really disallowed?

Pig Latin game: stimulus design

60 filler items:
- oral vowels only but otherwise the same characteristics as the experimental words
- three filler words for each experimental item, matching it in terms of the type of sound following the first vowel (continuant vs. noncontinuant obstruent) and of the quality of the final vowel (/a/, /ɛ/, /i/, /ɔ/ or /ɨ/)

All randomized using blocking procedure (5 blocks of 16 items).
Are word-initial nasal vowels really disallowed?

Pig Latin game: participants

- 20 non-paid participants (10 female, 10 male)
- all native speakers of Polish
- aged 22-52 (mean age 31.2)
Pig Latin game: results

Overall results

- Change: 19 (4.75%)
- Nasal: 376 (94%)
- Missing: 5 (1.25%)

n=20
Are word-initial nasal vowels really disallowed?

Pig Latin game: results

- Nasal vowels were pronounced at the beginning of the word in 94% of the cases
- No further differences found between factors (type of nasal vowel, sound following the nasal vowel)
Are word-initial nasal vowels really disallowed?

### Pig Latin game: conclusion

The lack of word-initial nasal vowels is an accidental gap

<table>
<thead>
<tr>
<th>a. disegmental</th>
<th>b. monosegmental</th>
<th>c. autosegmental</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1" alt="Disegmental Diagram" /></td>
<td><img src="image2" alt="Monosegmental Diagram" /></td>
<td><img src="image3" alt="Autosegmental Diagram" /></td>
</tr>
</tbody>
</table>

Zaleska and Nevins (Leipzig & UCL) Polish nasal vowels LAGB 2014 31 / 54
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Vowel replacement game: rules

Rule
Change every vowel in a word into one, given vowel (/a/, /ɛ/, /ɔ/, or /u/) (traditional)

Example
rower [ɔ.vɛr] ‘bicycle’ ⇒ [ruvur]

Aim
To decide between the autosegmental vs. monosegmental representation of nasal vowels.
Monosegmental or auto-segmental?

Vowel replacement game: possible outcomes

Possible outcomes for kąsek [kɔ̃w.ᵉk] ‘morsel’

a. dis-segmental

b. monosegmental

c. auto-segmental

[ką̃w sak]  [kəsak]  [ką̃w sak]

Zaleska and Nevins (Leipzig & UCL)  Polish nasal vowels  LAGB 2014
30 disyllabic words (C)CV(C)CV(C)C with nasal vowels - all nouns in nominative case.

- 15 disyllabic words with ą, 15 words with ę
- for ą words:
  - in 9 the nasal vowels was in the first syllable (in 5 words followed by a singleton and in 4 by a cluster), in 6 in the second syllable
  - in 8 words, the nasal vowel was followed by a [+continuant], in 7 by a [-continuant]
- for ę words:
  - in 10 the nasal vowels was in the first syllable (in 5 words followed by a singleton and in 5 by a cluster), in 5 in the second syllable
  - in 5 words, the nasal vowel was followed by a [+continuant], in 10 by a [-continuant]
Vowel replacement game: stimulus design

120 filler items:

- oral vowels only but otherwise the same characteristics as the experimental words (disyllabic (C)CV(C)CV(C)C).
- four filler words constructed for each experimental word, matching them in terms of vowel quality (modulo nasality) and type of sound following each vowel

All randomized using blocking procedure (5 blocks of 30 items).
Monosegmental or autosegmental?

Vowel replacement game: participants

- 40 non-paid participants (32 female, 8 male) - 10 for each vowel (/a/, /ɛ/, /ɔ/, and /u/)
- all native speakers of Polish
- aged 19-52 (mean age 31.475)
Vowel replacement game: results

Vowel replacement game

Overall results

- Oral: 545 (45.42%)
- Nasal: 574 (47.8%)
- Missing: 81 (6.75%)

p = 0.386 (ns)

n=40
Vowel replacement game: results

- Nasality was not retained significantly more often than being lost (Brazilian Portuguese: 97% of vowels in an o-replacement game realized as nasal, see Guimarães & Nevins 2013)

- There were differences between factors: the resulting vowel was nasal significantly more often when:
  - the original nasal vowel was ⟨ɛ⟩
  - the nasal vowel was followed by a noncontinuant
  - the target vowel was /ɛ/ or /u/
Monosegmental or autosegmental?

Vowel replacement game: results

(4) Variation in the vowel replacement game

<table>
<thead>
<tr>
<th>Oral</th>
<th>Nasal</th>
<th>Missing</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>29</td>
<td>1</td>
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<tr>
<td>2</td>
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<td>23</td>
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</tr>
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<td>1</td>
</tr>
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<td>2</td>
<td>20</td>
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<td>1</td>
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<td>16</td>
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<td>8</td>
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<td>11</td>
<td>10</td>
<td>9</td>
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<tr>
<td>14</td>
<td>9</td>
<td>7</td>
</tr>
<tr>
<td>18</td>
<td>9</td>
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<td>8</td>
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<td>2</td>
<td>4</td>
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<tr>
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<td>1</td>
</tr>
<tr>
<td>28</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>

5 13 17 21 22 26 31 40 46 57 59 60 61 67 72 74 79 85 93 95 97 112 114 117 125 126 129 131 139 147

Zaleska and Nevins (Leipzig & UCL)

Polish nasal vowels

LAGB 2014 40 / 54
Vowel replacement game: results

- Logistic regression: univariate models
  - the probability of nasality disappearing is 20% lower for the vowel ə
  - the probability of nasality disappearing is 25% smaller when the following sound is a noncontinuant
  - the probability of nasality disappearing is smallest when the target vowel is an /u/ (85% less likely than when the vowel is /a/)

- Logistic regression: multivariate models
  - quality of nasal vowel not significant (following sound and target vowel were significant)
Vowel replacement game: results

- Logistic regression: multivariate models with random effects (Likelihood Ratio Test)
  - Effect of participant.
    H0: \[\text{result} = \text{sound after nasal vowel} + \text{target vowel} + \text{participant}\] not better than \[\text{result} = \text{sound after nasal vowel} + \text{target vowel}\]
    p-value = 0.000
  - Effect of word
    H0: \[\text{result} = \text{sound after nasal vowel} + \text{target vowel} + \text{word}\] is not better than \[\text{result} = \text{sound after nasal vowel} + \text{target vowel}\]
    p-value = 0.861
Vowel replacement game: results

The factors most responsible for the results are:

- Effect of participant
- Quality of the target vowel (nasality is more likely to be retained when the target vowel is /u/ or /ɛ/ and more likely to disappear when the target vowel is /ɔ/ or /a/).
- Sound following the nasal vowel (nasality is more likely to be retained if a noncontinuant follows and more likely to disappear when a continuant follows).
Monosegmental or autosegmental?

Vowel replacement game: discussion

- Spelling vs. sound?
- Participants targeting different parts of the representation?
- Participants targeting different stages of derivation?
- Different representations of the nasal vowels for different speakers?
Vowel replacement game: discussion

<table>
<thead>
<tr>
<th>Spelling vs. sound</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>kəsek</strong></td>
</tr>
<tr>
<td>↓</td>
</tr>
<tr>
<td><strong>kasak</strong></td>
</tr>
<tr>
<td>‘monosegmental’</td>
</tr>
</tbody>
</table>

Inconsistent with the results of the coda deletion game
Vowel replacement game: discussion

Targeting different parts of the structure: monosegmental representation

ROOT

LARYNGEAL

SUPRALARYNGEAL

SOFT PALATE

PLACE

LABIAL

CORONAL

DORSAL

[±cg]

[±sg]

[±stiff]

[±slack]

[nasal]

[±round]

[±anter]

[±dist]

[±high]

[±low]

[±back]

‘autosegmental’

(Feature tree: Sagey 1986: 2)
Vowel replacement game: discussion

Targeting different parts of the structure: autosegmental representation

\[ +\text{nasal} \]

\[ \text{ka}^{\text{w}}\text{sak} \]

‘autosegmental’

\[ \text{kasak} \]

‘monosegmental’
Targeting different stages of derivation

‘[T]he ludling component is hypothesized to consist of two or three discrete modules, each taking a different level of representation as its input.’ (Bagemihl 1988: 489); ‘We may find dialect or versions of the same ludling assigned to different modules.’ (Bagemihl 1988: 508)
Vowel replacement game: discussion

Different representations of the nasal vowels for different speakers

**Speaker 1: autosegmental**

\[
\begin{array}{c}
\sigma \\
\sigma \\
R \\
R \\
N \\
N \\
k \quad \sigma \quad s \quad \varepsilon \quad k \\
\end{array}
\]

\[
[ka\tilde{w} sak]
\]

**Speaker 2: monosegmental**

\[
\begin{array}{c}
\sigma \\
\sigma \\
R \\
R \\
N \\
N \\
k \quad \tilde{\sigma} \quad s \quad \varepsilon \quad k \\
\end{array}
\]

\[
[kasak]
\]
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Nasal vowels in Polish

Both monosegmental and autosegmental representations are possible

a. disegmental

b. monosegmental

c. autosegmental

[+nasal]
Nasal vowels in Polish . . .

- . . . are not disegmental
- . . . are not banned at the beginning of the word
- . . . may have different representations for different speakers
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Joanna Zaleska: joanna.zaleska@uni-leipzig.de
Andrew Nevins: a.nevins@ucl.ac.uk
References I


References II


