On some parallels between defective and normal inflection

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What is inflectional defectiveness?

<table>
<thead>
<tr>
<th></th>
<th>singular</th>
<th>plural</th>
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<tbody>
<tr>
<td><strong>nominative</strong></td>
<td>θálassa</td>
<td>θálasses</td>
</tr>
<tr>
<td><strong>accusative</strong></td>
<td>θálassa</td>
<td>θálasses</td>
</tr>
<tr>
<td><strong>genitive</strong></td>
<td>θálassas</td>
<td>θalassón</td>
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<tr>
<td><strong>vocative</strong></td>
<td>θálassa</td>
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<td>kopéla</td>
<td>kopéles</td>
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<tr>
<td><strong>accusative</strong></td>
<td>kopéla</td>
<td>kopéles</td>
</tr>
<tr>
<td><strong>genitive</strong></td>
<td>kopélas</td>
<td>*</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

Table 1: Defectiveness in the Modern Greek genitive plural

missing form = paradigmatic gap
What is inflectional defectiveness?

<table>
<thead>
<tr>
<th>sprosit'</th>
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<tbody>
<tr>
<td>1st</td>
<td>sprošu</td>
<td>sprosim</td>
</tr>
<tr>
<td>2nd</td>
<td>sprosiš'</td>
<td>sprosite</td>
</tr>
<tr>
<td>3rd</td>
<td>sprosit</td>
<td>sprosjat</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ubedit'</th>
<th>singular</th>
<th>plural</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>*</td>
<td>ubedim</td>
</tr>
<tr>
<td>2nd</td>
<td>ubediš'</td>
<td>ubedite</td>
</tr>
<tr>
<td>3rd</td>
<td>ubedit</td>
<td>ubedjat</td>
</tr>
</tbody>
</table>

Table 2: Defectiveness in the Russian non-past 1sg

Classically, gaps are seen to contradict the productive nature of inflectional morphology, fly in the face of speakers’ tendency to generalize, and represent ad hoc exceptions to general grammatical principles (see, e.g., Halle 1973).
So how weird are gaps?

- Premise: If irreducible patterns of defectiveness are, in some sense, 'morphological objects' (i.e. lexically-specific information about morphological structure), we can compare the properties of gaps to the properties of 'normal' (i.e. non-defective) word-forms.

- Question: Do paradigmatic gaps exhibit properties that are typical of inflectional formatives?

- Preview: Perhaps surprisingly, paradigmatic gaps can display many of the same properties as inflectional morphology generally.
Some properties of inflectional formatives

- Part of a relatively small closed system
- Shape determined by properties of the base

- High degree of stem selection
  - Incl. lexical specificity
- Participate in blocking relations
- Prone to lexicalization

- Vary in degree of productivity
- Sensitive to paradigmatic structure
- Sensitive to the structure of lexical neighborhood
  - Analogical spreading of defectiveness
1. 'Productivity' of defectiveness?

What we are looking for:
greater 'market share' among the least frequent lexemes
Reminder: Paradigmatic gaps in Greek

<table>
<thead>
<tr>
<th></th>
<th>Nominal</th>
<th>Plural</th>
</tr>
</thead>
<tbody>
<tr>
<td>θάλασσα</td>
<td>θάλασσα</td>
<td>θάλασσες</td>
</tr>
<tr>
<td>kopέλα</td>
<td>kopέλα</td>
<td>kopέλες</td>
</tr>
</tbody>
</table>

Table 1: Defectiveness in the Modern Greek genitive plural

- According to online version of the *Lexiko tis koinis neoellinikis* (1998), 1560 nouns are defective in the genitive plural.
- Not evenly distributed across inflection classes
Distribution of defective lexemes

Low-frequency lexemes are more likely to be defective than are high frequency lexemes.
1. 'Productivity' of defectiveness?
2. Sensitive to paradigmatic structure?

What we are looking for:
generalizations that require reference to multiple cells in the paradigm
Paradigmatic structure

- Stump (2010): Defectiveness and syncretism interact in Sanskrit such that one may override the other
  - See also Hansson (1999); Gaps in Icelandic imperatives can be construed as an instance of syncretism overriding defectiveness

- Paradigmatic coherence: Form-level implicational relations holding between cells of a paradigm (Ackerman et al. 2009; Bonami and Boyé (2002); Brown et al. 1996; Finkel and Stump 2007, 2009)
  - See Boyé and Cabredo Hofherr (2010) for how implicational relations among stems helps make sense of paradigmatic gaps in Spanish and French
## Greek nominal inflectional formatives

<table>
<thead>
<tr>
<th>Singular Formatives</th>
<th>Plural Formatives</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOM</td>
<td>GEN</td>
</tr>
<tr>
<td>-Ø</td>
<td>-s</td>
</tr>
<tr>
<td>-s</td>
<td>-Ø</td>
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<tr>
<td>-os</td>
<td>-u</td>
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<td>-Ø</td>
<td>-tos</td>
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<td>-s</td>
<td>-tos</td>
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<tr>
<td>-ma</td>
<td>-matos</td>
</tr>
<tr>
<td>-mo</td>
<td>-matos</td>
</tr>
</tbody>
</table>
Stress hierarchy

\[
gpl\ fixed
\]

\[
gpl = \ldots o\sigma\#
\]

\[
gpl = \ldots \sigma\sigma#
\]

\[
gpl = \ldots \sigma\sigma#
\]

\[
gpl = gsg
\]

\[
gpl = \ldots o\sigma\#
\]

\[
gpl = gsg
\]

\[
gpl = \ldots \sigma\sigma#
\]

\[
gsg = gpl = accpl
\]
(Lack of) correspondence between singular, plural and stress formatives

<table>
<thead>
<tr>
<th></th>
<th>‘force’</th>
<th>‘mother’</th>
<th>‘greengrocer’</th>
<th>‘tourist’</th>
<th>‘father’</th>
</tr>
</thead>
<tbody>
<tr>
<td>NOM.SG.</td>
<td>դինամի</td>
<td>մամա</td>
<td>մանավի-ս</td>
<td>տուրիստա-ս</td>
<td>պատերա-ս</td>
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<tr>
<td>ACC.SG.</td>
<td>դինամի</td>
<td>մամա</td>
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<tr>
<td>NOM.PL.</td>
<td>դինամի-ս</td>
<td>մամա-դես</td>
<td>մանավի-դես</td>
<td>տուրիստ-ես</td>
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A 'bit' of introduction to entropy

\[ H(X) = - \sum_{x \in X} p(x) \log_2 p(x) \]

- H(X) is the entropy of the morphosyntactic property set (MSPS; e.g. genitive plural)
- Function of average surprisal
- Measured in bits
  - HIGH value for H(X) means MORE UNCERTAINTY associated with the MSPS
  - LOW value for H(X) means LESS UNCERTAINTY associated with MSPS
A 'bit' of introduction to entropy

\[ H(Y \mid X=x) = - \sum_{y \in Y} p(y \mid x) \log_2 p(y \mid x) \]

- \( H(Y \mid X=x) \) is the conditional entropy of the MSPS \( Y \), given a particular value \( x \), belonging to morphosyntactic property set \( X \).
- For instance, how much uncertainty is associated with the form of the word occupying the genitive plural cell, given that the nominative singular has the form \(-os\)?
Class O17-O20, O34-O36

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<tbody>
<tr>
<td>NOM</td>
<td>-os</td>
<td>-i</td>
</tr>
<tr>
<td>GEN</td>
<td>-u</td>
<td>??</td>
</tr>
<tr>
<td>ACC</td>
<td>-o</td>
<td>-us</td>
</tr>
</tbody>
</table>

X={ACC_PL,...}, x={/us/,...}

H(GEN.PL|X=x)

Reading graph:
Low entropy value = low level of uncertainty associated with genitive plural form (i.e. genitive plural form is more predictable)
Class O39-O42

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Reading graph:
Low entropy value = low level of uncertainty associated with genitive plural form (i.e. genitive plural form is more predictable)
Reminder: Stress hierarchy

gpl fixed

\[ \begin{align*}
gpl &= \ldots \sigma\sigma# \\
gpl &= \ldots\sigma\sigma# \\
gpl &= \ldots\sigma\sigma# \\
gpl &= \ldots\sigma\sigma# \\
gpl &= \text{gsg} \\
gpl &= \text{gsg} \\
gpl &= \text{gsg} \\
gpl &= \text{gpl} \Rightarrow \text{accpl}
\end{align*} \]
This is the class containing (almost) all of the defective verbs!
Uncertainty associated with genitive plural form (and with other forms given genitive plural) is (historically) connected to existence of paradigmatic gaps.

This suggests that paradigmatic gaps in Greek are sensitive to the implicational relations holding among cells in a paradigm.

- Parallels to, e.g., analogical extension
2. Sensitive to paradigmatic structure?
3. Sensitive to the structure of the lexicon?

What we are looking for:

evidence that paradigmatic gaps behave similarly to lexical gangs
The challenge: Under what conditions can paradigmatic gaps lose their original motivating factors and still persist? What (type of) information must be available to a speaker for lexicalized defectiveness to be learnable?

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<td>ubedit</td>
<td>ubedjat</td>
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</table>
More about the Russian gaps

- Key observation: All of the defective lexemes belong to morphological subclass of 2nd conjugation dental stems
  - See Baerman (2008) for discussion of historical causes
- However, defective lexemes are in the minority even within that subclass
- Moreover, many of the defective lexemes are quite infrequent

<table>
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</tr>
</thead>
<tbody>
<tr>
<td>gaps / all lexemes (RNC)</td>
<td>13.3% (19/143)</td>
<td>12.4% (14/118)</td>
<td>11.9% (5/42)</td>
<td>4.8% (3/62)</td>
<td>4.3% (2/47)</td>
</tr>
</tbody>
</table>
The challenge

- How do speakers learn that a given verb is defective when...
  - ... the number of encountered examples of the lexeme is small
    - Suggests that we need more than statistical inference from lack of attestation
  - ... and well-formedness is always more likely within the class than is defectiveness?
    - And we would expect, if anything, for there to be a bias towards speakers eliminating the gaps
A hypothesis

- It’s about expectations. Paradigmatic gaps are usually considered violations of expected morphological behavior. Is this correct?
  - (Non-defective) low frequency lexemes rely on their neighbors.
  - Suggests the possibility that for some lexemes, “defectiveness” is expected – if a sufficient number of the neighbors are also defective.
    - Self-reinforcement of morphophon.-defined clusters of gaps.

- Two ways to learn gaps
  - (In the absence of synchronic motivation), learning a gap involves estimating the (near-zero) probability of a given combination of lexeme and inflectional property set being used.
    - Word-specific learning for highly frequent lexemes
    - Analogically-driven learning from lexical neighbors for lower frequency lexemes

- Observed data and morphological class/neighbors may individually be insufficient, but together can they pick out the correct subset of lexemes?
For example...

<table>
<thead>
<tr>
<th></th>
<th>Raw #</th>
<th>Relative freq</th>
<th>‘Normal’ lexemes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1SG</td>
<td>1</td>
<td>0.2%</td>
<td>12.9%</td>
</tr>
<tr>
<td>2SG</td>
<td>53</td>
<td>11.7%</td>
<td>7.5%</td>
</tr>
<tr>
<td>3SG</td>
<td>210</td>
<td>46.4%</td>
<td>38.7%</td>
</tr>
<tr>
<td>1PL</td>
<td>27</td>
<td>6%</td>
<td>10.6%</td>
</tr>
<tr>
<td>2PL</td>
<td>71</td>
<td>15.7%</td>
<td>9.7%</td>
</tr>
<tr>
<td>3PL</td>
<td>91</td>
<td>20.1%</td>
<td>20.6%</td>
</tr>
<tr>
<td>Sum</td>
<td>453</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

– If learner hears many UBEDIT’ tokens, but no or few tokens of UBEDIT’+1SG, infers that relative absence is a property of UBEDIT’

– If learner hears few tokens (e.g. KUDESIT’ ‘do magic’), distribution of lexical neighbors is more influential.
A computational simulation

- Adults talk (100,000 nouns each), children listen
- End of generational cycle: adults die off, children learn grammar, mature, reproduce
- Speech of new adults based on the grammar that they learned
- 10 generations
- 50 adults and 50 children per generation
- Each child connected to 10 adults on average (random network)
- First generation seeded by sampling from Russian National Corpus
Evaluating the model

• Evaluation question
  • Does the number of gaps remain (relatively) constant for multiple generations?

• Conditions
  • Two types of analogical influence from lexical neighborhood: unweighted vs. morphophonologically-weighted
  • Four levels of analogical influence
Morphophonological similarity metric

- Weighting metric: In MP condition, weight = \{1, 0.67, 0.33, 0\} depending on phonological feature distance of stem-final consonant, comparing target to neighbor
  - e.g., both /di/ → 1
  - e.g., one /ti/, one /di/ → 0.67 (one feature difference)

- Gap criteria
  - Remove low sampling: raw lemma frequency > 37 tokens in output of model at each generation
  - No impersonal verbs: 3sg+3pl < 85% of relative freq
  - 1sg < 2% relative frequency
    - (2% = valley of bimodal distribution)
2) Average relative freq for lexical neighborhood

<table>
<thead>
<tr>
<th>neighborhood</th>
<th>w</th>
<th>1s</th>
<th>2s</th>
<th>3s</th>
<th>1p</th>
<th>2p</th>
<th>3p</th>
</tr>
</thead>
<tbody>
<tr>
<td>balamutit’</td>
<td>2/3</td>
<td>7.1</td>
<td>7.1</td>
<td>57.1</td>
<td>0</td>
<td>0</td>
<td>28.6</td>
</tr>
<tr>
<td>brodit’</td>
<td>1</td>
<td>9.2</td>
<td>3.7</td>
<td>48.1</td>
<td>3.3</td>
<td>1.8</td>
<td>33.8</td>
</tr>
<tr>
<td>vykrasit’</td>
<td>1/3</td>
<td>42.8</td>
<td>0</td>
<td>28.6</td>
<td>7.1</td>
<td>7.1</td>
<td>14.3</td>
</tr>
<tr>
<td>pobedit’</td>
<td>1</td>
<td>0.1</td>
<td>4.5</td>
<td>61.9</td>
<td>16.8</td>
<td>1.5</td>
<td>15.1</td>
</tr>
<tr>
<td>javit’sja</td>
<td>1/3</td>
<td>5.1</td>
<td>2.8</td>
<td>69.9</td>
<td>1.3</td>
<td>3.5</td>
<td>17.3</td>
</tr>
</tbody>
</table>

Average relative freq (lexical neighborhood)  12.9  3.6  53.1  5.7  2.8  21.8

3) Observed relative freq

<table>
<thead>
<tr>
<th>Raw tokens (ubedit’)</th>
<th>1</th>
<th>53</th>
<th>210</th>
<th>27</th>
<th>71</th>
<th>91</th>
</tr>
</thead>
<tbody>
<tr>
<td>Observed relative freq (ubedit’)</td>
<td>0.2</td>
<td>11.7</td>
<td>46.4</td>
<td>6.0</td>
<td>15.7</td>
<td>20.1</td>
</tr>
</tbody>
</table>

4) Mix, weighting by raw number of observations

| Predicted relative freq (ubedit’) | 0.3 | 11.6| 46.4| 6.0 | 15.6| 20.2|
Results of simulation

Unweighted Influence of Neighbors

Generation

# of Gaps

beta=0.05
beta=0.25
beta=1.25
beta=6.25

MP-weighted Influence of Neighbors

Generation

# of Gaps

beta=0.05
beta=0.25
beta=1.25
beta=6.25
Morpho-phonological weighting helps!

Weighting by morphophon. similarity increases the number of gaps in a generation when analogical influence is strong.

Number of gaps per generation increases, then reaches point of local stability.
Lesson to take away from simulations

- Successfully modeled the persistence of Russian paradigmatic gaps – but only when behavior of morphophonologically similar neighbors was given greater weight.
- Conclusion: Not random that gaps follow distribution of alternation.
  - Morphosyntactic distribution (low 1sg relative frequency) promoted by morphophonological coherence
  - Defectiveness as the *expected* behavior
- This is fundamentally similar to a lexical gang effect
  - Compare to mild productivity of some English irregular past tense gangs
3. Sensitive to structure of the lexicon?
Some concluding thoughts

- Paradigmatic gaps are remarkably similar in some respects to more 'normal' inflectional patterns.
- Perhaps this shouldn't surprise us; 'canonical' defectiveness involves lexical specification, and many classically morphological traits are tied to the organization of the lexicon.
  - See recent line of work suggesting that all of the oddballs of the inflectional system (e.g. suppletion) aren't so odd at all. Inflectional defectiveness is, probably, the most odd of them all – an outright failure of inflection. But it may just be the end of the cline.
  - Manifests morphosyntactically, rather than morphophonologically.
- But why defectiveness? If defectiveness is so similar to other kinds of inflectional phenomena, then why do we have defectiveness at all? It is disruptive to the linguistic system...
- Keeping a clear eye on the speaker – I speculate that the difference between analogical extension and defectiveness rests in social conditions, more than in the structural preconditions.
Thank you!
4. Prone to lexicalization?

What we are looking for:
covert reanalysis of defectiveness as a lexical property
Greek gaps: Experimental methodology

- Replication of Albright (2003)'s methodology for studying Spanish verbal gaps
- Experiment with three tasks
  - Word familiarity judgment
  - Cloze procedure – produce word-form for sentence context
  - Self-rating of confidence in production in cloze procedure
    - (Percentage scale, later converted to ranking of items)
- Albright's primary conclusion: Two patterns of Spanish verbal gaps fall out epiphenomenally from competition among inflectional patterns and frequency sensitivity
  - Correlation between interspeaker agreement and self-rating of confidence in production
  - Single continuum for defective and non-defective lexemes
    - Defective \(\rightarrow\) least interspeaker agreement and lowest confidence
Greek gaps: Experimental methodology

- Two forms elicited for each target lexeme
  - Genitive plural
  - Nominative singular or nominative plural
- 30 target lexemes, split between normatively defective and normatively non-defective
  - Comparable frequencies in Hellenic National Corpus
  - All belonged to class in Table 1
- 35 native Greek speakers
  - All students at Aristotle University of Thessaloniki
  - 31 females, 4 males
Prone to lexicalization

Intersubject Agreement about Stress Shift
Average Subject Confidence (Rank Order)
regular genitive plural
defective genitive plural

Correlation between intersubject agreement and confidence self-ratings. However, no single continuum for defective and non-defective lexemes.
Defective items receive lower ratings than do non-defective items.

Conclusion: Covert reanalysis of Modern Greek gaps as lexical generalizations.

Contra Albright's conclusions for Spanish.
4. Prone to lexicalization?