Processing inflectional complexity: competing assumptions, calculations and correlations

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Short overview

Morphological theories conceptualize inflectional structure in distinct ways. Lexical theories posit stored representation of morphemes. Inferential theories abstract over relationships between whole words. In this poster I contrast metrics associated with two such views of word structure (primitive features and entropy) for Russian nous in an experimental task. I find that both metrics are significant predictors of response time when analyzed independently. However, both metrics are correlated with (and inferior to) affix frequency. This complicates experimental (in)validation of competing morphological theories and invites caution when working with metrics of inflectional complexity.

Background and research question

Experimental support for …
lexical theories (Clahsen et al. 2001): more features = longer to process
inferential theories (Kostič 1991): more information = longer to process
and ... less frequent = longer to process

Because of different theoretical assumptions of the approaches, these metrics are (rarely) directly compared. **Research Questions**:

Are response times to inflected forms better predicted by the features, information or frequency of the inflectional ending of Russian nouns? To what extent do these measures make distinct contributions?

Experiment design: Visual lexical decision task

Real words:
- 5 morphosyntactic property sets
- 11 different suffixes
- low lemma frequency (1.5-5 ipm)
- 5 lists balanced for freq and form length
- presented in random order

Non words (2 types):
- phonologically changed form
  - **portanty* (from *platany* 'sycamore'
- morphologically invalid stem/suffix combo
  - **kolodnik'ju* (from *kolodnik* 'convict')

Russian noun exponents

black = suffixes included in lexical decision task

	Class I	Class II	Class III	Class IV
Nom.Sg	-$Ø_{sg}$	-a_{sg}	-$Ø_{sg}$	-o
Acc.Sg	-$Ø_{sg}$	-u	-$Ø_{sg}$	-o
Gen.Sg	-a_{sg}	-y_{sg}	-y_{sg}	-a_{sg}
Loc.Sg	-e_2	-e_1	-y_{sg}	-e_2
Dat.Sg	-u	-e_1	-y_{sg}	-u
Inst.Sg	-om	-oj	-ju	-om
Nom.Pl	-y_{pl}	-y_{pl}	-y_{pl}	-a_{pl}
Acc.Pl	-y_{pl}	-y_{pl}	-y_{pl}	-a_{pl}
Gen.Pl	-ov/-ej	-$Ø_{pl}$	(ov)/-ej	-$Ø_{pl}$
Loc.Pl	-ax	-ax	-ax	-ax
Dat.Pl	-am	-am	-am	-am
Inst.Pl	-ami	-ami	-ami	-ami

Calculating factors

Features

I adopt Müller's (2004) account of Russian nouns which has 3 types of features: Number Feature:[+/- pl]
Case features:[+/- subj] [+/- gov] [+/- obl]
Class features:[+/- α] [+/- β]

Some exponents have more features than others (sg shown):

/oj/ = /ju/ > /om/ = /e_1/ = /e_2/ > /o/ > /Ø/ = /y/ = /u/ > /a/

Information (Shannon Entropy)

Exponents induce varying degrees of uncertainty about the morphosyntactic properties and class of the word form; this uncertainty can be measured in bits using the following formula:

Shannon Entropy: $H = -\sum p_i \log_2(p_i)$

Where p_i is the probability of a particular outcome (morphosyntactic properties and class) of a random variable (the exponent)

Note: p_i was weighted by the type and token counts described in affix frequency

Affix frequency

Affix frequency was estimated by taking the proportion of word types in each class (extracted from Zaliznjak (1977)) and the proportion of tokens in each morphosyntactic property set (from RNC disambiguated corpus, ~5.9 million tokens).

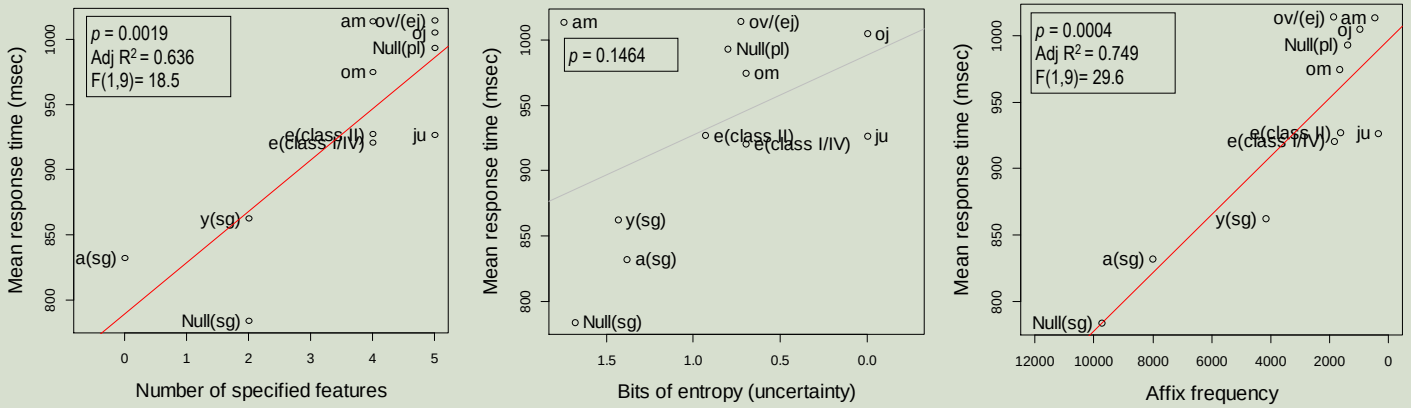
Cells with affixes considered syncretic in Müller (2004) were summed.

Correlations

Linear model(s): lm (RT ~ lemma_freq + log(form_freq +1) + form_len + pres_order + ?? features / entropy / affix_freq ??)

Adding features, entropy or affix frequency to the model results in a significant effect and a better model. No combination of two improve the model (collinearity).
If investigated independently, these data would 'support' the validity of any of these complexity metrics!

Regression over mean RT per suffix



Conclusions

- Features, entropy and affix frequency are surprisingly similar predictors for processing of inflected forms of Russian nouns
  - despite different underlying theoretical assumptions and methods of analysis (and different granularities)
- Any of the 3 factors is significant if taken separately in linear regression (above and beyond lemma freq., form freq., word length and presentation order)
- Overall for Russian nouns, affix frequency is a (slightly) better predictor than features or entropy for response times in a visual lexical decision task
- Predictions based on metrics from distinct theories can overlap significantly; complicates experimental (in)validation of divergent morphological theories

References

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AIMM 3, October 2-4, 2015, UMass Amherst