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Convergent evidence, divergent frequency effects: A study of the Russian ditransitive construction

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Outline

1. Associations between constructions and collexemes: multiple sources of evidence
2. Russian ditransitive construction
3. 66 (versions of) corpus-based measures of associations between constructions and collexemes
4. 2 experiments
5. Conclusions

Background

- Given construction C1 and lexeme L1, which measure reflects the best the strength of association between C1 and L1?
- There exist a variety of association measures from statistics, psychology and information theory – from simple frequency of L1 in C1 to hypergeometrical log-likelihood and other sophisticated statistics
- All usage-based linguists would probably agree that frequency L1*C1 should be taken into account, but how exactly? Opinions differ...

Raw frequency

- according to some linguists (Bybee 2010; Goldberg et al. 2004), 'raw' or relative frequency of L1 in C1 reflects the centrality/peripherality of C1 exemplars and helps to identify the leading constructional exemplars, e.g. *go* in the directed motion construction and *give* in the ditransitive construction
- experimental support: grammaticality judgements, facilitation of C learning

Contingency information

- some argue (e.g. Gries et al. 2005, 2010; Ellis 2006) that it is necessary to take into account contingency information, i.e. not only the frequency L1*C1, but also how often L1 is used in other CC, e.g. log-transformed p-value of Fisher's Exact Test and ΔP
- experimental support:

  - FET: sentence completion (verbs as triggers) (Gries et al. 2005); self-paced comprehension task (Gries et al. 2010); ESLearner's uptake (Ellis & Ferreira-Jr. 2009)

  - minimum sensitivity: eye-tracking comprehension task (Wiechmann 2008), though followed by FET

Different frequency effects

- there is an opinion that 'attraction' of L1 to C1 (relative frequency of L1 in C1) and 'reliance' of L1 on C1 (how often L1 is used in C1 in comparison with other CC) are different types of information that should not be 'lumped' together (Schmid 2010)
- experimental support: not much (known to me), though “each of the measures is biased in some way” (Divjak 2008)

State of Affairs

- The evidence is far from being conclusive
- The results are difficult to compare:

  - different experimental designs (LL vs. CC as cues, metalinguistic judgements vs. production)

  - different sets of corpus measures

  - different stats (ANOVA, correlation, regression)
- Usually only one experimental design serves as THE manifestation of cognitive reality, which should be matched by corpus measures
- Predominantly English

The main questions of this study

- Are C-L associations uni- or bidirectional?

  If L1 serves as a cue, and C1 as the response, is the strength of association the same as it would be the other way round? Is one associaton measure enough?

- Should simpler measures of association be preferred, or should contingency frequencies be taken into account (if yes, how?)

  "Consider how, in the learning of the category of birds, while eyes and wings are equally frequently experienced features in the exemplars, it is wings which are distinctive in differentiating birds from other animals.(...) Raw frequency of occurrence is less important than the contingency between cue and interpretation." (Ellis & Ferreira-Jr. 2009)

Steps

1. Compute as many corpus-based C-L association measures as possible

2. Carry out two experiments:

    a) C (cue) → L (response)

    b) L (cue) → C (response)

3. Compute correlations between the experimental and corpus scores.

Operationalization

- Directionality: if the relationships between C and L are unidirectional, one and the same corpus measure, or very similar ones, will be the most strongly correlated with the results of both experiments
- Contingency: if contingency information is vital for the associations between C and L, then contingency-based measures should be more predictive of the responses than contingency-free ones

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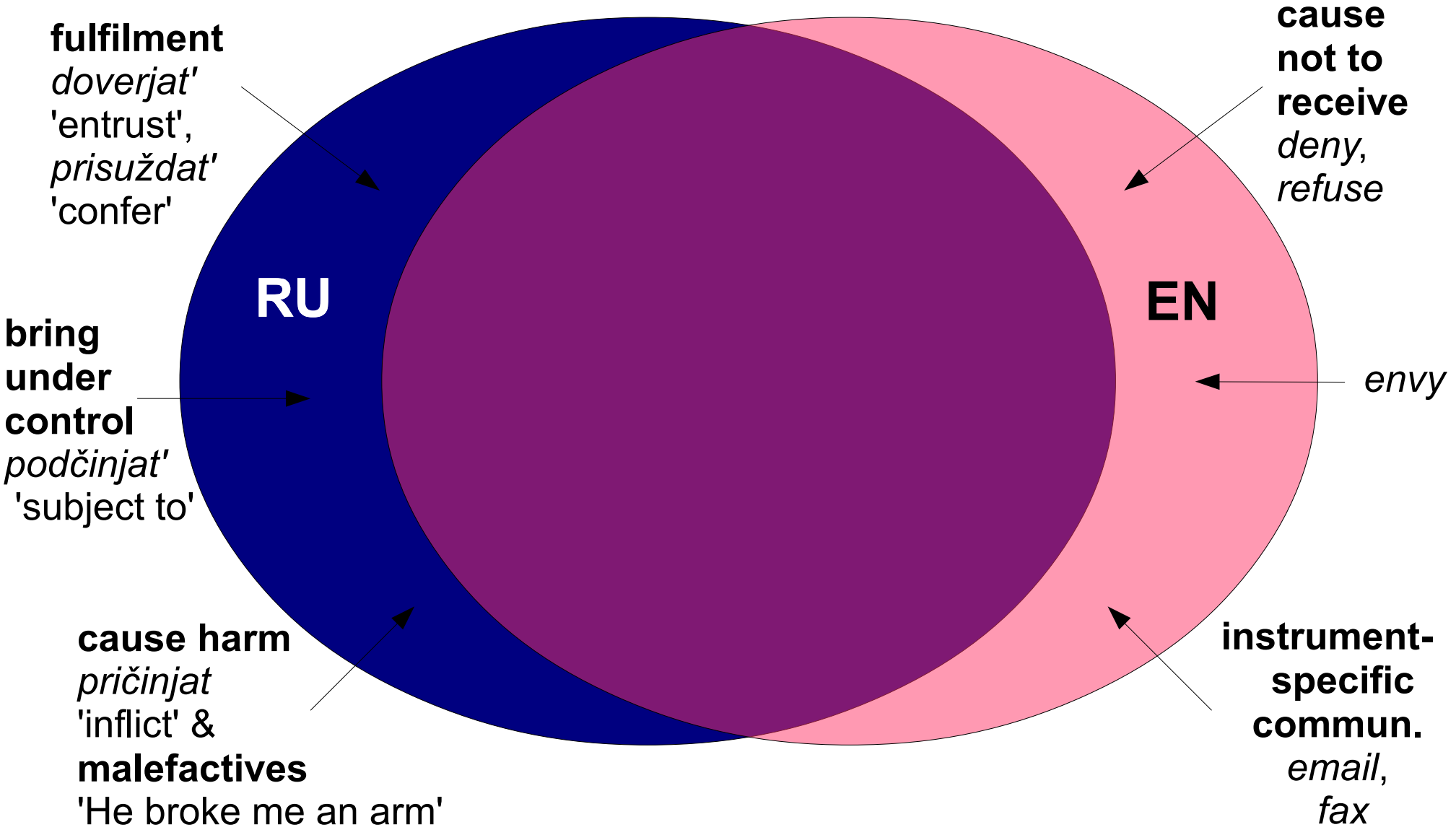
Ditransitive family

- three-argument verb constructions: an agent, a theme and a recipient (Malchukov et al. 2010)
- physical transfer as the prototype (*give*, *hand*, *return*)
- metaphorical and metonymical extensions from the prototype (e.g. Goldberg 1995):
    - spatial transfer (*bring*),
    - ballistic motion (*throw*),
    - transfer of information (*tell*)
    - future giving (*bequeath*), etc.

Russian vs. English DitrC: Semantics



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Corpus data

- Russian National Corpus: syntactically annotated part (appr. 760 000 words)
- C = V + NP_{DAT} + NP_{ACC} (also NP_{DAT} + NP_{GEN} with mass nouns), in any order
- 667 occurrences of the ditransitive construction (automated search and manual cleaning)
- 119 verbs (aspectual pairs, e.g. *dat'* – *davat'* 'give', are represented by the imperfective form)

Unidirectional measurements

- change if we swap the rows and the columns
- relative frequency, reliance, relative risk, ΔP

	C1	¬C1
L1	*a*	*b*
¬L1	*c*	*d*

Bidirectional measures

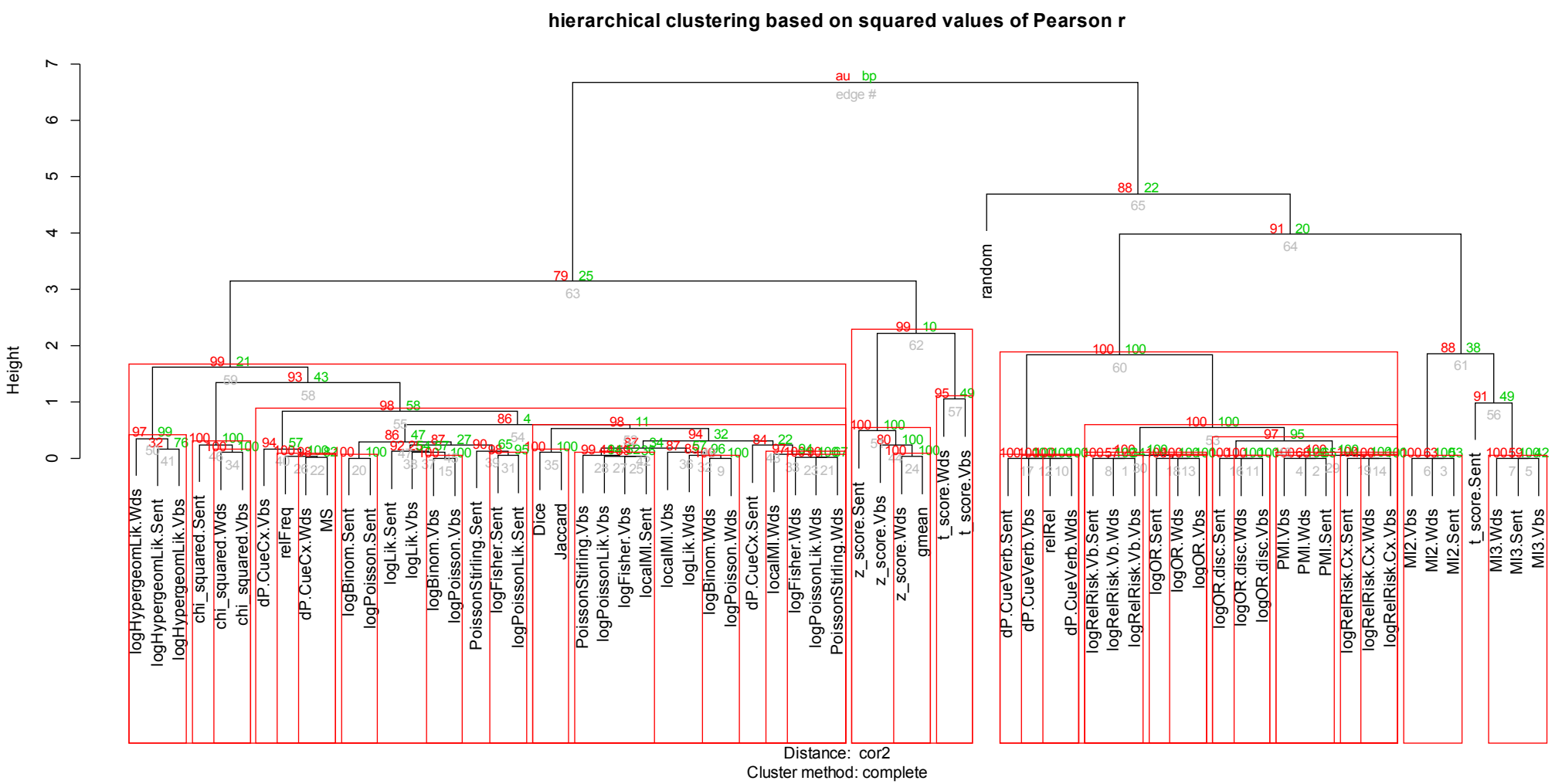
- measures of the degree of association between L and C (log-odds ratio, Dice and Jaccard index, minimum sensitivity, etc.)
- significance of association measures derived from statistical hypothesis tests (Fisher's exact test, chi-squared test, etc.)
- information-theory measures (different types of mutual information)

based on Evert 2004

Quantitative analyses

- R Development Core Team (2012)
- correlations between measures (Pearson's *r*, Spearman's rho, Kendall's tau)
- hierarchical clustering of measures (multiscale bootstrapping in `pvclust` package) based on different correlation statistics, different distance definitions and different clustering methods
- Multidimensional scaling

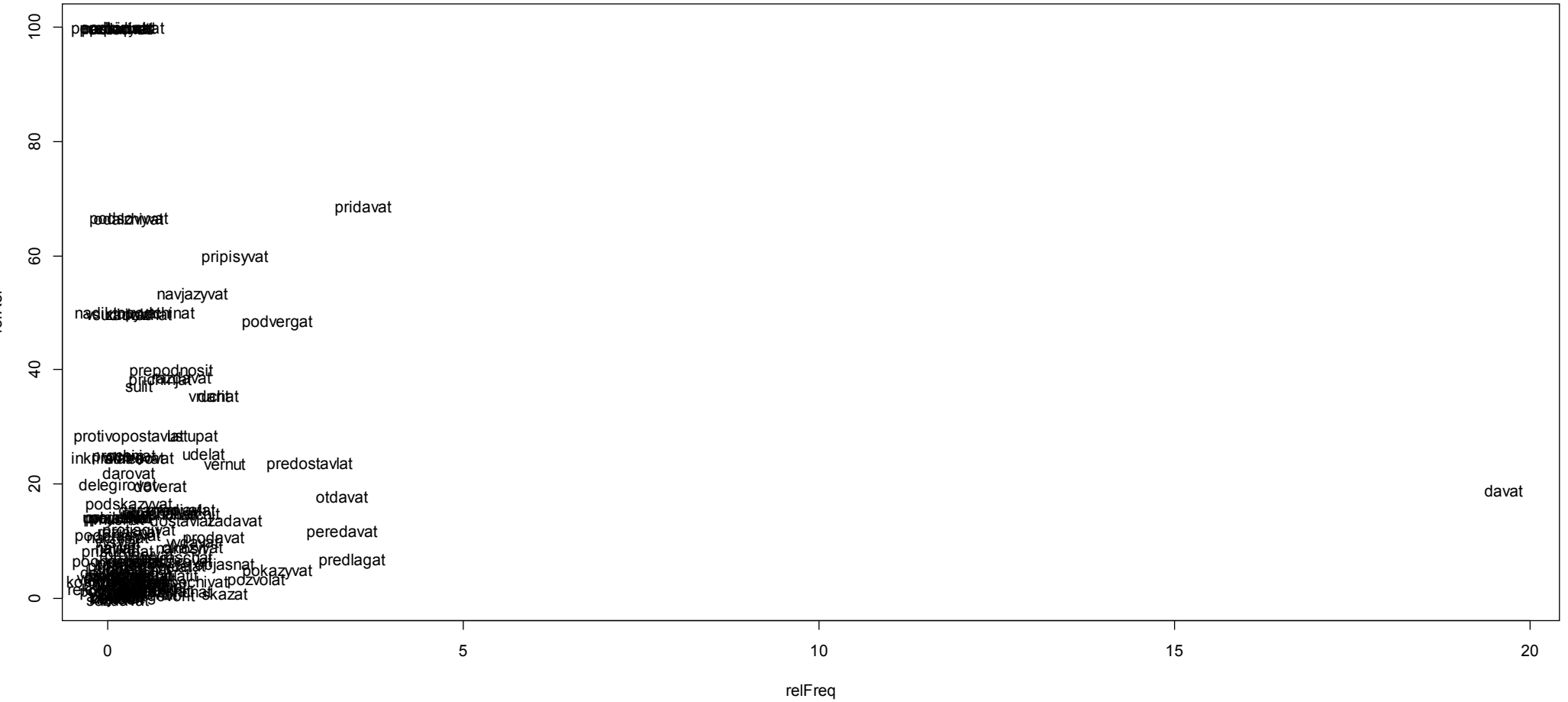
Hierarchical cluster analysis of 66 measures



Corpus measures: summary

- relative frequency correlates strongly with many bidirectional hypothesis-testing measures (e.g. log-*p* FET) and some others (MS, Dice, Jaccard)
- reliance correlates strongly with some bidirectional strength of association measures (e.g. odds ratio) and PMI
- many scores are very similar because of two constants: C1 frequency *a* + *c* and the overall frequency *a* + *b* + *c* + *d*. This restricts variation in C-L association scores (Evert, p.c.)

Attraction vs. reliance



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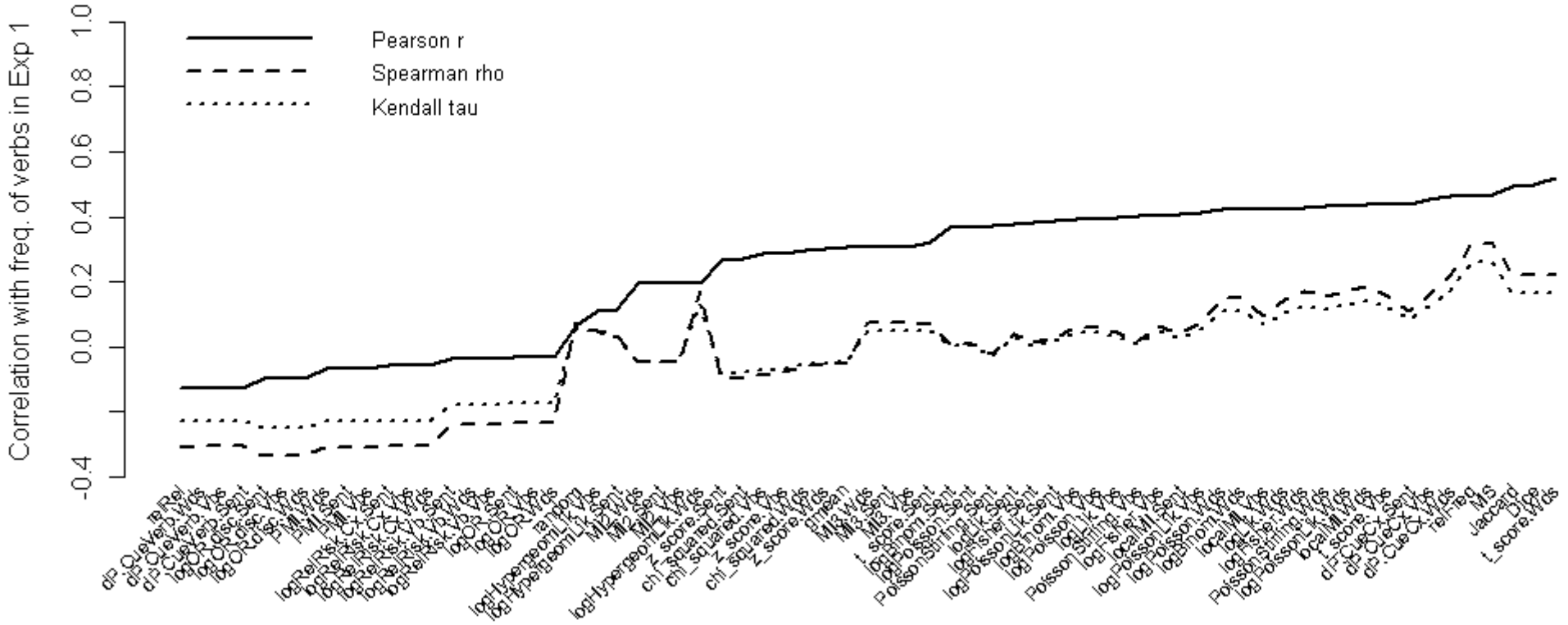
Experiment 1

- design: constructions as stimuli, verbs as responses
- subjects: 66 native speakers
- online form
- Stimuli: 10x4 nonse word structures (16x4 fillers), e.g.

> Секаб _____ (что делает?) его тому лепаву.

- task: write 3-5 verbs that fit the context
- measure: overall frequency of each verb as response

Correlations with corpus measures



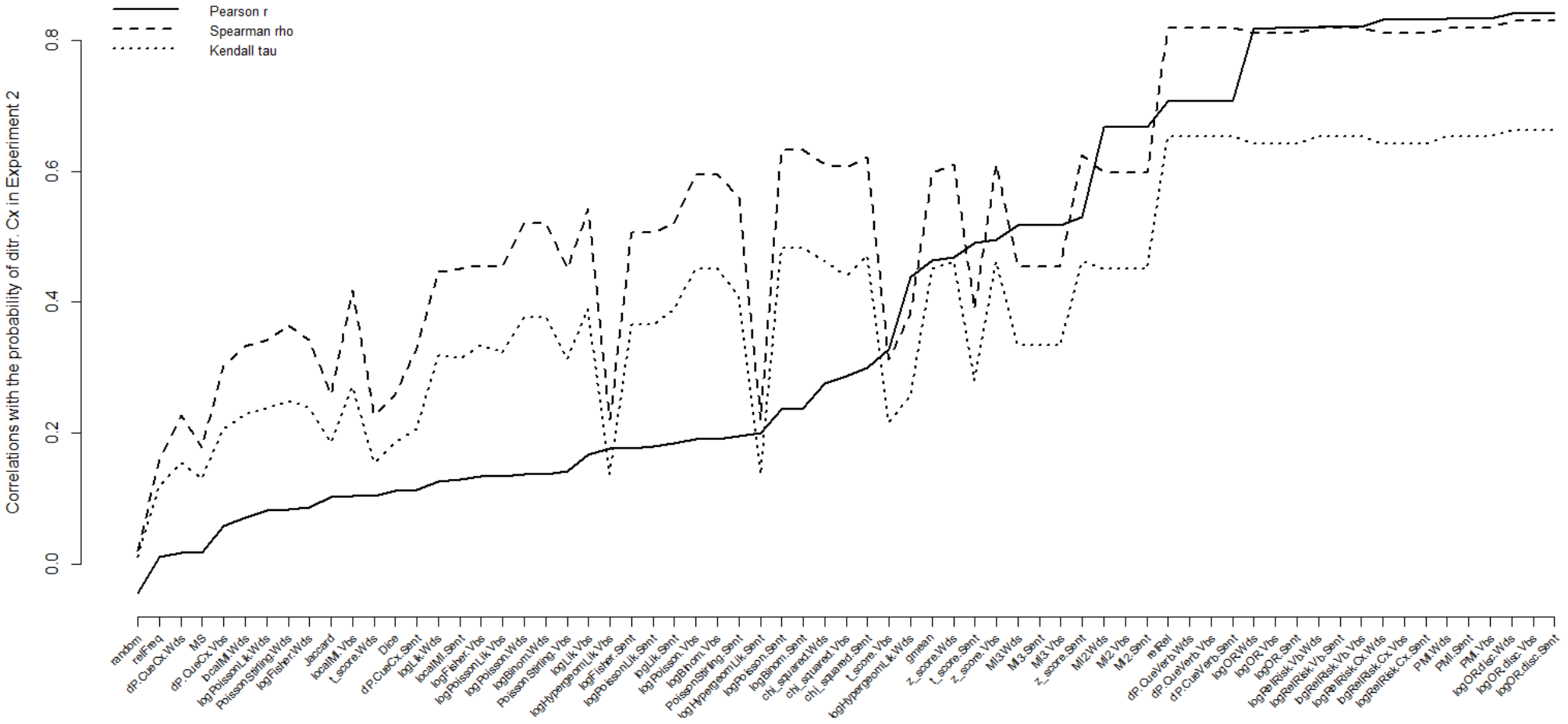
Results

- relative frequency (and similar measures) is the most strongly correlated with the production frequencies of the verbs, though the correlations are not particularly strong
- reliance and similar measures are the most strongly negatively correlated ones
- Interestingly, *davat'* 'give' is not the most frequent verb in the responses. It is outperformed by more specific *otdavat'* 'give away', *peredavat'* 'transfer' and *darit'* 'give as a gift'. Is the semantics of *davat'* not specific enough?

Experiment 2

- design: verbs as stimuli, constructions as responses
- subjects: 41 students of Pskov State University
- stimuli: 10x2 collexemes (16x2 fillers)
- task: make a sentence with each verb
- measure: proportion of sentences with DitrC in the responses

Correlations with corpus measures



Results

- reliance and its 'friends' are the most strongly correlated with the proportion of DitrC in the responses
- relative frequency is correlated with the corpus-based measures very weakly – very much like the random score

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Summary

- The corpus-based measures form two large stable groups: relative frequency and its 'friends', and reliance & Co.
- Correlation analyses between the corpus-based and experimental measures show that relative frequency and reliance behave in very different ways:

  - if constructions are cues, relative frequency is correlated positively and the most strongly with the experimental frequencies. Reliance has the lowest (negative) correlation scores.

  - If verbs are cues, the effect is opposite. Reliance comes to the foreground, and relative frequency totally fails to predict the experimental scores.

Interpretation

- There is no single frequency measure of association between L and C. This suggests that the relationships between L and C are bidirectional
- Using the contingency-based measures does not give us any advantages. The more parsimonious contingency-free measures (relFreq, relRel) should be used as approximations of C–L associations (at least)
- Note that many measures are very similar due to two constant values, unlike in L-L association studies. This might partly explain the diverging results of the previous studies.

Questions for future research

- difference and similarities between L-C and L-L associations (greater variation in the latter)
- nominal slots
- other experimental designs, esp. metalinguistic evaluation
- new constructions, new languages...

Thank you!

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