Morphological Productivity: Corpus-Based Approaches

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Granada "Morphology and Corpora" Seminar

Outline

Attested and possible words

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- Need to delimit set of *possible* but *unattested* words

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  - NN compounding in Germanic vs. Romance languages
- *-ness* and Germanic NN compounding are *productive* processes

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- Vast literature on productivity (see refs.)

Productivity: the classic definition

Schultink (1961), translated by Booij

Productivity as morphological phenomenon is the possibility which language users have to form an in principle uncountable number of new words unintentionally, by means of a morphological process which is the basis of the form-meaning correspondence of some words they know.

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Productivity as all-or-nothing

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- Different from "grammatical" vs. "ungrammatical": *kingdom*, *growth* are "grammatical"

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- Baayen (2003) finds productive uses of *-th* on the Net ("Maintainance (sic) of greenth")

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- Corpora: you need to count something, to find out that X is more productive than Y (dictionary entries not appropriate)
- Lexical statistics: we must count properties of our *sample* (instances of wf process attested in the corpus) to infer properties of the *population* our sample is taken from (all possible instances of wf process)

Outline

1. Introduction
2. Quantitative productivity: Baayen's approach
3. Methodological issues in measuring quantitative productivity
4. The interpretation of (quantitative) productivity
5. Conclusion

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- Productivity as a nuisance: target sample (text, corpus) does not contain full vocabulary
- Development of methods to assess "growth rate" of vocabulary and estimate vocabulary size (and other measures) in whole population

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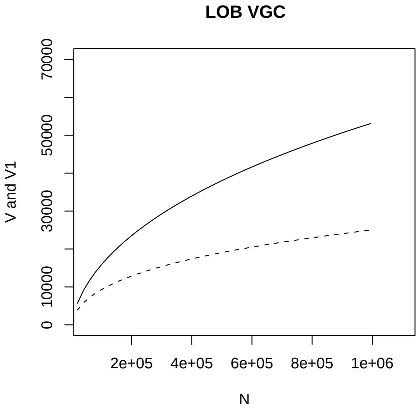
- N: 8, V: 3, V1: 1
- (Most VGCs below smoothed with *binomial interpolation*)

Vocabulary growth curve of LOB corpus



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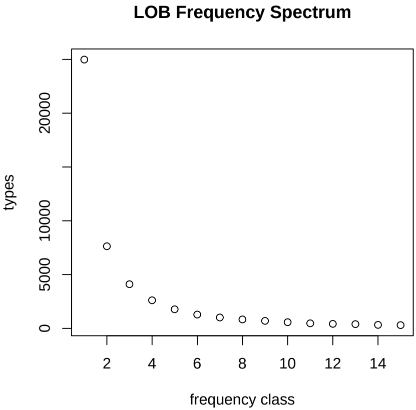

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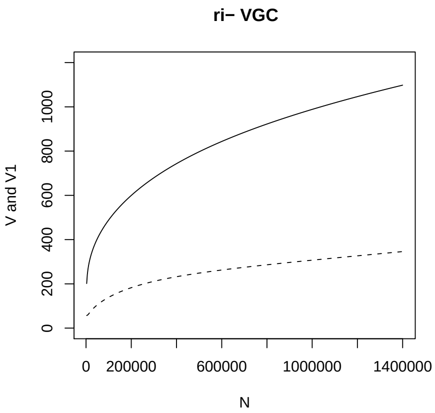
- V1: number of hapax legomena characterized by target wf process

ri- in Italian *la Repubblica* corpus



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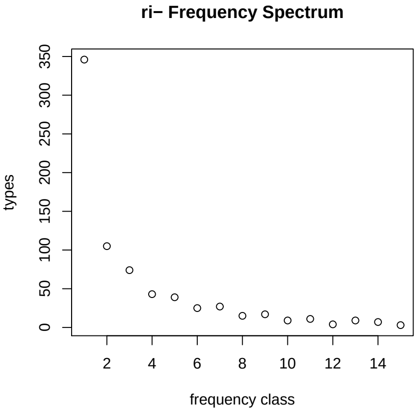

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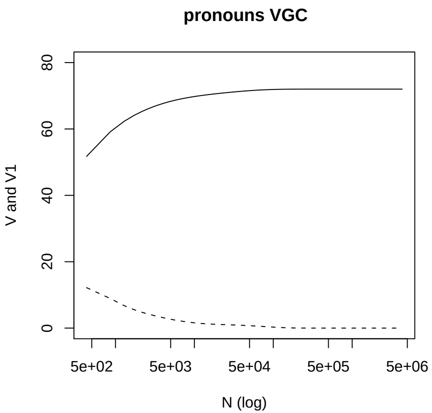

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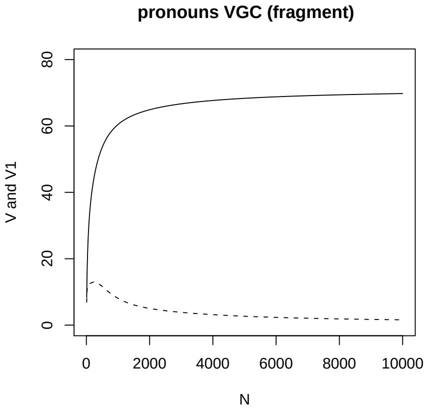

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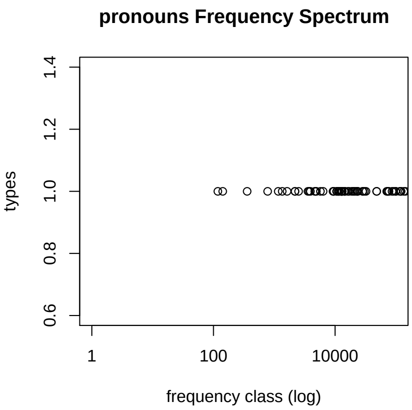

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- (V of whole population *could* measure potential – see below)

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- There is a close relation between hapax legomena and words-yet-to-be-seen

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- A *productive* process is a process that is more likely than others to produce new words
- Thus, the more a process is productive, the more it is likely that the next word we see that has been generated by that process is a new word

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- Thus, we can estimate probability of sampling a new word as relative frequency of hapax legomena in our sample:
  $\mathscr{P} = \frac{V1}{N}$
  (where V1 and N are limited to words displaying the relevant process)

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- $\mathscr{P}$ as productivity measure matches intuition that productivity should measure *potential* of process to generate new forms

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- Again, "rate of growth" of vocabulary generated by wf process seems good match for intuition about productivity of wf process

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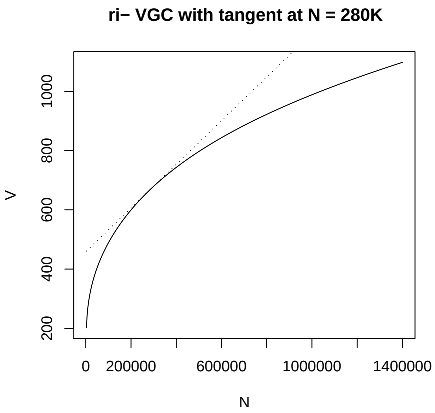

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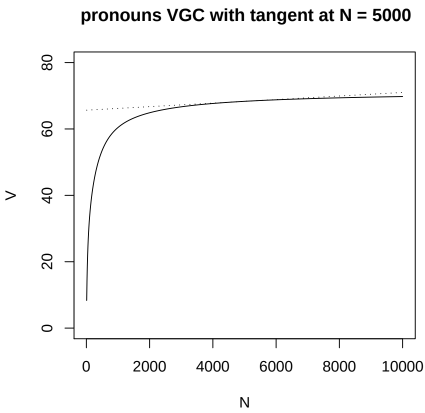

Baayen's $\mathscr{P}$ and intuition

class	V	V1	N	$\mathscr{P}$
it. ri-	1098	346	1,399,898	0.00025
it. pronouns	72	0	4,313,123	0
en. un-	119	25	7,618	.00328
en. de-	141	16	86,130	.000185

Applications of $\mathscr{P}$

- Extensive tradition of corpus-based analyses of derivational morphology based on $\mathscr{P}$ (and V), by Baayen and colleagues (esp. English and Dutch), but not only (e.g., Lüdeling and Evert on German morphology, Gaeta and Ricca on Italian morphology)

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  - ...but affixes such as *-ity*, *-ous* and *in-* have $\mathscr{P} > 0$ (and there are category-of-the-base effects)
  - dual nature of *re-*: few high frequency forms make it look unproductive (*remove, recite, recall...*) (but see below on *re-*, $\mathscr{P}$ and sample size)

Plag, Dalton-Puffer & Baayen (1999)

Productivity across speech and writing

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- Different productivity of different affixes in different registers: *-like* is "written-only", *-ness* is strongly "written", productivity reversal of *-ize* and *-ish* in written vs. demographic
- Productivity is affected by register, it cannot be explained in purely structural terms

Other examples

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- Lüdeling and Evert (2005): medical and non-medical *-itis* in XXth century German (with focus on methodological aspects)

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  - Problems of (automated) data-cleaning/complex word identification (Evert and Lüdeling 2001)
  - Theoretical issues (delimitation and identification of application of a wf process) (Gaeta and Ricca 2003, to appear)

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  - Pattern matching heuristics (e.g., candidate prefixed form must be analyzable as *PRE+VERB*, with VERB independently attested in corpus)

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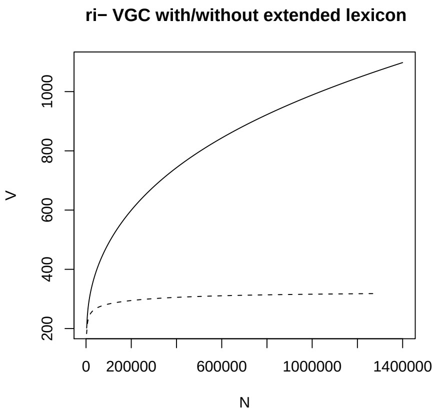
- Writers are more likely to use dash to mark transparent morphological structure

Productivity of *ri-* with and without an extended lexicon



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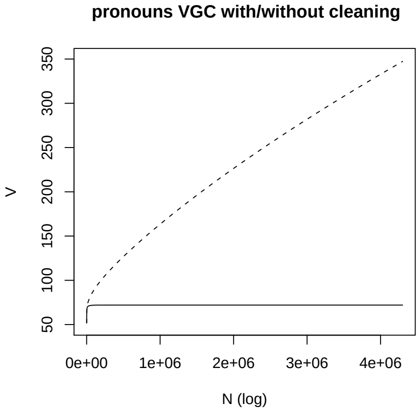
- Dashed strings can be anything, including full sentences
- This creates a lot of pseudo-pronoun hapaxes: *tu-tu, parapaponzi-ponzi-pò, altri-da-lui-simili-a-lui*

Productivity of the pronoun class before and after cleaning



$\mathscr{P}$ (and V) with/without correct post-processing

- With:

class	V	V1	N	$\mathscr{P}$
ri-	1098	346	1,399,898	0.00025
pronouns	72	0	4,313,123	0

- Without:

class	V	V1	N	$\mathscr{P}$
ri-	318	8	1,268,244	0.000006
pronouns	348	206	4,314,381	0.000048

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- Is *deXize* a different wf process from *de-*?

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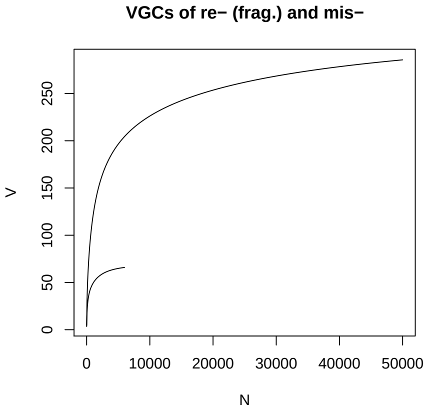
V and N

English *re-* and *mis-*



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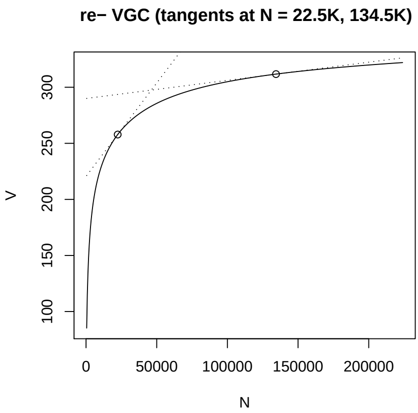
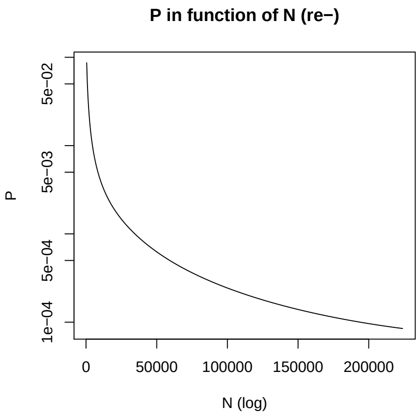
- At the beginning, any word will be a hapax legomenon; as sample increases, hapaxes will be increasingly lower proportion of sample
- A specific instance of the more general problem of "variable constants" (Tweedie and Baayen 1998) in lexical statistics (cf. type/token ratio)

Growth rate of *re-* at different sample sizes



$\mathscr{P}$ as a function of N (*re-*)



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- I.e., if 3 processes have sample sizes $N_a > N_b > N_c$, compare processes *a* and *b* at N_b, *b* and *c* at N_c and infer productivity ranking of *a* and *c* on the basis of their relationship to *b*

Controlling N: $\mathscr{P}$

class	$N = 6097$	$N = 35107$	$N = 223970$
re-	0.007	0.00098	0.000085
en-	0.00075	0.00014	NA
mis-	0.00082	NA	NA

Controlling N: V1 (interpolated values!)

class	$N = 6097$	$N = 35107$	$N = 223970$
re-	43.7	34.4	19
en-	4.5	5	NA
mis-	5	NA	NA

Problems

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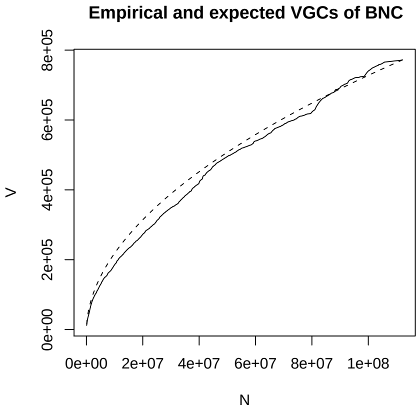
- Clumpiness and other non-randomness effects

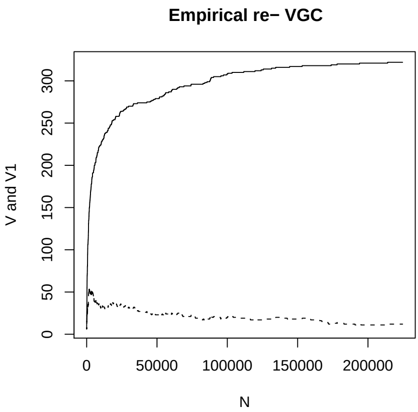
Non-randomness

Empirical and interpolated VGCs of BNC



Non-randomness

The “real” *re-* VGC



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  - Effects of specialized language, genre, register (in our version of BNC, spoken texts are almost entirely at end of corpus)
- For less frequent process, we take sample from whole corpus, whereas for more frequent process we take sample from first N_{sub} tokens, probably resulting in more clumpiness and less variety of genre and topics

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- Most plots shown on these slides are based on binomial interpolation

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- Counting number of documents in which a word occurs, rather than overall occurrences, might be a cure for clumpiness (but increases data-sparseness problems, and complicates the assumptions about sampling)
- However, non-randomized VGC plot provides very valuable information, and should always be included in quantitative productivity studies

Non-randomness: a bigger problem

- The whole corpus is probably a non-random sample of the "population" we are interested in (e.g., the population of words illustrating word formation with *re-*, or the population of words known by an English speaker)

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- Unfortunately, we cannot take a randomized sub-sample from the whole population like we can do when taking a sub-sample from the whole corpus (that's what a corpus is supposed to be in the first instance!)

Non-randomness and parametric (lexico-)statistical models

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- (Please stay tuned)

Outline

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- See, e.g., Plag (1999), who uses quantitative productivity as exploratory tool, and looks for qualitative structural explanations (phonological, semantic, morphosyntactic) of different degree of productivity of similar affixes

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- My ongoing work on productivity and semantic transparency (Baroni and Vegnaduzzo 2003, Baroni 2005)

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- The higher the base-to-derived-form relative frequency is, the more likely it is that a word is treated as complex

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- Hay and Baayen (2002) report high correlation between $\mathscr{P}$ and relative frequency for 80 English derivation affixes

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- If productivity is caused by low relative frequency of bases, what causes this low relative frequency? (Or vice versa?)
- Nature of variables as epiphenomenal indices seems to be recognized by Hay and Baayen (2004), which analyze a constellation of densely inter-correlated measures related to parsability and productivity

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- Here, direction of causation should be clear

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  - Semantically similar words occur near each other

Contextual similarity

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- My parameters:
  - Targets: affixed form/base pairs
  - Contexts: all content words
  - Window: 1 sentence

Co-occurrence

- Measured by *Mutual Information* (MI):

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- My parameters:
  - Targets: affixed form/base pairs
  - Window: 1 sentence

Wf processes explored

- "Baayen prefixes"
- Mean productivity rank assigned by 4 English morphologists:

un	1.500
re	1.625
mis	3.250
de	3.625
be	5.875
en	5.875
in	6.250

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- More "sophisticated" methods (that rely on further automated processing) perform worse than this "brutal" approach

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- NB: hapax legomena are not playing a (crucial) role!

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- More nuance needed: polysemy of *in-*, *de-* vs. *deXize*

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- Targets:
  - Single prefixed words
  - Class of *ri-* words (compared to other prefixed/non-prefixed words)
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- Patterns of co-occurrence (both similarities and differences):
  - With bases (or prefixed forms with same bases)
  - With other *ri-* forms
  - With base+*again*
  - Direct co-occurrence with words that tap into the semantics of *ri-*

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- *ri-* is more productive than *de-* in Italian (excluding *deXizzare* pattern)
- Prediction: on average, *ri-* words will have more *ri-* words in their distributionally defined nearest neighbor set than *de-* words will have other *de-* words

Distributional data

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- Automated thesaurus function of Word Sketch Engine (Kilgarriff et al. 2004)
- Based on Lin's (1998) distributional similarity measure

Lin's algorithm

- Collect collocates of each target word with other words in small set of grammatically meaningful patterns (e.g., for V collects N collocates in patterns `N ADJ* ADV* AUX* V`, `V ART* ADV* ADJ* N`, etc.)

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- For each pair of target words (with same POS), compute score based on number of shared collocates, weighted by MI (so that more unusual collocates will have more weight)
- Pick as neighbor set of a target word all other target words with similarity score above a certain threshold (I used WSE defaults)

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- E.g., neighbor set of *ricomporre* ("to recompose") include *ricostituire* ("to reconstitute"), *scomporre* ("to decompose"), *assemblare* ("to assemble")

Experiment

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- Percentage of forms with same prefix over total number of neighbors:

	min	med	mean	max
ri-	10%	31%	28%	44%
de-	4%	8%	8%	13%

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- The need to express something depends on extra-linguistic factors (like the political situation, fashion, etc.)
- There is no *baayenitis* without Baayen!

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- However. . . does competition exist? (cf. Plag 1999: where all have the rivals gone?)
- Probably it does (ongoing work on a set of German compound heads meaning "too much" with a disease connotation)

Outline

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  - Theoretical relevance of quantitative data
  - Methodological expertise in using corpus data to answer linguistic questions
  - Development of descriptive techniques (VGCs etc.) and index ($\mathscr{P}$) to explore productivity in data-set

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- Productivity measures have played and can play an important role in choosing productive phenomena to focus on (Baayen and Lieber 1991, Plag 1999, Lieber 2004)
- Possible criterion also in preparation of L2 teaching/lexicographic materials
- Many other areas of application still to explore: e.g., non-morphological productivity in studies of lexical richness, stylometry

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  - New analytical tools to study context and meaning from corpus linguistics, e.g., Stefanowitsch and Gries' (2005 and elsewhere) collustructional analysis

THE END