HEINRICH HEINE
UNIVERSITÄT DÜSSELDORF

Seminar series

Labex EFL

Spoken Morpholgy: Morpho-phonology revisited

Ingo Plag

LABEX International Chair – Empirical Foundations of Linguistics

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Introduction

Morpho-phonology as we know it

1. Morpho-phonological alternations are categorical but may have lexical exceptions.

2. The formal level of representation of morphemes is phonological in nature.

3. Post-lexical phonology and phonetics have no access to lexical information.

1. Morpho-phonological alternations are categorical but may have lexical exceptions.

- Stress shift
  - *-able* does not shift stress

(1) adóre ◆ adórable, understánd ◆ understándable, ánswer ◆ ánswerable

but

(2) prefér ◆ préferable, compáre ◆ cómparable

- Velar softening
  - base-final [k] is realized as [s] before certain suffixes

(3) classic ◆ classicize, opaque ◆ opacify, historic ◆ historicism

but

(4) zinc ◆ zin[k]ify, anarch(y) ◆ anarchism, monarch ◆ monarchism

2. The formal level of representation of morphemes is phonological in nature.

English suffixes

-ic

/ɪk/ ~ /ɪs/

/ɪk/ → /ɪs/ | __ {*-ize, -ify, -ism, ...*}
/ɪk/ → /ɪk/ | elsewhere

/ɪk/ → [ɪs] | __ {*-ize, -ify, -ism, ...*}
/ɪk/ → [ɪk] | elsewhere

No reference to sub-phonemic detail

plural, 3sg, genitive

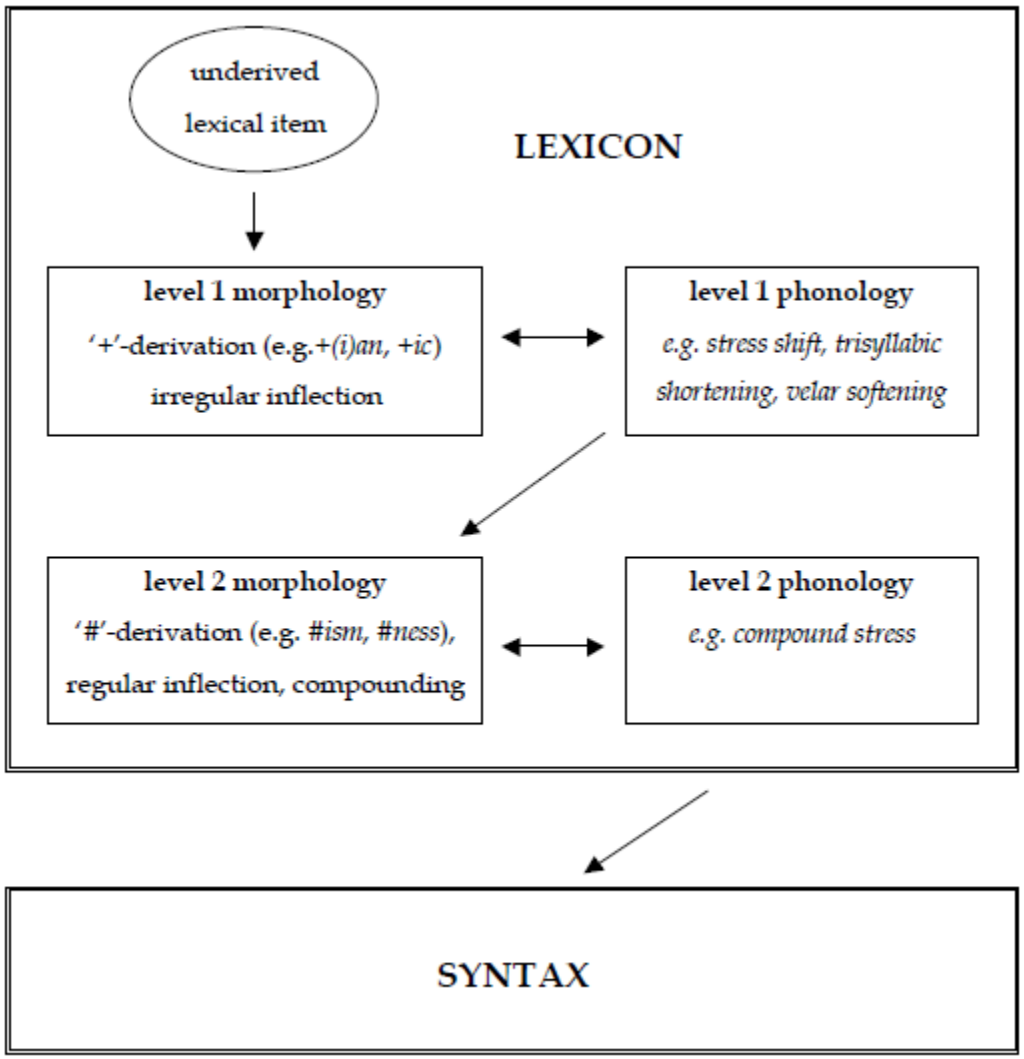
/z/ ~ /s/ ~ /ɪz/

/z/ → /s/ | ...
/z/ → /z/ | ...
/z/ → /ɪz/ |...

/z/ → [s] | ...
/z/ → [z] | ...
/z/ → [ɪz] |...

No reference to sub-phonemic detail

3. Post-lexical phonology and phonetics have no access to lexical information.



(from Plag 2003: chapter 7)

3. Post-lexical phonology and phonetics have no access to lexical information.

lexical rules (= inside the lexicon)

- Cyclic
- Have lexical exceptions
- Structure-preserving (output is a possible underlying representation)
- Not necessarily phonetically natural
- Never apply across words
- Apply only in derived environments
  (Trisyllabic shortening)

post-lexical rules

- Non-cyclic
- No lexical exceptions
- Not necessarily structure-preserving
- May apply across words
- May not refer to word-internal morphological information
  (Flapping in Am. English)

Problems with morpho-phonology as we used to know it

- Many studies have found effects that call into question the perceived wisdom

- **Alternations**
  - Variable stress preservation (e.g. Collie 2008, Bauer, Lieber & Plag 2013)
  - Type-dependent (Oh and Redford 2013) and speaker-dependent (Kaye 2005) variation in degemination with *in*-prefixed words
  - Dutch and German compound linking morphemes (e.g. Krott and colleagues 2001, 2002, 2007)
- **Phonetic detail**
  - Free and bound variants of a base differ acoustically (Kemps et al. 2005, Blazej & Cohen-Goldberg 2015)
  - Duration of Dutch compound linking morphemes depends on paradigmatic probability (Kuperman et al. 2007)
  - Vowel frontness of Russian verbal suffix depends on paradigmatic probability (Cohen 2014)
- **Challenges**
  - for models that are categorical in nature
  - for models that build on the strict separation of lexical and post-lexical phonology

Research questions

- How does paradigmatic and syntagmatic morphological structure affect the articulatory, acoustic and phonological properties of complex words?

- What do the phonological and phonetic properties of complex words reveal about the morphological structure of these words and about their paradigmatic relationships?

- What are the implications for the organization of the mental lexicon and for models of morpho-phonology, of lexical processing, of speech production and speech perception?

Seminar series:
Recent research from my lab

- Session 1
  - **Compound stress, informativity and analogy**
- Session 2
  - **Morphological Gemination and Degemination in English**
- Session 3
  - **Homophony in morphology:**
    The acoustic properties of word-final S and D in English
- Session 4
  - **Morpho-phonology and hierarchical morphological structure:**
    The case of triconstituent compounds

Please ask questions along the way!

Seminar session 1

Compound stress, informativity and analogy

Collaborators
Melanie Bell (Anglia Ruskin U), Sabine Arndt-Lappe (U Trier), Harald Baayen (U of Tübingen), Gero Kunter (U Düsseldorf), Maria Braun, Kristina Kösling, and Mareile Schramm (U Siegen)
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The problem: stress in NN compounds

crédit card
táble lamp
súmmer school
tóy factory

silk shírt
kitchen sínk
summer dréss
toy fáctory

Compound stress rule (e.g. Chomsky and Halle 1968):
Compounds are stressed on the *left* constituent

Central questions

How can we account for this variation?
What determines whether a compound is left-stressed or right-stressed?

What **is** compound stress?

(Gussenhoven 2004, Kunter & Plag 2007, Kunter 2011)

- left prominence/left stress:

  one pitch accent: on *left* constituent

- right prominence/right stress:

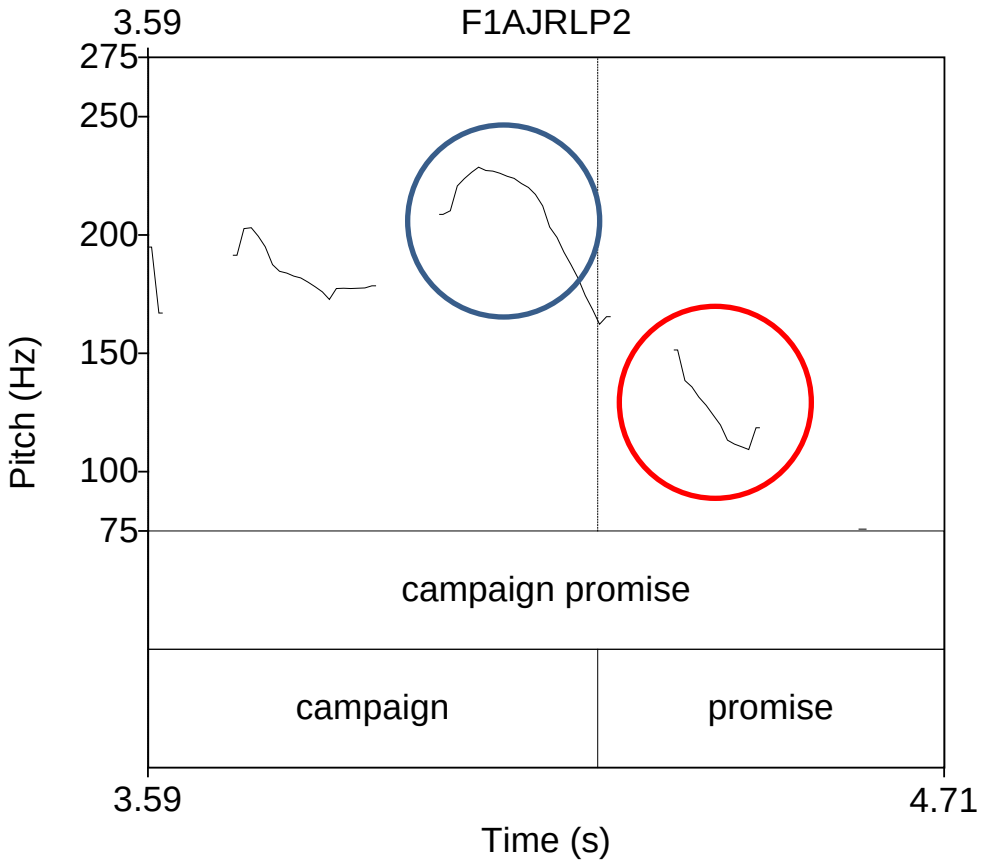
  two pitch accents: *one on each* constituent

One pitch accent

In nineteen seventy-six, Democratic Governor Michael Dukakis fulfilled a

campaign promise

to de-politicize judicial appointment.



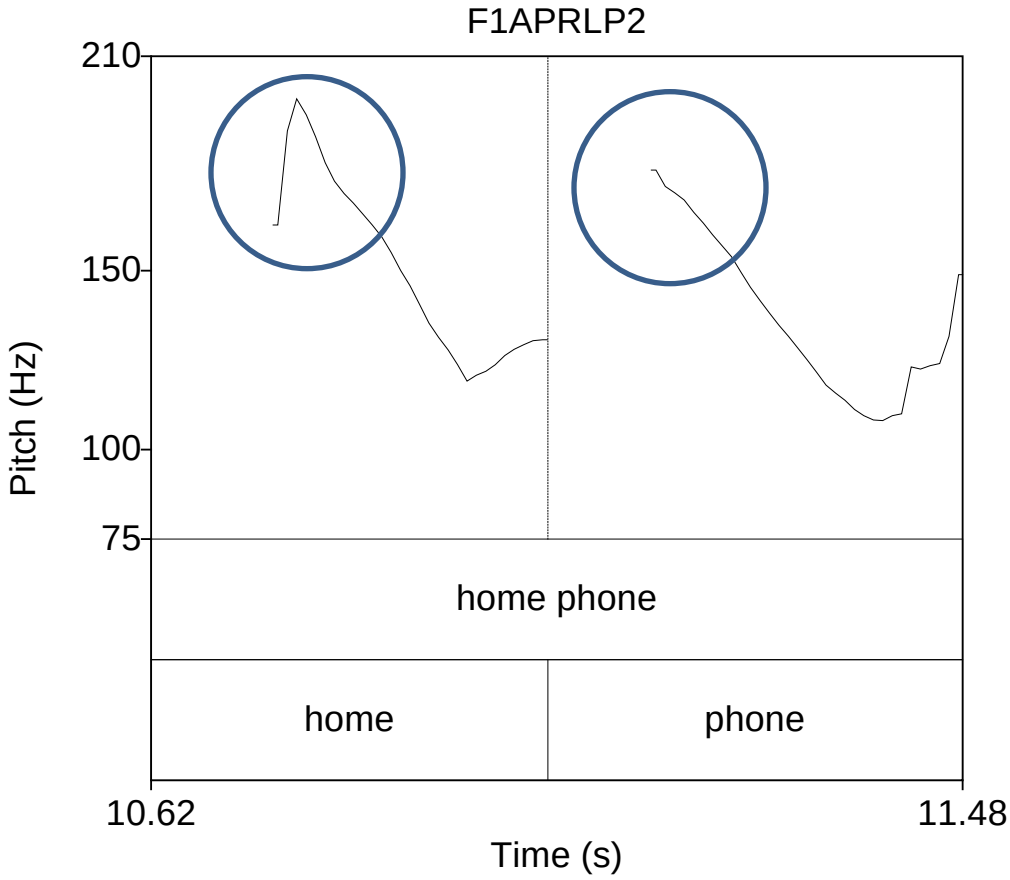
from: *Boston University Radio Speech Corpus* (BURSC, Ostendorf et al. 1995)

Two pitch accents

When a computerized call is made to a former prisoner's

home phone,

that person answers by plugging in the device.



from: *Boston University Radio Speech Corpus* (BURSC, Ostendorf et al. 1995)

Potential determinants of compound stress assignment

- structure
- semantics
- analogy
- informativity
- length

Structural hypothesis

(e.g. Giegerich 2004)

- Modifier-head structures are regularly stressed on the right constituent (*steel brídge*).
- Argument-head structures are always left-stressed (*ópera singer*).
- Left stress on modifier-head structures is due to lexicalization (*ópera glasses*).

Semantic hypothesis

(e.g. Fudge 1984)

- Certain semantic relations are right-stressed (e.g. 'locative' compounds, *Boston hárbour*).
- Certain semantic classes of constituents trigger right stress (e.g. substance nouns as N1, *silk shírt*).
- Lexicalized semantics goes together with left stress (*sílk worm*).

Analogical hypothesis

(e.g. Schmerling 1971, Plag 2006)

Stress is assigned by analogy with similar compounds in the mental lexicon.

Óxford Street	*Oxford Róad*	*state administrátion*
Régent Street	*Mill Róad*	*state búdget*
Hárley Street	*Upland Róad*	*state bénefits*
... Street	*... Róad*	*státe house*
100 % left	0 % left	*state fúnds*
		state ...
		10 % left

'constituent family stress bias', 'constituent identity effect'

Length hypothesis

(e.g. Jespersen 1909)

Longer compounds tend to be right-stressed

Empirical evidence

(Plag 2006, Plag et al. 2007, 2008, Kunter 2011, Plag 2010, Arndt-Lappe 2011)

- A number of studies based on different types of data, different varieties of English, different types of analytical tools
- Significant factors: semantics, lexicalization and analogy (constituent identity)
- Predictive power of deterministic rules based on the structural and/or semantic hypothesis is very bad.
- Probabilistic and exemplar-based models are much better, but not wholly satisfactory. Nature of analogical effects not quite clear.
- Can we do better?

Another hypothesis: Informativity

(e.g. Sweet 1892, Marchand 1969, Ladd 1984, Bell 2008)

General assumption about accentuation

Uninformative elements tend to be unaccented, while more informative and unexpected information is accented.

Re compounds

An uninformative constituent in the right position will not receive an accent, i.e. the compound will be left-stressed.

A highly informative constituent in the right position will receive an accent, i.e. the compound will be right-stressed

This paper

Two studies testing the effect of informativity (alongside other predictors)

Study 1: *British National Corpus*

Study 2: *Boston University Radio Speech Corpus (BURSC)* and *Corpus of Contemporary American English (COCA)*

How to measure informativity

"In some compounds the uneven [left] stress seems to be the result of the second element being less *logically prominent* than the first, through being a word of *general meaning* and *frequent occurrence* in compounds" (Sweet 1892:288)

Information Theory (Shannon 1948):

'information content' = negative log likelihood of a word in a corpus

☞ **probability of occurrence**

☞ **semantic specificity**

Measuring informativity

- Probability of N2 (= log of N2 family size)

  H: the larger N2 family size, the more probable is N2, the less likely it is for N2 to be accented

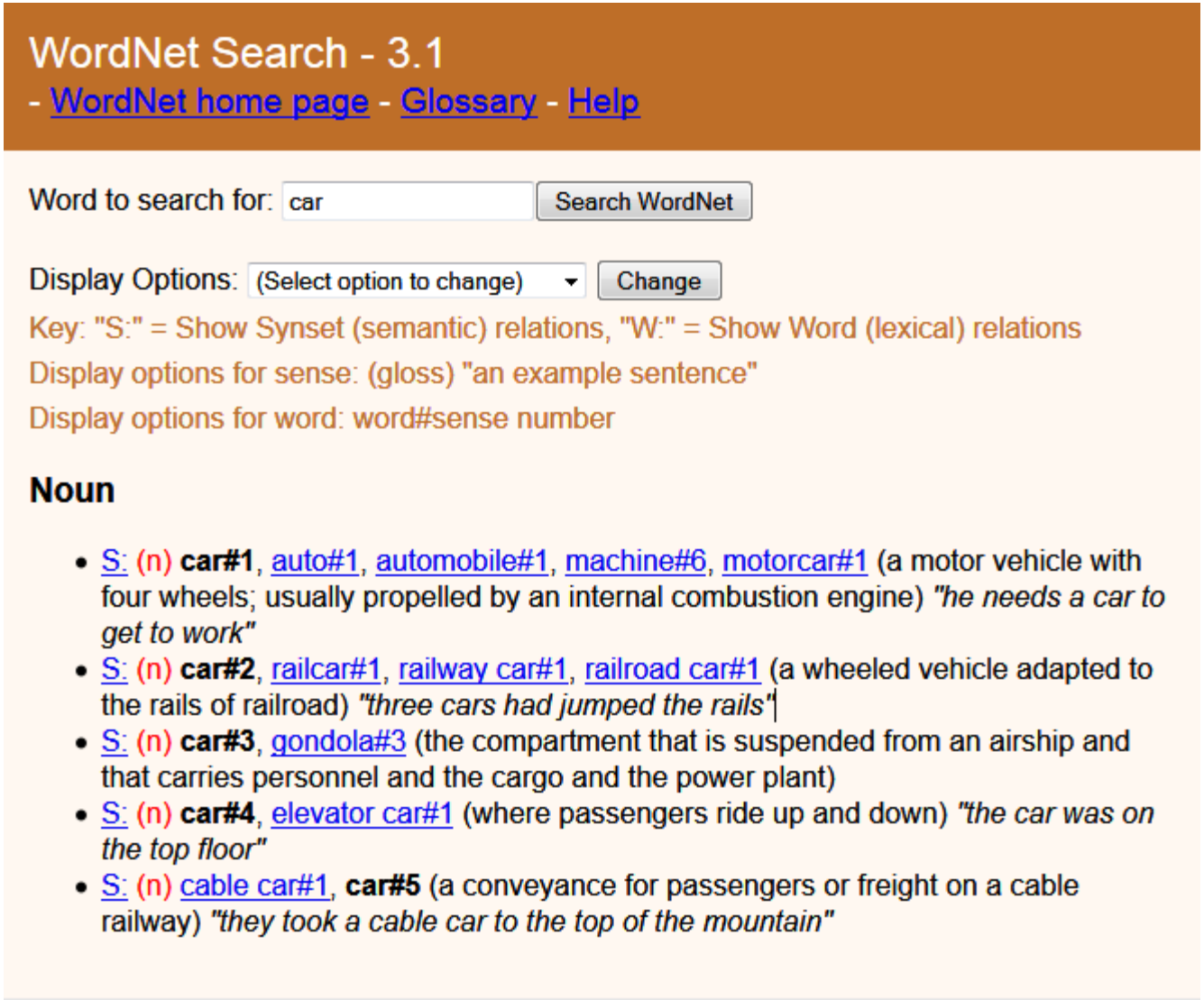
- Conditional probability of N2 (= log of 1/N1 family size)

  H: the more probable N2 given N1, the less likely it is for N2 to be accented

- Semantic specificity: number of different senses (= number of synsets of N1 and N2 in WordNet)

  H: the larger the number of synsets, the less specific the constituent, the less likely to be accented (relational: N1 x N2)

Measuring semantic specificity: synsets



WordNet Search - 3.1

- WordNet home page - Glossary - Help

Word to search for: car Search WordNet

Display Options: (Select option to change) Change

Key: "S:" = Show Synset (semantic) relations, "W:" = Show Word (lexical) relations

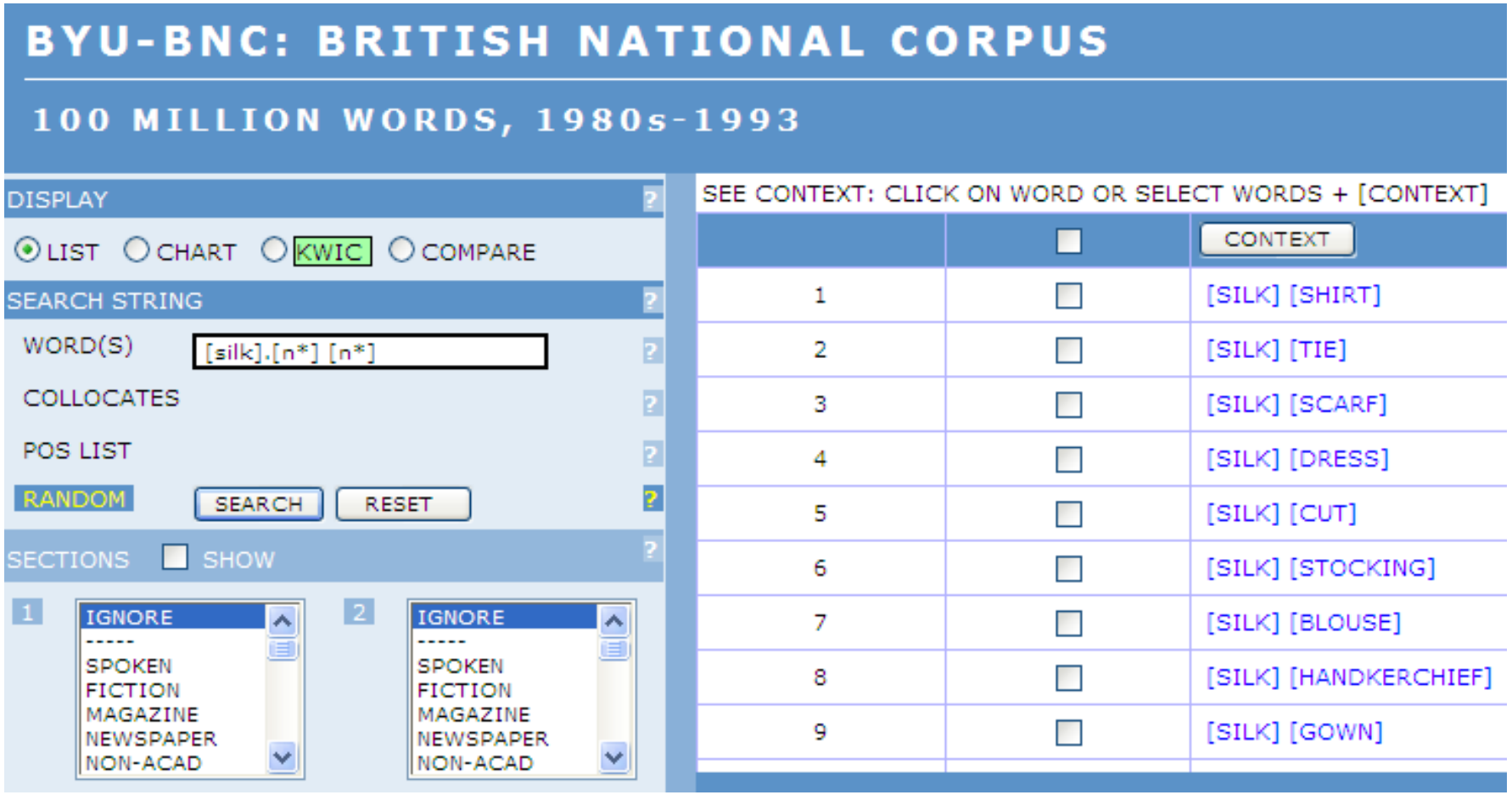
Display options for sense: (gloss) "an example sentence"

Display options for word: word#sense number

Noun

- S: (n) **car#1**, auto#1, automobile#1, machine#6, motorcar#1 (a motor vehicle with four wheels; usually propelled by an internal combustion engine) *"he needs a car to get to work"*
- S: (n) **car#2**, railcar#1, railway car#1, railroad car#1 (a wheeled vehicle adapted to the rails of railroad) *"three cars had jumped the rails"*
- S: (n) **car#3**, gondola#3 (the compartment that is suspended from an airship and that carries personnel and the cargo and the power plant)
- S: (n) **car#4**, elevator car#1 (where passengers ride up and down) *"the car was on the top floor"*
- S: (n) cable car#1, **car#5** (a conveyance for passengers or freight on a cable railway) *"they took a cable car to the top of the mountain"*

Measuring family sizes

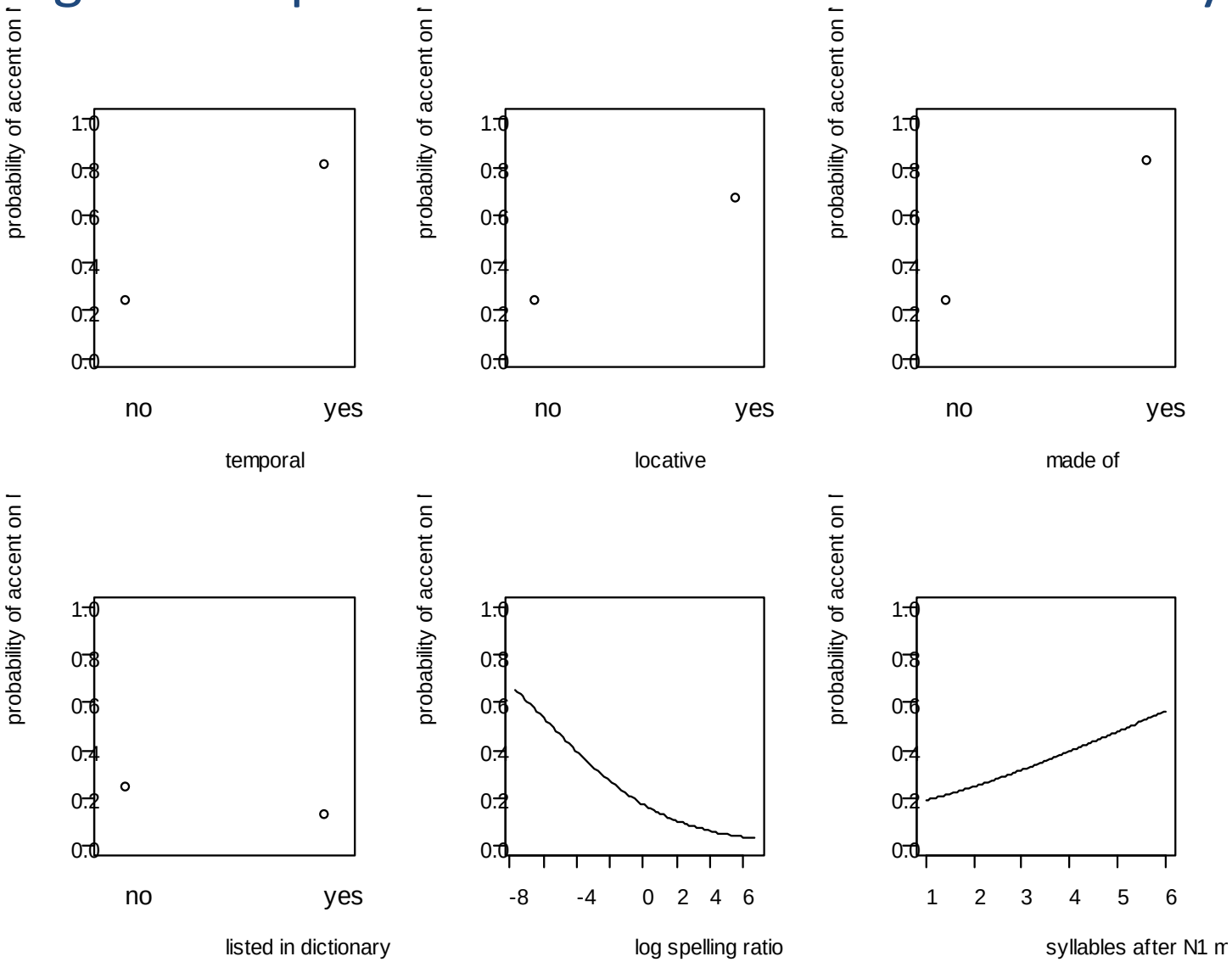


Study 1: *BNC*

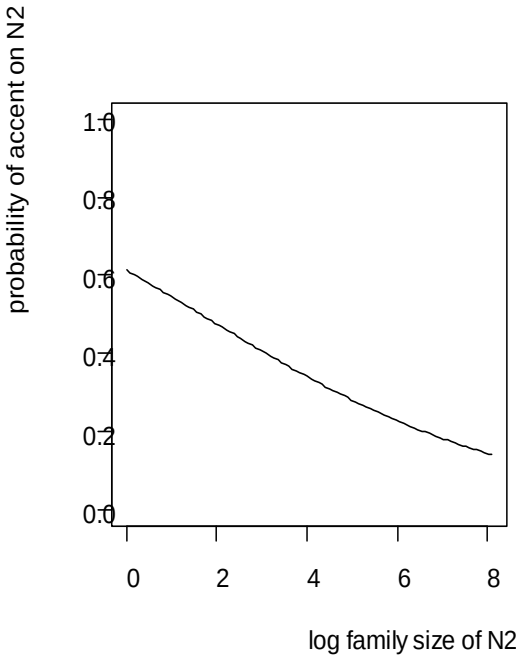
- compounds from BNC, spoken in an experiment and rated by experts (N = 3252, V = 864, 60 % left stressed)
- coded for pertinent predictor variables (semantics, lexicalization, informativity, length)
- generalized mixed effects regression analysis, with speaker as random effect (e.g. Baayen 2008)

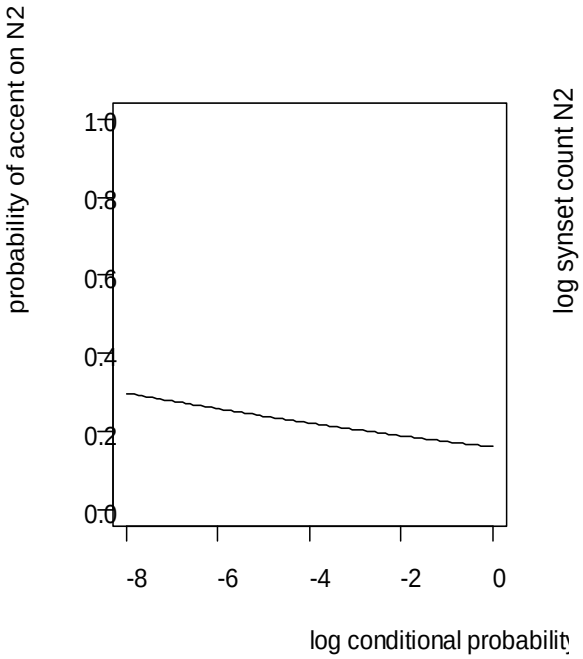
Results BNC:

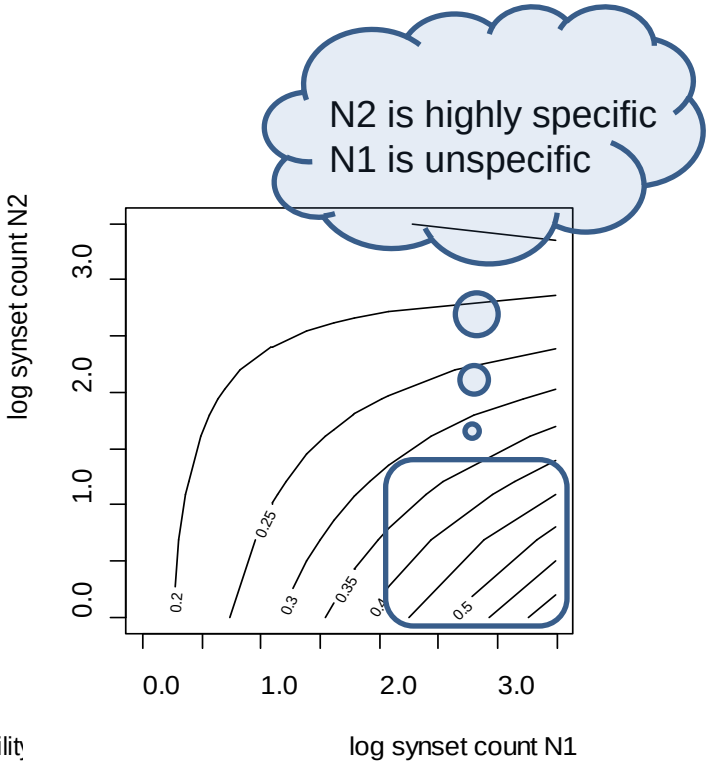
Significant predictors unrelated to informativity



Informativity effects







Summary and implications of Study 1

- Informativity emerges as a significant predictor of compound stress in English, also in the presence of other predictors.
- Models with informativity are highly successful in their predictions (C = 0.85).
- Problem: Informativity vs. analogy (constituent identity)?
- Further investigation is needed:
  Include all known potentially influential factors!

Study 2: Aims and method

Aims

- replicate informativity effect in the presence of family stress bias (and other effects)
- investigate the nature of the family stress bias in more detail

Method

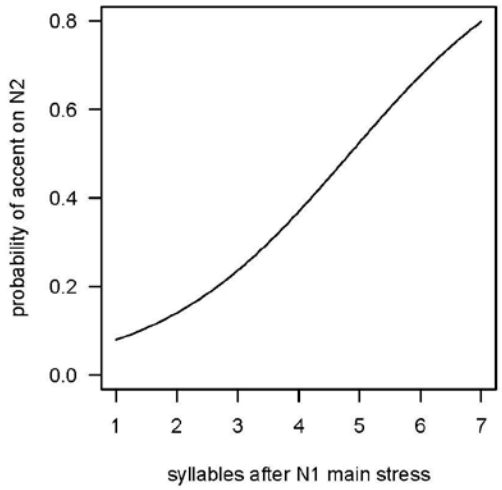
- subset of data set from Plag et al. (2008), N = 1154, V = 592, stress judged by two experts
- add informativity measures from COCA and Wordnet
- compute and add family stress bias
- generalized mixed effects regression analysis (speaker as random effect)
- different analyses with different combinations of predictors

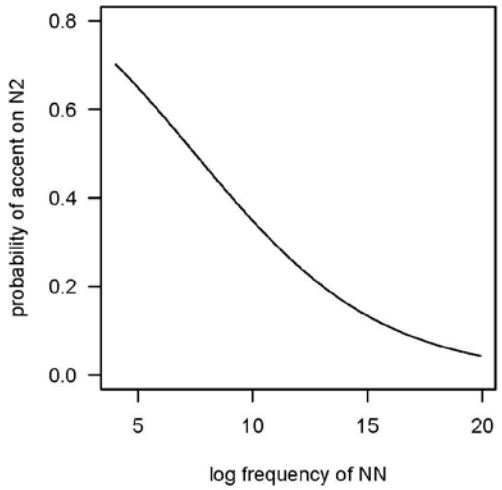
Methodology: Predictors in final models

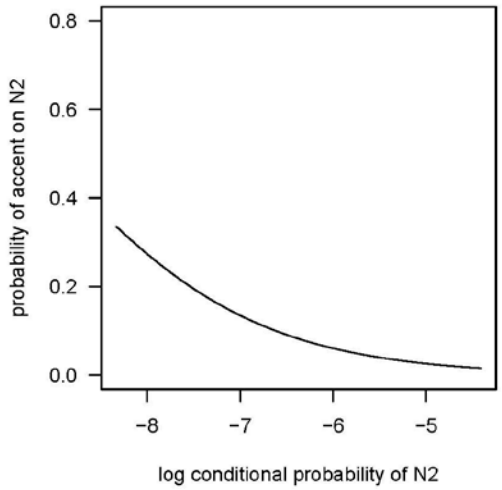
- informativity:
  - probability of N2 (family size), conditional probability of N2 (family size)
  - synset count N1 and synset count N2
- constituent family bias of N1 and of N2
- covariates (= controls, significant, not discussed in detail):
  - NN frequency
  - length of NN after main stress of N1
  - no semantics

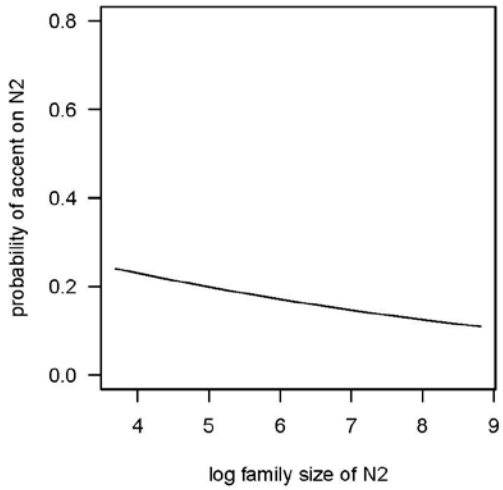
Results: Effects of informativity

(family bias is **not** included in the initial model)



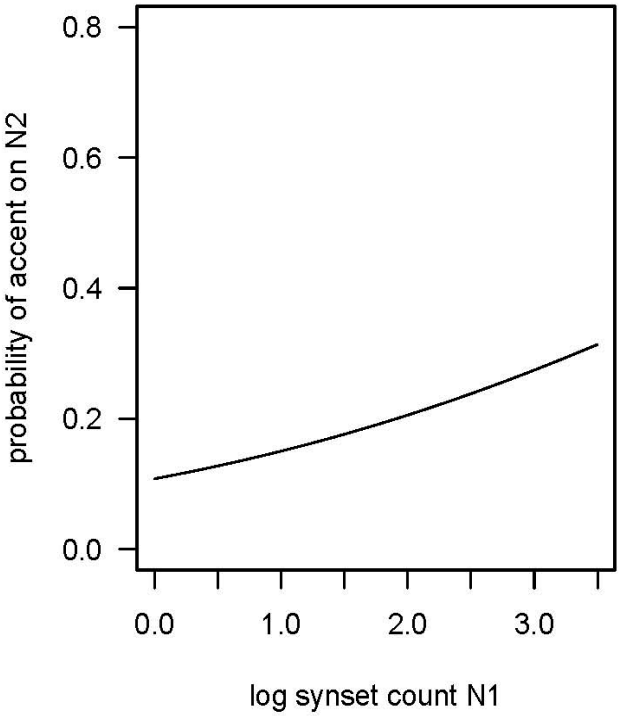


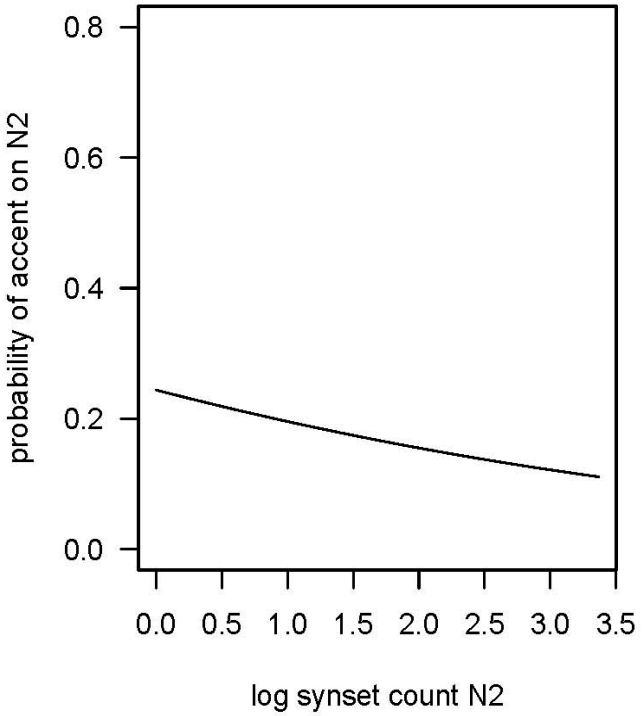




Results: Effects of informativity

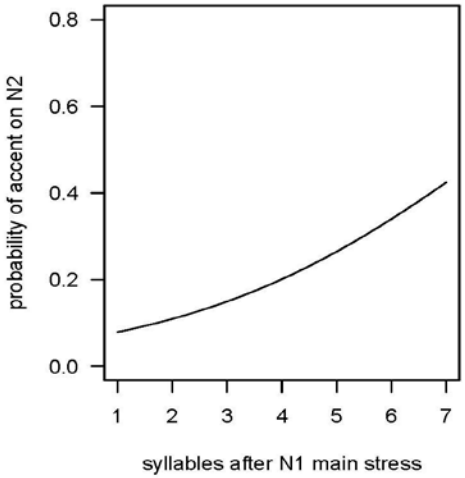
(family bias and probabilities are **not** included in the initial model)

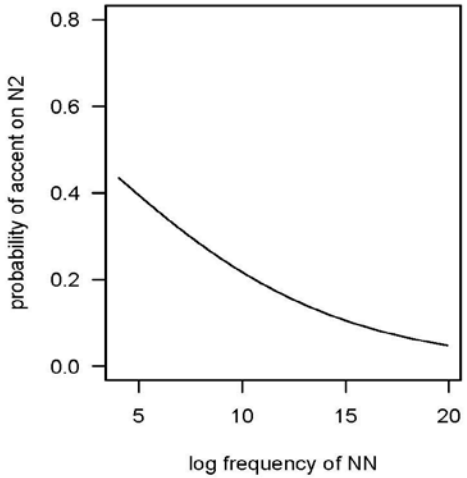


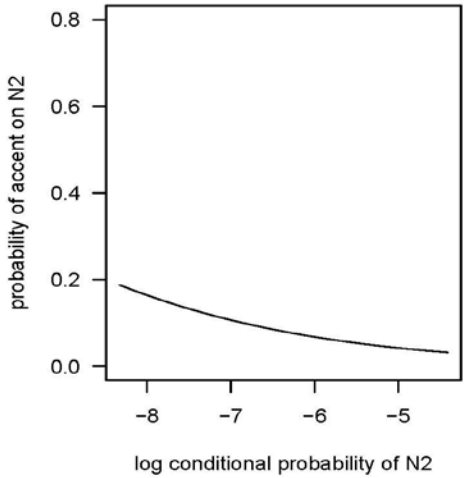


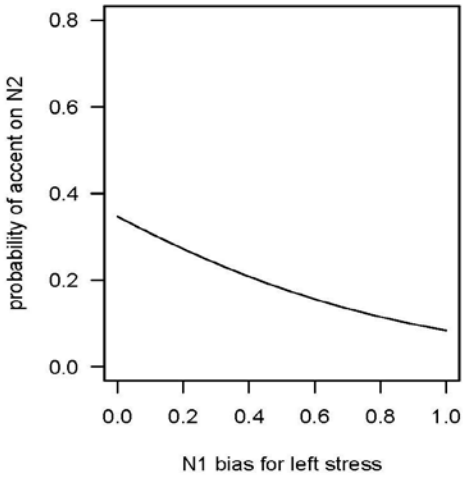
Results: Effects of informativity

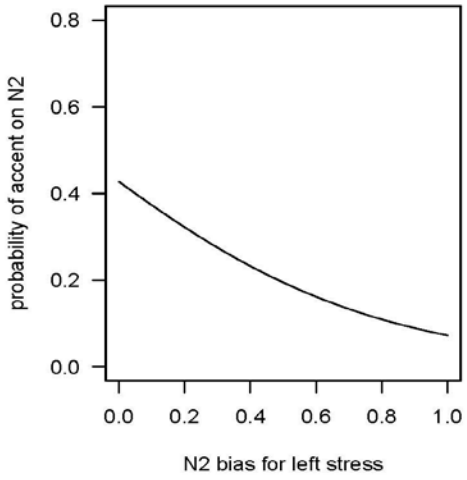
(all variables included in the initial model)











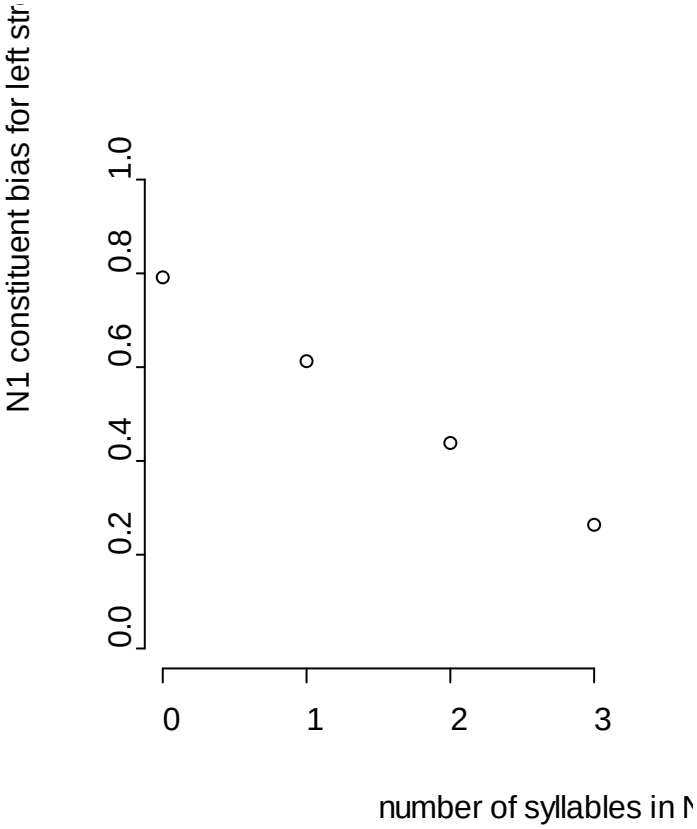
Constituent identity and informativity

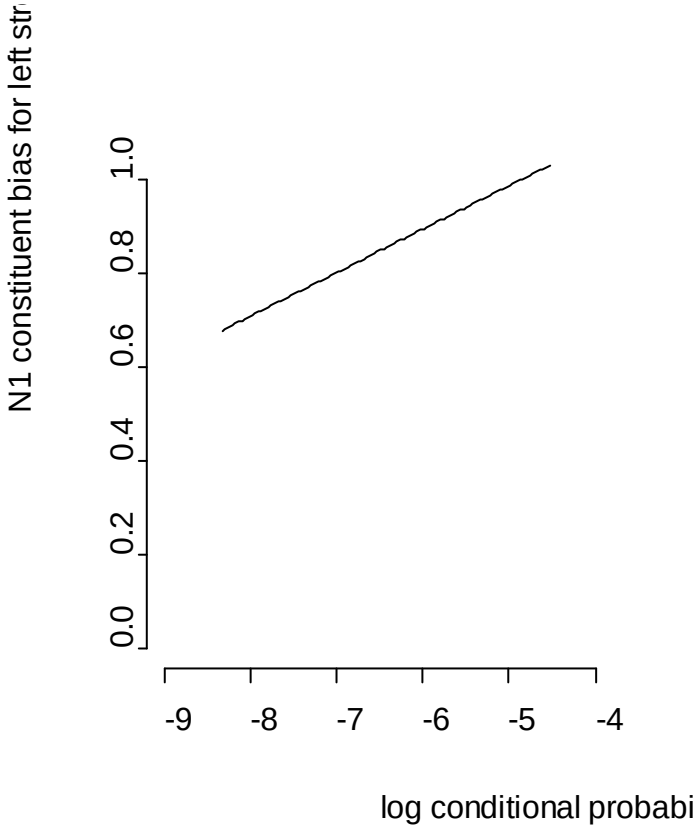
- What is the relationship between the constituent identity effect and the informativity effect?
- Are they independent of each other?

Some considerations

- Family bias: orthographic strings as a proxy for all constituent properties
- Any constituent property that is predictive of stress placement will contribute to the stress bias of that constituent
- e.g. more informative constituents in N1 position will have greater N1 biases for left stress
- Can we predict stress bias on the basis of constituent properties, including informativity?

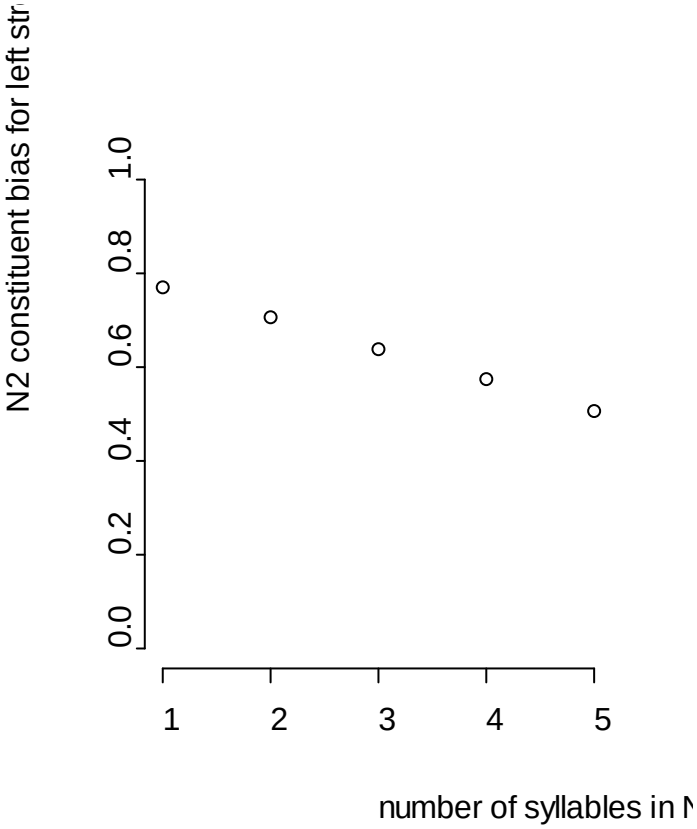
Predicting N1 family bias from N1 properties

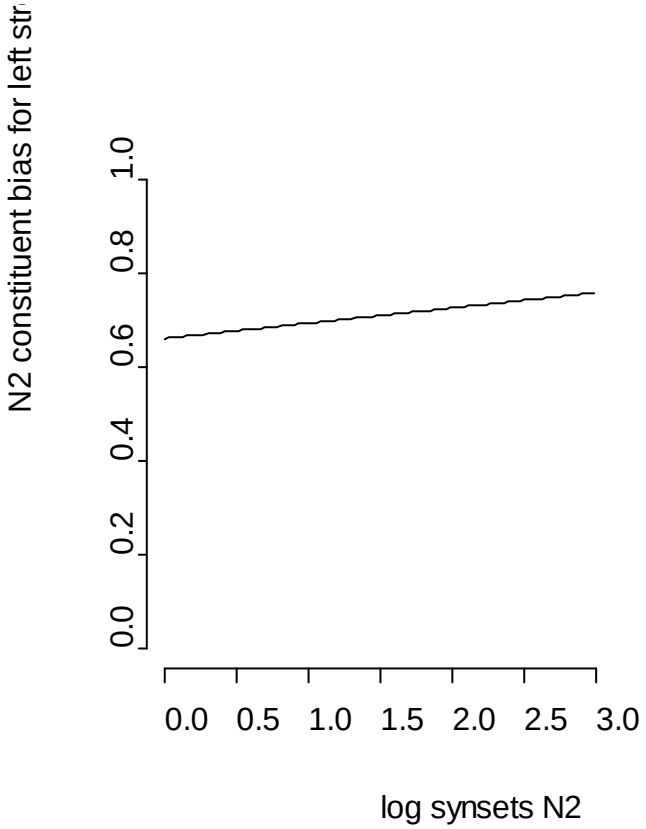




Final model, adjusted R-squared=0.3007

Predicting N2 family bias from N2 properties





Final model, adjusted R-squared=0.1071

Constituent identity and informativity

- The constituent identity effect absorbs large parts of the effects of the other constituent-based predictors
- What if we use the constituents itself as predictors?
- Mixed effects regression with N1 and N2 as random effects (and no fixed effects)
- Highly successful models (C = 0.956, even without speaker as random effect)
- Constituent identity accounts for nearly all the variation
- Supports our hypothesis that the effect of constituent identity on stress subsumes those of family size, synset count, length etc.

Constituent identity and informativity

- Is stress assigned purely on the basis of constituent identity?
- Very unlikely!
- Constituent informativity effects necessarily lead to constituent identity effects
- In contrast, biases based only on constituent identity would not necessarily produce an informativity effect
- Informativity underlies constituent stress bias!

Implications: *tóy factory* vs *toy fáctory*

- *tóy factory* ‘a factory for making toys’
- *toy fáctory* ‘a model factory that is a toy’
- Can this contrast be explained by informativity? Yes!
- More fine-grained informativity measure is needed
- Polysemy of *factory*

  core meaning: ‘a building with machinery for the manufacture of goods’

  metonymic reading: ‘model of a factory’

Implications: *tóy factory* vs *toy fáctory*

- empirical analysis:
  50 most frequent NN compounds with *factory* as N2 in COCA
- 46 of these types: core meaning (*shoe factory*, *paint factory*, *munitions factory)*
- 4 types: metaphorical reading 'institution producing N1' (*dream factory, hit factory, idea factory* and *soul factory)*
- 0 types: metonymic reading ‘model of a factory’
- core/metaphorical meaning: large family size → stress on N1
- metonymic reading: small family size → stress on N2
- informativity can account for minimal stress pairs with different meaning!

Summary and conclusion

- Across data sets, informativity turns out to be a robust determinant of compound stress in English.
- Constituent identity effects result from informativity (not the other way round)
- The effect of informativity is in accordance with an intonational theory of compound stress.
- Wider theoretical implication

Compound stress assignment is usage-based,
i.e. is based on distributional properties of lexical items,
rather than on abstract rules.

Thank you very much for your attention!

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