Perceptual distance in Norwegian retroflexion

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Norwegian retroflexes

- In Urban East Norwegian (UEN), a laminal coronal series /t d n s/ contrasts with a retroflex series /T D N S/
- /kɑt/ ‘cat’ - /kɑT/ ‘map’
- /rɔːd/ ‘advice’ - /ɭɔːD/ ‘lord’
- /tʉːn/ ‘yard’ - /tʉːN/ ‘gymnastics’
- /mɑːs/ ‘nagging’ - /mɑːS/ ‘Mars’

Norwegian retroflexion

- Retroflexes can also be derived across morpheme boundaries
- When a morpheme ends in /-ɾ/, and the following morpheme begins with /t d n s/, the sequence surfaces as /T D N S/
- /ʊɔːɾ-tæjn/ > /ʊɔː-Tæjn/ ‘spring sign’
- /ʊɔːɾ-dɑːg/ > /ʊɔː-Dɑːg/ ‘spring day’
- /ʊɔːɾ-nɑt/ > /ʊɔː-Nɑt/ ‘spring night’
- /ʊɔːɾ-suːɽ/ > /ʊɔː-Suːɽ/ ‘spring sun’

Rate of retroflexion

- Two experiments tested how often retroflexion is applied
- The results revealed the following hierarchy:

  n/d > sk > st > s

  (> = ‘undergoes retroflexion significantly more often than’)
- This means that /n/ is more likely to alternate with /N/ than /s/ is to alternate with /S/

Perceptual distance

- Steriade (2001, 2009) proposes that the greater the perceptual distance between two forms *x* and *y*, the less likely *x* and *y* are to alternate
- Could imply that /s/ alternates less with /S/ than /n/ with /N/ because the perceptual distance in /s/-/S/ is greater than in /n/-/N/
- If so …

Perceptual distance hierarchy

- Then the perceptual distance hierarchy should be the inverse of the retroflexion hierarchy
- Retroflexion hierarchy:

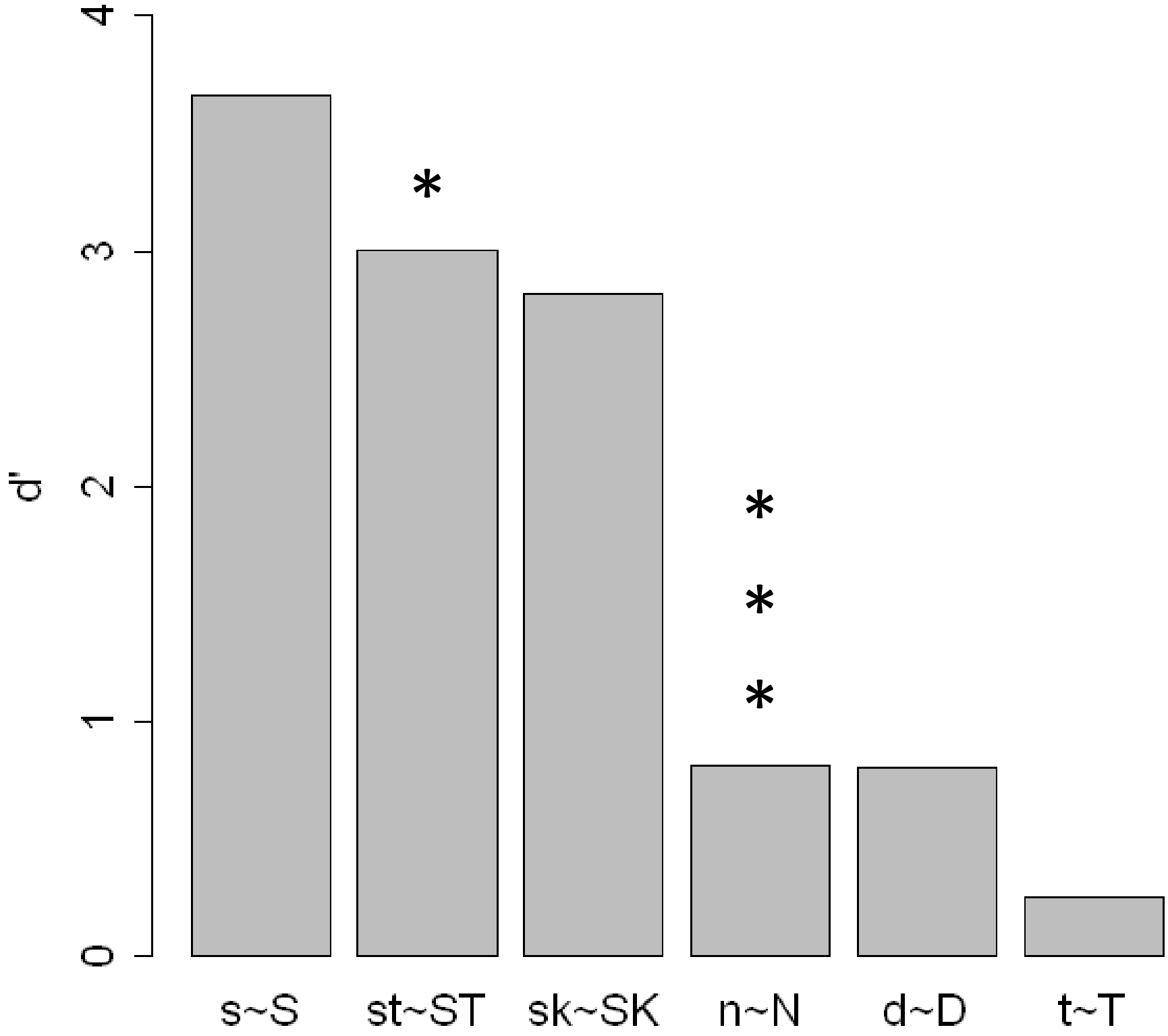
  n/d > sk > st > s
- Hypothesized perceptual distance hierarchy:

  s-S > st-ST > sk-SK > n-N/d-D (& t-T)

= The perceptual distance /s/-/S/ is greater than the perceptual distance /st/-/ST/, etc.

Perceptual experiment

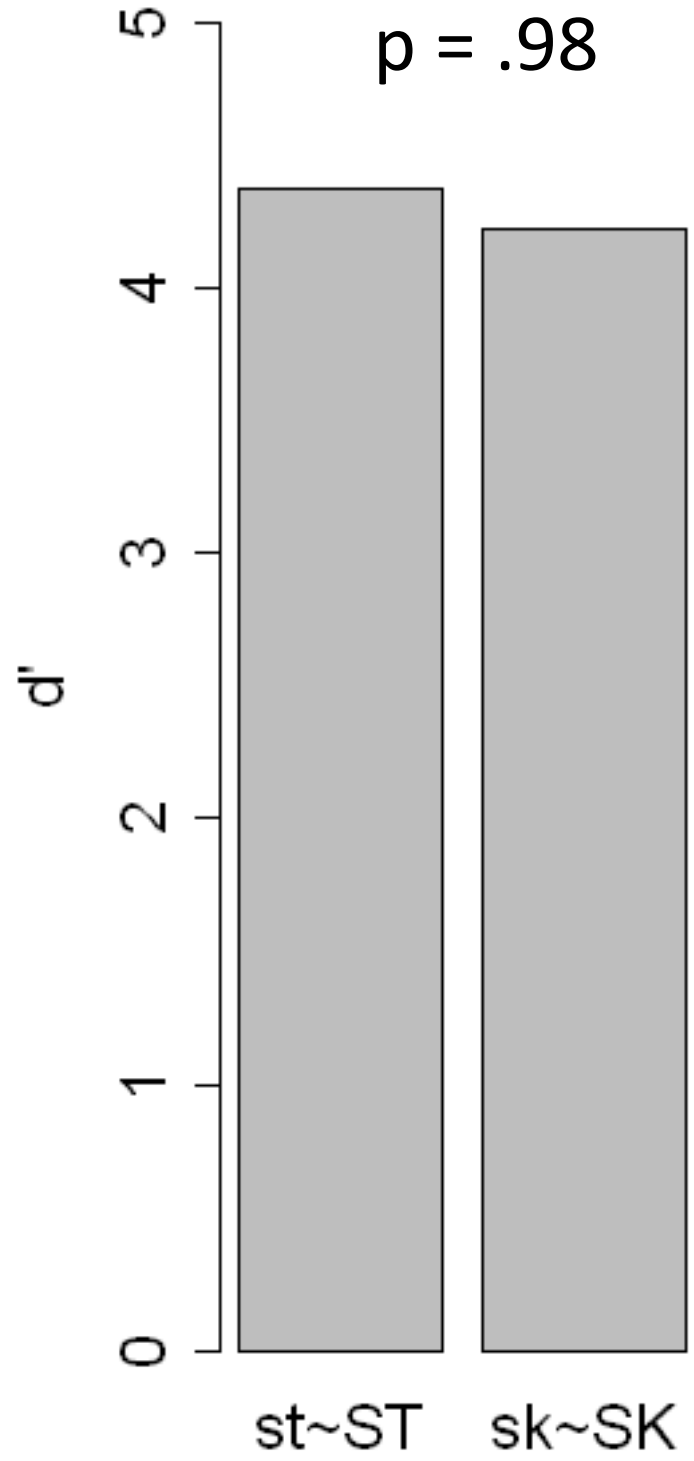
- 12 UEN subjects in an AX discrimination task
- Stimuli were two groups of /ɑCɑ/ words:
  1) C = /s st sk t d n/
  2) C = /S ST SK T D N/
- Amplitude of the vowels was RMS equalized
- Trial overlaid with babble noise (S/N ca. –7 dB)
-  /ɑsɑ/ - /ɑSɑ/
- 192 trials x 12 subjects = 2304 trials


d'
0
1
2
3
4
*
*
*
*
s~S
st~ST
sk~SK
n~N
d~D
t~T

- Perceptual hierarchy from the experiment:

  s-S > sc-SC > t-T/d-D/n-N
- sc = st-ST > sk-SK ?
- In the experiment /st-ST/ and /sk-SK/ were treated the same
- Could be the result of the relatively clear distinction between the sibilants in /**s**t/ - /**S**T/ and /**s**k/ - /**S**K/

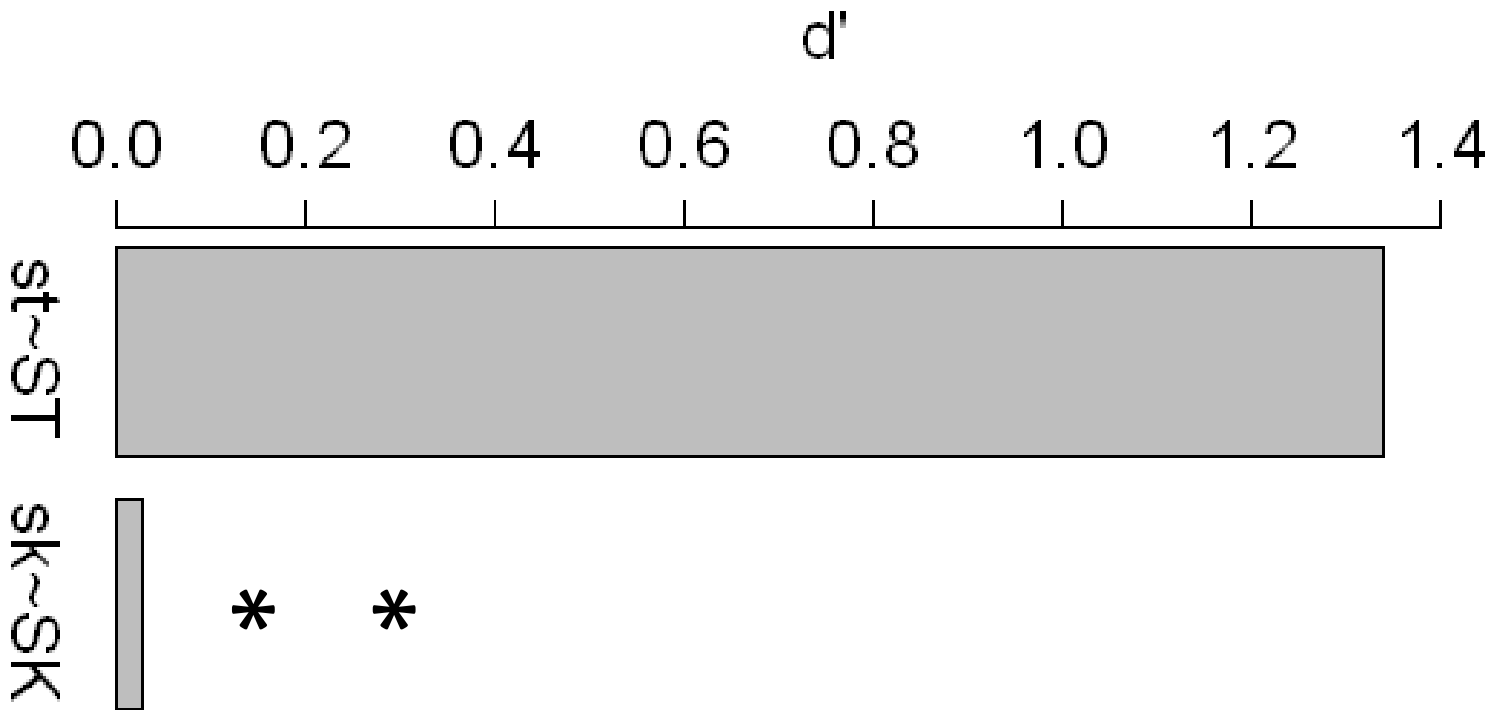
- In the experiment, the /s-S/ distinction trumps any other distinctions, so /st-ST/ and /sk-SK/ come out the same
- If so, /st-ST/ and /sk-SK/ should be the same when only the sibilant is presented
- Subjects were presented with only /ɑs/ and /ɑS/, excised from the original /ɑstɑ-ɑSTɑ/-/ɑskɑ-ɑSKɑ/ sets


p = .98
d'
0
1
2
3
4
5
st~ST
sk~SK

- If /st-ST/ is different from /sk-SK/, then the difference lies in the following consonant
- Test whether the remaining /t-T/ is more distinct than /k-K/

- If /c/ can be distinguished from /C/, it means that they have different phonetic qualities correlating with the quality of the preceding sibilant (/s/-/S/)
- Speakers should be able to identify the preceding sibilant from the quality of the stop
- The perceptual distance /c/-/C/ was therefore measured by how successfully subjects identified the preceding sibilant as /s/ or /S/

- Presented as an identification task
- No added noise
-  /Tɑ/  /tɑ/
- 96 trials x 12 subjects = 1152 trials


d'
0.0
0.2
0.4
0.6
0.8
1.0
1.2
1.4
st~ST
sk~SK
*
*

- The hypothesized perceptual distance hierarchy is confirmed:
- s-S > st-ST > sk-SK > n-N/d-D/t-T
- The larger the perceptual distance /c/-/C/, the less likely /c/ is to undergo retroflexion

The question

How can perceptual distance influence phonological production?

- Two observations from UEN:
  1) Variation (sometimes retroflexion, sometimes not)
  2) Context dependent variation (more retroflexion for /n/ than for /s/)

- Surface variation can be modeled in various ways:
  - Variable rules (Labov 1969)
  - Stochastically ranked constraints (Boersma & Hayes 2001)
  - Multiple grammars (Anttila 2002)
  - Random sampling from exemplars (Pierrehumbert 2002)
- Asymmetry according to context can be achieved by adding segment/feature specific rules or constraints to such models
- The models formally describe how the observed variation can be generated once variation is in the input
- But no model by itself explains where the variation and the asymmetry in the variation originally come from

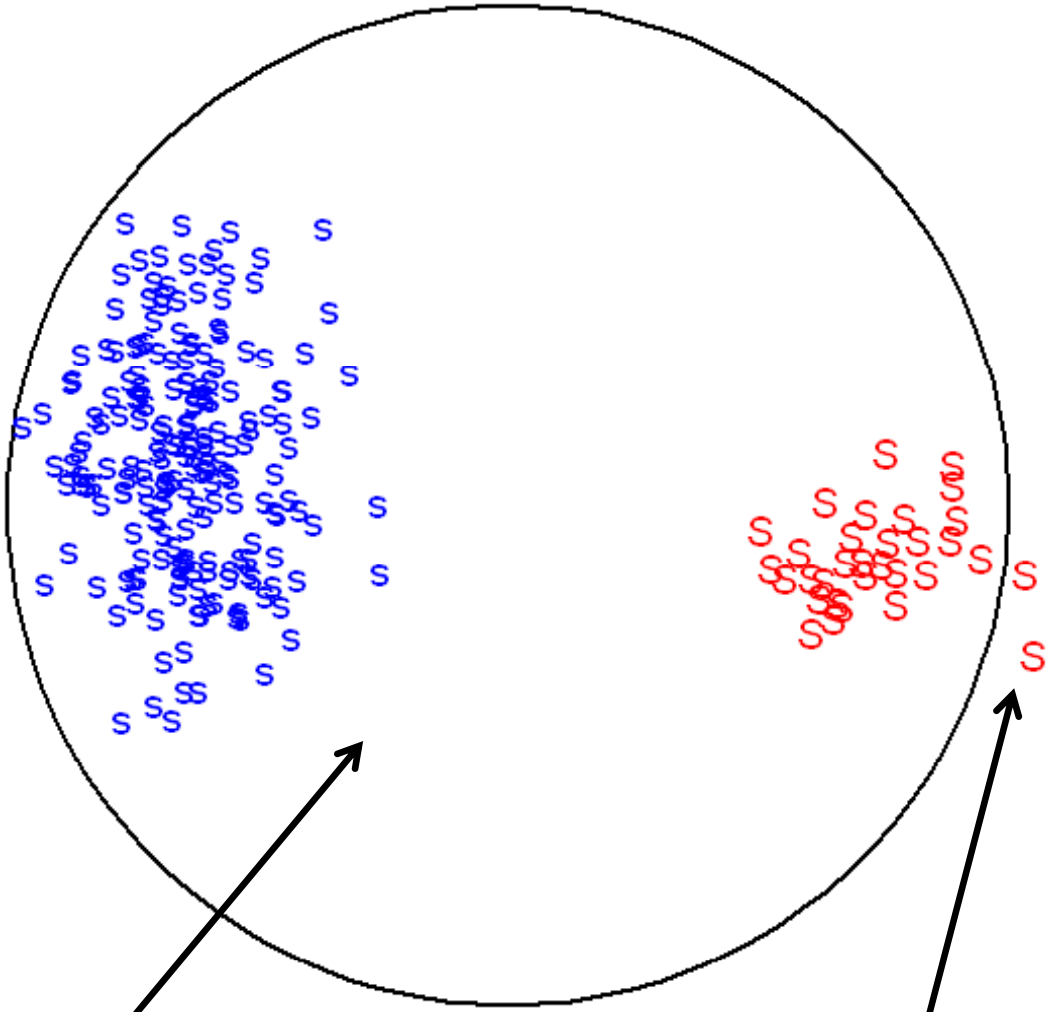
Cause of asymmetry?

- The cause needs to be independently identified, and then supplemented to the model
- If contrasts with large perceptual distances are treated differently from contrasts with small perceptual distances, there is a bias somewhere in the system
- Explore the possibility that this is a *perceptual bias*

- Marlsen-Wilson et al. (1996) show that the larger the perceptual distance between word *x* and non-word *y*, the greater the chance that *y* is not categorized as a token of *x*
- In this illustration, this effect will be supplemented to the exemplar model, since perception and categorization of tokens according to a similarity metric is an integral part of this model

- Standard assumption:
- Retroflexion came about through coarticulation /ɾ/+/c/
- At the initial stage, there is an articulatory bias for producing retroflex tokens under this condition
- So for any /c/-word, there will be a number of [C]-tokens
- Marlsen-Wilson et al.'s results can be illustrated as follows for Norwegian:

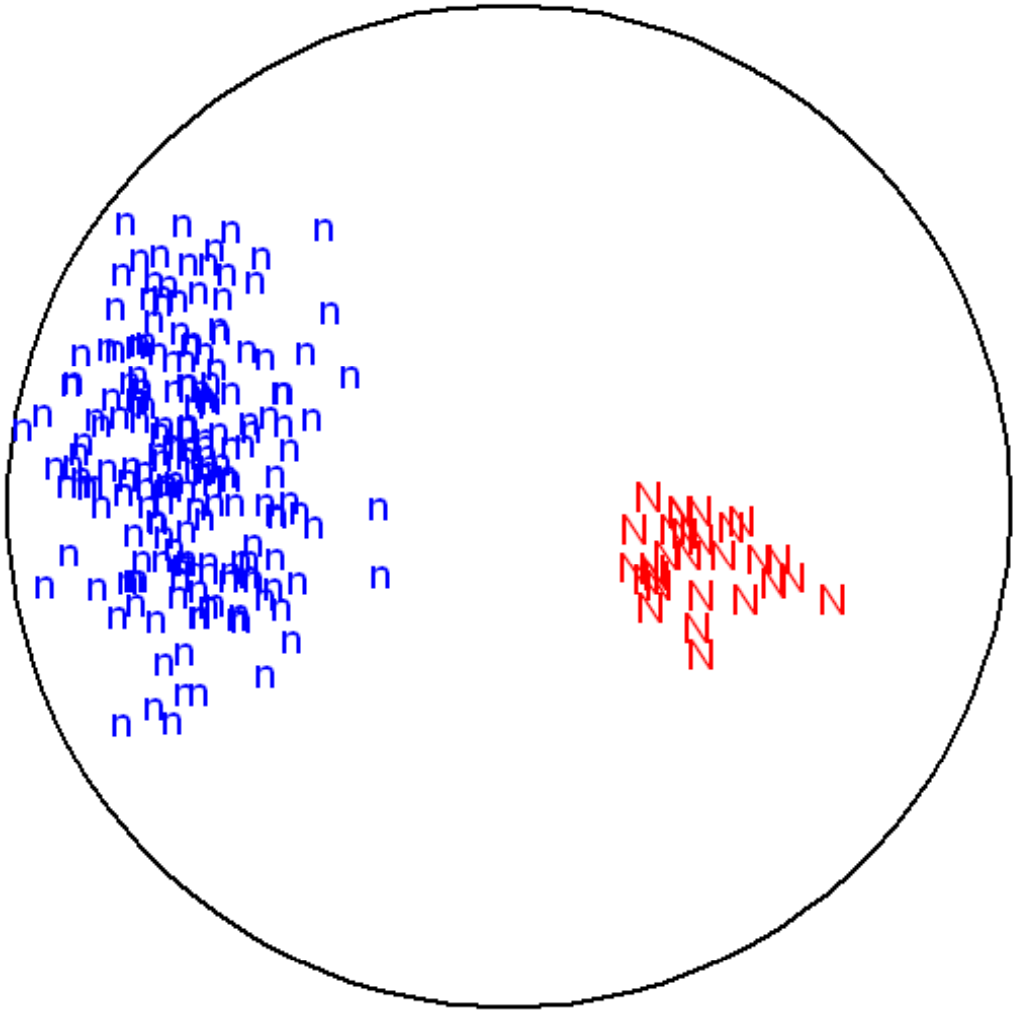
Category: /s/-word



Tokens identified as /s/-word

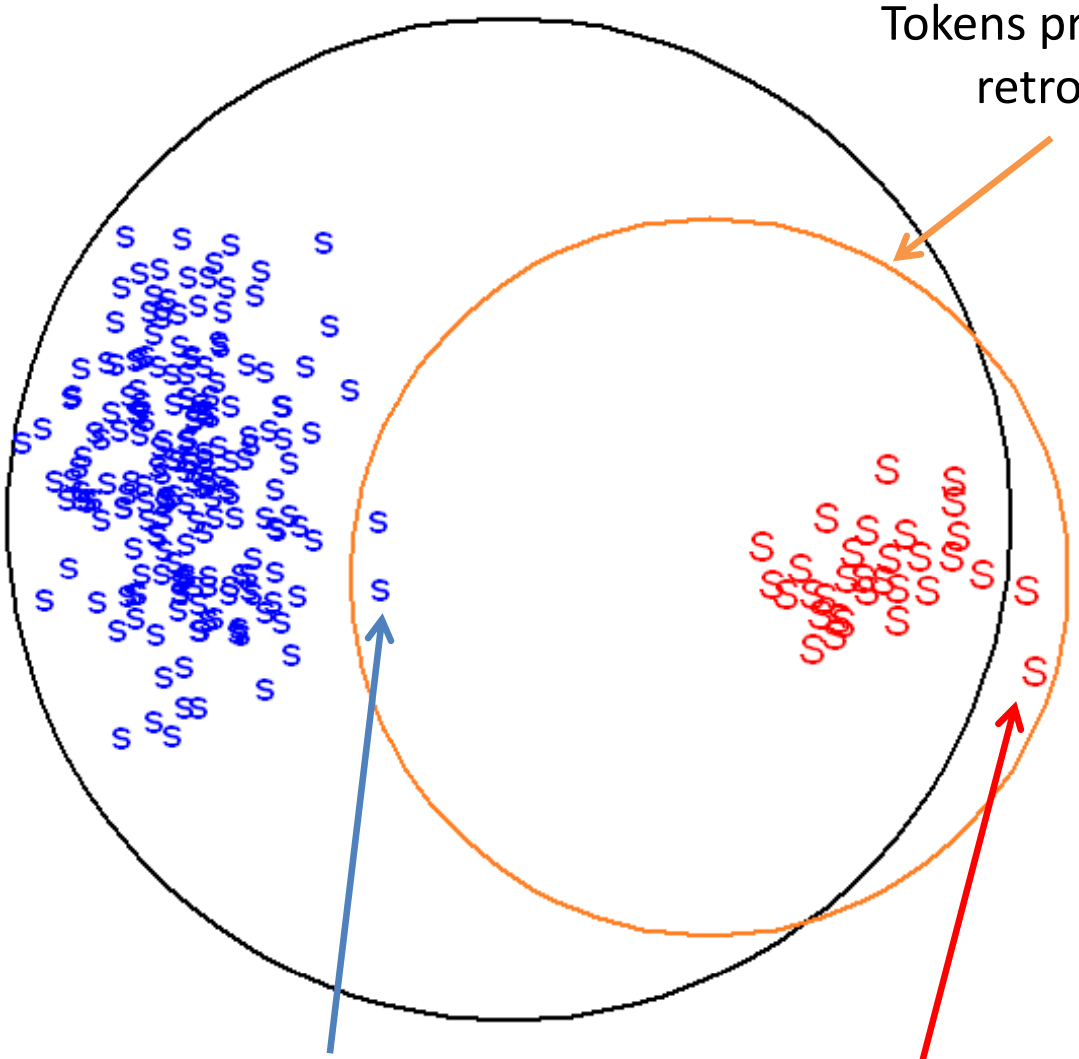
Tokens not identified

Category: /n/-word



Category: /s/-word

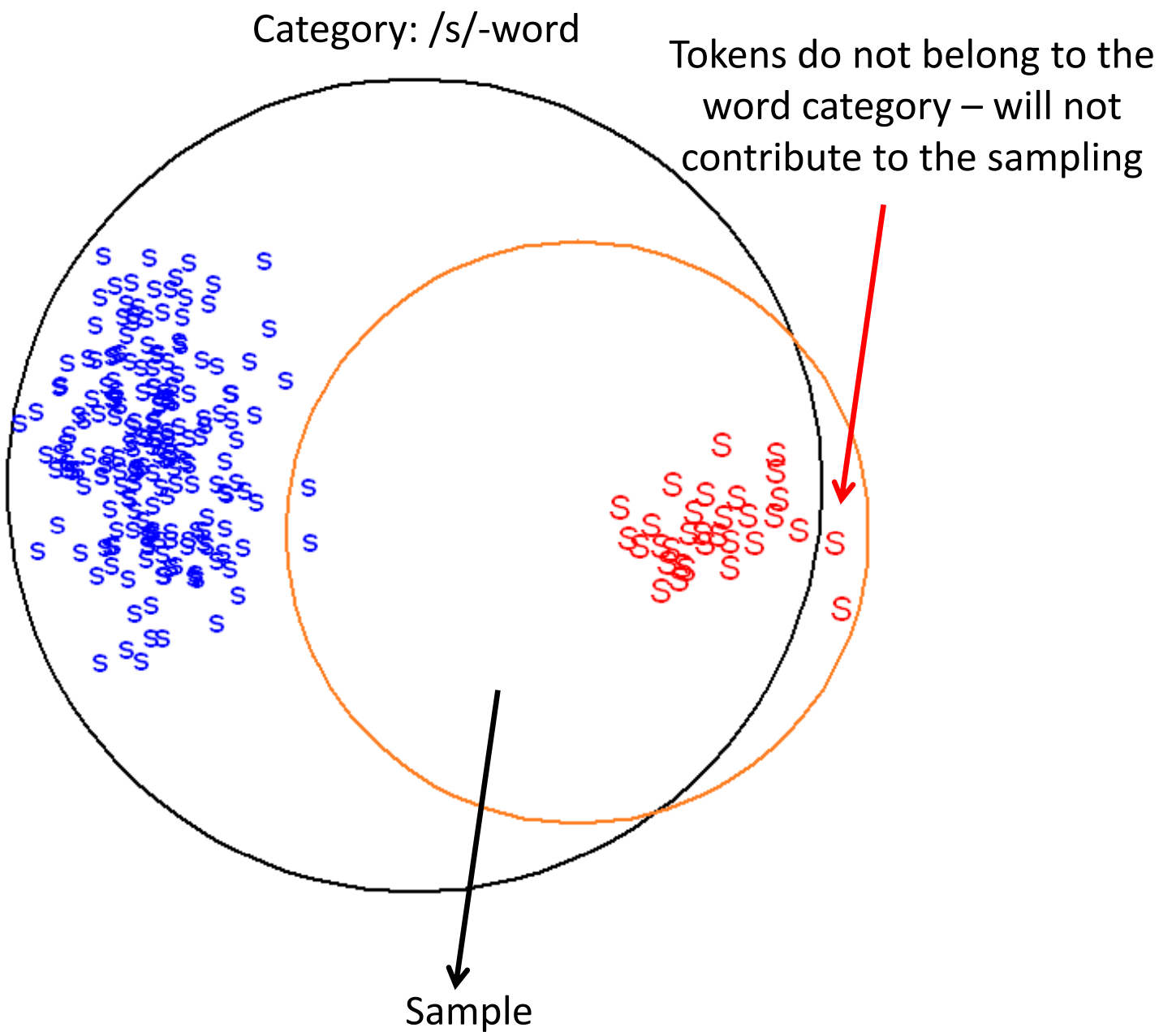
Tokens produced under the retroflex condition

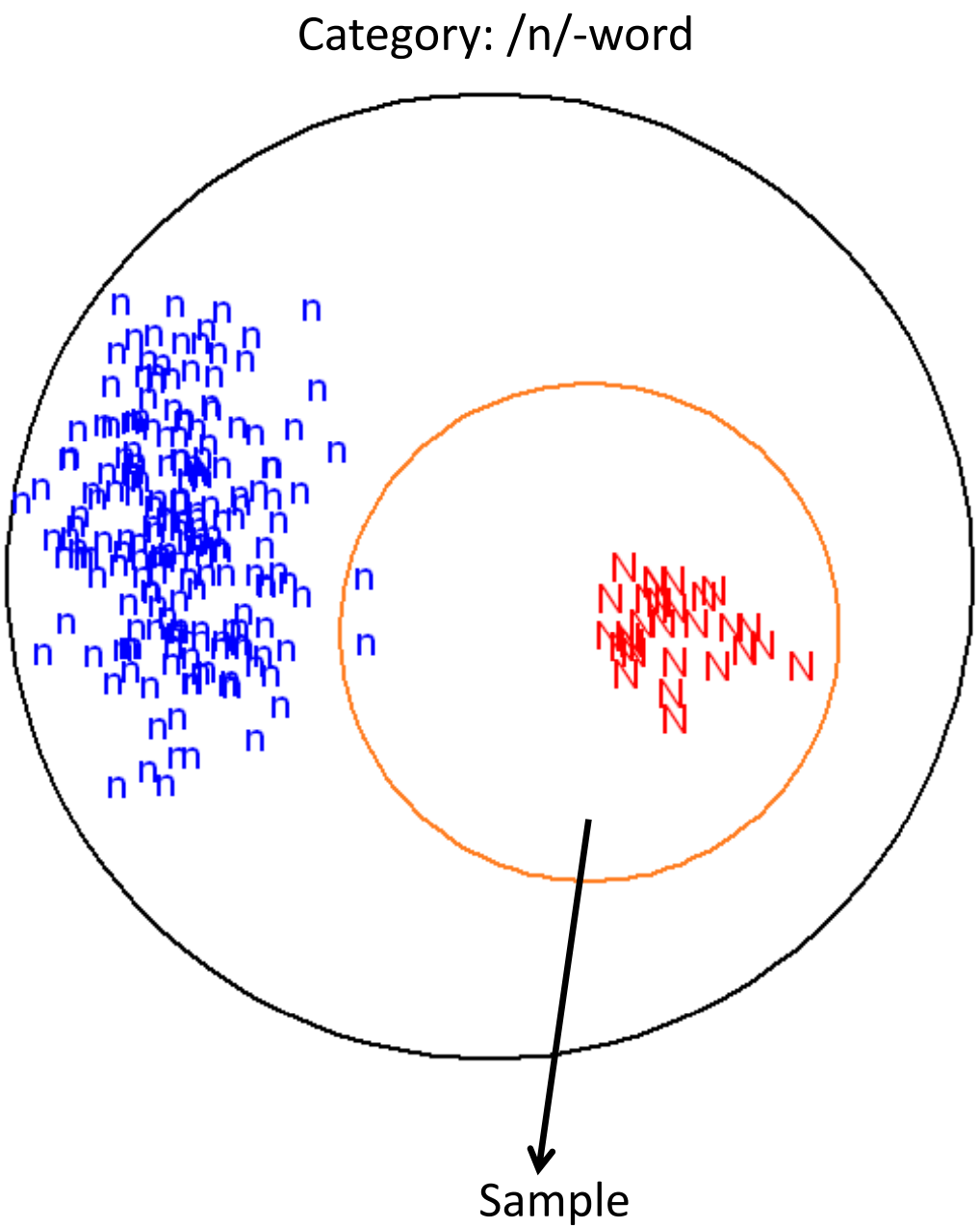


Tokens produced in slow/careful speech – no coarticulation

Tokens produced under the retroflex condition, but not recognized as the /s/-word category

- Production in the exemplar model:
- For category /x/, sample randomly from its categorized tokens (Pierrehumbert 2002)
- UEN ‘retroflex rule’ = sample from the retroflex condition of the category


Category: /s/-word
Tokens do not belong to the word category – will not contribute to the sampling
Sample


Category: /n/-word
Sample

- More [N]-tokens contribute to the sampling of an /n/-word in the retroflex condition than [S]-tokens to an /s/-word
- ⇒ The likelihood of producing a retroflex token in the retroflex condition is higher for /n/ than for /s/
- This difference accumulates for every perception/production loop, ultimately giving a highly significant difference in production today

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References

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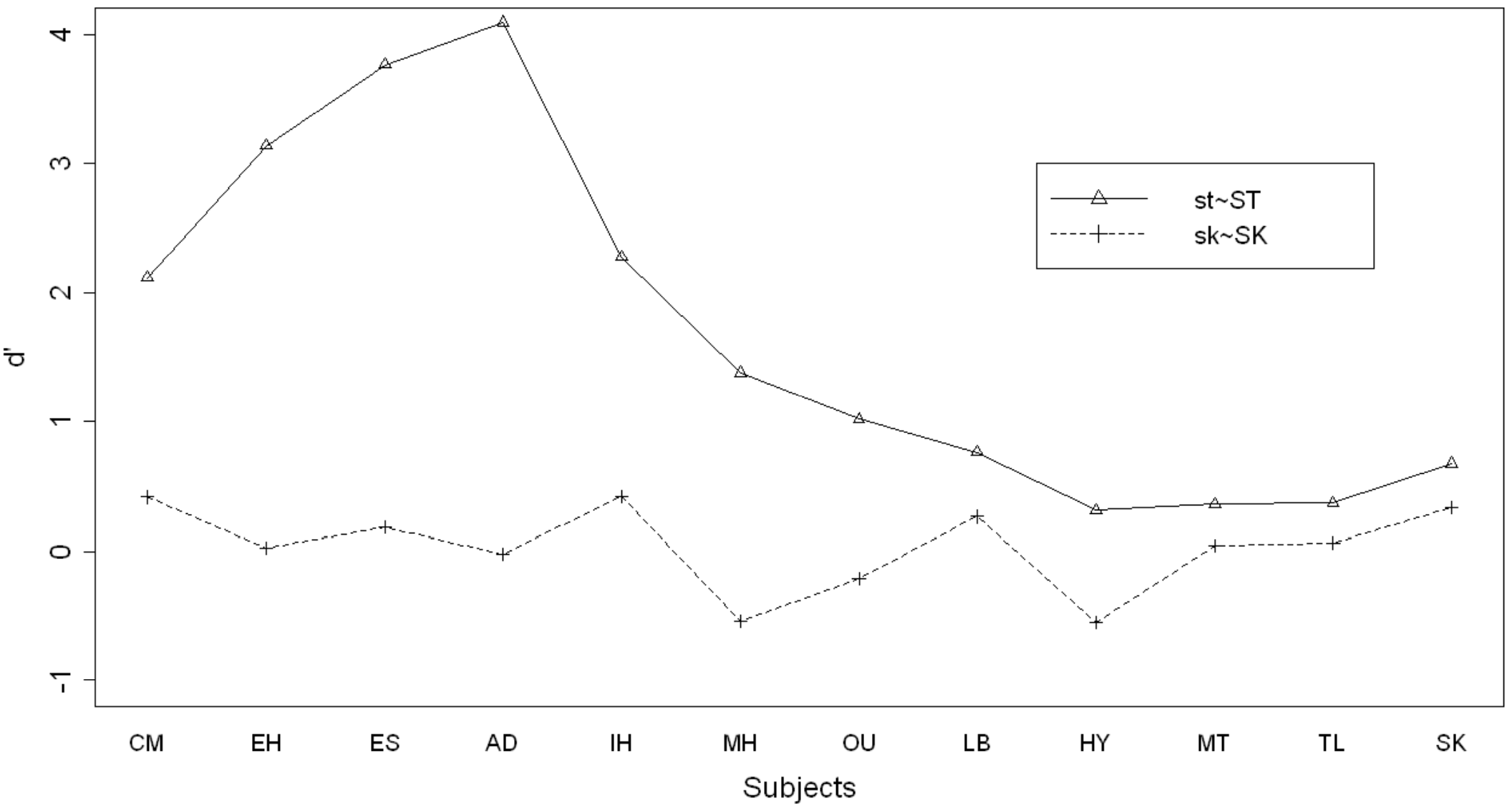
d'
4
3
2
1
0
-1
st~ST
sk~SK
CM
EH
ES
AD
IH
MH
OU
LB
HY
MT
TL
SK
Subjects