# Mapping experience onto phonetic categories

## The effect of social network on bilinguals' production of /r/

Alessandro Vietti, Lorenzo Spreafico,
Vincenzo Galatà & Constantijn Kaland

Abstraction, Diversity, and Speech Dynamics - IPS Workshop | May 3-5, 2017, Herrsching am Ammersee

# Language experience and speech production

- Bloomfield (1933: 47): density of communication

> «Imagine a huge chart with a dot for every speaker in the community, and imagine that every time any speaker uttered a sentence, an arrow were drawn into the chart pointing from his dot to the dot representing each one of his hearers. At the end of a given period of time, say seventy years, this chart would show us the density of communication within the community.»

# Language experience and speech production

- Bloomfield (1933: 47): density of communication
- Exemplar-based phonology (Pierrehumbert 2001; Harrington 2006; Docherty & Foulkes 2014; Foulkes & Hay 2015)
- Flexibility (in the production) of phonological categories in relation to the differential use of languages in bilingual speakers (*gestural drifts*, Sancier & Fowler 1997)

# Language experience …

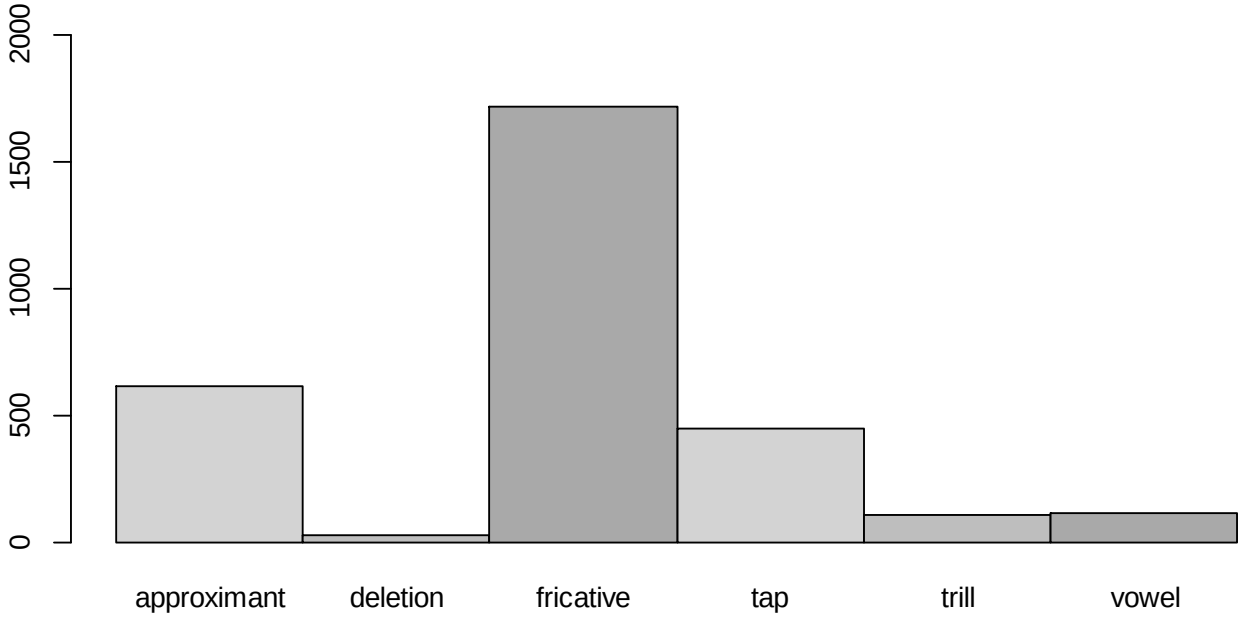
- Personal social network as an approximation to individual social and communicative experience (quantitative social network analysis, Scott & Carrington 2011)
  - Structural properties (centrality, cohesion and partition in subgroups; Fagyal et al 2010; Vietti 2011)
  - Compositional properties (social attributes, languages used within the network)
- Implications for sociophonetics
  - High density leads to conservative behaviour (Milroy 2002)
  - (bilingual) social actors living in dense and hyper-connected networks will speak the same language to all members of their network

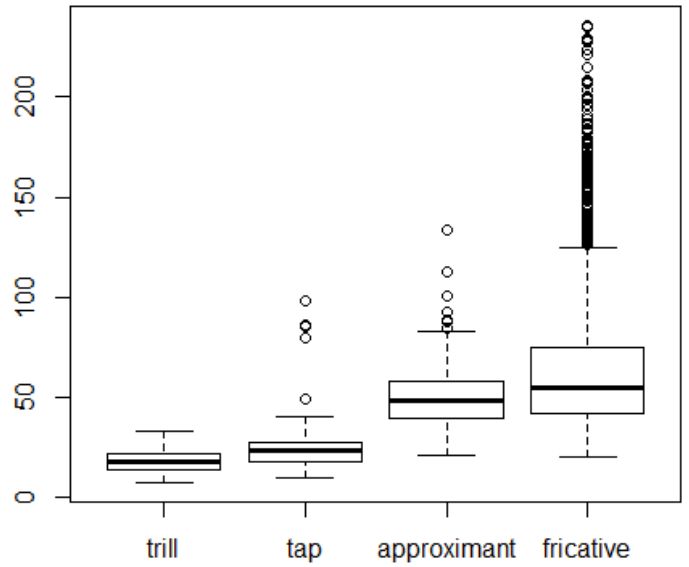
# … and speech production

- Phonetic categories: production of uvular /r/ in Tyrolean (German dialect) by bilingual speakers (Italian-Tyrolean)
  - High degree of variability (uvular trills, taps, approximants, vocalized /r/ and fricatives)
  - Plasticity as a function of social factors (Labov 1966, Scobbie 2006)

# Closure duration in /r/

- Closure duration: measure of the duration of the constriction phase in the realization of r-sounds (trill, tap, approximant, fricative)
- Discriminate /r/-variants (Tyrolean /r/ in Galatà et al. 2016)
- Analysis in our dataset (3020 tokens): Trill (18.2 ms) < Tap (23.5 ms) < Approximant (49.5 ms) < Fricative (64.9 ms)



# Closure duration in /r/: tap

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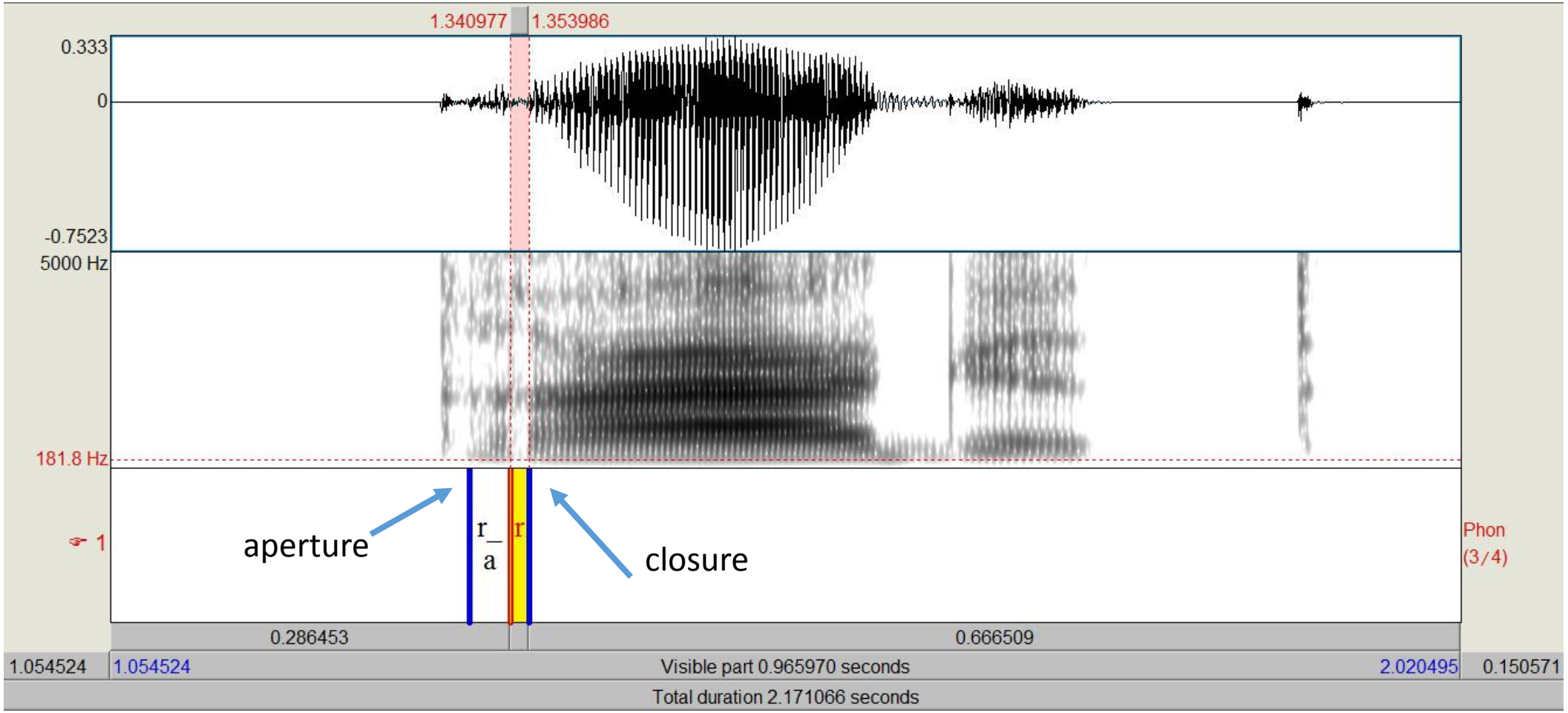


tyr. *traaget,* ‘pregnant animal’

# Contact-induced phonetic variation

- /r/ in Italian in South Tyrol  (Spreafico, Vietti 2016):
  - Alveolar tap is the most frequent variant (67%) in Italian dominant speakers
  - Uvular tap is also the most frequent variant (33.5%) in Tyrolean dominant speakers
- Italian (alveolar) tap (26.18 ms) and trills (25.23 ms) present short closure duration (Celata, Vietti and Spreafico, in press; Spreafico et al 2015)

# So far…

- A more balanced use of the two languages and a less dense network determine significant shifts in the central tendency values of closure duration of /r/ in Tyrolean
- Hypothesis: intenser contact with Italian determines more taps and shorter closure duration in Tyrolean

# Experimental overview

- Participants
  - 14 subjects: 8 sequential bilinguals Tyrolean-dominant (*tyr*), 6 simultaneous bilinguals (*sim*) (11 F, 3 M; age: mean = 26.5, sd = 5.31)
- Setting
  - Simultaneous acquisition of articulatory and acoustic data in Tyrolean and Italian
- Stimuli
  - Reading list: 69 Tyrolean words
  - /r/ simple-cluster in both syllable onset and coda
    - C: full set of surrounding plosive consonants (C: /t, d, k, g, p, b/) for /r/ in syllable onset (CRV) and coda (VRC) position
    - V:  surrounding vowels : /a:, i:, o:/ (whenever possible)
    - VRN and –eR contexts added to elicit vocalization
- Social network data collection
  - Computer-based questionnaire on personal social network (e.g. “name the last 15 persons you interacted with…”; egonet free software)

# Dependent variable

- Normalized closure duration
  - milliseconds X (syllable/ms) = normalized closure duration (i.e. a fraction of the average syllable in the surronding word)

# Independent variables

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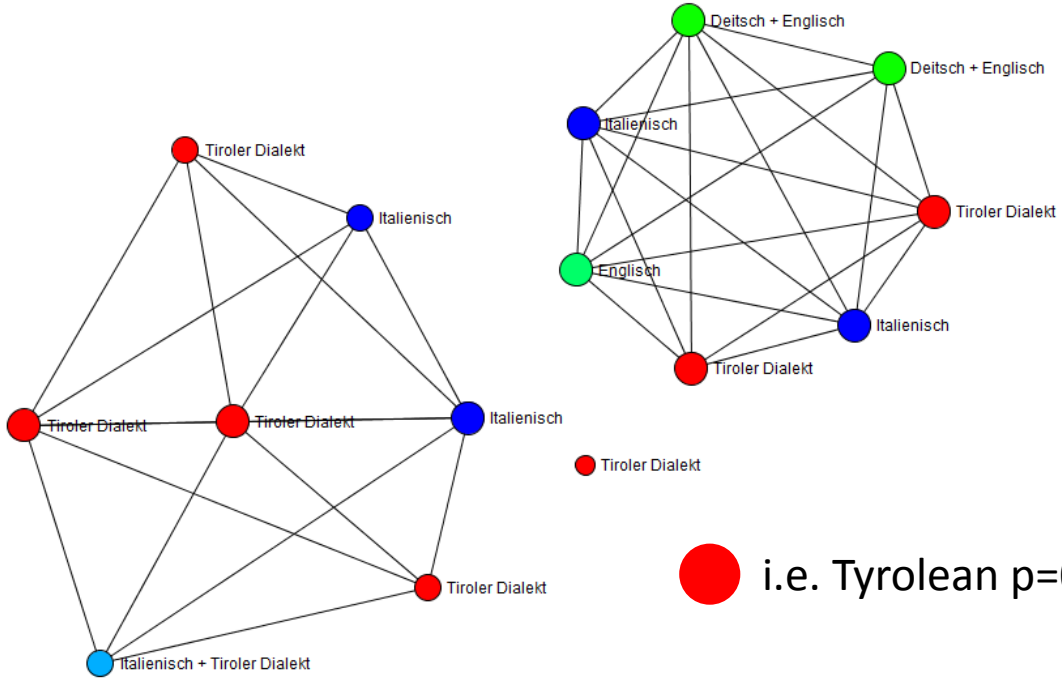


i.e. Tyrolean p=0.47

Shannon's entropy $H = -\sum p_i(\log_2 p_i)$

i.e. H = 1.93

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- Density of the network
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- Degree of bilingualism (Paradis 2007)
  - Simultaneous bilinguals: the child acquires the two L1s at the same time
  - Sequential bilinguals (Tyrolean dominant): the child acquires Italian after 6 y.o.

# Hypotheses

H1) Are /r/ variants different as regards closure duration?

H2) Is there any relation between the variability in the use of the two languages (entropy) within the social network and the closure duration of /r/?

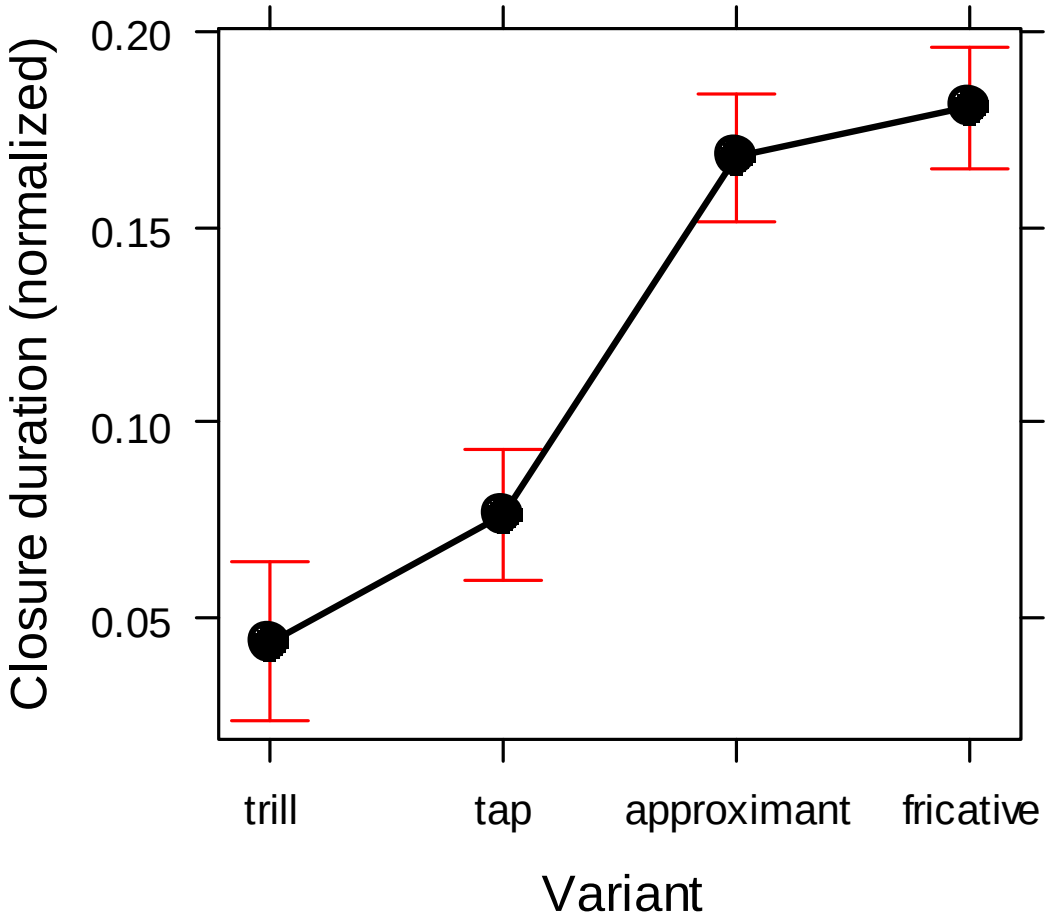
H3) Is there any relation between the structure (density) of the social network and the closure duration of /r/?

# (1) Discriminating /r/ variants

/r/ variants are significantly different as regards closure duration (Log-likelihood test $\chi^2(3)= 681.22$, $p < 0.001$)

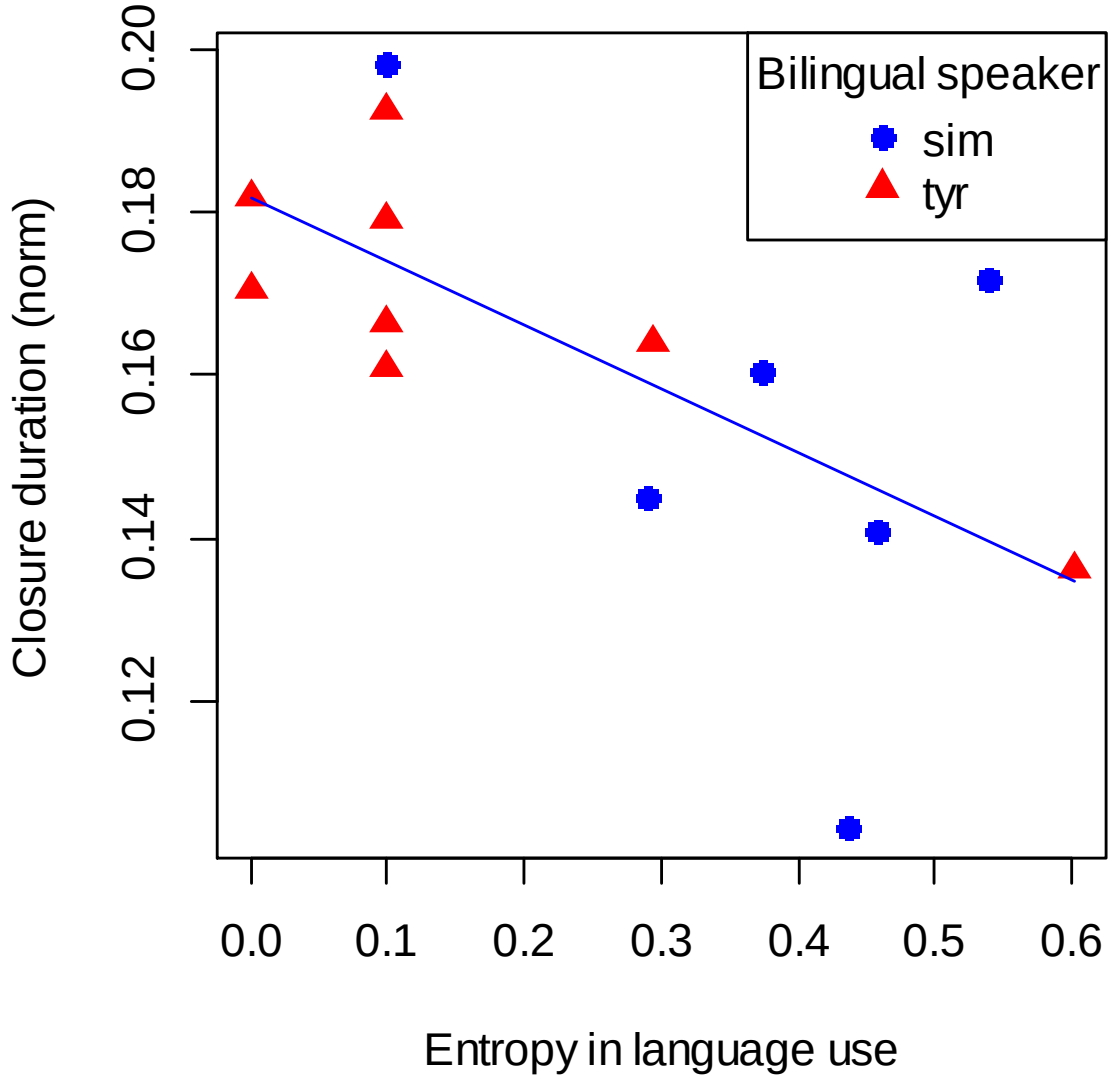
Linear mixed model fit by REML t-tests use Satterthwaite approximations to degrees of freedom

| | Estimate | Std. Error | df | t value | Pr(>\|t\|) | |
|---|---|---|---|---|---|---|
| **Trill (Intercept)** | 0.0439 | 0.0105 | 263.8 | 4.184 | 0.001 | *** |
| **Tap** | 0.0325 | 0.0079 | 2750 | 4.12 | 0.001 | *** |
| **Approximant** | 0.1239 | 0.0077 | 2787 | 16.032 | 0.001 | *** |
| **Fricative** | 0.1368 | 0.0074 | 2795 | 18.609 | 0.001 | *** |



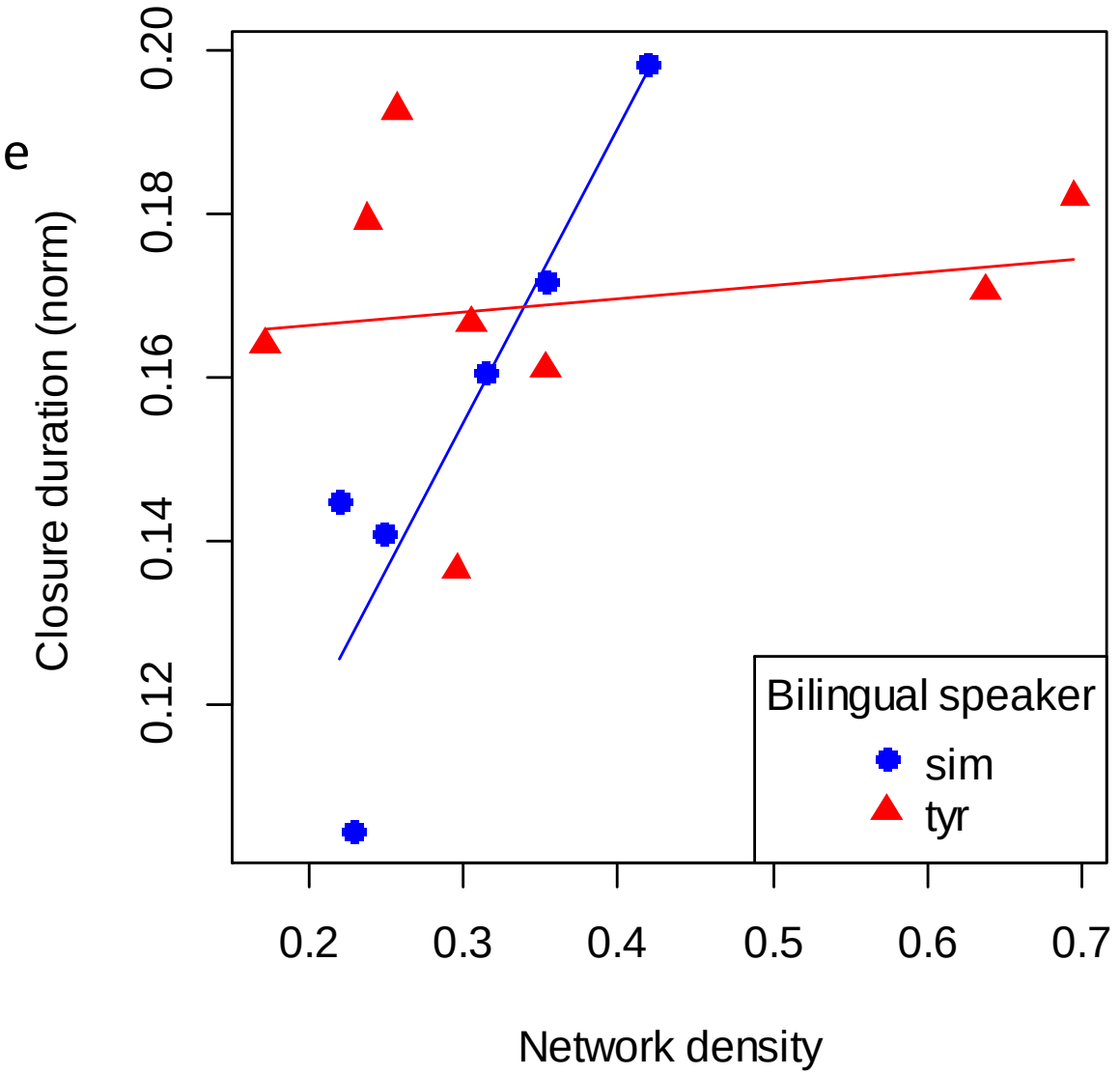
# (2) Language use and closure duration

- Remember: high entropy = balanced use of both languages within the network (50% Italian - 50% Tyrolean)
- Speakers' mean values of closure duration are negatively related to entropy in language use ($\beta$ =-0.078, $p < 0.05$)



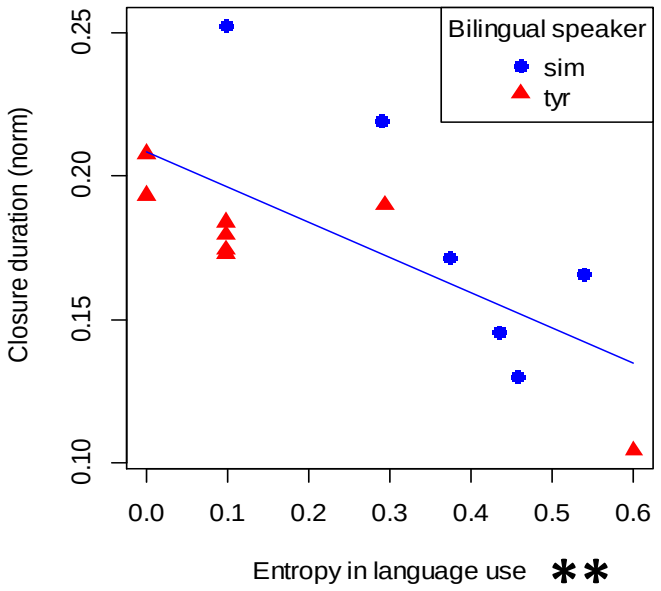
# (3) Network density and closure duration

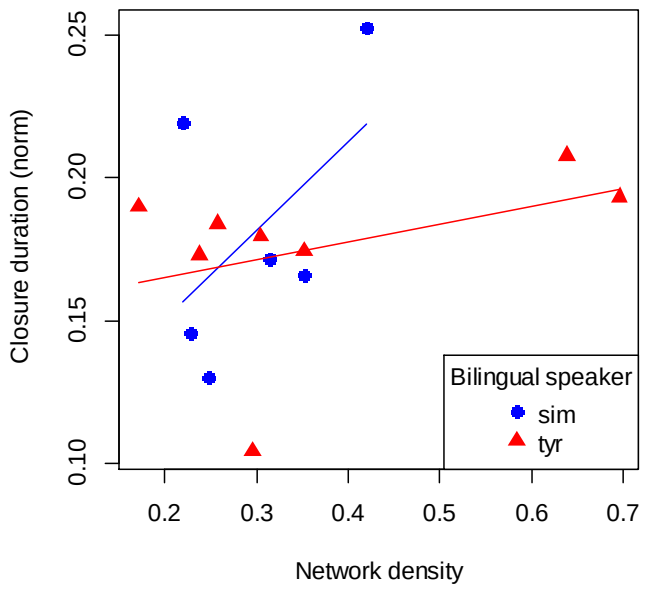
- Density is not significant as main effect (β = 0.063, p > 0.10)
- Significant interaction effect: density X degree of bilingualism (*sim* or *tyr*)
- Different slopes in simultaneous (*sim*) and sequential (*tyr*) bilinguals:
  - sim -> strong positive linear relation (β = 0.358, p < 0.01),
  - tyr -> no relationship (β = 0.016, p < 0.01)
- Only *sim* group is influenced by network density (Vietti 2017)
  - Denser networks corresponds to longer closure duration (i.e. fricative or approximants)



# (4) Analysis on the subset of fricatives

- Differences in closure duration might be related to a «categorical» selection of allophones (i.e. tap vs. fricatives) rather than the adjustment of a continuous parameter
- What happens if we run the same analysis on the subset of fricatives?
  - Entropy of language use is significantly related to closure duration ($\beta = -0.122$, $p < 0.01$)
  - Density alone or in interaction with type of bilingualism is not significant



# Conclusions

H1) Are /r/ variants different as regards closure duration?

YES, each /r/ variant is distinct from every other variant

H2) Is there any relation between the variability in the use of the two languages (entropy) within the social network and the closure duration of /r/?

YES, more variable use of the two languages within the network relates to shorter closure duration

H3) Is there any relation between the structure (density) of the social network and the closure duration of /r/?

YES, but only in interaction with the degree of bilingualism

# Conclusions

Do the same conclusions hold for the subset of fricatives only?

H2) Is there any relation between the variability in the use of the two languages (entropy) within the social network and the closure duration of /r/?

YES

H3) Is there any relation between the structure (density) of the social network and the closure duration of /r/?

NO

# Conclusions

- Entropy of language use
  - A balanced use of the two languages within the personal network produces significant contact-induced shifts (i.e. in the mean values of phonetic categories), modifying the distribution of duration in Tyrolean /r/ from a “monolingual” to a “bilingual” network
  - Both simultaneous and sequential bilinguals are both influenced by entropy of language use
- Network density
  - Density is a structural property without any specific content that acts as a reinforcement of linguistic norms
  - In simultaneous bilinguals, denser networks are presumably more embedded into one of the two linguistic communities (i.e. Tyrolean)
  - Sequential bilinguals are less sensitive to the density of the network

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