

## Mapping language experience onto phonetic categories

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### Background

Sociophonetic perspectives on linguistic variability, such as the exemplar-based (Docherty & Foulkes 2014), assume that adult speakers are constantly re-shaping and updating their phonetic categories as they integrate new acoustic, articulatory, and socio-indexical information. However, it remains unclear how speakers implement in production the varied repertoire of linguistic representations stored in the episodic memory (Pierrehumbert 2001; Foulkes & Hay forthcoming; Harrington 2006).

In our proposal, we investigate the relation between the linguistic experience and the variability of sociophonetic categories in a sample of bilingual speakers from South Tyrol. Firstly, we discuss possible ways of quantifying linguistic experience in terms of frequency of language use, especially basing on quantitative social network analysis (Milroy 2002; Carrington et al 2005). Secondly, we study how social networks structure and content affect the production of uvular /r/ in Tyrolean (German dialect). We focus on the network effects on the duration of the constriction phase of /r/. As showed in a previous preliminary study (Galatà et al 2016), this acoustic cue significantly discriminates between the observed /r/ variants, namely uvular trills, taps, approximants, and fricatives. The former two are characterized by shorter mean values (trill 17ms, taps 23ms), whereas the latter pair exhibits longer mean values (approximants 46ms, fricatives 71ms). Moreover, a pilot inspection of the cross-linguistic distribution of the /r/ variants in our dataset shows that short-closure variants, like taps and trills are more frequent in Italian, whereas long-closure variants are more used in Tyrolean (see Table 1).

$\chi^2(3)=570.16, p < 0.001$	ITA		TYR	
		%		%
Approximant	482	22.2	527	23.4
Fricative	556	25.6	1269	56.5
Trill	186	8.6	80	3.6
Tap	944	43.5	372	16.5
Total	2168	100.0	2248	100.0

Table 1 – Cross-tabulation of /r/ variants by language

Basing on this knowledge, our hypothesis is that 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.

In order to address this hypothesis, we draw on a dataset coming from on a large-scale experiment whose primary aim was to investigate the relation between social networks and speech production in bilinguals.

### Experiment

The main aim of the experiment is the study of the variation of /r/ in a community of bilingual speakers of Italian and Tyrolean. /r/ variation is relevant to the purposes of the present study because it is characterized by a high degree of variability (Vietti et al. 2015) and it conveys social identity values within the South Tyrolean community (Spreafico & Vietti 2013, Kaland et al. 2016).

For the experiment, we recruited 30 speakers (17 females, 13 males,  $M_{age} = 29.3$ , range: 20-42), born and living in South Tyrol and presenting varying degrees of bilingualism in Italian and Tyrolean. Data collection session is composed of two phases. First, synchronized acoustic and articulatory data were recorded using the ultrasound tongue imaging technique. Second, data on the sociolinguistic biography and the personal social network of each speaker were collected via a computer-based questionnaire. As regards the description of subjects' social and communicative experience within their network, we considered the following variables:

- Individual social features regarding the subjects themselves (age, gender, degree and nature of bilingualism, i.e. early vs. late bilingual acquisition);
- Relational data regarding the characteristics of the network members and the structural properties of the network, basing on both compositional measures (e.g. social role, languages spoken in the network, etc.) and structural measures (density, centrality, closeness, etc.).

Concerning speakers' linguistic production, participants were asked to read aloud two lists of target words. Each list was designed to elicit all possible contexts in which /r/ can occur in Italian and Tyrolean. We also controlled for the preceding and following vowels and consonants in different syllabic contexts.

The scope of the proposed analysis is reduced if compared to the overall research framework illustrated above, largely due to the exploratory nature of the present study. The investigation is reduced in three ways. First, in this study our perspective is monolingual and the language investigated is Tyrolean. Second, we select from the sample two groups of speakers: one composed of late sequential bilinguals (Tyrolean dominant), and one composed of simultaneous bilinguals. Third, we choose only three variables for the statistical analysis in order to illustrate one possible model out of the complex web of relations than interconnects acoustic, articulatory and social information. The three variables are:

(Normalized) Closure duration, Entropy of language use and Density of the network. Closure duration is measured as the time interval of the first closure of a rhotic sound (for more details see Galatà et al. 2016). To control for the possible effect of speaking rate, Closure duration is normalized by the number of syllables produced per millisecond. Entropy in language use is normalized Shannon's entropy applied to the language choice made by the speakers within their personal networks: e.g. the higher the entropy, the more balanced the use of Italian and Tyrolean in the network. Density of the network is a simple measure of the overall density of speakers' personal network (e.g. the ratio between the observed ties and the total possible ties in a network). Given these restrictions, we test three hypotheses:

H1) Are the /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 of the social network and the closure duration of /r/?

### Analysis and discussion

Statistical analysis on a dataset of 2248 tokens produced by a subsample of 14 subjects (8 Tyrolean-dominant (*tyr*), 6 simultaneous bilingual speakers (*sim*); gender: 11 F, 3 M; age: mean = 26.5, sd = 5.31) reveals the following patterns.

H1) A linear mixed-effects model (random factors: Speaker and Item) shows that the four /r/ variants are significantly different as regards closure duration (Log-likelihood test  $\chi^2(4) = 705.19$ ,  $p < 0.001$ ). The model (Fig. 1) predicts that the normalized closure phase of the trill is the shortest (0.042,  $p < 0.001$ ) followed by the tap (0.074,  $p < 0.001$ ), the approximant (0.165,  $p < 0.001$ ), the fricative (0.179,  $p < 0.001$ ) and the vocalized /r/ (0.183,  $p < 0.001$ ).

H2) A linear regression reveals that entropy in language use significantly correlates with normalized closure duration. Fig. 2 shows how the speakers' mean values of duration are negatively related to entropy in language use ( $\beta = -0.078$ ,  $p < 0.05$ ). As expected, an increase in entropy negatively affects the duration of the closure phase. More balanced use of the two languages in the network corresponds to a shift in mean values of closure duration, possibly as an effect of a higher rate of interactions in Italian.

H3) A linear regression reveals that the density of the network has a significant impact on closure duration only in interaction with the type of bilingual speaker. Fig. 3 indicates (a) a positive linear relation ( $\beta = 0.358$ ,  $p < 0.01$ ) in simultaneous bilinguals, and (b) no relationship between density and closure duration in sequential bilinguals ( $\beta = 0.016$ ,  $p < 0.01$ ). In the *sim* group, denser networks correspond to socially and linguistically more homogeneous groups (Milroy 2002). The sociolinguistic norm in close-knit and Tyrolean-oriented networks requires the production of longer variants of /r/, namely fricatives and approximants. In the *tyr* group, network are denser (see the intercept value) and variation in density doesn't affect closure duration.

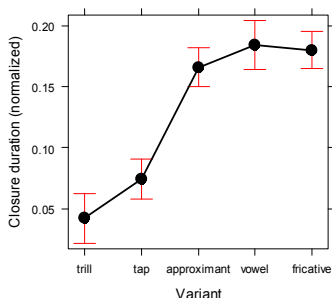


Fig. 1

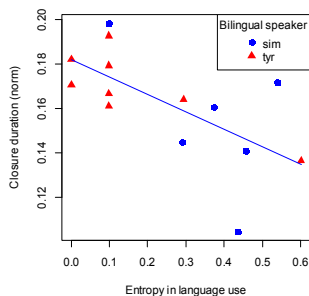


Fig. 2

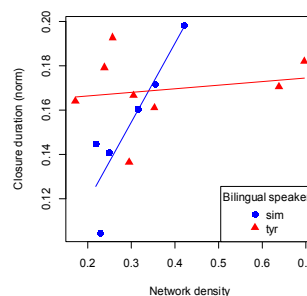


Fig. 3

In conclusion, our investigation shows that both entropy in language use and network density exert an influence on the duration of the closure phase of /r/ in Tyrolean. The sociophonetic implications of these preliminary findings are extremely promising and challenging for the understanding of the process that maps everyday communicative experience into phonological categories.

### References

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