Pre-registration of a study on vowel duration, voicing duration, and vowel height in Italian

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1 Study information

1.1 Title

Vowel duration, voicing duration, and vowel height: Acoustic and articulatory data from Italian.

1.2 Authorship

Stefano Coretta (The University of Manchester).

1.3 Research questions

Vowel height has been shown to correlate with vowel duration, such that high vowels are shorter than low vowels. Moreover, data from Italian shows that the duration of the C1 Release to Vowel Offset interval (RVoffT) in VCVC words is affected by vowel height in the same direction: higher vowels have a shorter RVoffT (Esposito, 2002). Less attention has been given to the duration of the voiced interval including the vowel. In the context of two flanking voiceless stops, it is possible to measure the duration of the portion with voicing (vocal fold vibration) flanked by the voiceless stops. This allows us to answer the following question:

- Q1: Is the duration of the voicing interval between two voiceless stops in CV́CV words affected by vowel height?

1.4 Hypotheses

In the following hypothesis and subsequent section, 'vowel' refers to the stressed vowel in CV́CV words. In relation to Q1, the following null and alternative hypotheses will be tested:

- $H1_0$: The duration of the voiced interval is not affected by vowel height.
- $H1_1$: The duration of the voiced interval is shorter for higher than for lower vowels.

As an extension of Esposito (2002) (which is based on VCV́C words), the following hypotheses will also be tested:

- H2: Higher vowels are shorter than lower vowels.
- H3: VOT is shorter in higher than in lower vowels.
- H4: RVoffT is shorter for higher than for lower vowels.

2 Sampling plan

2.1 Existing data

Registration prior to creation of data: As of the date of submission of this research plan for preregistration, the data have not yet been collected, created, or realised.

2.2 Explanation of existing data

NA.

2.3 Data collection procedures

2.3.1 Participants

Inclusion rule: Native speakers of Italian, from the VCO province (Italy), 18+ yo, with no reported hearing or speaking disorders, with normal or corrected to normal vision.

2.3.2 Procedure

The participants will be recorded while reading sentences with CVCV target words (see `Other` for the list of target words and `Manipulated variables` for the list of frame sentences) presented on a computer screen with PsychoPy (Peirce, 2009), in a quiet room in Verbania (Italy). Time-synchronised audio and electroglottographic data will be collected using a Glottal Enterprises EG2-PCX2 electroglottograph and a RØDE Lavalier microphone, at a sample rate of 44100 Hz (16-bit; downsampled to 22050 Hz for analysis). The acquisition of the signals will be controlled with Audacity running on a MacBook Pro (Retina, 13-inch, Mid 2014). The recordings will be subject to force alignment with SPPAS (Bigi, 2015) for analysis in Praat (Boersma & Weenink, 2018).

2.4 Sample size

30 participants, 43 words, 4 repetitions. Grand total: 5,160 (= 172 tokens per participant * 30 participants) observations.

2.5 Sample size rationale

Brysbaert & Stevens (2018) suggest to have around 1600 observations per condition (e.g., 40 participants, 40 stimuli). Given the limited time available for this study, 30 participants seems a more reasonable target. According to a power analysis with simulated data (mean and standard deviations based on a pilot study) using `simr` (Green & MacLeod, 2016), 12 subjects * 100 tokens per subject are sufficient to detect a difference of 5 ms at 80% of power. See `power.Rmd` for the code.

2.6 Stopping rule

Data collection will be terminated earlier if the 30 participants target hasn't been reached by the end of September 2018.

3 Variables

3.1 Manipulated variables

- **Vowel height**: high (/i, u/), mid-high (/e/), mid-low (/ɔ/), low (/a/).
- **Place of articulation of C1**: labial, coronal, velar.
- **Place of articulation of C2**: labial, coronal, velar.
- **Frame sentence**: *Scrivete X sul foglio*, *Ha detto X sei volte*, *Sentivo X di nuovo*, *Ripete X da sempre*.

See `Other` for a list of word stimuli.

3.2 Measured variables

- From the acoustic signal:
  - **Vowel duration**: from onset to offset of higher formant structure.
  - **Release to Vowel Offset**: from release of C1 to V1 offset.
  - **Speech rate**: calculated as syllables per second (`n of syllables / sentence duration`) (Plug & Smith, 2018).
- From the EGG signal:
  - **Duration of voiced interval**: from voice onset to voice offset.
- From both the acoustic and EGG signal
  - **Voice Onset Time**: from the release of C1 to voice onset.

3.3 Indices

NA.

4 Design plan

4.1 Study type

Experiment—A researcher randomly assigns treatments to study subjects, this includes field or lab experiments. This is also known as an intervention experiment and includes randomized controlled trials.

4.2 Blinding

No blinding is involved in this study.

4.3 Study design

Repeated measures.

4.4 Randomisation

The sentence stimuli will be randomised within participant by means of the built-in randomisation procedure in PsychoPy (Peirce, 2009).

5 Analysis plan

5.1 Statistical models

Separate models will be fitted in R to independently assess effects on vowel duration, voicing interval duration, VOT, and RVoffT. *P*-values (α = 0.05) will be obtained with the `lmerTest` package (Kuznetsova et al., 2017), which uses the Satterthwaite's method of approximation to degrees of freedom.

```
library(lme4)
library(lmerTest)

vowel_lm <- lmer(
  vowel_duration ~
    height +
    c2_place +
    height:c2_place +
    speech_rate +
    (1+height|speaker) +
    (1+height|item),
  REML = FALSE
)

vot_lm <- lmer(
  vot ~
    height +
    c2_place +
    height:c2_place +
    speech_rate +
    (1+height|speaker) +
    (1+height|item),
  REML = FALSE
)

rvofft_lm <- lmer(
  rvofft ~
    height +
    c2_place +
```

```r
    height:c2_place +
    speech_rate +
    (1+height|speaker) +
    (1+height|item),
  REML = FALSE
)
```

Since I wish to directly test both the null and the alternative hypothesis concerning the duration of the voiced interval (H1), BIC approximation of Bayes factors will be used instead of *p*-values (Wagenmakers, 2007).

```r
voicing_lm_1 <- lme4::lmer(
  voicing_duration ~
    height +
    c2_place +
    height:c2_place +
    speech_rate +
    (1+height|speaker) +
    (1+height|item),
  REML = FALSE
)

voicing_lm_0 <- lme4::lmer(
  voicing_duration ~
    height +
    c2_place +
    height:c2_place +
    speech_rate +
    (1+height|speaker) +
    (1+height|item),
  REML = FALSE
)

bf_01 <- exp((BIC(voicing_lm_1) - BIC(voicing_lm_0)) / 2)
```

5.2 Transformations

NA.

5.3 Follow-up analyses

NA.

5.4 Inference criteria

P-values will be used for the effect of vowel height on vowel duration and RVoffT, with $\alpha = 0.05$. *P*-values below 0.05 will be deemed significant. Bayes factors will be employed for the effect of vowel height on voicing interval duration, since I am interested in testing both the null and the alternative hypothesis.

5.5 Data exclusion

Tokens in which the consonant closure is entirely voiced will be excluded.

5.6 Missing data

NA.

5.7 Exploratory analysis

An exploratory analysis will assess the effect of vowel identity and the interaction between vowel height and vowel backness on vowel duration, voicing duration, RVoffT. Also, the effects of vowel and place of articulation on voicing during closure will be examined.

6 Script (Optional)

6.1 Analysis scripts (Optional)

See `Statistical models` section.

7 Other

List of target words: * *peto* ‘fart’ and *caco* ‘I shit’ are not included in the list of target words due to their meaning.

papo	tapo	capo
pepo	tepo	chepo
pipo	tipo	chipo
popo	topo	copo
pupo	tupo	cupo
pato	tato	cato
*	teto	cheto
pito	tito	chito
poto	toto	coto
puto	tuto	cuto
paco	taco	*
peco	teco	checo
pico	tico	chico
poco	toco	coco
puco	tuco	cuco

References

Bigi, Brigitte. 2015. SPPAS - Multi-lingual approaches to the automatic annotation of speech. *The Phonetician* 111–112. 54–69.

Boersma, Paul & David Weenink. 2018. Praat: doing phonetics by computer [Computer program]. Version 6.0.40. http://www.praat.org/.

Brysbaert, Marc & Michaël Stevens. 2018. Power analysis and effect size in mixed effects models: a tutorial. *Journal of Cognition* 1(1). doi:10.5334/joc.10.

Esposito, Anna. 2002. On vowel height and consonantal voicing effects: Data from Italian. *Phonetica* 59(4). 197–231.

Green, Peter & Catriona J. MacLeod. 2016. SIMR: an R package for power analysis of generalized linear mixed models by simulation. *Methods in Ecology and Evolution* 7(4). 493–498. doi:10.1111/2041-210X.12504.

Kuznetsova, Alexandra, Per Bruun Brockhoff & Rune Haubo Bojesen Christensen. 2017. `lmerTest` package: Tests in linear mixed effects models. *Journal of Statistical Software* 82(13). doi:10.18637/jss.v082.i13.

Peirce, Jonathan W. 2009. Generating stimuli for neuroscience using PsychoPy. *Frontiers in Neuroinformatics* 2(10).

Plug, Leendert & Rachel Smith. 2018. Segments, syllables and speech tempo perception. Talk presented at the 2018 Colloquium of the British Association of Academic Phoneticians (BAAP 2018).

Wagenmakers, Eric-Jan. 2007. A practical solution to the pervasive problems of p values. *Psychonomic bulletin & review* 14(5). 779–804.