Breathing affects reaction time in simple and delayed naming tasks

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Background

- Reaction Time (RT) is an important measure for empirical support for processing costs and speech planning models (e.g., Levelt 1992)
- Longer planning or reaction time:
  - At several linguistic levels
    - syntax (complexity: Ferreira 1996, unit size: Sternberg et al. 1978)
    - lexicon (word frequency: Jescheniak & Levelt 1994, phonotactical neighborhood: Vitevitch 2002)
    - phonological factors (syllable frequency: Levelt & Wheeldon 1994, syllable structure: Mooshammer et al. 2012)

Research Questions

Based on on adaption to Sternberg's seminal experiment (Sternberg, Monsell, et al. 1978) and pilot study of Mooshammer et al. 2020, this study investigate: **How breathing patterns affect acoustically measured reaction time?**

AIM is to investigate whether and **how respiratory activity affects the planning time during a simple and a delayed naming experiment.**

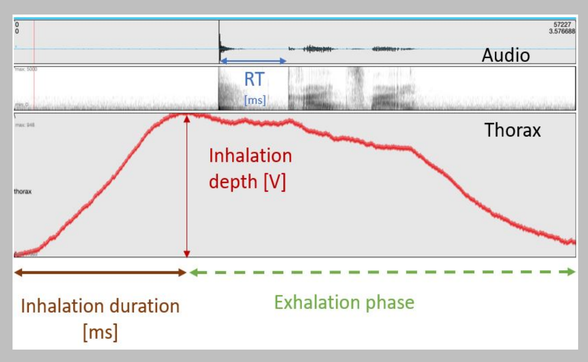
Methods

- **Participants:**
  - 21 native speakers of German (10 f, 11 m)
  - age: between 21 and 33 years
- **Recording:** thoracic and abdominal volume changes by means of Inductance plethysmography, simultaneous with audio signal
- **Task:** reading ordered sequences of 1 to 5 digits (ascending & randomized)
- ***Naming condition:***

  - ***Simple naming:*** stimuli as numbers on a screen at the same time as an acoustic beep and a change of colour on the frame of the screen
  - ***Delayed naming***: beep delayed by a randomized Inter-Stimulus Interval (ISI) between 500 and 1000 ms

- **Labelling of acoustic and breathing events:**
  Acoustics: a) beep, b) speech onset, c) speech offset
  Respiration: d) inhalation peak e) inhalation onset

Calculation of parameters:
- Reaction time (RT): t(Onset of speech) – t(beep)
- Inhalation phase: t(Inhalation peak) – t(preceding inhalation onset)
- Exhalation phase: t(following inhalation onset) – t(inhalation peak)
- Inhalation depth: y(Inhalation peak) – y(preceding inhalation onset)



Results

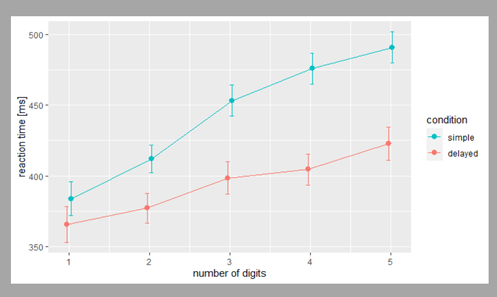
1.) Where does the beep occur in the breathing phase?

Participant	Beep-respiration <I	I	E
f02	1.00	70.00	29.00
f04	8.00	21.00	71.00
f05	3.00	68.00	29.00
f06	14.00	73.00	13.00
f07	17.00	67.00	16.00
f08	41.00	29.00	30.00
f09	4.00	86.00	11.00
f10	21.00	78.00	1.00
f12	7.00	27.00	66.00
f21	4.00	38.00	58.00
m01	15.00	60.00	25.00
m03	4.00	88.00	8.00
m11	1.00	37.00	63.00
m13	14.00	59.00	27.00
m14	6.00	80.00	15.00
m16	10.00	69.00	21.00
m17	2.00	61.00	36.00
m18	3.00	82.00	15.00
m19	15.00	65.00	19.00
m20	0.00	55.00	45.00
m22	31.00	69.00	0.00
total	11.00	62.00	27.00

Most cases inhalation phase
Exceptions for f04, f08, f12, f21, m11 (exhalation phase)

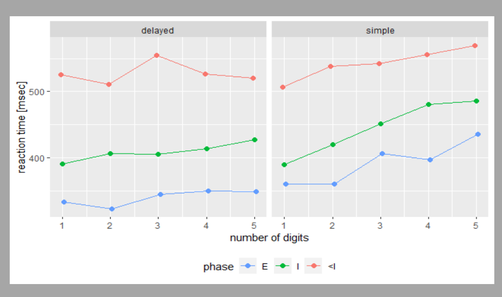
Phase = categorization of data regarding beep occurence:
<I Beep **prior to inhalation**
I Beep **during inhalation**
E Beep **during exhalation**

2.) Does nr. digits effect RT? Yes
Does RT ~ task + (1|subj)? Yes



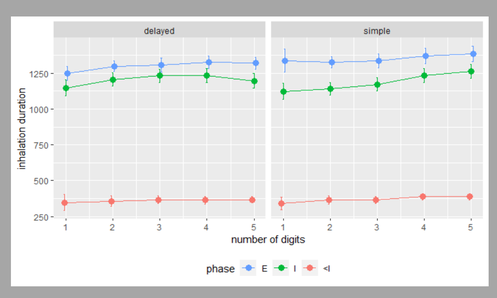
simple: 361+27.5x
delayed: 263+12.6x

3.) simple: Does RT ~ nr.digits + phase + init.seg. + (1|subj)?
delayed: Does RT ~ nr.digits*phase + order + (1|subj)?



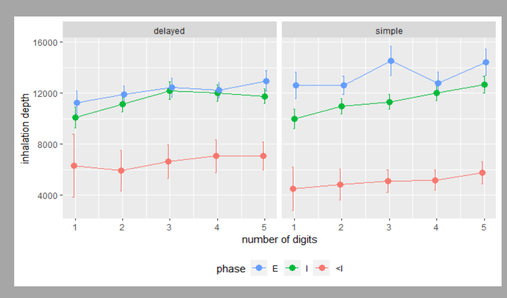
nr. digits: yes
phase: yes
initial segment: yes
digit order: yes

4.) Does inh. depth ~ phase + nr. digits + (1|subj)?



phase: yes
nr. digits: yes

5.) Does inh. duration ~ phase + nr. digits + (1|subj)?



phase: yes
nr. digits: no

Summary and Outlook

- The results indicate that breathing is an integral part of speech planning during initiation and leads to substantial delays in speech onset.
- The large variability found in reaction time experiments can be explained by the observed breathing patterns.

- **Future experiments**
  - should monitor respiration and take respiratory phases in reaction time measures into account
  - vary Inter-stimulus-interval to a larger extent – and investigate whether this leads to differences in simple and delayed naming

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