The role of speech planning in the articulation of pause postures
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1. Introduction

Does articulation during pauses reflect speech planning?

The duration of a pause is influenced by the length of an upcoming utterance, suggesting that speakers plan the upcoming utterance during the pause (e.g., [1-6]).

Different types of pauses have different articulatory kinematic properties (e.g., [7-9]).

Question: Do Pause Postures (PPs) provide additional planning time for an upcoming utterance?
- Pause postures (PPs): specific configurations of the vocal tract associated with speech pausing (Fig.1) [10,11].

Hypotheses:
1. An increase in upcoming utterance length leads to *more frequent PP occurrence.*
2. An increase in upcoming utterance length leads to *longer PPs.*

3. Data analysis

Bilabial consonants surrounding the boundary: labeled on the lip aperture trajectories, semi-automatically using mview (Haskins Labs, under development).

Pause postures (PP) on lip aperture identified as movements that deviate from a clear interpolation trajectory between the pre-boundary and post-boundary consonant constrictions.

Identified PP landmarks (using mview):
PP onset and offset: velocity zero-crossing
PP target maximum constriction of the lips (i.e. minimum LA).

1. PP duration (from onset of PP to offset of PP)
2. Boundary duration (from maximum constriction of the LA of the pre-boundary consonant to maximum constriction of the LA of the post-boundary consonant)
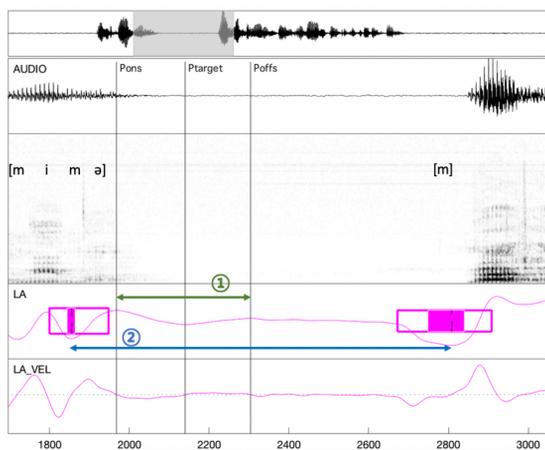
Fig. 1. Labeling for boundary adjacent bilabial consonants and PP. Pink boxes indicate consonant gesture onset (left end of the box), gesture offset (right end of the box), and the dashed line indicates maximum constriction. The vertical lines show PP onset, target(maximum constriction) and offset. 1 – PP duration, 2 – boundary duration.

Statistics:
Generalized Linear Models (GLM) tested the effects of upcoming phrase length on boundary duration, on PP occurrence, and PP duration.

To ensure that effects on PP are not due to overall increase in boundary duration, model comparisons compared models that included boundary duration and post-boundary length as predictors to models that included only post-boundary length as predictors.

2. Method

Stimuli: 24 sentences with the target pause between two phrases
- pre-boundary phrase: five or six syllables long
- post-boundary phrase varied in length to examine the question
    - short: 4 syllables
    - medium: 10 syllables
    - long: 17 syllables
- The pre-boundary phrase ended in [mɑ] or [mə]; the post-boundary phrase started with [b] or [m]

Table 1: Sample stimuli (3 out of 24). # - represents targeted pause.

Condition	Stimuli
short	I think it was MIma. # Bob told me so.
medium	I think it was MIma. # Bob told me about her marriage last week.
long	I think it was MIma. # Bob just talked to me about her upcoming marriage and honeymoon.

8 participants read the sentences 8 to 11 times.

Data collection: electromagnetic articulometry (EMA)
- Sensors on the tongue tip, body, and dorsum, on the upper and lower lips, on the jaw, along with three reference sensors

4. Results

PPs occurred in 393 out of 1446 tokens (27.18%).
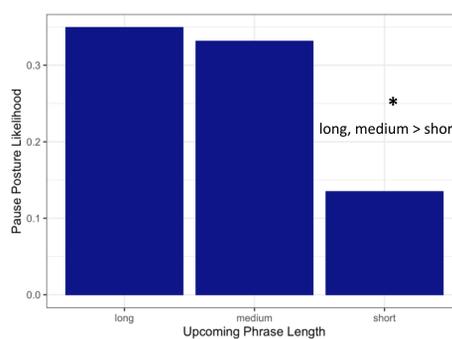
Fig 2. The effect of upcoming phrase length on PP occurrence, speakers pooled
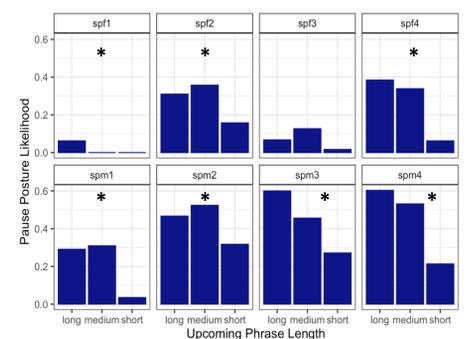
Fig 3. The effect of upcoming phrase length on PP occurrence, by speaker
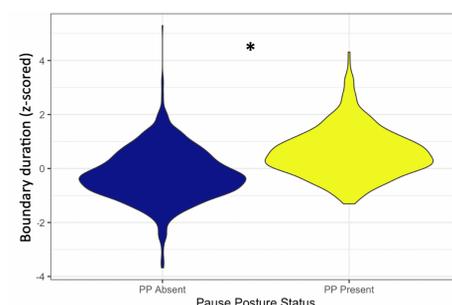
Fig 4 The effect of boundary duration on the occurrence of pause posture, speakers pooled
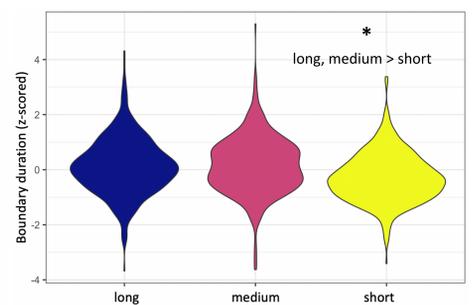
Fig. 5. The effect of upcoming phrase length on boundary duration

There is an effect of:
- boundary duration on PP occurrence, for speakers pooled (Fig 4) and all speakers individually;
- upcoming utterance length on boundary duration (for boundaries with and without PPs combined), for all speakers pooled (Fig 5) and for 4 speakers individually;
- upcoming phrase length on likelihood of PP occurrence, independent of the effect of boundary duration, **supporting hypothesis 1** (Fig 2 & 3).
There is no effect of upcoming phrase length on PP duration, **contrary to hypothesis 2**.

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5. Discussion: Pause postures are associated with planning, allowing speakers *additional* planning time for the upcoming utterances. The lack of effect on PP duration may indicate a relatively stable scope of planning for upcoming speech regardless of its actual length (possibly due to read speech effects). [Supported by NSF]