

Pausing in speech: An acoustic and kinematic speech breathing analysis across age

Katharina Polsterer^{1,2,3}, Valerie Querner¹, Valentine Lucquiault^{1,2}, Martijn Wieling^{1,2,4}, Anne Hermes⁵, Teja Rebernik^{4,5}

¹Center for Language and Cognition, University of Groningen, The Netherlands; ²Research School of Behavioural and Cognitive Neurosciences, University of Groningen, The Netherlands; ³Acoustics Research Institute, Austrian Academy of Sciences, Vienna, Austria; ⁴Brussels Centre for Language Studies, Vrije Universiteit Brussel, Belgium; ⁵Laboratoire de Phonetique et Phonologie, CNRS & Université Sorbonne Nouvelle, France

Pauses in speech reflect planning, with higher planning demands linked to more or longer pauses [1-3]. Relatedly, inhalations during pauses are deeper and longer when upcoming utterances require more planning [1]. Pausing and speech breathing behaviour also change with aging, with older adults showing more frequent pausing and shorter utterances per breath group [4,5]. These changes may reflect cognitive slowing, physiological constraints or altered coordination between cognitive and motor processes [4]. However, it remains unclear how planning demands affect speech breathing across adulthood. In this study, we investigated the effect of a speech-external motor planning load on breathing during speech pauses. Participants read a text either on its own or while clapping on predefined words. This dual-task manipulation was designed to add motor coordination demands during speech planning. Based on prior work [6,7], we hypothesized that added planning demand would increase pausing frequency, particularly ungrammatical pauses (i.e. not at syntactic boundaries, whereas grammatical pauses are located there [7]). Given that respiratory patterns during speech pauses are similarly sensitive to planning demands [1], we further expected inhalation frequency to increase under added planning load. These effects may potentially be modulated by speaker age [4,5].

Sixty-six native Dutch speakers aged 20–78 years (34 female) read a short text in a simple (reading only) and a complex (reading + clapping) condition. Acoustics were recorded simultaneously with speech breathing kinematics using electromagnetic articulography (NDI VOX-EMA), with sensors placed on the sternum to capture breathing movements and on the cervical spine for reference [8]. Ongoing analyses focus on the number of pauses (≥ 150 ms), their grammaticality, and inhalations during these pauses detected via EMA (Fig. 1). Preliminary results are based on 12 speakers (7 female), including four speakers each in their 20s, 40s, and 60s.

We created two generalized linear mixed-effects models predicting the number of pauses and inhalations, respectively, based on age group, condition and pause grammaticality. Overall, ungrammatical pauses were less frequent than grammatical pauses ($\beta = -2.5$, $p < .001$). In the complex condition, the number of ungrammatical pauses increased ($\beta = 1.5$, $p = .01$; Fig. 2). Age-related modulations of this effect were weak in the current subset. Specifically, the preliminary analysis showed a trend suggesting that speakers in their 40s showed less difference between conditions in the number of ungrammatical pauses compared to younger adults ($\beta = -1.3$, $p = .09$). Inhalations mainly occurred during grammatical rather than ungrammatical pauses ($\beta = -3.7$, $p < .001$). No reliable main effect of planning load on inhalation frequency was observed (Fig. 3), but there was a trend toward more inhalations during ungrammatical pauses in the complex condition than the simple condition ($\beta = 1.9$, $p = .08$).

Together, our preliminary results indicate that added speech-external motor planning demand primarily altered pausing behaviour, increasing ungrammatical pauses in the complex condition. This supports the hypothesis that ungrammatical pauses are sensitive to planning demands. In contrast, the predicted increase in inhalation frequency was not observed. Speech breathing during pauses appears more closely linked to syntactic boundaries. Age-related effects on pausing and inhalation frequency were not evident in this subset. However, age may influence pause and inhalation durations [9] rather than frequencies, which remains to be tested. Analyses of the full dataset, to be reported at the conference, will assess the robustness of these patterns and further characterize age-related changes in speech planning under increased cognitive demand.

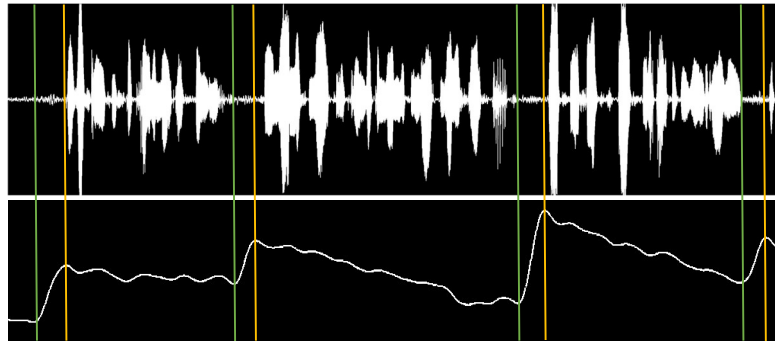


Fig. 1. Example of an audio signal (top) and the corresponding breathing trajectory recorded simultaneously using EMA (bottom) with inhalation onsets (green vertical lines) and inhalation offset (yellow vertical lines).

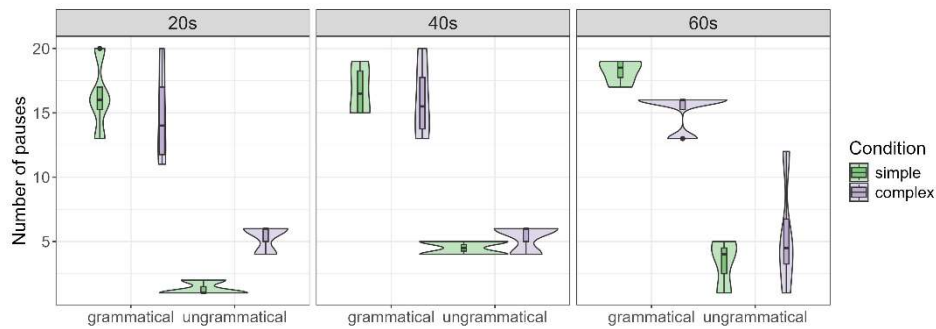


Fig. 2. Number of grammatical and ungrammatical pauses per condition and age group.

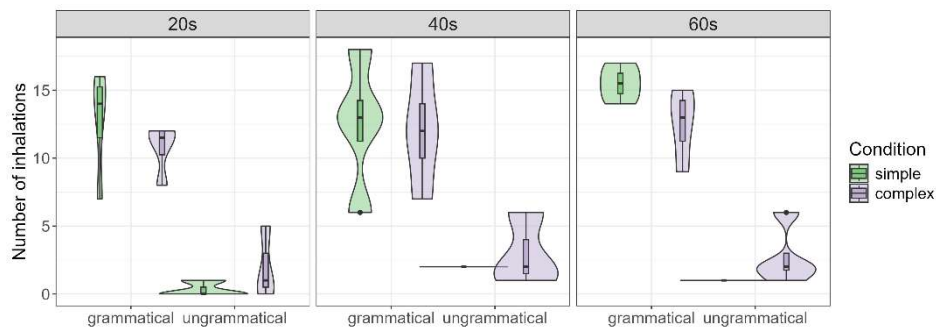


Fig. 3. Number of inhalations during grammatical vs. ungrammatical pauses per condition and age group.

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