

Temporal organization of breath vs. silent pauses in spontaneous German speech under varying respiratory load

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Controlled breathing is essential for phonation, yet little is known about how breath pauses are coordinated with speech and silent pauses in spontaneous talk. To investigate their distribution, the speech-breathing system was perturbed by introducing additional breath pauses via aerobic exercise. German data from three experimental conditions of increasing respiratory load were analyzed in terms of the duration, frequency and location of breath vs. silent pauses.

INTRODUCTION

Speech cannot occur without regular inhalations, but it is unclear how breaths are interwoven with linguistic structure. In read speech, most pauses are breath pauses and almost all breath pauses occur at grammatical breaks [1]. Spontaneous speech, however, may contain twice as many silent pauses as breath pauses, and up to 30% of inhalations occur at non-grammatical breaks [2]. These differences are attributed to the increased cognitive load of online speech production, but it is unclear i.) how breath-planning is affected and ii.) whether breath and silent pauses can be used interchangeably for planning.

Following the literature, it is hypothesized that breath and silent pauses will generally be in complementary distribution: breath pauses are planned and tend to occur at grammatical junctures; silent pauses arise in periods of hesitation/planning and thus at non-grammatical junctures. To test this hypothesis, additional breath pauses will be introduced through aerobic activity and pause distribution compared in different conditions.

METHOD

The dataset [3] consists of acoustic and respiratory data collected from 11 adult speakers of German in a laboratory setting. Respiratory load was increased using a stationary bicycle and breathing data were recorded with respiratory inductance plethysmography (RIP). Spontaneous speech was elicited with an item-choice task in three conditions: 1) sitting still; 2) cycling with moderate resistance; and 3) cycling with heavy resistance. Acoustic data (≈ 90 s/trial/participant) were annotated in Praat (2019; Version 6.0.43) on three tiers:

- 1) Interval: SPEECH INTERVAL, BREAK IN SPEECH (>100 ms)
- 2) Pause type: INHALATION, SILENT PAUSE, AUDIBLE EXHALATION
- 3) Pause location: CLAUSE-FINAL, CLAUSE-MEDIAL, PHRASE-MEDIAL, WORD-MEDIAL

The audio signal and visual inspection were used to label 1); RIP data were additionally used to label 2); examination of the speech material was used to label 3).

Timestamps were extracted for speech/pause intervals to calculate duration and percentage of breath/silent pauses and speech per condition, duration of each pause type and duration of each pause per location. The aim of this annotation is to test whether a systematic relationship exists between pause type and location/duration and thus whether breath planning in spontaneous speech is sensitive to speech planning at different linguistic levels.

PRELIMINARY RESULTS

Unexpectedly, silent pauses all but disappeared under heavy respiratory load. This suggests that breath pauses may indeed take on the function of silent pauses if necessary. A further observation is that speakers regularly produce inhalations of considerably different depths. It is not clear whether these inhalation depth correlates with, e.g., certain locations. It is thus necessary to annotate depth of inspiration on a further tier. Finally, breaks in speech often comprised different combinations of inspiration, silence and expiration. To our knowledge this phenomenon has been described in only two papers – as “pause typologies” [4] or “pause patterns” [5] – and merits further investigation. Taken together, the findings may shed light on speech planning and execution and also inform speech synthesis/recognition technologies.

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