Exploring the presence and absence of inhalation noises when speaking and when listening

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Breath noises in speech communication can usually be observed during articulatory activity but not when speakers let their articulation rest, for instance when they focus on listening [1]. Even though respiration is at work all the time it seems to be the case that inhalation is made audible only in active (or planned) articulation, though there are occasionally speakers who suppress the audibility of their breathing while speaking. However, this more informal observation is based solely on acoustic but not on physiological speech data. For this reason, we intend to check this general impression with speech data featuring synchronously recorded acoustic and kinematic (respiratory) signals.

The material for this exploratory study consists of acoustic and kinematic data of four speakers of German who were engaged in two different tasks: listening to a fable (LN) and re-telling this fable (SN). The kinematic signals recorded the activities of the rib cage (RC) and the abdomen (AB). For details see [2] where the data were first used for a different study.

A first comparison between the kinematic respiration patterns of both tasks (for an illustration of a sample see Fig. 1) reveals that subjects have more breath cycles in LN than in SN. In addition, the duration of the inhalation phase is substantially longer in LN while the exhalation phase in SN is much longer and more variable in its duration.

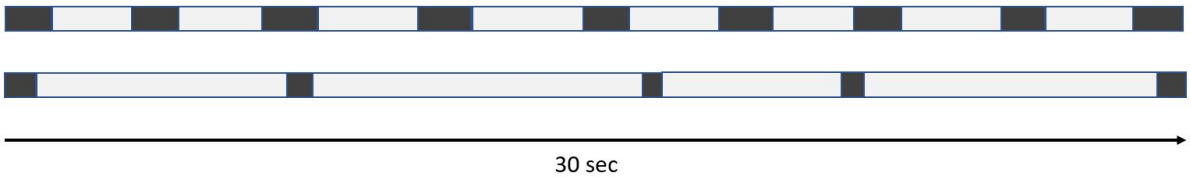

Fig. 1: Exhalation (light grey) and inhalation phases (black) of two 30-sec excerpts of the inspected kinematic data of one speaker (S01_008) in both conditions (top: LN, bottom: SN).

As expected, only few breath noises in LN were observable (in the phases before and after the playback of the tale to be listened to; during the playback an observation was not possible). The few instances of breath noises in LN were very soft compared to those in SN. In addition, in SN all inhalation phases were acoustically reflected by a salient breath noise. Interestingly, all four speakers shifted their AB phase in relation to RC to an earlier timepoint when speaking as compared to listening.

A typical acoustic feature of an inbreath noise is that it is sandwiched between short intervals of silence. These "edges" [1] to the left and right of the breath noises typically have an average duration of 50 ms, whereas the breath noises themselves have a duration between 200 and 500 ms [1]. Thus, we aimed to find a link between the timing of the "edges" in the acoustic signal and the respiratory activities of RC and/or AB in the inhalation phase in breath pauses in speech. When inspecting the temporal structure of the acoustic signal (articulation phases and inhalation noises) together with the kinematic signal (RC and AB) the following pattern was observed for two of the four individuals as illustrated in Fig. 2. The end of articulation in the acoustic signal (1) seems to be aligned with the start of AB (7) whereas the start of an articulation phase (2) seems to be aligned with the end of RC (6). In contrast, the start of the inhalation noise (3) seems to be synchronous with the start of RC (5) whereas the end of the inhalation noise (4) and the end of AB (8) seem to be synchronised.

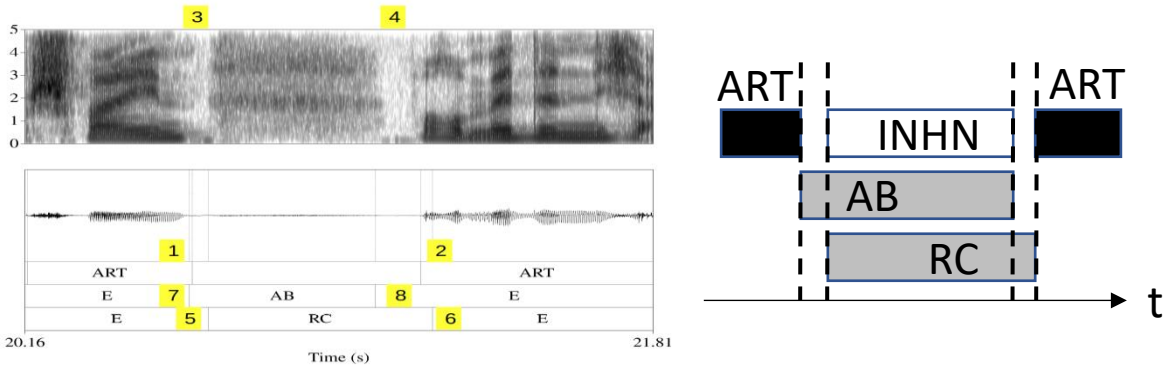

Fig. 2: The temporal alignment of articulation phases, inhalation noises (INHN) and AB and RC in an inhalation phase between two articulation phases: in a speech signal (left, for numbers see text, speaker S04) and in a schematic drawing (right).

In summary, although the inspected data sample is very small there is a strong support for the general assumption that the acoustic reflections of inhalation is predominantly observable when being articulatory active but not when articulatory inactive, as when listening without speaking. In addition, both articulatory phases and inhalation noises seem to be closely coupled to the activity of RC and AB, which often leads to short near-silent gaps around the inhalation noise. Future analysis of greater samples of acoustic and kinematic speech data is needed to confirm the patterns observed in this exploratory study and to contribute to explanations currently discussed in the scientific community.

References

[1] Trouvain, J., Werner, R., & Möbius, B. 2020. An acoustic analysis of inbreath noises in read and spontaneous speech. Proc. Speech Prosody, Tokyo, pp. 789-793.

[2] Rochet-Capellan, A. & Fuchs, S. 2013. Changes in breathing while listening to read speech: the effect of reader and speech mode. Frontiers in Psychology 4, doi: https:// www. frontiersin. org/article/10.3389/fpsyg.2013.00906