Csilla Ilona Dér, Viktória Horváth, Anna Huszár & Valéria Krepsz

# The relationship between breathing and backchannel responses in spontaneous conversations: Pilot study


## Abstract

Breathing in conversation is likely to be organized along the intention of turn-taking. A specific element of conversation is the backchannel response (BCR), which is a type of short feedback from the participant in the listening role to the speaker. It is a heterogeneous category, both formally and functionally, that has been little studied in terms of the organization of breathing and speech in conversations. The aim of this research is to investigate how different breathing characteristics can be described in the case of the BCRs. The present research is primarily concerned with the methodological possibilities of the problem we focus on, so its goal is not to present a comprehensive analysis, but rather to illustrate the diversity of the phenomenon under investigation, which can serve as a basis for a later, systematic, empirical study. The audio material consisted of 3 task-oriented conversations. The respiratory patterns of the 6 speakers in spontaneous conversations were analyzed using Respiratory Inductance Plethysmography for the first time in Hungarian. The results showed that laughter has a particular respiratory characteristic usually involving the exhalation of air. But other strategies may be specific to BCRs as well: (a) speakers produced BCRs while exhaling – thus, no change in the breathing cycle was seen compared to silent breathing; (b) they added some extra air to their existing exhalation: without starting a new breathing cycle. The results of this study might add a new perspective of the aforementioned definition of the BCR's: some of them may have a possible role in the organization of the turn-takings. Additionally, they provide new information on the relationship between speech and respiratory planning, and also help to examine the specificities of smooth and rapid turn-takings.


## 1. Introduction

Breathing is a complex process when the air is moving into and from the lungs to facilitate gas exchange with the external environment, to flush out carbon dioxide and bring in oxygen. (For details of the respiratory mechanism and the structure of the respiratory organs; see Clark, Yallop & Fletcher 2007). This unconditional process also acts as a basis for speech production, as using the respiratory system to produce the airflow necessary for phonation (for details see Fuchs & Rochet-Capellan 2021). A number of linguistic and non-linguistic features may influence the actual form of the breathing pattern and the specific realization of the speech production, such as: age and physical status of the speaker, strength of the boundary, length of the utterance, topic, speech situation, speaker role (Serré et al. 2021; Bortfeld et al. 2001).

The study of breathing goes back a relatively long time. However, although respiration seems to be an easy phenomenon to observe, it is very difficult to measure especially during speaking. Respiratory Inductance Plethysmography

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(RespTrack) is probably the most commonly used technique at present (Heldner et al. 2019). This sensor "is an inexpensive, non-invasive, easy-to-use transducer for collecting respiratory movement data" (Chen & Hsiao 2018, 1293). By using this RespTrack device, the timing pattern and depth of the breathing (value of the amplitude) can be measured using belts, one on the abdomen and chest. In parallel, the sound is recorded using a microphone.

Hixon (1987) describes in detail the differences between silent breathing and speech breathing. Tidal and speech breathing considerably differ from each other in various parameters. The rate of tidal breathing is about 12 breaths per minute (range: 7–19 breaths per minute), while it is 20 breaths per minute in the case of speech breathing (range: 14–31 breaths per minute; cf. Hoit & Lohmeier 2000). Silent breathing involves relatively equal phases of inhalation and exhalation in terms of duration, amplitude and speed. Speech breathing is characterized by short inhalations and long exhalations. The short duration of inhalations helps to maintain speech fluency. Exhalations are simultaneously much longer due to the greater resistance of the upper airway, which allows longer utterances, and the cavity obstruction, which is the basis of sound production and prevents rapid air outflow.

Earlier research using the RespTrack system showed that the inhalation occurs mostly at syntactic boundaries (Fuchs & Rochet-Capellan 2021). In addition, inhalations are deeper before stronger boundaries (between sentences) than before weaker boundaries (Conrad, Thalacker & Schönle 1983). Moreover, speakers may anticipate the length of the upcoming sentence when inhaling and try to size up the required air volume before starting to talk (Rochet-Capellan & Fuchs 2013), which means that the inhalation is deeper before longer sentences than before shorter ones.

Less is known about the breathing patterns in conversational situations: in the previous studies, the transcript of the recordings generally contains the labels of the audible inhalations and exhalations, because they may have a role in managing conversations, e.g., inhalation 'noise' may indicate intention to speak and exhalation 'noise' may indicate turn-end. In contrast, research using objective measurement techniques has found that breathing adapts to the turn-takings and has investigated the effect of breathing on interspeaker coordination based on turns and turn takings of speech (Rochet-Capellan & Fuchs 2014, 5). Rochet-Capellan & Fuchs (2014) investigated how breathing cycles can adapt to communicative events. Their results showed that speakers shortened inhalation durations in order to maintain their turn and their right to speak compared to inhalation durations coinciding with turn-takings. These results therefore show that breath coordination is related to speaker intention.

Therefore, measurements on breathing in conversation on the basis of using devices may add new information on discourse management.

Backchanneling has been considered a significant phenomenon in conversations, therefore many linguistic studies have dealt with it in the last decades. Scholars use different terms for it, such as *backchannels* (Yngve 1970; Cutrone 2005), *continuers* (Schegloff 1982), *listener responses* (Deng 2009), *backchannel responses* (Li et al. 2010), *feedback utterances* (Prévot, Gorisch & Bertrand 2016). In agreement with Ward & Tsukahara (2000, 1177) we define backchannel responses (BCRs) as "the short utterances produced by one participant in a conversation while the other is talking". It is important, that this participant (the listener) does not take the floor, just provides verbal and/or nonverbal feedback in order to signal understanding, attention, or different emotions (sympathy, boredom, surprise, skepticism; cf. Ward & Tsukahara 2000), for example Hung. *igen* 'yes', *ühüm* 'hum', *aha* 'uhhuh' or *juj* 'ouch'. BCRs are typically relatively short units because the listener doesn't want to interrupt or 'talk down' the speaker.

The frequency and type of BCRs might vary along a number of factors, such as the topic and the (social-communicative) goal of the conversation, the environment (e.g., noisy place), the number, gender and age of the participants, their physical-mental state and individual characteristics, the language of the speakers, as well as the culture of the interlocutors. For example, in more than 1.000 American English conversations, 19% of the utterances were realized as BCRs (Jurafsky et al. 1997). According to many studies, women do more agreeing and showing of support using BCRs, in both same- and mixed-sex interactions (e.g., Carli 1989; Edelsky & Adams 1990). Moreover, men and women produce more BCRs in mixed-sex conversations than in single conversations (Feke 2003). As for the age of the participants, younger adults use more BCRs than older adults – it is assumed that they actively monitor the interlocutor's production (Gould & Dixon 1993).

The different types and realizations of BCRs can be placed on a continuum based on their phonetic features (articulation, vocal/verbal character, duration), grammatical structure and function. It is essential that there are no clear-cut boundaries between the different types of BCRs and that neighboring categories share common parts. One end of the continuum is represented by nonverbal, non-lexical elements, such as laughter, sighing, sniffing. At the other end there are lexical-verbal units, which can have simple or complex structure (cf. Wong & Kruger 2018).

Simple backchannel expressions are made up of a single word, such as *igen* 'yes' or *persze* 'of course'. Complex backchannel expressions are made up of more than one lexical unit, even one (or two) separate sentence(s), as in *Ja, értem* 'oh, I see', *Aha, Jézusom!* 'Aha, Jesus!'. Semi-verbal items have characteristics of both nonverbal and verbal BCRs: humming is the most frequent type of them (and also among BCRs; Markó 2005). Interjections such as *ú* 'wow', *jaj* 'ouch', *hajjaj* 'ah, well' etc. have also a half lexical - half nonverbal character. In complex cases lexical elements appear combined with nonverbal or semi-verbal elements, e.g., humming + *ja* 'yes'.

The frequency and the prosody of English affirmative words were analyzed as well as the prosody of the BCRs' context in a 9-hour-long material, regarding their function (Benus, Gravano & Hirschberg 2007). Results showed that despite their high lexical variability, BCRs were prosodically well-defined. Affirmative words in backchannel function were realized with higher pitch and intensity as well as with greater pitch slope than those expressing other pragmatic functions. The duration of the affirmative words was found to be longer in the backchanneling function than in other functions.

The aim of the present study is to describe the relationship between the realization of breathing patterns and BCRs, regarding their type and their possible role in turn-takings, firstly in Hungarian. The present research is primarily concerned with the methodological possibilities of the problem we focus on, so its goal is not to present a comprehensive analysis, but rather to illustrate the diversity of the phenomenon under investigation, which can serve as a basis for a later, systematic, empirical study.

The research examines the frequency and type of respiratory characteristics, compares data according to the position in which the inhalation activity occurs, and examines patterns of individual respiratory characteristics.

## 2. Material, method

Currently, we develop a corpus consisting of video, audio recordings and respiratory recordings using the Respiratory Inductance Plethysmography system (Heldner et al. 2019) at the same time. Dialogues are recorded in a studio using different speech tasks. Participants are young female speakers (aged between 18 and 24 years). All of the participants are Hungarian monolingual females with normal body mass index values, unimpaired hearing and speech disorders.

For the present pilot study, 3 dialogues were selected from the given corpus (altogether 15 minutes). The 6 participants were asked to talk about their summer holiday programs, their favorite activities during holiday etc. The members of the pairs knew each other well.

The material is annotated manually using the Praat software (Boersma & Weenink 2023): interpausal units, silent and filled pauses were labeled as well as BCRs. Furthermore, breathing cycles, inhalation and exhalation phases of both participants were also annotated.

The frequency and the types of BCRs, the occurrence of BCRs during speech or pause were analyzed as well as the occurrence of BCRs preceding turn-takings, on the one hand. On the other hand, respiratory curves of the different types of BCRs were also investigated. Additionally, comparison of respiratory characteristics of silent and speech breathing (length of inhalation and exhalation) is also demonstrated with respiration curves.

## 3. Results

Altogether 67 BCRs were found in the material. The frequency of the phenomena showed great differences in the 3 dialogues (Table 1).

| | Number of BCRs | Frequency of BCRs (items/minute) |
|---|---|---|
| Recording 1 | 22 | 7.3 |
| Recording 2 | 29 | 5.6 |
| Recording 3 | 16 | 5.3 |

*Table 1: The occurrence of backchannel responses in the recordings*

The occurrence of BCRs was analyzed regarding their appearance. The majority of the BCRs were produced by the listener during a silent pause (sp) of the current speaker (37%), 30% occurred overlapping the current speaker's speech, while 33% during pause + speech. The analysis of the types of BCRs showed that the most frequent type (42%) was the verbal category ('yes, I see'). Listeners produced nonverbal responses in 27% of the cases (it was mostly laughter). The ratio of the semi-verbal category (humming) was 21%, while the mixed type consisting of verbal and nonverbal elements as well (humming + 'yes, yes' + laughter), was the least frequent (10%).

Large individual differences were found in the frequency of BCR signals (Table 2). One listener produced only 2 BCRs in the entire 3-minute recording, while her partner produced 13 times as many. In addition to the number of items, the frequency was expressed as the number of such signals produced by the current listener during the speaker's pure speaking time (not counting pauses, only the total speaking time). This frequency, when expressed during the speaker's speaking time, also showed large individual differences in the frequency of the phenomenon.

| Recording | Speaker | Number of BCRs | Frequency of BCRs (items/min) in the speaking time of the current speaker |
|---|---|---|---|
| 1. | 1 | 5 | 4.8 |
| 1. | 2 | 17 | 13.8 |
| 2. | 3 | 27 | 15.8 |
| 2. | 4 | 2 | 0.8 |
| 3. | 5 | 8 | 12.4 |
| 3. | 6 | 8 | 4.6 |

*Table 2: The frequency of the backchannel responses*

Producing BCRs may have individual characteristics; however the occurrence of the various types may be affected by other factors like the topic and the participants' relationship. Our aim was to control for these effects by: (i) making recordings with participating subjects who knew each other well; (ii) selecting the same topic of conversation in all cases. We found that the mixed category of BCRs (nonverbal and verbal signal) occurred only in half of the subjects' speech; while semi-verbal signals were found in 83% of the participants. *Igen* 'yes' and *ja* 'yeah' were the most frequent verbal signals – they were produced by 67% of all speakers. Laughter as a BCR was produced by all the subjects, probably due to the close relationship between the subjects participating in the given dialogue.

### 3.1 Breathing pattern with examples

The duration of the inhalation and the exhalation phase is quasi equal in tidal breathing, while speech breathing cycle is characterized by a strong asymmetry with a short inhalation and a long exhalation (Figure 1). The amplitude of the inhalation is also an important parameter: speech breathing occurs with deeper inhalations than tidal breathing, with more variable amplitude values. Therefore, the slope of the breathing curve – based on RespTrack recordings – is different in speech breathing and tidal breathing. The absolute value of the curve-slope in the inhalation and exhalation phase is similar (positive value in the inhalation phase, while negative in the exhalation phase) during tidal breathing. The speech breathing is characterized by a higher slope in the inhalation phase and a lower slope in the exhalation phase. These parameters are influenced by various linguistic (length of the utterance, the syntactic boundaries etc.) and non-linguistic factors (age and vital capacity of the speaker, lung diseases, smoking habits, activity etc.; e.g., Rochet-Capellan & Fuchs 2013; Fuchs & Rochet-Capellan 2021; Serré et al. 2021).

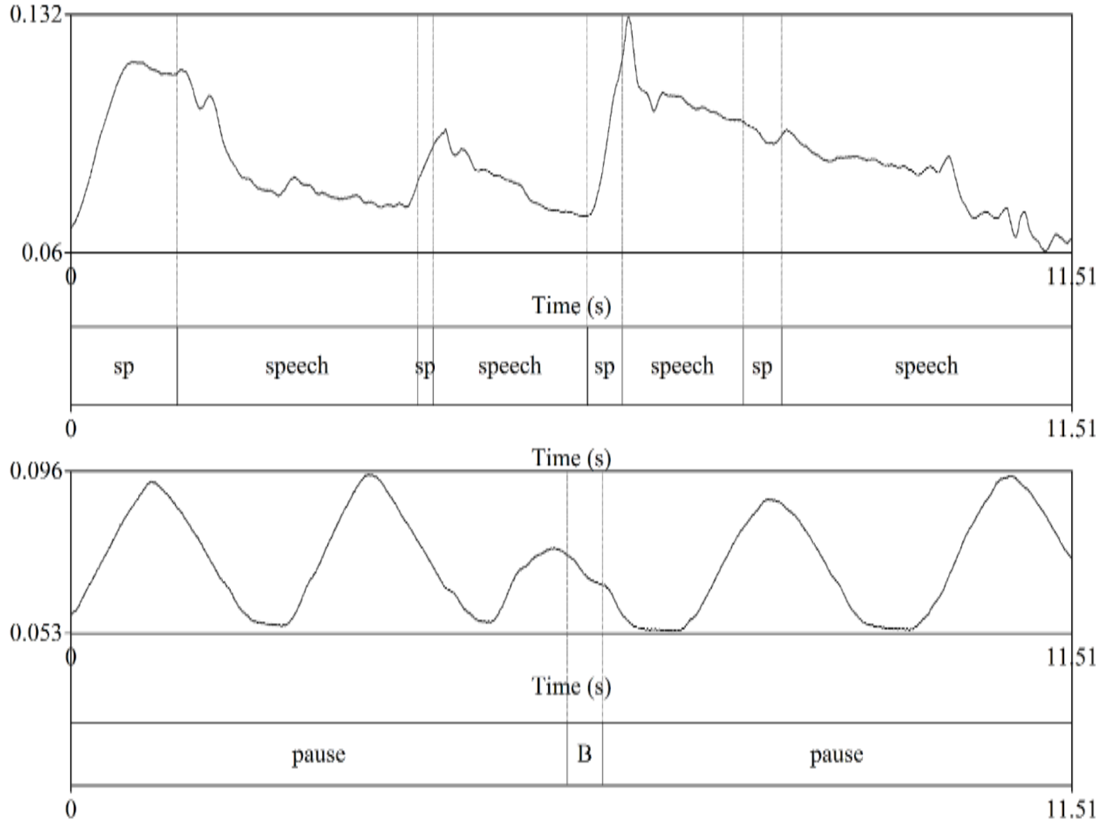


*Figure 1: Breathing curves of speech breathing (above) and tidal breathing (below)*

The breathing data of one participant illustrates the differences between the characteristics of tidal and speech breathing (Table 3).

| | Tidal breathing | Speech breathing |
|---|---|---|
| Ratio of inhalation in the breathing cycle | 35% | 16% |
| Ratio of exhalation in the breathing cycle | 65% | 84% |
| Mean duration of inhalation | 1,28 sec | 0,55 sec |
| Mean duration of exhalation | 2,48 sec | 3,26 sec |

*Table 3: Breathing parameters of a participant*

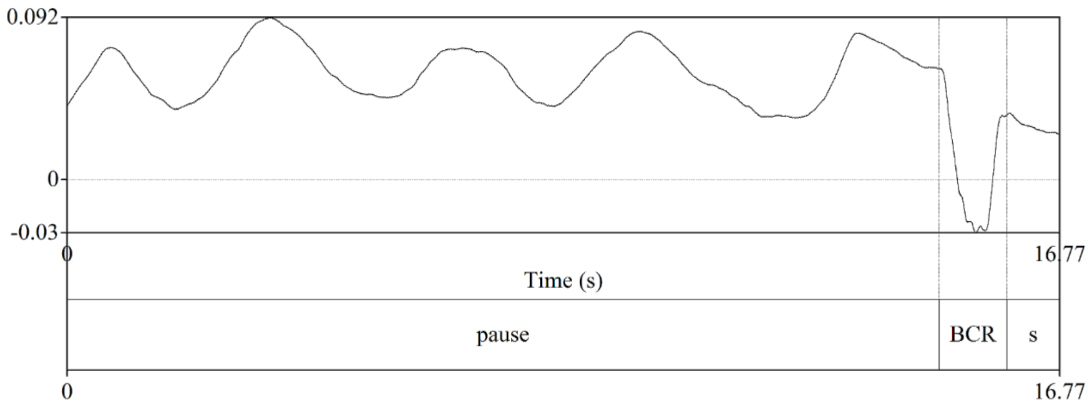


*Figure 2: Breathing curve of laughter as backchannel response (s: speech)*

The ratio of inhalation and exhalation within the breathing cycle was 1:2 in the case of tidal breathing. The ratio of the inhalation decreased, while the ratio of the exhalation increased while speaking. The mean duration of inhalation phases was 1,28 sec, while the exhalation was one second longer (2,48 sec) during tidal breathing. The difference between the duration of inhalation and exhalation increased while speaking.

Laughter has a special breathing pattern. During laughter a bigger amount of air is pressed from the lungs relatively suddenly, thus the curve-slope of both the inhalation and exhalation phase gets steeper than in tidal breathing (Figure 2).

Laughter may occur in an inhalation phase in some cases (Figure 3): the speaker needs more air to continue laughing, therefore a new inhalation phase occurs in the total duration of laughter. In addition, the degree of planning and awareness in the speech process as well as the voluntariness of the laughter may have an effect on the breathing pattern. Thus, in these cases laughter may contain an exhalation phase and an inhalation phase.

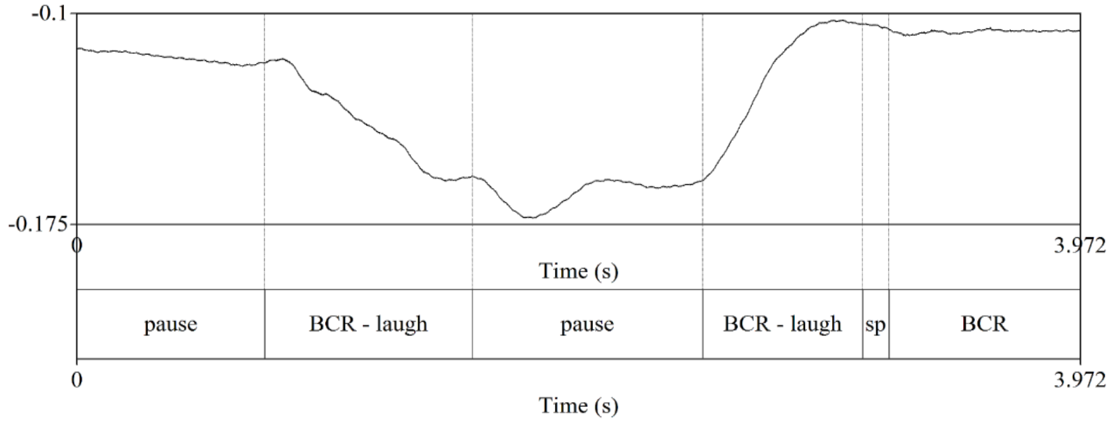


*Figure 3: Laughter as backchannel response occurring in an inhalation phase*

The BCRs (not including laughter) did not occur in a separate breathing cycle, but rather during the expiratory phase in 39% of all cases of the corpus (Figure 4). In these examples, the BCRs are short (consisting of only one speech unit), so their production did not require additional air, the amount of air present in the lungs being sufficient to produce the utterances. However, the slope of the exhalation phase curve is reduced. These examples show that the breathing pattern of BCRs may differ from both the breathing pattern during verbal speech production and the tidal breathing pattern.

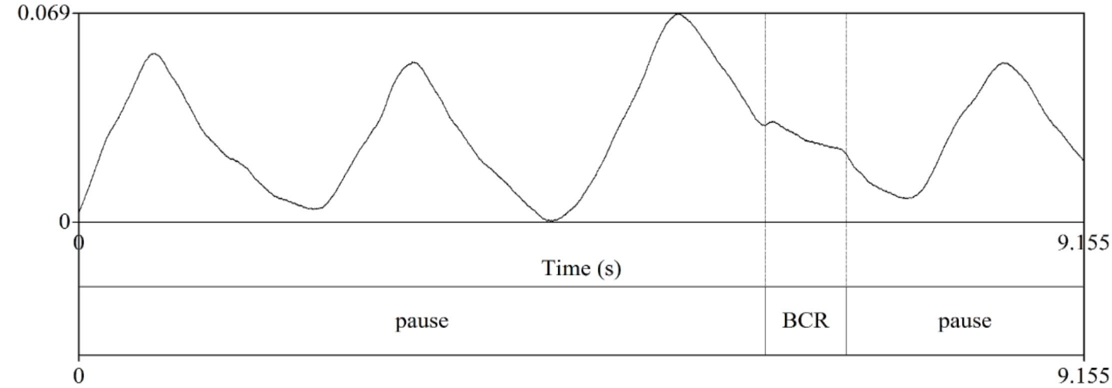


*Figure 4: Backchannel response in the exhalation phase of tidal breathing*

Considerable individual differences between speakers were observed even in the case of this relatively small group of respondents. In some cases, it was observed that the amount of air available in the lungs was not sufficient to implement BCRs (Figure 5). In this case, the speakers used (almost) their full lung capacity, so that the breathing curve took on a value lower than the minimum breathing value before the production started. The lungs are usually not completely empty, so a value of 0 is a relative starting point taken before inhalation.

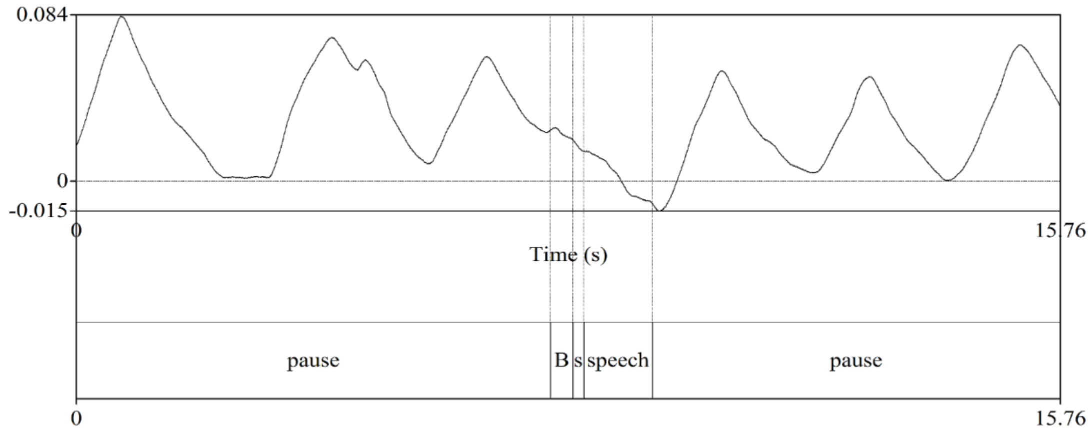


*Figure 5: Expending the expiratory reserve volume by backchannel response (B: backchannel response, s: silent pause)*

The BCRs can occur not only in the exhalation phase (Figures 4, 5), but less frequently in the inhalation phase as well. In this case, the speaker typically does not continue the inhalation, but only uses the available air for speech production (see Figure 6 for an example). As a result, the amplitude of the breathing curve will be lower than the values measured during the quiet breathing and the breathing cycle will be shorter (because less air is consumed in a shorter time).

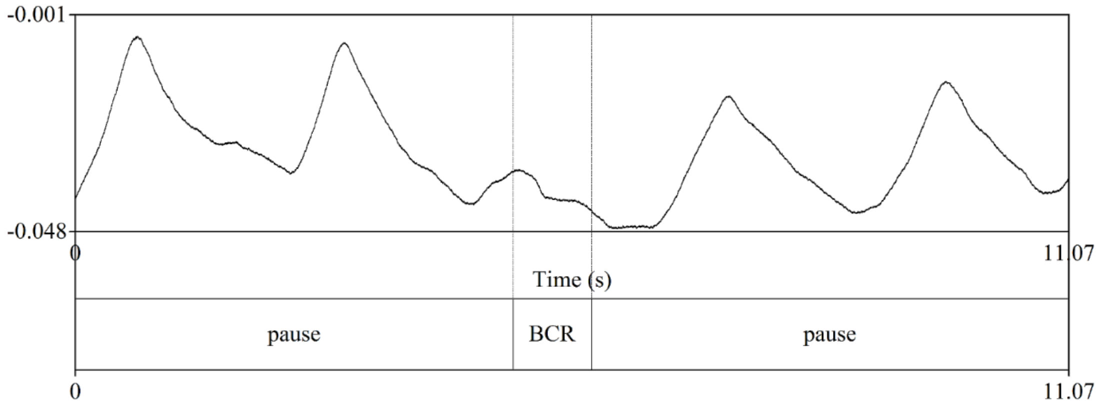


*Figure 6: Breaking the inhalation phase of the tidal breathing by a backchannel response*

The position of BCRs in relation to turns was analyzed. In 10% of the material, occurrences before turn responses were reported. Although by definition BCRs are not intended to take the turn, it is questionable whether they can be considered functionally as BCRs, although they behave formally as such. For example: 'yes (silent pause) and it happened first…'; 'of course (silent pause) and the beginning of September'. In these examples, speakers take the word to express agreement (e.g., 'yes', 'of course') and then they detail their opinions on the topic. The breathing pattern occurred in two forms: in nearly half of the cases, the backchannel response was achieved in the quiet breath, followed by a larger inhalation (Figure 7). In the other half, the inhalation occurred before the BCR; presumably these are more planned turn-taking actions (Figure 8).

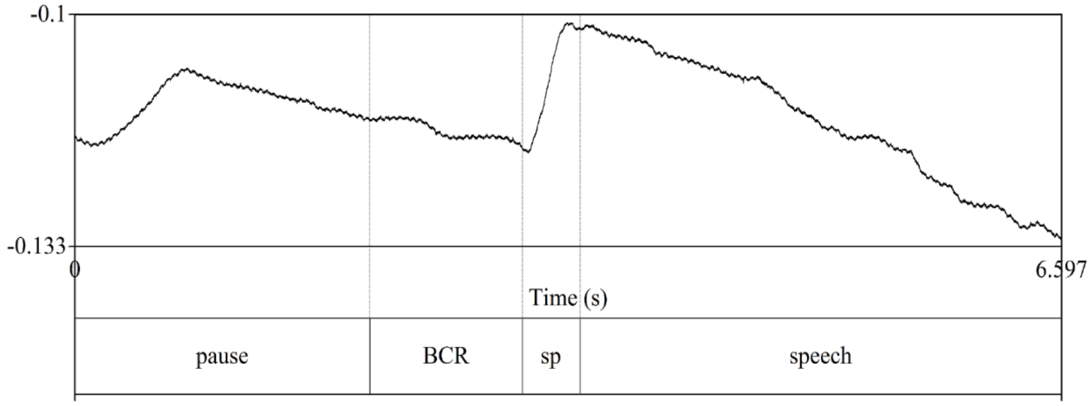


*Figure 7: Backchannel response before turn-taking (the BCR occurs in exhalation phase of the tidal breathing)*

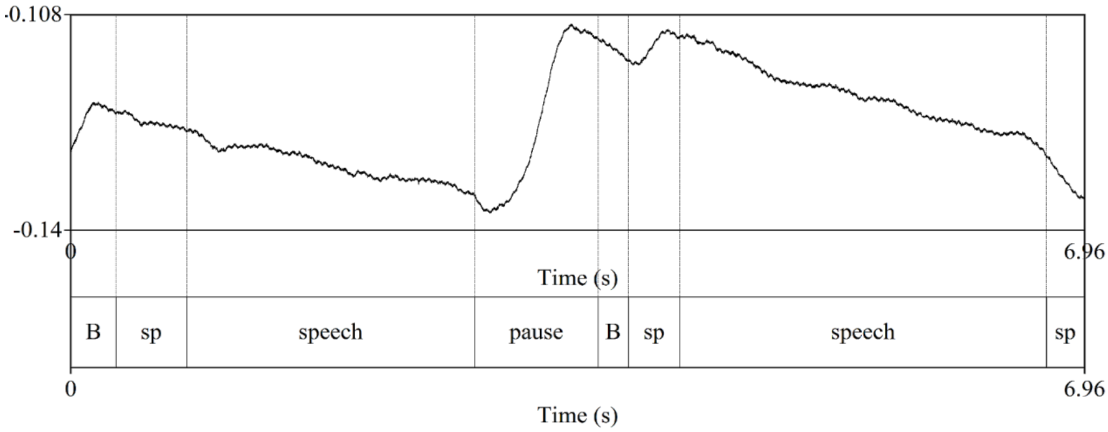


*Figure 8: Backchannel response before turn-taking (a greater inhalation before the BCR)*

## 4. Conclusions

The aim of the pilot study was to analyze the connection between producing BCRs and breathing in conversations, based on recordings conducted with the RespTrack system, firstly in Hungarian.

Results showed that these responses were verbal expressions in almost half of the cases (*igen* 'yes', *ja* 'yeah', *persze* 'of course' etc.). Conversation partners produced them during the speaker's silent pause in 37% of the cases. Two respiratory patterns were found to be the most typical in the sample examined: in the first case, the BCRs occurred during the exhalation phase of the silent breathing cycle, without a separate breathing cycle, even without another immediate inhalation, using the remaining available air in the lungs; in the other case, BCRs were achieved with a separate breathing cycle, in which case the amplitude of the breathing curves is smaller and the period shorter than in speech breathing.

Laughter as a nonverbal backchannel signal has specific respiratory characteristics: during laughter a bigger amount of air is pressed from the lungs relatively suddenly, thus both the curve-slope of the inhalation and exhalation phase get steeper, and the minimum value of the curve gets lower than in the case of quiet breathing. In addition, laughter may be produced during inhalation if the listener run out of air and needs a new inhalation to continue laughing.

The 10% of the BCRs were followed by a turn-taking. In some cases, the listener took a deep breath even before producing a backchannel response, probably due to the intention of speaking / being the next speaker. The systematic analysis of breathing patterns in these cases, may result in new information on the possible connection of backchannelling behavior and the intention of speaking as well as the signs of unsuccessful turn-takings.

The results of this study might add a new perspective on the previous definition of the BCRs regarding their role in the organization of the structure of the conversation. BCRs may mark the listener's intention of taking the floor in some cases, and this intention manifests in breathing patterns, e.g., when the listener produces a deep inhalation right before the BCR. Additionally, our data provide new information on the relationship between speech and respiratory planning, and also help to examine the specificities of smooth and rapid turn-takings.

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