

Segmenting Phonetic Units in Laughter

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Abstract

Laughter as an every-day, human-specific, affective, non-verbal vocalisation has attracted researchers from many disciplines. One consequence of the multi-disciplinarity is that the way of segmenting the acoustic signal of laughter as well as the terminology are used in a heterogeneous and partially contradictory way. This study tries to analyse the terminological variety from a phonetic perspective. A short overview on various types of laughter indicates that further concepts for description are needed. In a pilot study with a small corpus of spontaneous laughter the usefulness of the concepts and terms in practice is examined. This analysis revealed that the laughter events are much more complex than implied by an idealised segmentation and most of the existing descriptions of laughter types. More data, clear concepts and more knowledge about the production and acoustics of laughter are necessary to provide phonetically adequate descriptions of the large repertoire of laughter variants.

1. Introduction

Although laughter is one of the most important universal non-verbal vocalisations there are only few investigations of the phonetic structure of laughter. Since researchers from many disciplines have worked in the field, the terminology is heterogeneous and sometimes confusing. The missing common inventory for describing phonetic events makes data comparisons difficult and prevents the development of theories about the acoustic as well as the physiological and perceptual nature of laughter. In section 2 we shall present various segmentation units proposed in the literature, seen from a phonetician's perspective. The variety of forms of laughter requires a look at existing classification schemes (section 3). In a pilot study based on a small corpus of spontaneous laughs the usability of the descriptive instruments is tested (section 4).

2. Segmenting a "Typical" Laugh

When people are asked to imagine a typical laugh, it is assumed that most of them think of a laugh that expresses joy and mirth. Examining the acoustic phonetic structure of such a "typical" laugh reveals an alternating voiced-voiceless pattern resembling a consonant-vowel syllable structure. This is reflected in the orthographic realisations of laughter in various languages, such as "haha" (e.g. in

German and English), "ahah" (e.g. in French and Italian) or "xaxa" (e.g. in Russian).

One approach to segment a laugh signal is to consider laughter as articulated speech. At the low level there are sound segments that are either vowels or consonants. At the next higher level, there are syllables consisting of sound segments. The next higher level deals with larger units such as phrases which are made up by several syllables.

A look at the literature dealing with acoustic descriptions of laughter reveal a confusion in terminology. Terms are either not clearly defined, or they are used in different ways in different studies, or phonetic terms are used with different meanings. The following subsections attempt to assign the various terms in the literature to the proposed three-level distinction (schematically displayed in Fig. 1).

2.1. The segmental level

Depending on the study, the vocalic segment is named differently: "vocal peak" [13], "laugh pulse" [20], "note" [16], "laugh burst" [11], "call" [1], or "syllabic vocalization" [12]. In contrast to phonetic terminology, "syllable" [16] or even "plosive" [19] are used, while also "vowel" in its phonetic meaning occurs [1,3,7].

The consonantal segment is often seen as "interval" or "pause" rather than as an aspiratory phase. So, in [1] it is referred to as an "intercall interval", and in [20] as an "inter-pulse pause". Provine [16] notes that the vowel-like segment is "preceded and followed by a breathy aspiration", but nevertheless he gives the consonantal segment the name "interval".

In most studies the vowel-consonant alternations seem to be considered as sound-pause alternations, i.e. not viewed as segment-segment patterns but as segment-pause patterns. If the term "segment" is used, e.g. in [1], its meaning seems to differ from the common usage in the phonetic literature.

2.2. The syllable level

If we assume a syllabic level, with the vocalic segment as the syllable nucleus (no matter whether CV or VC as underlying structure), then several terms are in use to denote this joint CV unit. The syllabic unit in laughter is referred to as "interpulse interval" [20], "laugh event" [13] or "call" [1], but also as "laugh syllable" [2].

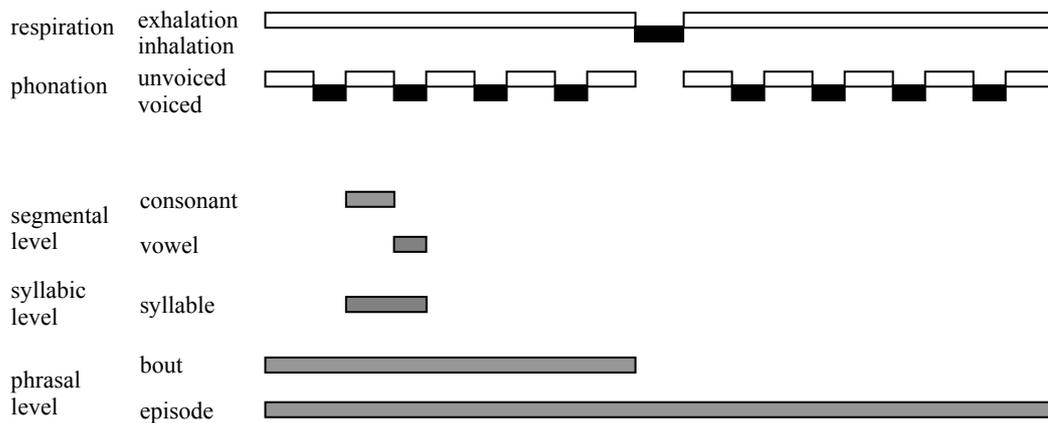


Fig 1: Schematic graph of the time course of a laughter. Top section: phases of respiration and phonation. Bottom section: examples for proposed segmentation units in a three-level distinction. Note that the role of inhalation phase is unclear.

Unfortunately, the syllable nucleus and the syllable itself often seem to be used synonymously, e.g. [17], whereas in [12] the term "syllabic vocalization" precisely stresses the role of the vowel as syllable nucleus. A distinction between nucleus and entire syllable is irrelevant to the number of "syllables", but it is relevant to the consideration of the ratio of the segment durations within the syllable. With respect to the temporal distribution of the vocalic and the consonantal segment in one syllable it is worth mentioning that the aspiration phase is markedly *longer* than the vowel (see e.g. [2,20], but see also [1]), i.e. inversely to the relationship usually found in speech.

2.3. The phrasal level

The term "bout" is used in different places [1,6,20] as a sequence of laughter syllables in one exhalation phase. An entire laugh can consist of several "bouts" separated by inhalation. The whole laugh is then called an "episode" [6,16,20]. Other words used are "laugh response" [11] or "laughing sound" [19]. While the role of the inhalation phases is determined as separator of different "bouts", it remains unclear whether this inhalation is part of the "bouts", and if so, part of which "bout". This issue is not just a theoretical problem because the perceptual role of the vocalised inhalation phase is often ignored (except, e.g. [12]). The resulting reverse phonation is often strongly marked by a distinct increase in F0 and intensity as was also shown for speech [18].

2.4. Start and end of a laugh

Little is said in the literature about where and when a laugh exactly starts and ends. Some studies use visual information in addition to the audible signal to determine start and end of a laugh [6,13]. Analysing just the acoustic channel, however, does usually not cause noticeable problems in determining the onset and offset of the research object. In [16] a "laugh episode" was considered as terminated after an *estimated* one second without further laughter. In [13] only those laughs were analysed that were sandwiched with silence (2 sec) and without overlapping acoustic events. In [1], terminal exhalation and inhalation events do usually not belong to the laugh.

3. Types of Laughter

Even if a "typical" laugh existed, it is commonly accepted that there is more than just one form of laughter. Evidence for a variety of laugh forms and against the theory that laughter is a stereotyped signal is provided by the large-scale study by Bachorowski and co-workers [1]. Their results show that only 30% of all analysed laughs are predominantly voiced (in their vocalic portions), and that about half of the laughs are unvoiced (the remaining 22% are mixed). Possibly, the description of a "typical" laugh is only partially applicable to other types of laughter. For this reason the variety of laugh qualities requires a closer look at the classification.

3.1. Spontaneous forms of laughter

For spontaneous and emotional forms of laughter, different ways of classification have been proposed. In [1] the laughter events are categorised in three basic types: voiced "song-like" laughter, "snort-like" laughter with perceptually salient nasal-cavity turbulence, and unvoiced "grunt-like" laughter with friction in laryngeal and oral cavities.

The presence of voice is the distinctive criterion used in [6] leading to "vocalized" and "non-vocalized" laughter. In [13], basic laughter types are mainly classified according to the number of laugh syllables: comment laugh (1 syllable), chuckle (2), rhythmical (3 and more), and squeal (very high pitched).

Poyatos [15] suggests a detailed record of the auditory impression of laughter quality (comparable to a narrow phonetic transcription of speech articulation). Laughter perception studies e.g. [7,9] use adjectives which express an estimated emotional content, such as joyful or cynical.

Normally, lexical denotations are used for laughter, often onomatopoeic words. For English, the following words are listed in [5]: laugh, giggle, cackle, guffaw, chuckle, chortle, guffaw, snicker, choke, titter, bray, howl, horselaugh, mock, groan, bellow, hoot, bleat, and neigh.

With respect to the classification of realisations of laughter by acoustic properties, not all studies agree in their findings regarding parameters related to F0, glottal excitation characteristics, vowel quality, intensity, and duration. One reason for this can be found in the lack of common definitions of units and types of laughter.

3.2. Special forms of laughter

Of course laughter can be generated deliberately, and there is no clear cut border between spontaneous and voluntary laughter. The latter include faked laughter as well as polite laughs similar to polite smiles. A special type of laughter consists in those forms due to extrinsic physiological stimulation such as tickling or laugh gas. Laughter can occur in a spoken form (as such often in an ironic sense), or it has to be sung (cf. [17]).

Although these forms of laughter can be seen as special from different perspectives they all share a comparable acoustic structure. This is not the case with the next two forms of laughter.

3.3. Speech-synchronous forms of laughter

A *speech-laugh* is a form of laughter which occurs simultaneously with articulation. There are only few studies investigating acoustic aspects of speech-synchronous laughs [14,23]. Characteristic for speech-laugh is a reinforced respiratory activity which is reflected by breathiness in the voiced portions and stronger aspiration in the unvoiced portions. Occasionally, a tremor occurs in the voiced parts. In any case, the articulatory configuration is maintained while the characteristic laugh elements are "nested" in the segmental structure. Thus, speech-laugh is not just laughter forms superimposed on articulation, although genuine laughter sometimes follows the articulation. Speech-laugh seems to represent an own category of non-verbal vocalisation.

Another speech-synchronous form of laughter in a wider sense is *smiled speech*. Smiling itself is primarily marked visually, and secondarily marked acoustically when articulation or another mode of vocalisation takes place. There are several studies showing evidence that smiled speech can be distinguished significantly from non-smiled speech by listening only [22]. Furthermore, there is evidence that a mechanical, unfeared smile is perceptually distinct from a felt smile [21].

Since Darwin [4], there is a discussion whether smiling and laughing are extremes of the same continuum. Both, smiled speech and speech-laugh are speech-synchronous, and mild and therefore underestimated forms of expressive speech. However, for listeners the difference between these "laughter-like" forms seem to be a *categorical* rather than a continuous one [23].

4. Pilot Study

The goal of this pilot study was to test the usefulness of the above listed inventory of terms in practice with "real world" data. Useful data must meet some requirements with respect to spontaneity, non-overlapping acoustic channel, involvement with speech, and this ideally in a dialogue.

4.1. Eliciting laughter

Eliciting *spontaneous* laughter on purpose, possibly combined with speech, does not seem to be a prospectuous enterprise as other authors already noted [17]. Here, it seems more promising to use the "garbage" of recordings made for purposes other than laughter, where spontaneous behaviour occurs as by-product. This can, for example, be done by using labelled databases of spontaneous conversations [23], or data collections for study of speech errors [2]. Other studies investigated laughter of people as actors, e.g. [3,7,9], spectators of funny video movies, e.g. [1,10,11,19], mothers in parent-child interaction [13,14] or babies in a similar situation [12]. The data in [16] were collected in public "areas where laughter was likely", whereas in [6] "strangers meet situations" in a closed room were recorded.

4.2. Material and method

The recordings used here were originally intended to gain material for German speech synthesis. In five hours of recorded material many instances of spontaneous laughter of a female speaker in various situations were found, e.g. when she produced slips of the tongue or when she was amused about typos or was in casual discussion with one of the two experimenters (one is the author).

4.3. Results

The most obvious result is that in the small corpus of investigation laughter appears in much more complex manifestations than expected. Isolated and clearly discrete forms, as implied in the literature, occur rarely. It is rather a mix of laughter interspersed with speech-laugh and smiled speech. The laughter events are often separated by short silent pauses of about 300 ms making them either one complex laugh or two consecutive laughs of different quality. Furthermore, there are several instances of laughing starting with a strong non-articulated exhalation. Similarly, laughter frequently terminates with strong, voiced, high-pitched inhalations which are either completely oral or first oral, then nasal. The inhalation sometimes first oral but finishes nasal. All phenomena at onset and offset of the laugh contribute to the impression of laughter and are surely a consequence of the very intense expellation of air during the laughter exhalation phase.

4.4. Summary and discussion

Laughing in a social context reveals not only a large repertoire of laughter types [1], but laughed communication is a complex mix of genuine laughter, speech-laugh and smiled speech. The descriptive instruments for an isolated "typical" laugh (section 2) are only of limited use as long as the definitions of laughter sections and laughter types are missing or unclear. Although this study is not representative (laboratory situation, only one subject) it shows that more data and more detailed concepts are necessary to provide phonetically adequate descriptions of the large repertoire of laughter variants.

5. Summary

Laughter is a research subject for many disciplines including primatology and behavioural research [4,7,16], inter-cultural studies [5,9,19], medicine [3,19], speech technology [2], forensic phonetics [8], developmental psychology [10,13,14], and particularly emotion research [1]. Phonetics can contribute to the research of this universal human peculiarity of every-day communication. Providing more precise terms for laughter description is a first step towards this end.

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