Exploring sequences of speech and laughter activity using visualisations of conversations

Jürgen Trouvain[1]*, Khiet P. Truong*[2]

[1]Phonetics, Saarland University, Saarbrücken, Germany
[2]Human Media Interaction, University of Twente, Enschede, The Netherlands
trouvain@coli.uni-saarland.de, k.p.truong@utwente.nl

Abstract

In this study, we analysed laughter in dyadic conversational interaction. We attempted to categorise patterns of speaking and laughing activity in conversation in order to gain more insight into how speaking and laughing are timed and related to each other. Special attention was paid to a particular sequencing of speech and laughter activity that is intended to invite an interlocutor to laugh (i.e. 'invitation-acceptance' scheme): the speaker invites the listener to laugh by producing a laugh after his/her own utterance, indicating that it is appropriate to laugh. We explored these kinds of sequences through visualisations of speech and laughter activity in conversations. Based on manual transcriptions of the HCRC Map Task corpus, we generated visualisations of speech and laughter activity. Using these visualisations, we found that people indeed show a tendency to adhere to the 'invitation-acceptance' scheme and that people tend to 'wait' to be invited to a shared laughter event rather than to 'anticipate' it. These speech-and-laugh-activity plots have shown to be helpful in analysing the interplay between laughing and speaking in conversation and can be used as a tool to enhance the researcher's intuition on underresearched fields.
Index Terms: laughter, conversation, speaker overlap

1. Introduction

Laughter as a vocal signal in human communication can be considered from different perspectives. Laughter can be used to express affect and, at the same time, can be used to help to setting up and regulating social relationships, usually in spoken interaction. The research questions of observing laughing in *spoken* interaction are manyfold. How is laughing connected to articulating of speech within the same speaker? In which parts of conversations do laughs occur? What possible functions does laughter have in conversation? How does the laugh of one conversational partner interact with the laugh and the speech of the other?

One way to gain more insights into how laughter is used in conversation by interlocutors is to study the timing of the conversation partners' laughing and speaking activities. To that end, we create visualisations of the temporal flow of the conversation partners' speaking and laughing activities. In this study, we will use these visualisations as a tool for exploring sequences of speech and laughter activity in spoken interaction, thereby considering laughter as an affective and social signal.

Many studies on laughter focus on laughter as an affective signal rather than as a high-frequent vocalisation in conversations. Those studies are usually performed with data recorded under lab conditions in non-communicative situations: for example, laughter that is elicited through external media [1] or laughter that is produced in a few emotion categories by actors [2, 3, 4].

Laughter is also considered a *social signal*. Laughter as a feature of social bonding leads to the assumption that when laughter appears in social interaction it is performed by both interlocutors [5, 6]. When laughter is not performed by both interlocutors, this can sometimes be seen as a signal of disaffiliation. In some situations, laughing can be the norm and when one does not laugh, this person can be seen as the 'odd one out' [7].

Social and affective signals such as laughter are prevalent in social situations such as in dyadic or multi-party conversations, and hence, the data we use to study laughter consists of spoken conversations. Considering laughter in *spoken interaction* goes beyond watching funny video clips or asking actors to portray types of laughter. Studying laughter in interaction entails studying conversations such as opposite-sex encounters of previously unknown persons [8] or every-day conversations of friends [9]. A crucial feature of spoken interaction is the occurrence of joint activity at various linguistic and phonetic levels that requires fine-tuned coordination. These phenomena of joint activity and coordination are, among other events, exemplified through the timing of laughter, and in particularly, the timing of shared laughter during conversation.

Studying the interaction between the timing of laughter and speech activity may help contribute to gaining insights into how people use laughter in conversation. For example, when the listener is producing a short laugh while the speaker is speaking and continues to speak after the short laugh, this laugh probably signals some sort of positive acknowledgement or a display of hearership, similar to how backchannels behave. Another laughter-speech sequencing that has been described in the literature is the so-called invitation-acceptance sequence, introduced by Jefferson [10] that describes that the speaker invites recipients to laugh by first laughing him/herself.

In this study, we look at speaking and laughing activities in conversation in order to explore how these are timed with respect to each other. We attempt to find categories of laughter on the phonetic grounds of interactional timing where we (among others) quantify categories such as the 'invitation-acceptance sequence'. We explore these timings and sequences by looking at visualisations of conversations that give quick overviews of speaking and laughing activity of each interlocutor in conversation. These visualisations will help us to categorise this invitation-acceptance sequence but also to reveal other speech and laughter activity patterns and sequences.

This paper is organised as follows: In section 2 we describe the conversational data used and the way the visualisations of the speech and laugh activities in the annotated con-

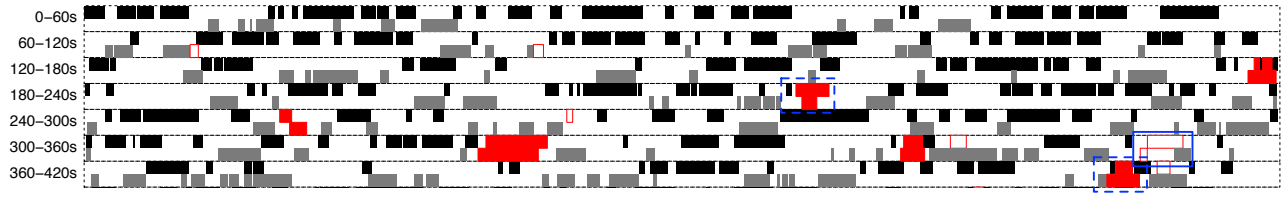


Figure 1: *Speech and laugh activity of the first seven minutes of the dialogue* `q1nc2` *from the Map Task corpus: Overlapping laughs (filled red bars), non-overlapping laughs (empty red bars) and speech (filled dark bars: Instructor with black, receiver with grey). Blue rectangle with solid border marks an example of a clear laughter pair in which the laughs do not overlap. Blue rectangles with dashed borders mark examples of Jefferson's invitation-acceptance laughter pairs.*

versations were generated. After this methodological part, a short overview on overlapping vocalisations, be it speech or be it laughter, is followed. Section 4 contains analytical work based on these visualisations, which will be discussed in the last section.

2. Data and visualisation

As speech material, we used cooperative dyadic interactions from the HCRC Map Task Corpus [11]. In "map task" conversations, a given route along various landmarks on an invented map must be explained by one of the two interlocutors, the instruction giver, to the other, the follower. Using the time-aligned speech transcriptions provided with the corpus, we made visualisations of speech and laughter activity of each interaction, comparable to the speech activity plots by Campbell [12]. Not only the timing but also the duration of speaking and laughing is made visible. These visualisations are expected to provide us with insights into how patterns of speech and laughter relate to each other.

In total, 96 conversations containing laughter from the HCRC Map Task conversations were used. The conversations consisted of face-to-face (n=44) and non-face-to-face (n=52) interactions. In addition, some of the conversations take place between speakers who are familiar with each other (n=52) and speakers who do not know each other (n=44) (note that it is not necessarily the case that the 44 face-to-face conversations are the same 44 conversations with unfamiliar speakers). There are a total of 966 laughs annotated in this set of conversations of which 352 are overlapping (OL) and 614 are not overlapping (NOL).

3. Overlapping vocalisations

In conversations, the paradigm of "one speaker at a time" seems valid. For instance in a larger cross-linguistic study Stivers et al. [13] showed "that all of the languages tested provide clear evidence for a general avoidance of overlapping talk". However, despite this general tendeny to avoid overlapping talk, it could be observed that conversational speech displayed a substantial amount of overlapping vocalisation, mainly known as 'cross-talk', e.g. [12, 14]. A specific type of vocalisation in particular, namely laughter, has a tendency to overlap with laughter from other conversational partners as could be shown by Laskowski and Burger [15, 16], Smoski and Bachorowski [6], and also by Truong and Trouvain [17].

Laughter seems to represent an optimal opportunity for joint vocalization, and more specifically for partner-specific adaptation in *timing*. Such a temporal alignment can sometimes also be observed in spontaneous speech where we can find collaborative completions [18] as continuations of the conversational partner with matching prosodic features. This type of emergent coordination is probably less often observed than planned vocal coordination in choir singing, ritualized community talking in church (e.g. common praying) and experiments with synchronous reading [19]. Fig. 1 visualises the laugh activity of two conversation partners in one of the map task conversations and gives an example of the close temporal vicinity of laughs in conversations which often lead to partial overlap of laughs.

The partner-specific adaptation of speaker-overlapping laughing not only concerns the timing of both vocalisers but also their phonetic-prosodic behaviour. Thus, laughter also seems to represent a good candidate for phonetic imitation when both interlocutors are laughing synchronously. In two recent studies [20, 17] we could show for various corpora of conversational speech that overlapping laughs are stronger prosodically marked than non-overlapping ones, in terms of higher values for duration, mean F0, mean and maximum intensity, and the amount of voicing. This effect is intensified by the number of people joining in the laughter event. We also found that group size affects the amount of overlapping laughs which illustrates the contagious nature of laughter and which could be interpreted as entrainment at group level.

4. Speech and laugh activities

4.1. Invitation-acceptance

One of the presumed various roles that laughter can play in interaction is that of inviting the conversational partner to laugh as described by Jefferson [21, 10]. Jefferson describes this invitation process as an 'invitation-acceptance' scheme. Laughter can be invited by a speaker in a particular way, i.e. a particular sequencing of speech and laughter activity. She describes that laughter can be invited by 'a post-utterance completion laugh particle by that utterance's speaker' – this invitation will be examined by the recipient for acceptance or declination. In other words, the listener is invited to laugh in reference to the speaker's utterance when the speaker him/herself indicates that laughter is appopriate by producing the first laugh him/herself following his/her own utterance [10], see Fig. 2. Jefferson does not specify whether the laughs should be overlapping – we presume that in most of the cases of the invitation-acceptance scheme, the laughs do overlap. However, it is possible to have clear laughter pairs in which the laughs do not overlap, compare for instance the sequence of laughs at 350 secs of the dialogue illustrated in Fig. 1 (marked with blue rectangles with solid borders). In addition it is not clear whether the acceptance of the invitation is generally connected with a taking of

the ‘turn’, leading to a change of the speakership.

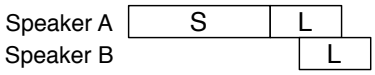


Figure 2: *Invitation-acceptance scheme (S=speech, L=laugh). In this example, the recipient has accepted the invitation.*

Although this type of overlapping laughter was observed in conversational data it is unclear how often this occurs there [10]. Visualising the speech and laugh activity of conversational partners may help to provide insights into the occurrence of this specific invitation-acceptance scheme.

Speech-and-laugh-activity plots such as the one in Fig. 1 allow an analysis of certain types of overlapping laughs such as the invitation-acceptance scheme. There it can be seen at a glance that among the six overlapping laughs only two follow the invitation-acceptance scheme in that the speaker starts laughing with a joining in of the hearer: One at around 210 sec, the other at around 400 sec (marked with blue rectangles with dashed borders). The remaining four overlapping laughs are all initiated by the conversational partner in the listener role.

We looked at all visualisations of speech and laugh activity in the HCRC Map Task corpus and counted all laughs that fit the invitation-acceptance scheme as depicted in Fig. 2. Table 1 shows that 16.1% of all laughs can be attributed to the invitation-acceptance scheme. What is striking is that recipient acceptance occurs almost twice as less frequently when the hearer rather than the speaker initiates the laugh (“anticipated invitation”, 8.7%). Following Jefferson’s intuition, it seems that people are more likely to accept an invitation to laugh when the speaker him/herself indicates that laughing is appropriate by initiating a laugh. We also note that we observed cases in which nearly overlapping laughs behaved like overlapping laughs (OLs), and which we treated as potential invitation-acceptance pairs.

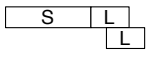
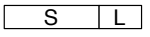
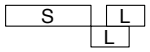
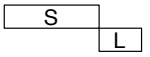
Type	OL	Type	NOL
	16.1%		24.2%
	8.7%		26.6%
‘unsure’	3.9%	‘unsure’	3.3%
‘no speech before’	2.4%	‘no speech before’	5.8%
‘complex’	7.5%	‘complex’	1.5
total	38.6%	total	61.4%

Table 1: *Frequency of speech-laugh patterns observed in the HCRC Map Task corpus (shown in percentages of the total number of laughs). OL= overlapping laugh, NOL= non-overlapping laugh, S=speech, L=laugh.*

4.2. Other observations

As can be seen in Table 1, we also observed other speech-laughter patterns. The majority of all laughs were not overlapping (61.4%). We observed a remarkably high number of non-overlapping laughs that would fit a backchannel-like role for laughter. A considerable amount of the pattern ‘speech of speaker A is followed by laugh of speaker B’ (14.7% of all laughs) were made in a situation where the current speaker speaks and continues speaking while the hearer produces a laugh.

It is also worthwhile to note that there is a large percentage of laughs, 13.8% of the OLs and 10.6% of the NOLs (third row in Table 1), that is unaccounted for. For the OLs, we took a closer look at these cases. About some of the cases we were ‘unsure’ about whether the sequence would fit a pattern and some cases were marked as ‘complex’, meaning that there are multiple laughs occurring at the same with silence or speech interspersed, see also section 4.3. For most of these unaccounted OL cases, these were ‘complex’ laughs of which an example is shown in Fig. 3. These type of events do not fit a scheme or pattern, should be treated separately, and require closer analysis.

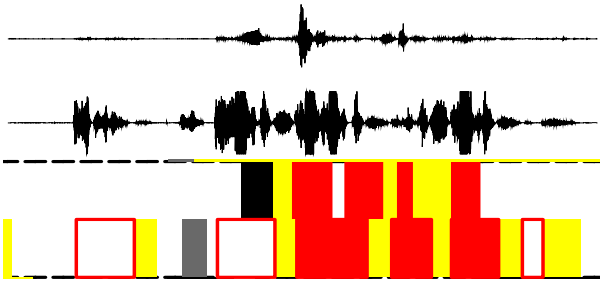


Figure 3: *Example of a complex laughter event at around 189s in conversation* `q2ec4`*. Top: waveforms of both speakers, bottom: annotations of speech (black and grey), laughter (OL=filled red, NOL=empty red), and breathing noises (yellow).*

4.3. Complexity of interaction in overlapping laughs

As observed in Table 1, there are some OLs that do not fit one of our predefined types of speech-laughter sequences and that are complex in their interactivity and require a closer look and analysis. An example of such a complex OL is shown in Fig. 3 at around 189s in the conversation. The complexity arises from the observation that there are multiple single laughs next to each other, either overlapping or non-overlapping each other, and which are interspersed with short segments of speech. There is also a labelling issue involved as the single laughs are interrupted by `<inbreath>` and `<outbreath>` labels (yellow bars in Fig. 3). On theoretical grounds, these breath sounds should have actually been labelled as part of the laugh but instead, were labelled as separate categories in the corpus.

There is also variation in the complexity. The OL in Figure 5 for instance can be seen as a cluster of various elements such as articulated speech, laughing with preceding and/or following audible breathing and acoustic pauses. In the mechanistic view of the proposed patterns from Table 1 this *one* laughing event consists of three NOLs (empty red bars), plus two OLs (filled bars) for each speaker.

Both examples make clear that the proposed patterns how speech and laugh interact across conversational partners are too simplistic but also that a more detailed explanation of such a complex social vocal interaction requires theoretically founded annotations of laughing and other non-verbal vocalisations such as breathing noises.

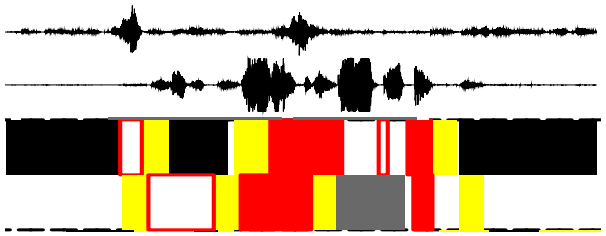


Figure 4: *Example of a complex laughter event at around 468s in* `q2ec4` *(different from that one in Fig. 3). Top: waveforms of both speakers, bottom: annotations of speech (black and grey), laughter (OL=filled red, NOL=empty red), and breathing noises (yellow).*

5. Discussion and conclusion

By checking how often the "invitation-acceptance" sequence with laughter of both interlocutors occurs we wished to gain some insight into how relevant this observed pattern of laughing together might be. On the one hand only 16% of all laughs work with this pattern and even fewer involve a change of the speakership. On the other hand one half of all *overlapping* laughs follow the pattern of invitation by the speaker followed by the acceptance of the listener. Obviously people show a tendency to "wait" to be invited to a shared laugh rather than anticipating an overlapping laugh. This result could be seen as a type of convention – similar to the widespread convention that somebody entering a room greets first which will be answered by the person/s already in the room.

There is also a tendency to avoid complex laugh-speak-overlaps. This might be due to a reduced quality in the acoustic transmission during overlapping laughs, the content of speech would simply not be understood.

The single conversations in the observed data sometimes differ very much regarding the number of laughs in general and the balance between OL and NOL. However, the majority of laughs were non-overlapping laughs, i.e. forms of laughs which could be analysed as *comments*. It is interesting to see that laughing comments of the listener occur about as often as "self-comments" of the speaker. Future studies must show how this comment function can be interpreted in more detail, e.g. as a rejected invitation or as qualitative feedback of the listener. Those interpretations would require to refer to the content of the conversation including interpretations of stance and attitude of the speakers – matters which are notoriously difficult to grasp. One benefit could be the analysis of dialogue acts and "moves" which were also annotated in this corpus.

Further future studies could investigate the differences between groups in given conversational data such as face-to-face vs. non-face-to-face interactions or familiar vs. non-familiar speakers (see section 2). Another fruitful task would be to study laughter as a feedback signal such as a backchannel utterance. So far it is unclear how the use of laughter with a feedback function differs from other types of feedback and how this feedback laugh differs from laughs with other functions.

Although the presented data confirms the fact that laughter is a *social* signal it remains unclear how much the laughter found in our data also signals *affect*. Real outbursts of laughs were sometimes observable in overlapping laughs but those were a minority. Although this question must remain unanswered it becomes clear that conversations like those in map task corpora do show only few laughs comparable to the prototypical affect burst-laughs produced by actors in laboratory studies such as [2, 3, 4].

We have refined the speech-activity plots of Campbell [12] to speech-and-laugh-activity plots to show the interplay of laughing and speaking in conversations. On the one hand we hope that these kinds of illustrations can function as an "eye-opener" which can also enhance the intuition of researchers, on the other hand the speech-laugh-activity plots allow an easy way for doing some basic descriptive statistical analysis (with a consequent acoustic analysis as well as hypothesis testing) in a field which still is largely underexplored.

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