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# A Cross-Disciplinary View
# on the Acoustics of Laughter

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**Abstract.** Evidence from three lines of research indicate that the production of laughter is a behaviour with deep evolutionary roots: Cross-cultural research shows that laughter is shared across all humans regardless of culture, research from congenitally deaf individuals demonstrates that developing laughter does not require auditory learning, and animal studies have found that laughter is a behaviour that human beings share with other species. Following an outline of this work, this chapter discusses the perception of human laughter and the cues employed in the listeners' experience of laughter. This literature indicates that laughs which are perceived as positive or amused tend to be voiced, with a high number of amplitude onsets and a large degree of spectral variation. It is concluded that to fully understand human laughter will require phoneticians working together with researchers from other disciplines, for example by providing a comprehensive phonetic description to enable the comparison of laughter from different populations and social contexts.

# 1   Introduction

Charles Darwin noted of laughter, that "the subject is extremely complex" (1872/1998, p. 198), a claim that many who have attempted to study laughter would agree with. But in the last decades, researchers from psychology, phonetics, biology, and cognitive neuroscience, have made considerable progress in our understanding of many aspects of this intriguing behaviour. In this chapter, I review animal work, cross-cultural studies, and research with deaf individuals, that all show that laughter is essentially a basic behaviour. I then discuss studies examining the perception of human laughter, including the cues used by listeners to judge the authenticity as well as emotional aspects of laughter. Although laughs and other nonverbal vocalisations also occur in the context of speech (see e.g., Erickson et al. (this volume), Vettin & Kipper (this volume), Vettin & Todt 2004), the present discussion focuses on "pure" laughs, likely to be the oldest type in evolutionary terms.

## 2    Humans laugh around the world

But although laughter is evolutionarily old, all human behaviours are influenced by a range of cultural factors, including the perception and production of laughter. So we may expect humans all around the world to have some form of laugh, but do they laugh in the same way?

In a recent study, we investigated whether laughter and other nonverbal vocalisations can be understood across cultural boundaries (Sauter et al. 2010b). We recorded vocalisations from individuals in England and in Namibia, elicited using short emotion stories. In one story, people were asked what kind of sound they would make if they were tickled by a child, and both English and Namibian people laughed. The laughs and other vocalisations were then played to new groups of people in both England and Namibia, and these new participants were asked to judge which sounds went with which emotion story. We wanted to see if people would recognise the feeling conveyed by the sounds and pair them with the right story, regardless of whether the person who made the sound and the person who was listening were from the same culture. For laughter, as well as for several other kinds of sounds, listeners could easily match the vocalisation to the story. This suggests that there are some basic commonalities to the laughter of humans regardless of culture.

Importantly, the Namibian participants in the study were from a group called the Himba, who live culturally isolated in a remote desert area. This means that although both the English and the Namibian participants could have been exposed to cultural norms that shaped their laughter, these cultural norms were not shared across the two groups. Since these two cultures are so different in many other ways, this finding can be taken to suggest that laughter is likely associated with the feeling of playful fun in all cultures. In fact, it was remarkably easy for listeners from both groups to match laughter with the tickling story, no matter where the laugh was produced. In this study, as in an earlier study comparing two closely related European cultures (Sauter & Scott 2007), listeners found it even easier to identify laughter as expressing a feeling of amusement if the laugh came from a member of their own culture. This means that there are likely some subtle acoustic cues in laughs that are shaped by culture-specific factors, although what these cues are remains a question for future work to address.

A related study examined whether the sound of laughter and other nonverbal vocalisations of positive emotions would be associated with a smile across cultural groups (Sauter 2010). Participants from England and Namibia were asked to match the sounds with smiles and other facial

expressions. The results showed that laughter was associated with a smiling facial expression across both groups. This suggests that not only is the sound of laughter shared across human cultures, but it is also consistently associated with a particular facial configuration, the smile. However, the faces were either smiling or expressing anger, fear, disgust, surprise, or sadness, and so it may be that, although laughter was reliably associated with smiles compared to any of the other expressions in this study, open-jawed smiles would likely be an even better fit (Preuschoft 1992). The characterisation of how laughter looks needs to additionally consider the changes of facial muscles over time and the movement cues of the whole body (see Ruch & Ekman, 2001, for a discussion of the facial muscles involved in laughing).

## 3   Laughter in the absence of auditory learning

Even though there is some evidence suggesting that laughter is characterised by a distinct facial expression, the most obvious way to learn how to laugh would be through the auditory channel. But what happens when an individual receives no auditory input? Several studies have examined the laughter produced by people born deaf to address this issue. If the way deaf people laugh is similar to the laughter of hearing people, this would suggest that laughter can develop without the need for auditory learning, that is, without hearing the sounds made by other people and oneself. Of course other routes of learning are available to congenitally deaf individuals by which they could be exposed to laughter cues, including facial configurations. But examining the laughter of deaf individuals allows us to establish which acoustic features of laughter require the ability to hear in order to develop.

Other studies have directly compared the acoustic cues of deaf and hearing laughter. In one study, Makagon, Funayama & Owren (2008) recorded laughter from deaf college students and normally hearing control participants. They analysed a range of acoustic features, including fundamental frequency, formant frequencies, and voicing. The results showed that the laughs produced by the deaf and hearing participants were fundamentally similar, although the deaf participants produced somewhat lower-amplitude and longer-duration laughs.

In a recent study of several positive and negative emotional sounds (Sauter, Crasborn & Haun 2010), we examined the perception of laughter produced by deaf and hearing individuals. We found that naive listeners were able to recognise laughter easily, regardless of whether it was produced by a deaf or hearing individual, although there was an advantage for the hearing laughs. Consistently with Makagon, Funayama & Owren (2008), this study

also found a great degree of similarity between the laughs of deaf and hearing individuals, although there was overall more variability in pitch in the vocalisations produced by the hearing participants.

It thus seems quite clear that relatively typical-sounding laughter develops without the need for auditory learning. It will be an interesting task for future work to establish what kind of input, if any, is necessary for laughter to develop. In particular, what role do visual cues from the face and body play in the learning of laughter? Case studies with deaf-blind born children have suggested that laughter develops in the absence of both auditory and visual cues (Eibl-Eibesfeldt 1973, Goodenough 1932), but precise acoustic characterisations of these vocalisations, and comparisons to the laughter of non-impaired children, are still lacking.

## 4   Acoustic cues in laughter perception

An important feature of laughter is that it is a highly social behaviour: We do not tend to laugh alone. But how do listeners extract meaning from laughter? A growing number of studies have begun to address this issue in recent years.

Descriptive studies have disagreed about the characteristics of human laughter, with early reports claiming it to be a relatively stereotypical vocalisation (Provine & Yong 1991), while recent studies have emphasized the variability of laughs in terms of a number of different acoustic cues, including fundamental frequency features (e.g., Bachorowski, Smoski & Owren 2001, Vettin & Todt 2004). These studies are informative in describing the characteristics of human laughter (see also Szameitat et al., 2011, for a discussion of formants in human laughter), but what cues do listeners actually make use of when hearing laughter?

Studies investigating how human listeners utilise the different acoustic cues in laughter have employed a range of different methodologies. This reflects the fact that when listeners hear a laugh, they can evaluate the sound in terms of several different features. For example, they may consider how authentic it is, what the affective state of the person laughing is, or what the identity of the person is. In real life listeners most likely perform these and many more evaluations in parallel, but studies have tended to address different aspects in turn.

In a series of experiments, Kipper & Todt (2001, 2003a, 2003b) employed acoustic manipulations to study the cues used by listeners in judging whether something sounds like a laugh. One notable finding from this work is that listeners found that laughter that varied more sounded more real than laughter bouts that were simple repetitions. This suggests that

variability is not only an important characteristic of laughter across individuals, but that it is also a key feature of single laughter bouts.

Researchers have also examined what sounds distinguish laughs that are perceived as particularly positive. Bachorowski & Owren (2001) asked listeners to evaluate several different kinds of laughs in terms of how much they would hypothetically like to meet the person, how friendly the person sounded, or how positive the laugh made them feel. They found consistently that songlike laughs were significantly more likely to elicit positive responses than were other types of laughs like grunts and snorts.

Other researchers make even stronger distinctions between different kinds of laughs: Across several studies, Szameitat and colleagues have distinguished between four different types: joyful, tickling, schadenfreude, and taunting laughs. They have found that listeners can to some extent differentiate between these categories of laughs (Szameitat et al. 2009a), and some acoustic features have also been found to differ between the laughter types (Szameitat et al. 2009b), although how the acoustic properties relate to the participants' perception of the proposed categories has not yet been addressed.

In a recent study (Sauter et al. 2010a), we examined the relationship between acoustic cues and the perception of different emotions from nonverbal vocalisations, such as amused laughs, fearful screams, and angry growls. Listeners were asked to rate the vocalisations on different scales, including how amused they sounded, and acoustic properties of the amplitude, pitch, and spectral profile of the stimuli were measured. Multiple linear regressions with participants' rating showed that how amused the sounds were perceived as could be predicted by a combination of spectral and envelope cues, specifically by a higher number of amplitude onsets and more spectral variation. This may be due to listeners evaluating the vocalisations in terms of an "archetypal" laugh (see Owren (this volume) for a discussion). An archetypal laugh would likely be characterised by, for example, many amplitude onsets and a lot of spectral variation, even though these features may not be associated with all laughs. Notably, the variance of perceptual ratings explained by the acoustic factors was lower for amusement than for any of the other nine emotions in the study, suggesting that factors such as voice quality, which were not examined, could play an important role in the perception of laughter.

## 5   Conclusions

Laughter is a behaviour that can be approached from a number of disciplines, allowing us to examine many different aspects of how it sounds and where it comes from. Several lines of research point in the same direction, indicating there are deep evolutionary roots of laughter, and that it is a robust behaviour which develops also in the absence of typical input. But although we have made great advances in our understanding of laughter since Darwin's writings, much is left to learn.

Phonetic descriptions of laughter are still being improved, and there may be important acoustic features that have not been fully considered. In this context it will be especially important to evaluate the full range of vocalisations that constitute laughter, in addition to understanding what characterises "archetypal" laughs. A comprehensive phonetic description will also be invaluable in comparing laughter from different populations and social contexts.

Relating the detailed acoustic cues of laughter to listeners' experience is only starting to be addressed, with some acoustic features, such as voice quality, not yet examined. We need also consider that laughter is, in typical instantiations, a multi-modal signal. This requires an evaluation not only of the roles of both auditory and visual features, but also of their interaction: What auditory features can be decoded from visual information alone? Addressing these and other questions will require phoneticians working together with researchers from other disciplines, in particular psychology and biology, to fully understand human laughter.

## Acknowledgements

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