Laughing out loud!
Investigations on different types of laughter

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Introduction
Laughter is an essential part of human communication occurring in social interactions. Laughter is related to social bonding, affection, and dynamics of group hierarchy. Laughter is also considered to be an expression of emotion (Meyer et al., 2007; Szameitat et al., 2009a; Szameitat et al., 2010; Wildgruber et al., 2013; Scott et al., 2014). Laughter production is fairly easy to achieve by means of air-flow control such as in breathing. Laughter may contain speech like components such as vowels and nasal consonants. Below, we want to point out findings from our own research and from other teams working on the production and perception of different types of laughter. A distinction of different types of laughter will be proposed from both a phonological and phonetic point of view. Moreover, some recent findings on the perception and cerebral processing of different types of laughter will be briefly summarised.

Why do we laugh?
Laughter is a phylogenetically very old communicational expression that has been observed in several nonhuman primates (e.g. bonobos, chimpanzees, gorillas, orangutans) (Davila-Ross et al., 2009) and rodents (e.g. rats) (Panksepp, 2005). Charles Darwin was the first researcher to report on the remarkable similarities between laughter in apes and man. He revealed his observations in his book „The Expressions of the Emotions in Man and Animals“, published in 1872. In nonhuman primates and rats, the typical triggering situation is a direct somatosensory stimulation of the body usually occurring during playful behavior among animals. It is interesting to note that this reflex-like laughter can also be evoked by tickling in these
animals in much the same way as we know it from humans (Panksep, 2005; Davila-Ross et al., 2011).

However, in humans there are much more diverse triggering situations where laughter is expressed. For example, humans produce laughter in specific social situations (i.e. an inviting or friendly laughter to welcome someone, a shy laughter or giggle as a signal of excuse, or a mean taunt laughter as a signal of rough rejection). Moreover, humans display laughter as a response to humour and jokes that require a high level of cognitive processing instead of bodily contact.

Regarding the underlying biological function, in animals laughter is assumed to increase bonding between the participating individuals through induction of positive emotions and might represent a reward for playing with the young ones, thereby increasing fitness and survival probabilities (Meyer et al., 2007). Humans also laugh mostly in positive social situations, establishing and reinforcing social bonding as pointed out by Provine (2004). This effect is further increased by a contagious reaction, since humans also laugh in situations when other people are laughing.

However, there are also less positive situations when people or rather one person laughs. This is often the case of ‘schadenfreude’ laughter, i.e., laughing about somebody else’s misfortune, or even so-called devil’s laughter, such as taunting laughter. In these situations usually one person wants to demonstrate his/her predominant position in the social hierarchy and uses laughter as an expression of superiority. At the same time, the person laughed at often feels submissive and vulnerable. In those situations, people laughed at may express their embarrassment by a kind of giggle, or another type of shy laughter (Beermann and Ruch, 2011).

Furthermore, laughter has also been described as serving as a sexual advertisement, signaling cognitive and physical fitness of individuals to attract possible mating partners, thus increasing the probability of reproduction (Mehu and Dunbar, 2008).

Regarding humour, Wild et al, (2003) proposed that our reaction to humour may elicit laughter by “violating social expectations in novel ways;” “nonsense humor,” “which is funny only because it makes no sense;” “sexual humor,” which may often be offensive, or by breaking taboos. All these violations of social expectations, however, can be
perceived as potential threats to group coherence. In this context it is interesting to note that the French philosopher Henry Bergson, who received the Nobel Prize in Literature in 1927, characterized laughter as a "social gesture" that is used to indicate the violation of social rules in human interaction, thereby allowing for a correction of social behavior. In this sense, laughter serves as a "corrective instrument" in society (Bergson, 1900). The evoked laughter in these instances is proposed to draw attention to the preceding violation of social rules as well as signaling the willingness to reintegrate the addressee within the group. If the involved individuals realize that the respective violation of social expectations means no serious harm to the well-being of the group and the violator has been reintegrated, the coherence of the group is further strengthened by laughing together.

The more diverse types of laughter in humans thus allow for a much more complex regulation of bonding and group coherence by expressing inclusion or rejection of individuals, thereby providing an even stronger increase in survival probability as compared to the more reflex-like laughter in animals.

**Figure 1. Phylogenetic Diversification of Laughter.** The figure shows a comparison between animal laughter and human laughter with respect to the trigger, emotional state of the laugher and receiver, as well as social function. The main difference between human and non-human primates/rodents is the human ability to encode a richer diversity of emotional states and social intentions in laughter. Only humans seem to be able to encode both positive and negative emotions in laughter.
Semiotics of laughter

Laughter can be characterised as a social signal expressing an emotion or intention without saying a word. As mentioned above, laughter is not always connected to positive emotions. Some types of laughter, such as 'schadenfreude' laughter and taunt laughter can induce negative emotions in the receiver, i.e., the person being laughed at. In a series of laughter production and perception studies (Szamaitat et al., 2009a/b; Szamaitat et al., 2010; Szamaitat et al., 2011a/b) these two negative laughter types have been compared to two types of positive laughter: friendly/joyful laughter and tickling laughter. Please note that friendly and joyful laughter are considered to belong to the same category here. All four types can be clearly differentiated by the social context and the triggering situations. Friendly laughter is a signal of invitation, welcoming, inclusion or acceptance.

Tickling laughter in contrast is bound to a very specific social interaction and requires physical contact, or body contact. Being tickled can induce laughter especially when the relation between the participants is a friendly and trustful one. However, this relationship is quite subtle. Without doubt, most of us don’t want to be tickled by a person we don’t have a close relationship or partnership with, such as someone we meet for the first time. However, a parental relationship, i.e., between father and son or mother and daughter, or between close friends is the ideal background for a frenzied tickling session. Regarding the link among physical stimulation, joy and laughter it is important to note that the feeling of being tickled can at some point become quite unpleasant if the tickling is overdone. Tickling can cause pain, and has been used as a mean of torture (Yamey, 2001). In these particular cases, body contact was not achieved between humans, but between animals and sensitive parts of the human body such as the feet dipped in brine.

Another specific characteristic of laughter is that all types of laughter can become contagious. This often happens in situations when members of a group share positive emotions. Those positive emotions can be induced by external events, e.g., sharing unexpected news or joyful events, and are often related to funny stories or jokes as well as trustful tickling situations. However, the dark side of contagious laughter may become obvious in situations of 'schadenfreude' laughter, i.e., laughing about somebody's misfortune,
a widespread phenomenon in some cultures. Communication may then turn from group laughter into a laughter that focuses on one person. In these situations, members of the group just starting to laugh can prime further laughter and thus reaffirm bonding between in-group members and at the same time express the exclusion of the person laughed at.

**How do we laugh?**

An unequivocal phonological ‘grammar’ of laughter production doesn’t exist so far. Therefore, the approach employed in this section is rather preliminary to cope with the heterogeneous data from acoustic analysis of laughter. In this section, an overview about common patterns in laughter will be provided. From a phonological point of view, the mode of laughter articulation and the place of articulation can be distinguished. The mode of articulation is related to the type of phonation. More generally, the type of phonation in laughter production is clearly related to breathing and vocalisation. The airstream is essential to speech production and laughter production. However, in laughter, the direction of the airstream varies as both exhalation and inhalation can be used. The airstream can pass through the vocal tract (mouth), or through the nasal cavity. In addition, if the airstream passes the vocal tract, the vocal cords can vibrate with the airstream going into both directions. During exhalation, the laughter can become voiced, and vowel-like sounds are produced. When the airstream is reversed during a laughter sequence, an inhalation can be voiced as well.

A second important phonological feature is the ‘place of articulation’ indicating which articulators can be used during sound production. Almost the same articulators as in speech production can be used in laughter production (Kohler, 2008). Those articulators are the pulmonary system, larynx, and the oral cavity with modification of articulation points such as the position of tongue, jaw and lip position. In some instance, also the involvement of the nasal cavity was observed (i.e., in cases of ‘snoring’ sounds with an ingressive airstream).
Figure 2. Phonation during laughter production. Basic features are the direction of the airstream, and the use of vocal cords resulting in voiced segments of laughter, or if not in use, resulting in unvoiced segments of laughter. Examples of voiced segments are vowel-like sounds such as in 'ha-ha-ha', or 'hi-hi-hi'. Unvoiced segments are often fricatives like 'fff-fff-fff'.

However, such parallels between speech and laughter production doesn't necessarily mean that laughter is speech-like. Laughter should be rather seen as a fairly simple glottal and supra-glottal modification of the incoming or outgoing pulmonary airstream. Even the vowel-like sounds, which are often paraphrased in balloons in comics, can be roughly described as close-open, i.e., /u/ vs. /a/ and front-back, i.e., /i/ vs. /o/ (Szameitat et al., 2009b, Szameitat et al., 2011a). The vowel-like sounds used in laughter are similar to those used in the phonological system of a given language.

Table 1. Supra-glottal features involved in laughter production. Please note that there are no reports of nasal vowels used in laughter so far. However, this possibility still exists.

<table>
<thead>
<tr>
<th>Supra-glottal modification</th>
<th>Oral</th>
<th>Nasal</th>
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<tbody>
<tr>
<td>Vowel</td>
<td>consonant</td>
<td></td>
</tr>
<tr>
<td>fricatives</td>
<td>vowel (?)</td>
<td></td>
</tr>
</tbody>
</table>

Supra-glottal features in laughter comprise the oral or nasal cavity and some coronal, labio-dental and labial constrictions resulting in different types of fricative-like sounds such as /sss/ and /fff/. 
Nasal consonants such as /m/ are also used in laughter with the oral cavity closed, and the nasal cavity open. However, the most important feature, which can be seen as a carrier of laughter sounds, is the pulmonary air stream in both directions. Therefore, at phonological level laughter is characterized by fairly simple mechanisms of sound production, and can be compared to breath control events such as coughing, sneezing, hiccoughing, sneezing and even snoring.

**Segmentation of laughter**

Laughter is produced by means of different articulatory mechanisms. Laughter often contains a sequence of vocalic segments. These segments are often vowel-like elements. However, as stated above, they may also be unvoiced in cases when there is no glottal activation. The result is then a sequence of unvoiced elements, such as fricatives like /s/s/, or simply noisy expiration. Those segments form larger units called laugh bouts. Laugh bouts are phrase-like units and are marked by a beginning and an end. They are similar to intonational phrases in speech. The beginning often starts with a perceivable inhalation that allows the pulmonary air stream to be exhaled with or without glottal activation. The end of laugh bouts is often marked by silence. If the laughter outburst is very long, i.e., exceeding the air volume intake and necessitates a new breathing cycle, the following bout starts again with an inhalation. This is often a marker for breathing and signals the beginning of a new laughter bout (see Figure 3). In analogy to speech, this boundary can be called an ‘intonational phrase boundary’. In written sentences, commas may indicate such boundaries which may be a sign to make a break, and to inhale, and to restart a new phrase. In laughter, such a new phrase is called ‘bout’. Thus, a bout indicates a break, followed be a reset. Vocalic segments are equal to syllables such as ‘ha-ha-ha’. A sequence in laughter is comparable to speaking a very long sentence divided by bouts/breaks. In laughter, instead of using comma intonation, i.e., rising the pitch at the end of an intonational phrase followed by a break, the onset of the new laughter bout is marked by inhalation. In laughter, this type of sequencing mostly follows the air volume capacity rather then syntactic and phonological structures as in speech. The rhythmical structure is another important characteristic of laughter. There is little variation in the temporal distance between
the laughter segments, and laugh bouts have a very consistent duration. This again is dependent on the pulmonary force of each individual. The following section will discuss some important acoustic features of laughter.

![Inhalation](image)

**Figure 3.** Time waveform (lower panel) and spectrogram (upper panel) of a laughter sequence consisting of two laugh bouts. The beginning of the second laugh bout is marked by a clear inhalation (Szamaitat et al., 2009b).

**Acoustics of laughter**

The following data are an extract of a large corpus of laughter data (Szamaitat et al., 2009b; Szamaitat et al., 2011a). Eight professional actors were asked to produce four types of laughter, i.e., friendly-joyful, tickling, schadenfreude, and taunting. Laughter was recorded following a specific procedure (see Szamaitat 2009b), digitised at a sampling rate of 48kHz and 16 bits, and cut into individual laughter sequences. Each sequence was then classified by 36 volunteers in a behavioural study according to the underlying laughter type. An exhaustive acoustic analysis was achieved on a final set of 127 laughter sequences. Overall, 43 acoustic parameters were analysed. A set of 23 parameters showed significant differences between the four types of
laughter. Below, we will focus on a set of acoustic features related to the basic mechanism of laughter – breathing control and phonation that were selected based on discriminant analyses (see Figure 2, Table 2 and Table 3).

Table 2. Selection of acoustic parameters related to phonation. These parameters were selected based on discriminant analysis. Most are related to vocal cord activations.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment duration</td>
<td>average duration of a segment</td>
</tr>
<tr>
<td>Laugh rate</td>
<td>average number of segments per second</td>
</tr>
<tr>
<td>Number of bouts</td>
<td>number of laugh bouts separated by inhalation</td>
</tr>
<tr>
<td>Inter-bout duration</td>
<td>average duration between bouts</td>
</tr>
<tr>
<td>F0 mean</td>
<td>average fundamental frequency measured across vocalic segments</td>
</tr>
<tr>
<td>Peak frequency (mean)</td>
<td>average peak frequency measured across vocalic segments</td>
</tr>
<tr>
<td>% voiced elements</td>
<td>percentage of segments with a clear harmonic structure</td>
</tr>
</tbody>
</table>

Table 3. Selection of acoustic parameters (Szamaitat et al, 2009). Pairwise t-tests were calculated for all combinations of laughter types. Left arrows (<) indicate a significantly smaller mean value for the respective laughter type as compared to at least one of the other laughter types; right arrows (>) indicate significantly higher mean values as compared to at least one other laughter type. (<, >) p<0.05, (<<, >>) p<0.01.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Joy</th>
<th>Tickle</th>
<th>Schadenfreude</th>
<th>Taunt</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment duration</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Laugh rate</td>
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<tr>
<td>Number of bouts</td>
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<td></td>
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<tr>
<td>Inter-bout duration</td>
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<tr>
<td>F0 (mean)</td>
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<tr>
<td>Peak frequency (mean)</td>
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<tr>
<td>% voiced elements</td>
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<tr>
<td>HNR</td>
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</table>
Discussion of acoustic data

Overall, the data show that tickling laughter was rapid and high-pitched. Tickling laughter had the shortest segment duration and inter-bout duration, as well as the highest laugh rate and number of bouts.

Joyful laughter had the longest time between bouts and a low peak frequency. However, joyful laughter had a high proportion of harmonic energy (HNR).

Schadenfreude laughter did not show any outstanding characteristics, i.e., most of its parameters were in the middle range. Schadenfreude laughter had a low harmonic-to-noise ratio.

Taunting laughter had the lowest fundamental frequency and the highest peak frequency, having a low amount of harmonic energy. Moreover, it showed a high segment duration, which makes it comparable to schadenfreude laughter.

Auditory distinction of laughter – behavioural evidence

The question arises whether these different types of laughter can be recognized and discriminated solely from the acoustic signal of the laughter recording without any further contextual knowledge. To answer this question, a selection of laughter recordings were presented to healthy subjects (Szamaitat et al., 2009a/b). The laughter stimuli were recorded from actors, that were instructed to put themselves into the appropriate emotional state using a script based auto-induction method and to laugh freely without thinking about the expression of the laughter (for details see Szameitat et al., 2009a). Overall, 429 sequences were used in this study. Participants (n=72) listened to each laughter sequence and had to judge whether the sequence was joyful, tickling, schadenfreude or taunting laughter (four-choice classification paradigm).

Each of the four different types of laughter were recognized and discriminated well above chance level. The mean identification accuracy across all four categories was 45% (see Figure 4).
In a follow-up study (Szamaitat et al., 2010), the emotional connotation of laughter sounds was evaluated in the framework of four emotional dimensions: arousal, dominance, sender’s valence, and receiver-directed valence.

Of the 429 sequences described above (Szamaitat et al., 2009a), only those recordings were used which were correctly rated for the different laughter categories (p=.05, two-tailed). The final stimulus set for the study consisted of 123 laughter sequences (n=49 for male speakers, 10-22 sequences per speaker, 21-36 per laughter type).

Each laughter sequence was classified with respect to four emotional dimensions: arousal (physically excited vs. calm), dominance (dominant vs. submissive), sender’s valence (sender being in a pleasant vs. unpleasant state), receiver-directed valence (sender feels pleasant vs. unpleasant towards the receiver). These dimensions were selected according to Wilhelm Wundt’s work on emotional dimensions (Wundt 1900). For each laughter sequence the listener rated the emotional state of the sender (and not his/her own state), that is, the listener evaluated how excited the sender was, how
dominant the sender was, whether the sender was in a pleasant state, or whether the sender was pleasant towards the listener.

Each emotional dimension was tested in an individual experiment (including all 123 laughter stimuli) by independent samples of 24 (12 male) participants each (in total 96 native English-speaking participants, mean age 22 years). Accordingly, each of the 123 laughter sequences was evaluated by 24 participants per emotional dimension (Szameitat et al., 2009a). For the classification, participants had to evaluate how strongly they found the investigated dimension to be expressed on a 4-point rating scale. The participants were not aware of the four laughter types included.

In summary, this study showed that the four different laughter types were associated with specific emotional dimensions. This is in accordance with the hypothesis that non-verbal vocalisations are powerful means of communicating emotional states to listeners. More specifically, participants perceived high arousal cues in tickling and taunt laughter and taunt laughter was clearly perceived negatively in the receiver-directed valence rating.

![evaluation of emotional dimensions](image)

Figure 5. This figure shows the different emotional dimensions encoded in distinct types of laughter according to listeners’ ratings for arousal, dominance and valence of the laugher and the receiver-directed valence (JOY – joyful friendly laughter, TIC – tickling laughter, SCH – schadenfreude laughter, TAU – taunting laughter).
Most interestingly, there were significant negative correlations between dominance and receiver-directed valence ($R = -0.74$, $p < 0.001$), for dominance and arousal ($R = -0.33$, $p < 0.001$), as well as for dominance and valence of the sender ($R = -0.26$, $p < 0.001$) across all laugh types. A positive correlation was observed for arousal and valence of the sender ($R = 0.59$, $p < 0.001$).

Again, during this study only auditory information was presented and differentiation of distinct laughter types regarding emotional dimensions was carried out in the absence of any further contextual cues.

**Perception of audiovisual laughter**

Aiming to evaluate modality dependent effects on the accuracy of laughter identification, Ritter and co-workers (unpublished data) presented laughter stimuli to 14 healthy participants (7 male, 7 female, mean age 24.6 ± 2.4 years) either unimodally auditory (A), unimodally visual (V) or bimodally (AV). The participants were asked to perform a categorical discrimination task (forced choice between three alternatives: friendly, tickling, taunting). The stimuli ($n = 187$) were recorded from eight actors (4 female, 4 male) using a script-based self-induction method for each emotional state. The recordings were edited with respect to alignment of the size of portrayed faces, vertical facial symmetry axis as well as normalization of sound intensity.

In accordance with the well-known facilitation effects of audiovisual integration, the highest identification rates were observed for audiovisual stimuli (AV: 68%) as compared to unimodal stimuli. It is interesting to note, however, that auditory presentation (A: 65%) of laughter sequences yielded significantly higher accuracy rates as compared to visual presentation (V: 59%). The opposite pattern of modality-dependent effects with higher accuracy ratings during visual presentation of nonverbal emotional cues as compared to auditory presentation of nonverbal emotional cues have been reported very consistently in the literature regarding perception of facial expressions and speech melody (Lambrecht et al., 2014). Moreover, evaluation of laughter-type specific modality effects
revealed lower identification rates during visual presentation of taunting laughter, whereas joyful laughter and tickling laughter – in contrast – showed similar accuracy rates for visual and auditory presentation (Ritter et al., 2016).

These results indicate an overall higher reliability of the acoustic signal as compared to the visual signal when decoding the emotional states and intention of the laugher. This effect is predominantly driven by misattributions of visually presented taunting laughter.

**Neurobiological correlates of laughter perception**

The neurobiological correlates of laughter perception have been evaluated in several studies using functional magnetic resonance imaging. These studies revealed activation of a bilateral network of brain regions including the fronto-temporal cortex and the amygdala during laughter perception (Meyer et al., 2005; Meyer et al., 2007; Sander and Scheich, 2001; Szameitat et al., 2010; Wildgruber et al., 2013). Considering specific patterns of cerebral responses depending on distinct types of laughter, a double-dissociation of hemodynamic activation has been observed during perception of tickling laughter and both types of social-intentional laughter (friendly, taunting). Perception of tickling laughter showed a stronger activation within right superior temporal regions including primary and secondary acoustic areas presumably linked to its higher acoustic complexity, whereas presentation of friendly and taunting laughter yielded increasing responses within the anterior rostral medial frontal cortex presumptively reflecting higher demands on social cognition (Szameitat et al., 2010).

Moreover, the distinct types of laughter were observed to modulate connectivity within the social perception network differently (Wildgruber et al., 2013). Tickling laughter induced stronger increases of connectivity between the auditory association cortex and the lateral prefrontal cortex, most likely reflecting specific demands on acoustic analysis due to increased density of auditory information. In contrast, friendly and taunting laughter were linked to stronger increases of connectivity between auditory association cortices and medial frontal as well as occipital areas. Moreover, it is interesting to note that friendly and taunting laughter were linked to dissociable changes in connectivity when compared directly. Friendly
laughter yielded a stronger increase of connectivity between the auditory association area and visual association areas within the occipital lobe. This effect might be linked to visual imagery supporting the formation of inferences about the intentions of our social counterparts. Taunting laughter, on the other hand, induced stronger increases in connectivity between auditory association areas and the antero-rostral medial frontal cortex presumably supporting mentalising processes required to decode the highly important social information conveyed by taunting laughter.

These laughter-type specific effects at the neurobiological level provide further support for the proposed phylogenetic diversification of human laughter from an unequivocal positive bonding signal triggered by somatosensory stimulation to laughter with distinct social-intentional connotations subserving complex social functions (Wildgruber and Kreifelts, 2015).

**Perspective of the self during laughter processing**

Since laughter conveys crucial cues about social acceptance or rejection, it is highly important for us to know who the addressee is. The social consequences differ dramatically if the laughter is directed at oneself or at someone else. To evaluate the effects of perspective taking during laughter perception, we carried out an experiment in which we asked the participants to imagine they were directly addressed by the laughter during one session (SELF), whereas they were instructed to imagine that another person was being addressed during the control condition (OTHER). Sixty participants (30 female, 30 male) took part in a behavioural study and 26 individuals (13 female, 13 male) participated in an fMRI-study (3T, Siemens Prisma). Using this approach, joyful laughter was rated as the most inclusive and taunting as the most exclusive laughter type under both conditions. Under the SELF-condition the difference between laughter types decreased as compared to the OTHER-condition (Ritter et al., 2015). At the neurobiological level an interaction effect (task x laughter type) with stronger responses during SELF-directed taunting laughter (vs. friendly) as compared to OTHER-directed laughter emerged within the bilateral amygdalae, most likely reflecting the much higher emotional relevance of cues expressing social rejection if these are directed at oneself (Wildgruber et al., 2016).
Interaction (task x laughter type)  

**SELF** (taunting > joyful) > **OTHER** (taunting > joyful)

- Bilateral amygdala showed stronger activation during SELF-directed taunting laughter as compared to OTHER-directed taunting laughter, whereas responses to joyful laughter did not differ between task conditions.

- In contrast, stronger responses during OTHER-directed taunting laughter (vs. friendly) as compared to SELF-directed laughter were observed within the left dorsolateral prefrontal cortex (Brodman areas 6, 8 and 9) that might be linked to higher degrees of cognitive control or stronger engagement of the mirror neuron system if social cues of rejection are directed at other persons.
**Figure 7.** Interaction of task (SELF-directed laughter vs. OTHER-directed laughter) and laughter type (TAU = taunting vs. JOY = joyful). The left dorso-lateral pre-frontal cortex (dLPFC) showed decreased activation during SELF-directed taunting laughter as compared to OTHER-directed taunting laughter, whereas responses to joyful laughter did not differ significantly between task conditions.

These findings highlight the usefulness of laughter as a highly relevant social signal for research on the interrelations of social cue perception and perspective taking (Wildgruber and Kreifelts, 2015).

**Gelotophobia and perception of laughter in psychiatric disorders**

About 2-10% of otherwise healthy subjects exhibit a specific fear of being laughed at that can be identified using a questionnaire developed by Ruch and Proyer (2008). This condition has been termed “gelotophobia” (Ruch, 2009) and has been observed in many different cultures all over the world (Proyer et al., 2009). Until now, it is still under debate, however, if gelotophobia can be considered a specific phobia just like a spider phobia or height phobia, independently of other symptoms, and if it can be clearly differentiated from social phobia since there is a considerable overlap of both concepts (Ruch et al., 2013). Moreover, a strongly
increased rate of gelotophobia has been observed in various psychiatric disorders such as autism spectrum disorder (45 %, Samson et al., 2011), schizophrenia (50 %, Forabosco, 2009), affective disorders (19 %, Forabosco, 2009) and borderline-personality disorder (87 %, Brück et al., manuscript in preparation). With respect to neurobiological correlates of gelotophobia, a first study observed positive associations between gelotophobia scores and path length in the brain’s white matter network (Wu et al., 2016).

In subjects with social anxiety, a negative laughter interpretation bias has been observed as well as an attention bias that is characterized by decreased response times towards taunting laughter (Ritter et al., 2015). Moreover, at the neurobiological level it has been observed that hemodynamic responses within the left dorsolateral frontal attention network are linked to this negative attention bias in patients with social phobia (Kreifelts et al., 2014). Based on this finding it is promising to evaluate the possibility of modulating cognitive biases in laughter perception by neuropsychological training, non-invasive brain stimulation or neural feedback-trainings in further research projects.

Summary

Laughter is a nonverbal vocalisation that serves to express various emotional states and intentions. Laughter is easy to produce given its relatively simple phonetic structure and can even be produced in a pre-language stage by four months old infants. Laughter is not simply a common expression of positive emotions. Positive emotional expressions have been found in both human and non-human primates when related to play behaviour and tickling, but laughter can also have hostile connotations. In the studies cited above, negative laughter expressions comprise ‘schadenfreude’ laughter and taunt. They share some commonalities with the positive laughter types. However, they also show distinctive acoustic patterns. Follow-up behavioural discrimination and classification tasks revealed that they can be discriminated at acoustic, perceptual and neurobiological level.

Laughter is a powerful social signal which can convey social rejection or acceptance even in the absence of further contextual information. It is well-suited to evaluate the neurobiological underpinning of
social-emotional communication and specific differences in patients with psychiatric disorders

Future research shall reveal how further types of laughter are produced and perceived, and how they fit into a system that is capable of expressing emotions without saying a word.

References


