

Differentiation of Emotions in Laughter at the Behavioral Level

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Although laughter is important in human social interaction, its role as a communicative signal is poorly understood. Because laughter is expressed in various emotional contexts, the question arises as to whether different emotions are communicated. In the present study, participants had to appraise 4 types of laughter sounds (joy, tickling, taunting, schadenfreude) either by classifying them according to the underlying emotion or by rating them according to different emotional dimensions. The authors found that emotions in laughter (a) can be classified into different emotional categories, and (b) can have distinctive profiles on W. Wundt's (1905) emotional dimensions. This shows that laughter is a multifaceted social behavior that can adopt various emotional connotations. The findings support the postulated function of laughter in establishing group structure, whereby laughter is used either to include or to exclude individuals from group coherence.

Keywords: nonverbal communication, social interaction, emotion, laughter, tickling

Although laughing forms an essential part of human social interaction, the role of laughter as a communicative signal in human interaction is poorly understood and rarely subject to systematic investigation.

A crucial factor in social interaction is the communication of emotions as it informs others about our motivational and intentional state and thereby influences their behavior (Juslin & Laukka, 2003). As most people know from their own experience, people laugh in different situations and various emotional states, such as joy, affection, amusement, cheerfulness, surprise, nervous-

ness, sadness, fear, shame, aggression, triumph, taunt, or schadenfreude (pleasure in another's misfortune; Askenasy, 1987; Berlyne, 1969; Chapman, 1976; Darwin, 1872; Eibl-Eibesfeldt, 1970; Giles & Oxford, 1970; Gregory, 1923; Hirson, 1995; McGhee, 1979; Mowrer, LaPointe, & Case, 1987; Panksepp, 2000; Poyatos, 1993; Provine, 1996; Rothgänger, Hauser, Cappellini, & Guidotti, 1998; Ruch, 1993; Ruch & Ekman, 2001). Therefore, one would naturally assume laughter to be a potential tool for communicating emotions.

However, although this assumption is widespread in the general public, empirical evidence on the communication of emotion in laughter is lacking. Accordingly, in the scientific community this topic is long disputed and several views have been put forward in the past 2 centuries. Charles Darwin (1872), for instance, assumed that laughter is an expression of mere joy and happiness. Eibl-Eibesfeldt (1970), on the other hand, theorized that laughter may not only be associated with joy and happiness, but can also have a clearly aggressive connotation. However, the question whether the laughter's emotional state is communicated via the acoustical laughter signal has not been addressed, and hypotheses concerning this question have been vague. For instance, Edmonson (1987) argued that laughter must encode more nuanced information than emotional arousal and speaker's identity, and Hirson (1995) speculated that laughter may be influenced by the emotional context in which it is uttered. Similarly, Ekman (1997) proposed that laughter can at least be based on a wide variety of positive emotions and that such different laughter types might differ in their acoustical structure. However, because empirical evidence is lacking, other authors doubt that laughter is a tool for communicating the send-

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This work was supported by grants from the Marie Curie Foundation and the German Research Foundation (DFG AL357/1 and WI2101/2).

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er's emotion (Bachorowski, Smoski, & Owren, 2001; Edmonson, 1987; Owren & Bachorowski, 2003). These authors argue that the acoustical structure of laughter produced in a single positive context is too variable to allow for encoding of the sender's emotional state, and that listeners interpret the laugh signal in regard to the sender's emotion, although the laughter itself does not carry any informational content. Thus, a fundamental yet unresolved question is whether laughter is a multifaceted behavior that can adopt various emotional connotations.

The question of whether laughter can encode different emotions is highly relevant for several reasons. First, theories ascribing laughter a prominent role in forming group structure (Eibl-Eibesfeldt, 1970) critically depend on the capabilities of laughter to be able to encode at least two different emotions or messages. Second, laughter is one of the few vocalizations that is shared by humans and nonhuman primates and, thus, may be a key element in understanding how human nonverbal vocalizations have been evolutionary developed from animal vocalizations. A thorough understanding of the functional capabilities of human laughter might lead to new insights regarding cross-species analyses. Therefore, the present research aimed at investigating whether laughter can encode different emotional connotations.

Despite the lack of research on vocal expression of emotion in laughter, hypotheses can be derived from other forms of emotional communication. In general, emotions can be communicated via multiple sensory channels, whereby emotional facial expressions (Ekman, 1973; Izard, 1971) and emotional prosody of speech (Juslin & Laukka, 2003; Scherer, 1986, 2003) are the most frequently investigated forms. Numerous studies have shown that facial and vocal expressions of emotion can be discriminated by naïve subjects well above chance level, even cross-culturally (Ekman & Friesen, 1971; Izard, 1994; Scherer, Banse, & Wallbott, 2001). Moreover, recent studies on vocal communication have shown that emotional communication is not restricted to speech. It is evident in nonverbal vocalizations as well, such as raw affective bursts (e.g., crying, screaming) or interjections (i.e., short verbal emotional utterances, e.g., *yippee*, *hooray*), both via lexical or prosodic cues (Dietrich, Ackermann, Szameitat, & Alter, 2006; Schroeder, 2003). Based on these findings, it can be hypothesized that laughter also can carry information about the speaker's emotional state.

Emotions can be investigated in different ways, depending on the underlying theoretical assumptions. Generally, emotions are described as brief events of synchronized response patterns of many organismic subsystems, such as physical arousal, cognitive appraisal, motor activity, and subjective feeling, in order to evaluate significant internal or external events (Scherer, 2000). The most common approach to describe emotions is the categorical emotional approach. It has been argued that a number of basic emotions exist, such as joy, anger, fear, sadness, contempt, surprise, or embarrassment (Ekman, 1994; Scherer, 2003), that are universal between species (Darwin, 1872) and are based on distinct neural circuits and motor programs (Tomkins, 1962, 1963, 1984). Accordingly, the most commonly employed paradigms in the investigation of emotional communication are classification paradigms, in which naïve listeners evaluate emotional stimuli according to emotional labels. Hence, to test whether listeners are able to perceive emotions in laughter, we examined whether nontrained participants could classify laughter sounds according to emotional

categories. The laughter used was produced by professional actors, which allowed the systematic investigation of the emotions expressed by the laughter. To achieve good discrimination, we first tested the two basic emotions (Ekman, 1994) joy and contempt (i.e., taunting laughter). To test whether more fine-grained emotional connotations can be communicated by laughter, we additionally included *schadenfreude*, which resembles possibly an affect blend of joy (German *Freude*) and taunt (German *Schaden* = English harm). Finally, we tested laughter provoked by tickling (hereafter named *tickling laughter*) because it seems to be a very basic form of laughter also emitted by nonhuman primates (Darwin, 1872; van Hooff, 1972) and one of the earliest elicitors of laughter during childhood.¹ Note that, although it is so far unclear whether tickling laughter is based on an emotion (Panksepp, 2000; Panksepp & Burgdorf, 2003) or whether it is merely a reflex-like behavior (Ruch & Ekman, 2001), we solely for the ease of reading include it in the category of "emotional laughter" throughout this article.

An alternative model to describe emotions is the dimensional approach (Wundt, 1905), whereby emotions are evaluated according to various emotional dimensions on continuous scales. The most frequently investigated emotional dimensions are arousal, valence, and dominance (also referred to as *coping power* or *potency*; e.g., Osgood, Suci, & Tannenbaum, 1957). Given that it has been argued that classification paradigms influence listeners' perception (Russell, 1994), we tested in a second experiment the ability to perceive emotions in laughter by assessing whether the laughter sounds are rated differently with respect to emotional dimensions. Because an important aspect in the perception of laughter might be the sender's intention to influence the listener, we tested not only the three basic emotional dimensions arousal, dominance, and valence (of the sender), but included as a fourth dimension receiver-directed valence, that is, whether the sender is pleasant (unpleasant) toward the receiver.

Experiment 1

Method

Sound Recordings

To attain a stimulus set with highly controlled and, at the same time, full-blown emotional content, we used emotional portrayals of laughter. For this, eight professional actors (three men, five women) produced four types of laughter (joy, tickling, *schadenfreude*, taunt). To enhance naturalness of laughter expression, we instructed the actors to use auto-induction techniques, that is, they were advised to "get into" the corresponding emotional state by means of imagination and emotional recall (mental induction) as well as voicing and body movements (e.g., screaming, stomping; induction of bodily sensations). As soon as they strongly felt the emotional state, speakers started on their own accord to laugh freely. The actors were instructed to focus exclusively on the experience of the emotional state but not at all on the outward expression of the laughter. Prior to recordings, speakers received

¹ Note that we named the different laughter types according to the situational context in which they occur, that is, tickling laughter occurs during tickling, joyous laughter while being joyous, and so forth.

instructions including an example scenario of each emotion. The example scenarios served only to illustrate the emotions, but the exact interpretation and expression of the emotions were left to the speakers themselves.

In detail, instructions for the actors defined joyful laughter as laughter based on the basic emotion joy (Ekman, 1994). The example scenario was laughing joyfully when meeting a good friend after not having seen him for a long time. Taunting laughter (which we consider to be synonymous with sneering laughter) was characterized as laughter based on an aggressive, destructive emotion, that is, the basic emotion contempt (Ekman, 1994), which serves to humiliate the listener. The example scenario was laughing at an opponent after having defeated him. Schadenfreude laughter was characterized as laughter based on schadenfreude (pleasure in another's misfortune), which resembles an emotional blend of taunt and joy. Although schadenfreude shares features with both joyful and taunting laughter, it can be distinguished from the latter two emotions. In detail, in schadenfreude the sender enjoys the situation (similar to joy), that is, the misfortune of the other person, but the sender laughs at the other person (opposed to joy, similar to taunt). However, the sender does not seriously want to harm the listener (opposed to taunt). The example scenario was laughing at another person to whom a misfortune has happened (e.g., slipping in dog dirt). Tickling laughter was characterized as laughter expressed during being tickled. The example scenario was laughing when being tickled.

Laughter sounds were recorded in a soundproof booth, with the microphone (Sanyo MP-101) approximately 0.5 m in front of the talker onto a DAT recorder (TASCAM DA-P). All recordings were digitized (sampling rate 48 kHz, 16 bit), normalized, and cut into individual sequences. Sequences containing verbal material, interjections, background noise, or of short duration (<3s) were excluded. No preselection was carried out according to the quality (goodness) of the expression of the emotions. Stimulus sets were balanced and pseudorandomized with respect to emotion, speaker sex, and speaker identity.

Materials and Procedure

The stimulus set consisted of 429 sequences (duration range 3–9 s) with 102–111 stimuli per emotion (5–22 stimuli per emotion and speaker). Sequences were subdivided into three different runs of the experiment (120–153 sequences each).

Twenty-four English native subjects (12 men) participated per run of the experiment ($N = 72$; mean age, 22 years). Participants were asked to classify laughter sequences presented via headphones by choosing one of four visually displayed answer boxes without time pressure.² Prior to the experiment, participants practiced for 20 sequences. Overall duration was 50 min.

Statistics

The unbiased hit rate for correct classification (H_u ; Wagner, 1993) was calculated for each emotion and compared to p_C (chance proportion for stimulus/judgment combination category) in paired-sample t tests. This procedure takes into account the hit and false alarm rates and the response bias of each participant (i.e., if the responses are not evenly distributed across all response categories). Furthermore, it allows the calculation of H_u values

separately for each response category, and it is independent of the number of response categories, that is, across-study comparisons are facilitated (Wagner, 1993). Although all statistical procedures were performed using H_u , in the "Results" section, we report the hit rates (i.e., percentage correct) for convenience of the reader.

Results

Statistical analysis showed that the classification of the laughter sounds matched the emotion portrayed by the actor well above chance level for each category of laughter sounds (see Figure 1), Bonferroni-corrected one-sample t tests, $n = 72$, joy: $t(71) = 14.5$, $p < .001$; tickling: $t(71) = 16.4$, $p < .001$; taunt: $t(71) = 22.0$, $p < .001$; schadenfreude: $t(71) = 8.7$, $p < .001$. Separate analysis for the three individual experiments confirmed this result; all $t(23) = 4.450$ – 16.568 , all $ps < .01$, Bonferroni corrected for 16 comparisons. The classification study, therefore, provides initial evidence for listeners' ability to decode the emotional connotations expressed in the laughter stimuli.

The overall recognition rate was 44%, whereby joy could be classified correctly with 44%, tickle with 45%, schadenfreude with 37%, and taunt with 50%. Statistical tests revealed that listeners classified joy, tickle, and taunt equally well, whereas schadenfreude revealed a lower decoding accuracy (repeated measure one-factor analysis of variance [emotion], $F[3, 213] = 12.546$, $p < .001$; Bonferroni-corrected post hoc contrasts [six comparisons] for schadenfreude individually versus all other emotions, all $ps < .01$; all combinations of joy, tickle, taunt, ns). To put these findings into perspective, we further calculated the effect size index according to Rosenthal and Rubin (1989), a measure that allows the comparison of performance data derived from experiments employing different numbers of categories. This analysis revealed an overall decoding accuracy (π) of 0.70, a value within the range of the decoding accuracy known for emotional prosody of speech (Juslin & Laukka, 2003).

Table 1 shows the confusion matrix, which reveals that some emotions were more often confused than others, a finding well known from emotions communicated via emotional prosody of speech (Banse & Scherer, 1996; Davitz, 1964; van Benzoijen, 1984). Schadenfreude was often confused with joy and with taunt: one-sample t tests against 25%: joy with schadenfreude, $t(71) = 2.291$, $p < .05$; schadenfreude with joy, $t(71) = 3.788$, $p < .05$; taunt with schadenfreude, $t(71) = 3.110$, $p < .001$; all others, ns (see Table 1), supporting the hypothesis that schadenfreude is an affect blend of taunt and joy.

Discussion

Emotional Communication via Laughter

The classification study revealed that listeners were able to decode the sender's emotional state expressed in the laughter stimuli. Therefore, our results provide the first empirical evidence that laughter can adopt various emotional connotations via its

² It could be argued that the validity would be higher if further emotions were presented as potential answers. However, Frank and Stennet (2001) showed that the inclusion of further nonused response alternatives does not affect the recognition rates in a notable way.

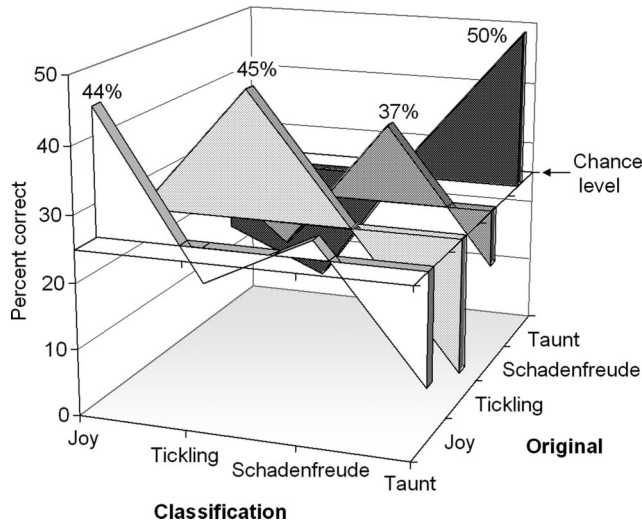


Figure 1. Identification of four emotions (25% chance level) for 429 laughter sounds expressing joy, tickling, schadenfreude, and taunt in Experiment 1.

acoustic signal, which supports previous speculations (Edmonson, 1987; Ekman, 1997; Hirson, 1995) and qualitative evidence (Habermann, 1955).

The present finding contradicts the assumption that the acoustical structure of laughter does not allow for encoding of the sender’s emotion but that listeners would reference their own emotional response into the laugh signal (Bachorowski et al., 2001; Owren & Bachorowski, 2003). In detail, Owren and Bachorowski (2003) argued that laughter produced in a single emotional context is acoustically too variable to allow for context-specific laughs. However, it should be noted that a high variability in laugh utterances does not exclude that the probability of diverse laugh variants might differ depending on the emotional context. In addition, the authors argued that the voicing aspect of laughter is functionally significant for the listener, but does not communicate information about the sender’s emotional state (Owren & Bachorowski, 2003). However, in their study, participants had to rate their own emotional state in regard to the laughter rather than the sender’s emotional state. Accordingly, the study does not provide information about whether the voicing aspect has a connection to laughter’s emotion. Consequently, our results are not in contrast with Bachorowski and Owren’s (2001) outcomes, as both results indicate that different acoustical laughter variants exist.

The Case of Schadenfreude

We included schadenfreude in the present study to test whether more fine-grained emotional connotation can be communicated by laughter as well. Opposed to joy and taunt, which can be considered (roughly opposite) basic emotions, and tickling, which may be more reflex-like laughter, schadenfreude is likely to be an affect blend of taunt and joy as indicated by its term (German *Schaden* = harm, *Freude* = joy). Our results show that participants were able to identify schadenfreude with above-chance accuracy, demonstrating that affect blends can be communicated by laughter as well.

Schadenfreude revealed a significantly lower recognition rate as compared with the other laughter types. A possible explanation for the lower recognition rate might be that, as mentioned above, schadenfreude is an affect blend of taunt and joy. This hypothesis is further supported by the fact that schadenfreude was often confused with joy and taunt. Affect blends might be less well decoded as full-blown emotions. However, our results show that even affect blends can be communicated by laughter. Despite the lower recognition rate, this finding demonstrates remarkable capabilities of laughter in the communication of emotions.

Stimulus Material

In this study, we used a stimulus set based on emotional portrayals produced by actors, which might differ in comparison to spontaneously emitted laughter. Generally, there is some controversy about emotional portrayals reflecting natural expressions. Although emotional portrayals are often seen as being modeled according to spontaneously emitted expressions and, thus, as representations of natural expressions (Davitz, 1964; Scherer, 1985), some authors claim that actors would express cultural stereotypes, which are modeled differently in comparison to spontaneous emotional expressions. They argue some acoustic parameters might be overemphasised so that emotional portrayals may be more intense and prototypical than spontaneous expressions. However, it has been shown that there are more commonalities than differences between emotional portrayals and spontaneously expressed utterances (Williams & Stevens, 1972). Furthermore, in regard to laughter, it is very hard to tell “faked” laughter and spontaneous laughter apart by laughs’ acoustical structure (Bea & Marijuán, 2003).

Using spontaneously emitted laughs gives advantages in ecological validity. On the other hand, such stimuli imply a range of other difficulties. For example, spontaneous laughter is emitted only infrequently, and in truly natural settings sound quality is often poor. Alternatively, laughter may be investigated not in a natural setting but in an experimental environment. For instance, participants may be invited to watch funny video clips in a laboratory (Bachorowski et al., 2001). However, in such settings it is difficult to determine the exact emotional content of the laughter because the same scene may be experienced differently by different participants. Furthermore, because participants are in an experimental setting, they might be self-conscious, and thus the laughter—and in particular the emotion—might not be very expressive.

Table 1
Confusion Matrix for Given Responses

| Stimulus | Response (%) | | | |
|---------------|-----------------------|-----------------------|-----------------------|-----------------------|
| | Joy | Tickle | Schadenfreude | Taunt |
| Joy | 44^a | 20 | 28 ^a | 8 |
| Tickle | 26 | 45^a | 25 | 5 |
| Schadenfreude | 30 ^a | 17 | 37^a | 16 |
| Taunt | 14 | 7 | 30 ^a | 50^a |

Note. Data in bold represent correct classification.
^a Emotion was chosen significantly more often than the guessing probability of 25% (one-sided one-sample *t* test against 25%, *p* < .05).

Given that empirical evidence on differentiation of emotions in laughter is lacking, using emotional laughter portrayals is already informative for the question of whether different emotional laughs can be distinguished at all. Although we were not able to decide whether laughter portrayals truly reflect spontaneous laughs, we tried to create a stimulus set that was as natural as possible. For this we used auto-induction techniques, in which the actors were instructed to concentrate solely on the emotional feeling on which the laughter was based (for tickling laughter, “being tickled” as laughter elicitor), but not at all on the outward expression of the laughter. Furthermore, an acoustic analysis revealed that the acoustical properties of our stimulus set were well within the range previously reported for spontaneous laughs (Szameitat, 2007), indicating that our stimulus set was rather representative for natural laughter.

Experiment 2

It has been argued that classification paradigms rely on semantic categories that may influence a listener’s perception (Russell, 1994). Our second experiment therefore tested how differences in the sender’s emotional state are perceived when the classification is conducted on the basis of emotional dimensions according to a modified model of Wundt (1905) rather than semantic labels (i.e., joy, tickling, schadenfreude, taunt). In detail, we tested the three basic emotional dimensions arousal, dominance, and valence (of the sender), and included as a fourth dimension receiver-directed valence because the sender’s intention to influence the listener might be an important aspect in the perception of laughter. If the laughter stimuli contained detectable emotional connotations, the dimensional ratings should show distinguishable patterns along the emotional dimensions.

We hypothesized that because of the high physical activation involved in the production of laughter, all laughter types should be associated with a heightened arousal. Given that laughter relieves stress and lifts the spirits (Darwin, 1872; McGhee, 1973; Provine, 1993; Ruch, McGhee, & Hehl, 1990), the sender’s valence should be positive for all laughter types. However, laughter types should differ according to the receiver-directed valence, that is, while joy and tickling might have a special role in reinforcing group structure and, thus, should have a positive receiver-directed valence, schadenfreude laughter and especially taunting laughter might function to segregate group members and, therefore, should have a negative receiver-directed valence (cf. Eibl-Eibesfeldt, 1970). Finally, regarding the dominance dimension, we proposed that in tickling laughter the sender is perceived as highly submissive because of the fact that subjects often feel helpless and as being at the other person’s mercy when being tickled. In contrast to that, schadenfreude and in particular taunting laughter should be perceived as dominant.

Method

Stimuli characterized by significant recognition rates in Experiment 1 (classification above chance level, $p < .05$) were selected. The resulting stimulus set consisted of 160 sequences (28–44 per emotion, 0–14 sequences per emotion and speaker), with an average classification rate of 63%.

The procedure was identical to Experiment 1, with the exception that laughter sequences were classified on a 4-point rating scale (+ + | + | - | - -) according to four emotional dimensions:

arousal (physically excited vs. calm), dominance (dominant vs. submissive), valence of the sender (sender being in a pleasant vs. unpleasant state), and receiver-directed valence (sender is pleasant vs. unpleasant toward the receiver).

Each dimension was tested in an individual experiment, so that each participant classified stimuli only with respect to one dimension and the four dimensions were derived from four independent subject samples.

Twenty-four English native subjects (12 men, mean age = 22 years) participated in each rating experiment. Subjects were unaware of the four types of laughter included in the experiment and of the remaining three emotional dimensions tested.

The 4-point Lickert scale (+ + | + | - | - -) was individually transformed for each participant and emotion. For this, response frequencies were multiplied with a factor (-1.5 for --, -0.5 for -, 0.5 for +, and 1.5 for ++) and then summed. This sum was divided by the highest possible sum (e.g., $40 \times 1.5 = 60$ for 40 stimuli) and multiplied by 100, rendering a scale ranging from -100 to +100.

To evaluate the relationship between emotional categories (joy, tickling, schadenfreude, taunt) and emotional dimensions, we carried out five discriminant analyses (DAs; SPSS 11.5; independents entered together). In detail, the first DA was calculated including all four emotional dimensions, followed by four further DAs, one for each emotional dimension.

Results

The data showed that the different laughter types indeed differed with respect to the emotional dimensions. In detail, within every emotional dimension, virtually all laughter types differed from each other in their rating values (Bonferroni-corrected paired-sample t tests, all $ps < .05$, except for tickle vs. joy for dominance and for receiver-directed valence, joy vs. taunt and tickle vs. schadenfreude for valence of the sender; see Figure 2). In addition, almost all rating values differed significantly from zero (Bonferroni-corrected one-sample t tests against zero, all $ps < .05$, except for taunt for arousal

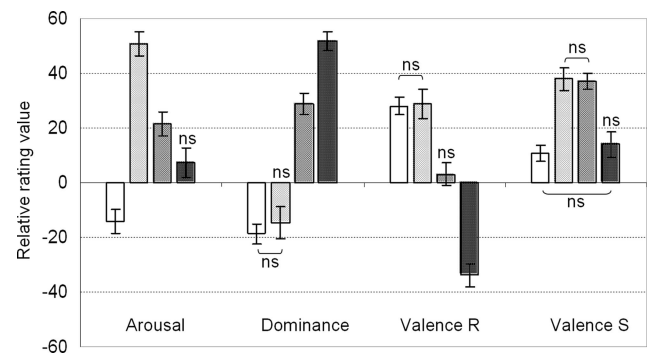


Figure 2. Ratings of four laughter types from a 4-point scale of four emotional dimensions. Except for nonsignificant ratings (*ns*), all rating values differ significantly from zero and from each other within a particular emotional dimension (all $ps < .05$; white = joy; light gray = tickling; dark gray = schadenfreude; black = taunt). Error bars show *SEM*. Ordinate shows relative values, with +100 and -100 being the maximum values (see *Method*). Valence R = receiver-directed valence; Valence S = valence of the sender.

and valence of the sender, tickle for dominance, and schadenfreude for receiver-directed valence; see Figure 2). The use of semantic labels, therefore, did not account for the classification effects found in the first experiment. Laughter, thus, is an acoustical nonverbal vocalization, which carries information about the sender's emotional state that can be decoded by the listener.

In detail, the four laughter utterances could be characterized as following (see Figure 2): Joy had a low arousal, it was submissive, and both receiver-directed valence and valence of the sender were positive. Tickling laughter was marked by its very high arousal, it was slightly submissive, and, similar to joy, had both a positive receiver-directed valence and valence of the sender. Taunt differed strongly from joy and tickling laughter, as it was the only laughter utterance with a negative receiver-directed valence, and it was very dominant. Its arousal and valence for the sender were in the middle region. Schadenfreude showed characteristics between joy/tickle and taunt. It was dominant, but not as much as taunt. Its positive valence of the sender was comparable to tickling laughter. The receiver-directed valence was neutral, and hence lay between the values of taunt and joy/tickle. Its arousal was rather positive, and lay between taunt and tickling laughter.

The first DA, which included all four emotional dimensions as predictor variables, revealed that on the basis of the dimensional ratings the sender's emotional state could be classified correctly with 73.1% accuracy ("leave-one-out cross-validation" 70.0%). To evaluate the power of each individual emotional dimension to differentiate emotions in laughter, we carried out four separate DAs. This revealed that the four emotional dimensions were differently powerful for emotional categorization. In detail, the most powerful dimension was receiver-directed valence with 59.3% classification accuracy ("leave-one-out cross-validation" 61.0%), followed by dominance with 49.6% (49.6%), arousal with 39.8% (39.8%), and finally valence of the sender with 35.8% (33.3%). This finding demonstrates that all four dimensions, although to a different extent, carry information about the emotion encoded in the laughter.

All above-described DAs showed highly significant discriminant functions (DA including all four dimensions [resulting in three discriminant functions] for functions 1 through 3, Wilks's $\Lambda = .140$, $\chi^2[12, N = 123] = 232$, $p < .001$; DAs including only one dimension [resulting in one discriminant function]: DA receiver-directed valence Wilks's $\Lambda = .262$, $\chi^2[3, N = 123] = 160$, $p < .001$; DA dominance Wilks's $\Lambda = .463$, $\chi^2[3, N = 123] = 92$, $p < .001$; DA arousal Wilks's $\Lambda = .790$, $\chi^2[3, N = 123] = 28$, $p < .001$; DA valence of the sender Wilks's $\Lambda = .867$, $\chi^2[3, N = 123] = 17$, $p < .01$). This demonstrates that all DAs can statistically significantly discriminate between emotional dimensions.

Statistical tests for cross-correlations revealed that some emotional dimensions correlated with each other (Pearson's correlation coefficient, Bonferroni corrected for 6 comparisons). In detail, there were significant correlations for dominance and receiver-directed valence ($R = -.74$, $R^2 = .58$, $p < .001$), for arousal and valence of the sender ($R = .59$, $R^2 = .37$, $p < .001$), and smaller correlations for dominance and arousal ($R = -.33$, $R^2 = .09$, $p < .001$), as well as for dominance and valence of the sender ($R = -.26$, $R^2 = .10$, $p < .001$); for all other combinations, *ns*).

Discussion

Emotional Dimensions in Laughter

The dimensional approach revealed that emotions expressed in laughter differ between each other in various emotional dimensions. Therefore, the second experiment confirmed the results of the classification paradigm that listeners are able to decode emotional connotations in laughter.

That laughs can differ according to the arousal is in accordance with Nwokah, Davies, Islam, Hsu, and Fogel (1993), who suggested that the arousal dimension is the distinguishing factor between different types of children laughs. However, we were not only able to support Nwokah and colleagues' suggestion empirically, but, in addition, were able to show that further emotional dimensions differ between the laughs.

Comparison of the Four Laughter Utterances

Joy. In contrast to our hypothesis that all laughter types should have a heightened arousal because of the physical activation involved in the production of laughter, joyful laughter was associated with a low arousal. This finding could be due to the situational context given to the actors, which was experiencing joy when meeting a friend after not having seen him for a very long time. In this particular context, the laughter sound might be associated with love and friendship, and therefore might reflect aspects of the emotions tenderness and affection, which have a low intensity (Hammerschmidt & Jürgens, in press) and are, too, associated with a low arousal. In a different context, however, joy might be associated with a high arousal, for example, as joy of triumph (Banse & Scherer, 1996).

Joyful laughter had both a positive sender's valence and a positive receiver-directed valence, which was in line with our predictions. Thus, joyful laughter might be specifically designed to promote positive relationships between sender and receiver (cf. Bachorowski & Owren, 2001).

Taunt. The arousal and sender's valence of taunting laughter were in the middle range, which was in contrast to our hypothesis that all laughs should have a heightened arousal and positive sender's valence. However, in accordance with our hypothesis, taunting laughter had a very negative receiver-directed valence. Our finding, that the sender's valence was in the middle range (slightly positive), is in contrast to Schröder's (2003) study, in which contempt (i.e., contemptuous laughter and the contemptuous interjections *pha* and *tse*) was associated with a negative valence. However, it remains unclear whether Schröder indeed measured the sender's valence, or whether listeners referenced their own valence, given that they were merely asked to position the stimuli on the valence scale ranging from positive to negative. In this case, Schröder's result would be in accordance with our findings because the receiver-directed valence was negative in our study. The neutral values in the two dimensions arousal and sender's valence might be a reflection of the sender's intention to appear to be in control of the situation, that is, to not be emotionally involved but to stay aloof. The negative receiver-directed valence and the high dominance of taunting laughter might be a reflection of the sender's intentions to segregate group members.

Joy and taunt showed opposite ratings in three of the four investigated emotional dimensions (arousal, receiver-directed valence, dominance), which is in accordance with recent findings for nonverbal

utterances (Schroeder, 2003) and shows that both emotions differed strongly from each other. This outcome is likely to be the reason why joy and taunt were only rarely confused with each other in the classification paradigm (11%). The phenomenon that emotions that differ the most on emotional dimensions are the least that are confused with each other is well known from studies on emotions expressed in speech prosody (Banse & Scherer, 1996).

Schadenfreude. Schadenfreude laughter had a heightened arousal and a positive sender's valence, which was in line with our predictions.

A striking pattern emerges when evaluating the dimensions dominance and receiver-directed valence: Whereas schadenfreude laughter is experienced as being dominant, it is not, as predicted, associated with a negative but neutral (even slightly positive) receiver-directed valence. Markedly, this pattern resembles exactly the situational context for schadenfreude given to the actors, which was schadenfreude about the misfortune of somebody, whereby the sender might be spiteful (but not necessarily), but doesn't want to harm the person laughed at. Therefore, schadenfreude laughter demonstrates impressively that fine nuances in a sender's emotional state can be expressed in laughter sounds. Furthermore, this pattern is in contrast with taunting laughter, as the latter is characterized by both a high dominance and a highly negative receiver-directed valence. Schadenfreude laughter might therefore represent a precise (and socially tolerated) tool to dominate the listener without concurrently segregating him from group context.

Tickling. Tickling laughter was associated with a very high arousal, which presumably represents the high level of physical activation induced in the sender when being tickled (Nwukah et al., 1993).

It is still unclear whether laughter provoked by tickling is based on an emotional response or whether it is simply a reflex-like behavior (Panksepp & Burgdorf, 2003). Although the present results cannot answer this question, the ratings of the four emotional dimensions of tickling laughter indicate that it might be not purely reflexive. The high arousal of tickling laughter, however, might reflect the reflexive part of the laughter. Some authors assume tickling laughter to be associated with joy (Panksepp & Burgdorf, 2003). However, we did find only some similarities between tickling laughter and joyful laughter given that both differed strongly in arousal and valence of the sender.

That both the sender's valence and the receiver-directed valence were positive is in accordance with empirical data showing that tickling (among rats) induces positive affect and social bonding in both sender and receiver (Panksepp & Burgdorf, 2003).

So-Called Negative Laughter

Although it has been suggested that laughter is generally pleasant (Russell, Bachorowski, & Fernandez-Dols, 2003), a controversial postulation by Eibl-Eibesfeldt (1970) suggests that laughter can involve aggression as well, and that such laughter might be perceived as threatening (Berlyne, 1969; Gregory, 1923; Provine & Yong, 1991; Ruch & Ekman, 2001). In particular, Eibl-Eibesfeldt suggested that laughter can take on the form of "laughing at," being perceived as aggressive and unpleasant for outsiders. Our data derived from the judgment of emotional dimensions confirm this assumption because only some types of laughter were perceived as pleasant (joy, tickling), whereas others (taunt, schadenfreude) were perceived as domineering

and unpleasant toward the receiver. Thus, hearing laughter is not a generally pleasant experience as previously suggested (Russell et al., 2003), but laughter can also have a clearly negative connotation for the receiver.

However, such perceived negative connotations did not exist for the sender, that is, laughter was always perceived as being pleasant for the sender (van Hooff, 1972). Although it remains to be clarified whether this pattern also applies to other types of potentially "negative laughter," such as laughter out of anxiety, fear, or embarrassment (Poyatos, 1993), our results are suggestive of substantial differences in the valence of laughter for the sender and receiver.

Correlation Between the Emotional Dimensions

There were some correlations between the emotional dimensions, for example, a negative correlation between dominance and receiver-directed valence, and a positive correlation between arousal and valence of the sender. This result is in contrast to theoretical predictions given that the emotional dimensions arousal, valence (of the sender), and dominance have been reported to be orthogonal (Mehrabian & Russell, 1974; Osgood et al., 1957). A possible explanation for the deviation of our results could be the restriction of the stimulus material examined, that is, that four specific emotions were investigated. For example, laughter uttered in a sexual encounter might be experienced as dominant, but such laughs should be positive for the receiver because the sender wants to approach the receiver. The correlation between arousal and valence of the sender could be due to the fact that none of the investigated laughter sounds was negative for the sender, as, for example, fearful or sad laughter might be.

General Discussion

In summary, the present data show that human laughter can communicate the sender's emotion and, therefore, can be regarded as a multifaceted social behavior.

The existing literature on emotions in laughter is predominantly theoretical; however, predictions derived from this literature remain to be tested. For example, Giles and Oxford (1970) suggested a "multidimensional theory of laughter causation" (p. 97), claiming that laughter occurs in multiple, mutually exclusive conditions, resulting in various forms of laughter, such as derision laughter or anxiety laughter (see also Poyatos, 1993). Critically, our results provide not only evidence for Giles and Oxford's theory, but also show that the sender's emotional state is imprinted in the mere sound of laughter and, in this way, is communicated to the receiver. Therefore, the presence of additional signals, like facial expressions or postural information, is not a necessary prerequisite for the communication of emotions in laughter (Grammer, 1990).

Comparison of Different Channels of Emotional Communication

Emotions can be communicated via a variety of channels, such as facial or vocal expressions (Ekman, 1973; Izard, 1971; Juslin & Laukka, 2003; Scherer, 1986, 2003). With regard to the vocal communication of emotions, an increasingly fine-grained picture is presently emerging. Although it is well known by now that emotions can be encoded in the semantic and prosodic features of

speech, evidence that emotions can be encoded in nonverbal communication is sparse. First studies demonstrated that emotions can at least be distinguished between different types or categories of nonverbal expressions, such as laughter versus crying (Dietrich et al., 2006; Schröder, 2003). However, it was unclear whether emotions can be communicated by different variants of a single type of nonverbal expression, such as different types of laughter or different types of crying. Our study demonstrates for the first time that a basic nonverbal expression such as laughter has the potential to communicate different emotions.

In our study, the average decoding accuracy of emotions in laughter was 44%. This is lower than in other studies investigating emotional communication via nonverbal vocal utterances, such as a series of raw affect bursts (e.g., laughter, crying) and interjections (e.g., *yippee*, *hooray*; Dietrich et al., 2006; Schröder, 2003). However, both studies compared different types of nonverbal vocalizations (e.g., laughter, crying, interjections) and not different emotional variants of a single type of vocalization. Furthermore, their stimulus sets differed in both lexical and prosodic features. In contrast to that, the different laughter types of the present study might have differed only with regard to the emotional prosody. And, indeed, the decoding accuracy of 44% is comparable to the decoding accuracy reported for emotional speech prosody (Banse & Scherer, 1996; Scherer, 2003). Thus, it appears that the present study is, in some respects, more comparable to studies of emotional speech than to other studies investigating nonverbal vocal expressions.

What Is the Functional Role of Human Laughter?

A critical question in the investigation of human laughter concerns its functional role. Eibl-Eibesfeldt (1970) ascribed laughter two functions in human social interaction: an integrative role that is particularly relevant for the reinforcement of within-group relations and a segregative role that serves to reject or exclude individuals and protects group unity against third parties. Thus, laughter may be used to integrate a group member, for example, by joyous laughter as a greeting, or to segregate a member, for example, by taunting laughter in a mobbing situation. Our finding that the receiver-directed valence can be either positive or negative lends empirical support to this idea. Molding group structure may therefore be one—if not the one—important role of laughter in social interaction. This idea has a strong evolutionary connotation given that laughter also exists in nonhuman primates (Darwin, 1872; van Hooff, 1972). Most interesting, laughter has the same social role in this case, namely, the molding of group structures because it functions as a metacommunicative signal in social play such as mock fighting and chasing (van Hooff, 1972). Thus, our data provide possible evidence that the functional role of laughter in social interaction has a shared origin in humans and nonhuman primates.

References

- Askenasy, J. J. M. (1987). The functions and dysfunctions of laughter. *Journal of General Psychology, 114*, 317–334.
- Bachorowski, J.-A., & Owren, M. J. (2001). Not all laughs are alike: Voiced but not unvoiced laughter readily elicits positive affect. *Psychological Science, 12*, 252–257.
- Bachorowski, J.-A., Smoski, M. J., & Owren, M. J. (2001). The acoustic features of human laughter. *Journal of the Acoustical Society of America, 110*, 1581–1597.
- Banse, R., & Scherer, K. R. (1996). Acoustic profiles in vocal emotion expression. *Journal of Personality and Social Psychology, 70*, 614–636.
- Bea, J. A., & Marijuán, P. C. (2003). The informal patterns of laughter. *Entropy, 5*, 205–213.
- Berlyne, D. E. (1969). Laughter, humor, and play. In G. Lindzey & E. Aronson (Eds.), *The handbook of social psychology* (2nd ed., Vol. 3, pp. 795–852). Reading, MA: Addison-Wesley.
- Chapman, A. J. (1976). Social aspects of humor laughter. In T. Chapman & H. Foot (Eds.), *Humor and laughter: Theory, research and applications* (pp. 155–185). London: Wiley.
- Darwin, C. (Ed.). (1872). *The expression of the emotions in man and animals* (3rd ed.). London: HarperCollins.
- Davitz, J. R. (1964). A review of research concerned with facial and vocal expression of emotion. In J. R. Davitz (Ed.), *The communication of emotional meaning* (pp. 13–29). New York: McGraw-Hill.
- Dietrich, S., Ackermann, H., Szameitat, D. P., & Alter, K. (2006). Psychoacoustic studies on the processing of vocal interjections: How to disentangle lexical and prosodic information? *Progress in Brain Research, 156*, 295–302.
- Edmonson, M. S. (1987). Notes on laughter. *Anthropological Linguistics, 29*, 23–34.
- Eibl-Eibesfeldt, I. (1970). *Ethology: The biology of behavior*. New York: Holt, Rinehart & Winston.
- Ekman, P. (Ed.). (1973). *Darwin and facial expression*. New York: Academic Press.
- Ekman, P. (1994). Strong evidence for universals in facial expressions: A reply to Russell's mistaken critique. *Psychological Bulletin, 115*, 268–287.
- Ekman, P. (1997). What we have learned by measuring facial behavior. In P. Ekman & E. L. Rosenberg (Eds.), *What the face reveals* (pp. 469–485). New York: Oxford University Press.
- Ekman, P., & Friesen, W. V. (1971). Constants across cultures in the face of emotion. *Journal of Personality and Social Psychology, 17*, 124–129.
- Frank, M. G., & Stennett, J. (2001). The forced-choice paradigm and the perception of facial expressions of emotion. *Journal of Personality and Social Psychology, 80*, 75–85.
- Giles, H., & Oxford, G. S. (1970). Towards a multidimensional theory of laughter causation and its social implications. *Bulletin of the British Psychological Society, 23*, 97–105.
- Grammer, K. (1990). Strangers meet: Laughter and nonverbal signs of interest in opposite-sex encounters. *Journal of Nonverbal Behavior, 14*, 209–237.
- Gregory, J. C. (1923). Some theories of laughter. *Mind, 32*, 328–344.
- Habermann, D. (1955). *Physiologie und Phonetik des lauthaften Lachens* (Vol. 10) [Physiology and phonetics of laughter]. Leipzig, Germany: Ann Ambrosius Barth Verlag.
- Hammerschmidt, K., & Jürgens, U. (in press). Acoustical correlates of affective prosody. *Journal of Voice*.
- Hirson, A. (1995). Human laughter—A forensic phonetic perspective. *Beiphol, 64*, 77–86.
- Izard, C. E. (1971). *The face of emotion*. New York: Appleton-Century-Crofts.
- Izard, C. E. (1994). Innate and universal facial expressions: Evidence from development and cross-cultural research. *Psychological Bulletin, 115*, 288–299.
- Juslin, P. N., & Laukka, P. (2003). Communication of emotions in vocal expression and music performance: Different channels, same code? *Psychological Bulletin, 129*, 770–814.
- McGhee, P. E. (1973). Birth order and social facilitation of humor. *Psychological Reports, 33*, 105–106.
- McGhee, P. E. (1979). *Humor: Its origin and development*. San Francisco: Freeman.
- Mehrabian, A., & Russell, J. A. (1974). *An approach to environmental psychology*. Cambridge, MA: MIT Press.

- Mowrer, D. E., LaPointe, L. L., & Case, J. (1987). Analysis of five acoustic correlates of laughter. *Journal of Nonverbal Behavior, 11*, 191–199.
- Nwokah, E. E., Davies, P., Islam, A., Hsu, H.-C., & Fogel, A. (1993). Vocal affect in three-year-olds: A quantitative acoustic analysis of child laughter. *Journal of the Acoustical Society of America, 94*, 3076–3090.
- Osgood, C. E., Suci, G. J., & Tannenbaum, P. H. (1957). *The measurement of meaning*. Urbana: University of Illinois Press.
- Owren, M. J., & Bachorowski, J.-A. (2003). Reconsidering the evolution of nonlinguistic communication: The case of laughter. *Journal of Nonverbal Behavior, 27*, 183–200.
- Panksepp, J. (2000). The riddle of laughter: Neural and psychoevolutionary underpinnings of joy. *Current Directions in Psychological Science, 9*, 183–186.
- Panksepp, J., & Burgdorf, J. (2003). “Laughing” rats and the evolutionary antecedents of human joy? *Physiology & Behavior, 79*, 533–547.
- Poyatos, F. (1993). The many voices of laughter—A new audible–visual paralinguistic approach. *Semiotica, 93*, 61–81.
- Provine, R. R. (1993). Laughter punctuates speech: Linguistic, social and gender contexts of laughter. *Ethology, 95*, 291–298.
- Provine, R. R. (1996). Laughter. *American Scientist, 84*, 38–45.
- Provine, R. R., & Yong, Y. L. (1991). Laughter: A stereotyped human vocalization. *Ethology, 89*, 115–124.
- Rosenthal, R., & Rubin, D. B. (1989). Effect size estimation for one-sample multiple-choice-type data: Design, analysis, and meta-analysis. *Psychological Bulletin, 106*, 332–337.
- Rothgänger, H., Hauser, G., Cappellini, A. C., & Guidotti, A. (1998). Analysis of laughter and speech sounds in Italian and German students. *Naturwissenschaften, 85*, 394–402.
- Ruch, W. (1993). Exhilaration and humor. In M. Lewis & J. M. Haviland (Eds.), *Handbook of emotions* (1st ed., Vol. 1, pp. 605–616). New York: Guilford Press.
- Ruch, W., & Ekman, P. (2001). The expressive pattern of laughter. In A. Kaszniak (Ed.), *Emotion, qualia, and consciousness* (pp. 426–443). Tokyo: Word Scientific.
- Ruch, W., McGhee, P. E., & Hehl, F. J. (1990). Age differences in the enjoyment of incongruity-resolution and nonsense humor during adulthood. *Psychology and Aging, 5*, 348–355.
- Russell, J. A. (1994). Is there a universal recognition of emotion from facial expression? A review of cross-cultural studies. *Psychological Bulletin, 115*, 102–141.
- Russell, J. A., Bachorowski, J.-A., & Fernandez-Dols, J.-M. (2003). Facial and vocal expressions of emotion. *Annual Review of Psychology, 54*, 329–349.
- Scherer, K. R. (1985). Vocal affect signalling: A comparative approach. In J. Rosenblatt, C. Beer, M.-C. Busnel, & P. J. B. Slater (Eds.), *Advances in the study of behavior* (Vol. 15, pp. 189–244). New York: Academic Press.
- Scherer, K. R. (1986). Vocal affect expression: A review and a model for future research. *Psychological Bulletin, 99*, 143–165.
- Scherer, K. R. (2000). Psychological models of emotion. In J. C. Borod (Ed.), *The neuropsychology of emotion* (pp. 137–162). Oxford, England: Oxford University Press.
- Scherer, K. R. (2003). Vocal communication of emotions: A review of research paradigms. *Speech Communication, 40*, 227–256.
- Scherer, K. R., Banse, R., & Wallbott, H. G. (2001). Emotion inferences from vocal expression correlate across languages and cultures. *Journal of Cross-Cultural Psychology, 32*, 76–92.
- Schröder, M. (2003). Experimental study of affect bursts. *Speech Communication, 40*, 99–116.
- Szameitat, D. P. (2007). *Perzeption und akustische Eigenschaften von Emotionen in menschlichem Lachen* (Vol. 91) [Perception and acoustic correlates of emotions in human laughter]. Leipzig, Germany: MPI Series in Cognitive Neuroscience.
- Tomkins, S. S. (1962). *Affect, imagery, consciousness* (Vol. 1). New York: Springer.
- Tomkins, S. S. (1963). *Affect, imagery, consciousness* (Vol. 2). New York: Springer.
- Tomkins, S. S. (1984). Affect theory. In K. R. Scherer & P. Ekman (Eds.), *Approaches to emotion* (pp. 163–196). Hillsdale, NJ: Erlbaum.
- van Benzoijen, R. (1984). *The characteristics and recognizability of vocal expressions of emotion*. Dordrecht, the Netherlands: Foris.
- van Hooff, J. A. R. A. M. (1972). A comparative approach to the phylogeny of laughter and smiling. In R. A. Hinde (Ed.), *Nonverbal communication* (pp. 209–241). Cambridge, England: Cambridge University Press.
- Wagner, H. L. (1993). On measuring performance in category judgment studies of nonverbal behavior. *Journal of Nonverbal Behavior, 17*, 3–28.
- Williams, C. E., & Stevens, K. N. (1972). Emotions and speech: Some acoustical correlates. *Journal of the Acoustical Society of America, 52*, 1238–1250.
- Wundt, W. (1905). *Grundzüge der physiologischen Psychologie* (5th ed.) [Basic principles of physiological psychology]. Leipzig, Germany: Engelmann.

Received December 19, 2007

Revision received January 29, 2009

Accepted January 29, 2009 ■