

# Laughter – the ordinary and the extraordinary

Is laughter a universal emotion? Sophie Scott investigates.

**Your heart is racing, you're struggling for breath. You're weakened and vulnerable. Your body crumples up, you can't sit or stand up straight, you can't look people in the eye, and you can't speak. Yet you feel good: rather than running for your life, you're helpless with laughter. Laughter – it's funny.**

Human vocal emotional expression includes both emotionally inflected speech, and non-verbal emotional vocalisations, like a scream or a sob. These non-verbal vocalisations are intriguing as they are unlike speech in terms of the ways they are produced, with little or no involvement of the articulators (tongue, jaw, soft palate, lips). Instead these vocalisations are dominated by effects of changes in breath control, subglottal pressure, laryngeal tensions and facial expression (Scott et al., 2009).

Notably, involuntary production of these non-verbal emotional vocalisations is preserved in patients with bilateral damage to speech motor areas, who are unable to speak or vocalise voluntarily (e.g. Simonyan & Horwitz, 2011). This may link non-verbal emotional vocalisations to evolutionarily 'older' vocal production systems, and the production of vocalisations that do not need to be learnt (Scheiner et al., 2004). In terms of their acoustics and production, we have argued that the basic non-verbal emotional expressions have more in common with mammal vocalisations than they do with human speech (Scott et al., 2009).

I first became interested in laughter as I was working on these non-verbal expressions of emotion, initially so that we could test neuropsychological patients with vocal equivalents of tests of facial expressions of emotion (e.g. Scott et al., 1997), and more latterly as an interesting

channel for emotional expression in their own right (Sauter, Calder et al., 2010). The emotions we were working with in the mid-1990s (fear, sadness, happiness, anger, disgust, surprise) were those previously identified by Paul Ekman and colleagues (Ekman et al., 1969) as expressions of basic emotions – that is, emotions hypothesised to have distinct expressions, different neurobiological profiles, be found in all human cultures and have an older evolutionary heritage (Ekman, 1992). Work by Ekman and his team had demonstrated that facial expressions of the 'basic' emotions (fear, anger, disgust, happiness, sadness, surprise) were recognised cross-culturally, and neuropsychological work in the 1990s found evidence for distinct neural systems involved in processing facial expressions of at least some of the emotions, such as disgust and fear (Broks et al., 1998, Sprengelmeyer et al., 1996), recognition of which could be selectively damaged following brain lesions.

We generated sets of emotional vocalisations (e.g. Scott et al., 1997) by giving people scenarios (e.g. 'someone you love has died') and asking them to produce non-verbal sounds that expressed how they might feel. Importantly, we did not give people example utterances to copy – any consistency across talkers was driven by their interpretation of the emotions, not because they were all attempting to model identical sounds. We also excluded any verbalised tokens (e.g. 'boo-hoo' or 'yuck'). We were after stimuli that were comparable to the facial expressions of emotion, which were entirely non-verbal.

We replicated some of the effects that had been previously demonstrated for the facial expressions of emotion with these non-verbal vocal expressions of emotion, finding that there was evidence for distinct patterns of acoustic properties that correlated with ratings of the different emotions (Sauter, Calder et al., 2010), and evidence for different neural systems

"the dominance of these negative emotions didn't relate to my experience"

## questions

Why do humans laugh?  
Are humans the only animals that laugh?

## resources

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associated with different emotions; for example, both vocal and facial expressions of fear are impaired following damage to the amygdala (Scott et al., 1997). Following several field trips to Namibia by Disa Sauter and Frank Eisner, also from my lab, we were able to demonstrate that there was bidirectional cross-cultural recognition of the emotions fear, anger, disgust, surprise and sadness by English and Himba people (Sauter, Eisner et al., 2010). Thus, English listeners recognise Himba expressions of fear, anger, disgust, surprise and sadness, and the Himba recognise the English expressions.

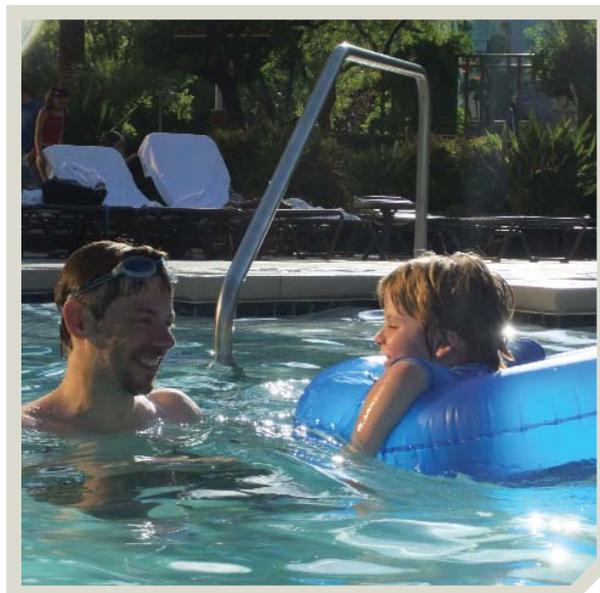
It was becoming clear that the basic emotions were not solely associated with facial expressions, but that they were also expressed with non-verbal emotional vocalisations. Further work has extended this to the body, using both static and dynamic cues, and finding that some basic emotions are well expressed through the body as well as the face and voice (e.g. Coulson, 2004). This is further evidence that it is the emotion, not one particular channel or mode of expression, which is 'basic'.

### 'The greater part of life is sunshine'

When I was first working in this area, I was struck that the basic emotions that we were working with – fear, anger, disgust, sadness, surprise and happiness – were so weighted towards negative emotions. Essentially, of the original six, four are negative, surprise is arguably neutral, or is perhaps a precursor to another emotion, and only one (happiness) is unambiguously positive. Psychology has been criticised by Barbara Fredrickson for having a profound negative bias (Fredrickson, 2003), and

the dominance of these negative emotions certainly didn't seem to relate to my everyday experience of emotions – both in terms of my own experience, and the emotions expressed by others.

At a meeting at University College London in the late 1990s I had the opportunity to ask Paul Ekman in person



Sophie Scott's partner, Tom Manly, and their son share laughter

why he thought there was such a negative bias to the basic emotions that we were all working with. Ekman explained that he thought that there would be more positive basic emotions than just 'happiness', and he had previously discussed this possibility (Ekman, 1992). Importantly, Ekman also hypothesised that these positive emotions might be primarily conveyed by the voice, rather than the face (and of course, by 'face' he was referring to still photographs). Specifically, Ekman identified the positive emotions associated with sensual pleasure, amusement, triumph, contentment and

relief as candidate positive basic expressions, and as likely to be primarily expressed by the voice (and facially with a smile). As we were already working on vocal expressions of emotion, my (then) PhD student Disa Sauter and I were inspired to test Ekman's hypothesis of a wider range of positive basic emotions that might be principally conveyed vocally, or perhaps most accurately distinguished from the voice.

We produced stimuli in the same scenario-based method described above, now for the expanded range of potential positive basic emotions, as well as for the negative emotions that I had already been investigating. Experimentally, we found some evidence for recognition of non-verbal vocal expressions of pleasure, triumph, amusement, sensual pleasure and relief in British English and Swedish listeners (Sauter & Scott, 2007), which suggested that we might refine the original list somewhat (possibly by subsuming 'contentment' into 'sensual pleasure'). However when Disa and Frank tested the recognition of these positive emotions by the Himba of North Namibia, a culture uncontaminated by Western influences, the only positive vocal emotional expression which was bidirectionally recognised was an expression of amusement, which was always expressed with laughter (Sauter, Eisner et al., 2010).

These studies provided the first concrete evidence that we could fractionate the wider emotional category of 'happiness' into different positive emotions (amusement, triumph, relief, sensual pleasure) in terms of their vocal expressions. Furthermore, we had some evidence that triumph and sensual

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## laughter

pleasure might be strongly culturally variable in their production, i.e. might not constitute 'basic' emotions. There was a suggestion that 'relief' might have elements of universality, and positive evidence that 'amusement' was bi-directionally recognised across very diverse cultures, consistent with it forming a basic emotion.

However, there was a question of what precise emotion laughter might represent. We were still largely equating laughter with amusement: however, it is much more likely that laughter reflects a basic positive social emotion, one that signals that 'our intent is play, not assault' (Provine, 2013). Robert Provine, who has been working on laughter for many years, has also suggested that we bear in mind that laughter is a social behaviour about which we do not have a lot of insight. If you ask people what makes them laugh, they will make references to jokes and humour. However, if you look at what happens when people actually laugh, it's mostly when we are talking with our friends (Provine, 1996; Vettin & Todt, 2004). We are 30 times more likely to laugh if we are with other people than if we are on our own, and it's not the case that conversing with our friends results in a stream of jokes – during conversation most of the laughter is associated with statements, and indeed people laugh most often when they are themselves speaking, rather than when they are listening (Provine, 1996). Laughter may thus be associated more with signalling affiliation, agreement and affection than it is with amusement *per se* – it may be most accurate to consider laughter as an expression of a strongly positive social emotion, which we use to form and reinforce social relationships, and which has only relatively recently been expressly linked to 'humour'.

Along these lines, laughter has been shown to be produced by people in a context-specific way. For instance, in conversation, laughter is used to mark agreement and affiliation in addition to amusement (Vettin & Todt, 2004). Antiphonal laughter – laughter produced

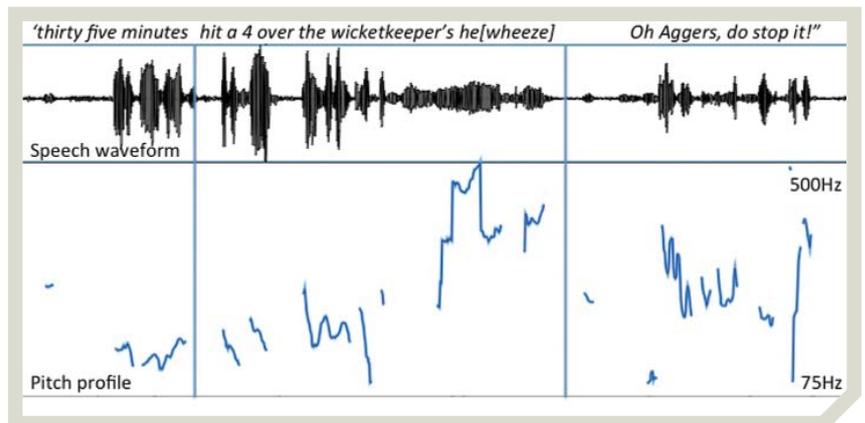
in response to another's laughter – is produced by women more in response to male laughs, and by men as an index of their familiarity with the other person (male or female) (Smoski & Bachorowski, 2003). The coordination and timing of laughter during conversation between deaf signers is similar to that seen during spoken conversation, which indicates that the timing of laughter is associated with higher-order aspects of the interaction, rather than practical aspects of how spoken language is timed (Provine & Emmorey, 2006).

This social role of laughter has been shown to be neatly modulated by the channels available for social interactions. A striking paper from Robin Dunbar's lab (Vlahovic et al., 2012) contrasted the amount of laughter that was reported to occur during, and people's ratings of positive affect after, different kinds of interactions. Using self-reports and ratings, they found that people laughed most (and were happiest) when they were in face-to-face contact with a conversational partner,

whether this was in person or online video conferencing; this effect was reduced for phone conversations, and lowest of all for text-based interactions, such as text messaging and e-mails. This is evidence that the more sources of social information that there are – face and body as well as voice – the more laughter is produced, which may itself be a direct index of how much people enjoy an interaction.

### Laughing fit to burst

The physical effort involved in laughter means that energy expenditure increases during 'genuine' laughter, by around 10–20 per cent, and raises heart rate above baseline levels (Buchowski et al., 2007), and this increased physical exercise is associated with many of the pleasant feelings associated with laughter, including the increased uptake of endorphins: this can be demonstrated as an elevated pain threshold after laughter (Dunbar et al., 2012). Laughter has some specific acoustic qualities that arise from



**Anatomy of a laugh:** Transcript of Brian Johnston (with Jonathan Agnew) laughing while trying to broadcast a cricket summary in 1990. The phrase is '35 minutes, hit a four over the wicketkeeper's head, oh Aggers, do stop it'. The upper plot shows the speech waveform, and the lower plot the estimated pitch profile. Note how high the pitch rises, from '35 minutes' to 'head', and how 'head' dissolves into a wheeze due to a spasm of the intercostal muscles. The full laughter episode is annotated here: [tinyurl.com/at8f4z7](http://tinyurl.com/at8f4z7)

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the way it is produced. In her PhD, Disa Sauter (2006) ran some experiments looking at how modifying vocal expressions of emotion (e.g. with noise vocoding: see [tinyurl.com/cemf67f](http://tinyurl.com/cemf67f)) affected the recognition of the emotions. A striking finding was that as long as the amplitude envelope of the sound was preserved, people could recognise laughter (Sauter, 2006). This was not true of other non-verbal expressions of emotion, which typically needed some pitch or spectral properties (Sauter, Calder et al., 2010). This is probably because laughter is better considered to be a different way of breathing than it is of speaking (Abercrombie, 1967, cited in Kohler, 2008), and the characteristic repetitive contractions of the intercostal muscles and diaphragm lead to a very characteristic rhythmic profile of the sound, whether it is voiced or not.

This spasming of the intercostal muscles is the source of the weakness associated with helpless, involuntary laughter – as the intercostal muscles spasm, they become unavailable for the kinds of postural support that they normally confer. This is also one cause of the unavoidable effects that laughter has on speech. Human speech entails a very specific way of breathing out, such that a controlled flow of air passes through the larynx, and the vocal folds are vibrated to give the voice pitch and quality. This involves incredibly fine control of the intercostal muscles in controlling subglottal pressure: at first they need to prevent all the air rushing out, and as the air is released from the lungs, the intercostal muscles start to need to squeeze the air out to maintain the subglottal pressure. This is possible because of our upright gait – we have freed up our ribcage from a lot of its role in posture, and this enables us to use it to produce long controlled breaths when speaking (MacLarnon & Hewitt, 1999). Try talking to someone while doing press-ups and you will instantly notice how hard speech becomes when you need your ribcage to support your weight directly.

The high subglottal pressures generated when people laugh result in extremely high-frequency sounds being produced, far higher than those seen during normal speech production (Amoss et al., 2011), and these pitches increase as with increases in physiological arousal in the person laughing. It also leads to wheezes, snorts, grunts and glottal whistles. Listeners are very sensitive to these acoustic cues; for example, listeners find laughs produced with an 'open' mouth to be more positive than those produced with a closed mouth (Owren & Riede, 2010). There is a common assessment that 'voiced' or sung laughter is associated with higher positive valence than unvoiced laughter, snorts, etc., especially when participants are rating female laughter (Bachorowski & Owren, 2001). This has been interpreted as a deliberate use of laughter to control the affective response of a listener (Owren & Bachorowski, 2003).

### They all laughed

The bonding effects of laughter can be briskly diminished if one is excluded from laughter. I was on Ipswich railway station last year when some teenagers tapped me on the shoulder, then ran away. Their helpless mirth when I looked to see who had tapped my shoulder filled me with intense irritation and anger, because although their laughter was warm and genuine, it was directed at me, and there was no question – I was not included in that laughter group. Although



## 'Corpsing' in the studio

The studio might be the place to record that single take of pop perfection, but those attempts are often hijacked by hilarity. Here are some examples of laughter in song:

- New Order – Every Little Counts
- Arctic Monkeys – Love Machine (Live Lounge)
- Bob Dylan – Bob Dylan's 115th Dream
- The Beatles – And Your Bird Can Sing (Anthology version)
- The Divine Comedy – A Drinking Song
- Joni Mitchell – Big Yellow Taxi
- Ryan Adams – To Be Young

I have no great desire to befriend young men at train stations, this exclusion was an unpleasant sensation. Previous research has expressly tried to identify what characterises a 'taunting' laugh from a 'joyful' laugh (Szameitat et al., 2009), but any laugh is capable of sounding highly evil if one is on the receiving end of it. Just as laughter can be used as a way of bonding with others, it can also be used as a clear way of excluding others from a laughing group.

The question of emotional authenticity is important though: the ways that we laugh when we are helpless with laughter are very different from the kind of social laughter that we produce when we are talking to our friends. The difference may be best characterised as voluntary versus involuntary laughter (Gervais & Wilson, 2005). People are very good at distinguishing between mirthful and social

infants. *Folia Phoniatrica et Logopaedica*, 56, 27–40.  
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## laughter

laughter (Lavan et al., 2012), which likely reflect their different social meanings. We have also found several acoustic and phonetic differences between voluntary social laughter and involuntary mirthful laughter. Some of these link directly to the greater forces generated during involuntary laughter, which lead to high-frequency wheezes and glottal whistles that are extremely hard to produce voluntarily. We have also found that social laughter can be nasalised, while involuntary laughter is never nasalised (in our data sets). This suggests that social laughs are not necessarily simply weaker forms of 'real' laughs, but have their own clear markers, reflecting their social importance. This may also mean that social laughter may be more culturally variable than involuntary laughter, but that remains an empirical question.

### Laughter on the brain

The strong social importance of laughter can also be seen in the brain responses to the sounds of laughter. We have investigated the role of orofacial 'mirror' systems – brain areas that are activated both by hearing emotional vocalisations and by silently moving the face (Gazzola et al., 2006) – when people listen passively to emotional vocalisations (laughter, cheering, disgusted sounds, fearful sounds) (Warren et al., 2006). Mirror systems are recruited both by perception and production of the same kind of event, and are typically discussed as being directly analogous to the mirror neurons as they are described from the single-cell recording literature. There has been a lot of discussion about what this common activation of production systems by perception means, from ideas around the obligatory use of motor representations to recognise actions, through to the suggestion that they may simply reflect basic associations through a lifetime of paired presentations (Catmur et al., 2007). When we interrogated our data further, we found that the orofacial 'mirror system' was not equally activated by all the emotional vocalisations, and that there was a significant relationship

between ratings of the valence of the stimuli and activation in lateral premotor fields. The 'mirror' responses are thus not equivalent across all emotional expressions, and showed instead greater activation for the stimuli rated as more positive – triumph and amusement (laughter). We were interested in these



There are several acoustic and phonetic differences between voluntary social laughter and involuntary mirthful laughter

effects as it suggested that whatever the role of motor cortex during the perception of vocal emotional expressions, it was unlikely to reflect recognition processes (as all the stimuli were well recognised) or simulation processes, as there is no *a priori* reason why these should differ with valence. The 'mirror' response was also unlikely to reflect emotional contagion, as disgust (a very negatively rated emotion) is typically highly emotionally contagious. Instead, the effects seemed to be rooted in some more behavioural effects. The positive emotions we tested – triumph and amusement (laughter) – are highly social emotions, and 'mirroring' in social interactions is typically associated with positive affect. These motor responses may also reflect more direct 'priming' of behaviour: laughter is immensely

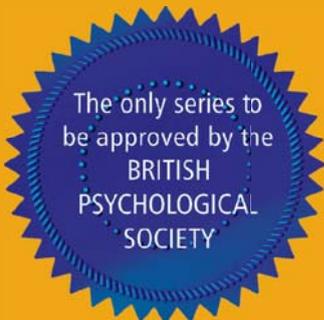
contagious (Provine, 1992), and we may be seeing a neural correlate of this behavioural contagion reflected in this motor activation. Another fMRI study, of yawning, showed that the more behaviourally contagious participants found a yawn (short of actually yawning), the more activation was found in orofacial 'mirror' regions (Arnott et al., 2009). However, the effect in our 2006 study was strong for laughter, but even stronger for triumphant sounds such as cheering: this is rated as an extremely positive and arousing emotion, but it is not behaviourally as contagious as laughter (or yawning). This may mean that for the laughter and triumph sounds, we are seeing a priming of more general smiling responses, rather than a more specific priming of particular emotional vocalisations. This would still be consistent with a role of mirror responses for positive social emotions, which, Ekman has pointed out, tend to share a smile (1992).

### You and me baby ain't nothing but mammals

The theory of basic emotions (Ekman, 1992) suggests that analogues of the basic emotions, which have older evolutionary histories than more culturally determined emotions, would be found in and expressed by other mammals (see also Darwin, 1872). From Aristotle to Nietzsche, laughter has been suggested to be something found only in humans, but there is now abundant evidence that laughter is found across a variety of different mammals, from gorillas to rats (Panksepp, 2005). Work with chimpanzees has shown that their laughter is modulated by social context – laughs produced when chimps are tickled differ from those produced in response to the laughter of others (Davila-Ross et al., 2011). Thus when humans laugh, we are engaging in a positive social emotional behaviour that has its roots in our evolution as mammals. Now, that's funny.



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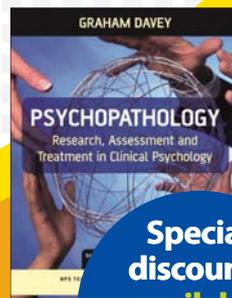
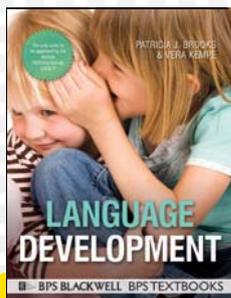
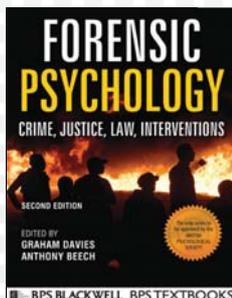
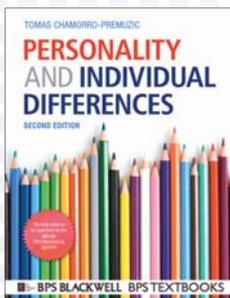
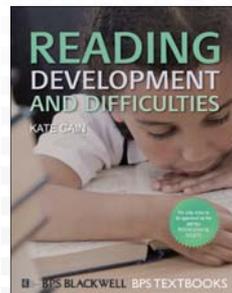
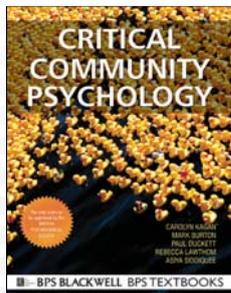
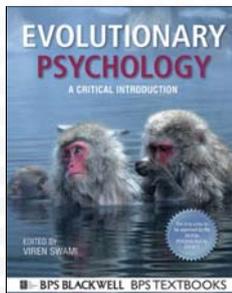
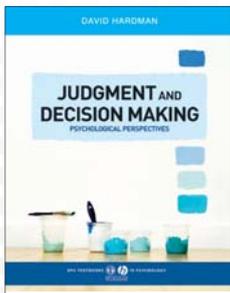
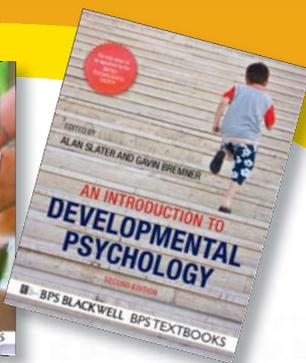
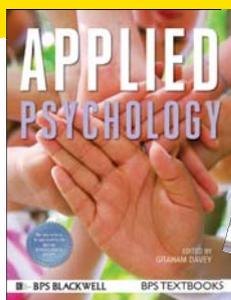
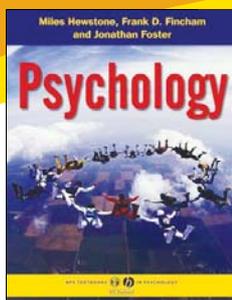
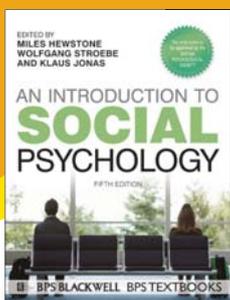


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