The emerging science of human screams

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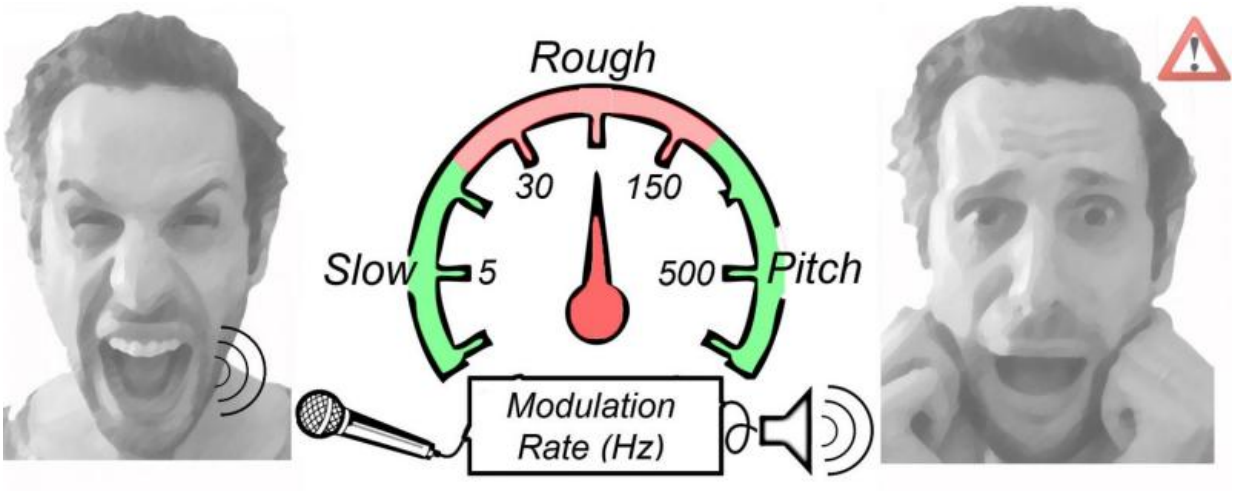

A property called roughness gives human screams their fear-inducing quality. Credit: Luc Arnal

Our noisy world is no match for a screaming infant. An airplane could be flying by as a house party rages on downstairs while a literal cat fight takes place outside, and still a wailing baby will win your attention. One possible explanation, published July 16 in the journal *Current Biology*, is that human screams possess a unique acoustic property found to activate not just the auditory brain but also the brain's fear circuitry.

"If you ask a person on the street what's special about screams, they'll say that they're loud or have a higher pitch," says study senior author David Poeppel, who heads a speech and language processing lab at New

York University. "But there's lots of stuff that's loud and there's lots of stuff that's high pitched, so you'd want a scream to be genuinely useful in a communicative context."

Humans make a variety of meaningful noises. Part of what makes us human is how our ears can distinguish speech patterns made from vowels and consonants, which is a step above being able to identify whether a sound is made by a male or female, or by our species or another species. Where in the brain we process this information is known, but there was one area that scientists assumed didn't have much to do with human communication. This is where screams come in.

After noticing how little research had been done on human screams, Poeppel's post doc Luc Arnal, now at the University of Geneva, led a series of studies to analyze the properties of screams. Because there is no repository of human screams, the researchers used recordings taken from YouTube videos, popular films, and volunteer screamers, who were asked to give their all in the lab's sound booth. The researchers plotted the sound waves in a manner that reflects the firing of auditory neurons, and they noticed that screams activate a range of acoustic information that scientists hadn't considered to be important for communication.

"We found that screams occupy a reserved chunk of the auditory spectrum, but we wanted to go through a whole bunch of sounds to verify that this area is unique to screams," says Poeppel, who also directs the Frankfurt Max-Planck-Institute Department of Neuroscience. "In a series of experiments, we saw [that] this observation remained true when we compared screaming to singing and speaking, even across different languages. The only exception—and what was peculiar and cool—is that alarm signals (car alarms, house alarms, etc.) also activate the range set aside for screams."

What sets screams and alarms apart from other sounds is that they have a

property called roughness, which refers to how fast a sound changes in loudness. Normal speech patterns only have slight differences in loudness (between 4 and 5 Hz), but screams can modulate very fast (varying between 30 and 150 Hz). When Arnal and his team asked people to judge screams on how frightening they were, those with the highest roughness came across as the most terrifying. Modifying the sound wave of a non-scream to be rougher can also make it scream-like. The researchers then confirmed that increases in roughness correspond to more activation of the fear response in the human amygdala.

The finding is also evidence that acoustical engineers have been tapping into the property of roughness just by trial and error. Alarms and movie shrieks do their job of getting our attention, but perhaps they can be better. "These findings suggest that the design of alarm signals can be further improved," Arnal says. "The same way a bad smell is added to natural gas to make it easily detectable; adding roughness to alarm sounds may improve and accelerate their processing."

The researchers plan to continue investigating human screams in the lab, particularly those of infants, to see if their screams are particularly rough. The researchers would also like to apply their analyses to animal screams to learn how much this trait is conserved across species.

"Screaming really works," Poeppel says. "It is one of the earliest sounds that everyone makes—it's found across cultures and ages—so we thought maybe this is a way to gain some interesting insights as to what brains have in common with respect to vocalization."

More information: L. H. Arnal, A. Flinker, A. Kleinschmidt, A. Giraud, D. Poeppel, Human Screams Occupy a Privileged Niche in the Communication Soundscape , *Current Biology*, Online Advance Publication, 16 July 2015. dx.doi.org/10.1016/j.cub.2015.06.043

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