Credit: designer491 / Alamy Stock Photo

Previous work had reported potential 'backfire' effects of topic rebuttals; that is, when audiences feel threatened by the science advocate's arguments and in response reject them. The current study found no backfire effect and thus supports the use of topic rebuttals. Combining both types of rebuttal had the same protective effect as individual rebuttals, which supports the less complex approach of using only one type.

Technique rebuttals are universally applicable and can be used for different domains. Indeed, the authors found in an additional experiment that technique rebuttals mitigate the effects of a science denier on attitudes towards climate change.

In conclusion, pointing out flawed arguments and highlighting scientific facts both work to mitigate the negative effects of science deniers. However, the authors point out that not giving science deniers the platform to influence audiences is the preferred option. If there is a debate, though, it is important that science advocates stand up for the facts.

Ursula Hofer

ORIGINAL ARTICLE Schmid, P. & Betsch, C. Effective strategies for rebutting science denialism in public discussions. *Nat. Hum. Behav.* https://doi.org/10.1038/s41562-019-0632-4 (2019)

curvature. There was a lot of diversity, ranging from short beans or commas to long hot-dog shapes.

The authors then used the elongation and curvature data to model the performance landscapes across an array of shapes for a number of tasks, including swimming, chemotaxis and ease of cell construction. These computer simulations found that a slightly elongated straight rod, similar to a medicine capsule, was the best shape for swimming. However, many other shapes had only marginally reduced swimming efficiency, except for very elongated, straight rods. By contrast, being slightly curved and very long was optimal for chemotactic performance, as elongation reduces the chance of being thrown off course by Brownian motion. However, building a curved cell wall is costly, as is having a large surface area, and therefore the easiest cell shape to build was a coccus.

These results indicate that there are complex trade-offs; at the same time, there is pressure to be short and straight for ease of building, to be long for chemotaxis and to be curved to avoid a swimming penalty. Improving at one task would compromise performance at another task. The authors modelled these trade-offs and found a 'morphospace' of possible shapes in which overall performance is optimized, although the weight of each task varied for specific morphologies. Most observed bacteria fell into this morphospace and many were generalists, attempting to optimize all three tasks, whereas a few specialized in one or two tasks. There were only two outliers, one of which, *Leptospirillum ferroxidans*, might have assumed its extreme C-shape to optimize surface contact.

In conclusion, this elegant study used simple cell images and a set of sophisticated models to shed light on the outcome of millions of years of natural selection by conducting supercomputing simulations of the motile behaviour of an array of bacteria.

Ursula Hofer

ORIGINAL ARTICLE Schuech, R. et al. Motile curved bacteria are Pareto-optimal. *Proc. Natl Acad. Sci. USA* https://doi.org/10.1073/pnas.1818997116 (2019)

IN BRIEF

CLINICAL MICROBIOLOGY

Causes of severe pneumonia in children

Pneumonia is one of the leading causes of death among children younger than 5 years. The Pneumonia Etiology Research for Child Health (PERCH) study reports the results of a case–control study to characterize the causes of childhood pneumonia. The researchers enrolled children aged 1–59 months without HIV infection who were admitted to hospital with severe pneumonia. The study included sites in seven countries in Africa and Asia in low-income and lower-middle-income settings. The results of the study revealed that ten pathogens were responsible for 79–90% of cases, viruses accounted for ~61% of pneumonia and bacteria accounted for ~27%. In particular, respiratory syncytial virus (RSV) was the most common cause of pneumonia at all sites, accounting for ~31%. The findings have implications for the prevention and treatment of pneumonia in those areas and underscore the importance of the development of an RSV vaccine.

ORIGINAL ARTICLE The Pneumonia Etiology Research for Child Health (PERCH) study group. Causes of severe pneumonia requiring hospital admission in children without HIV infection from Africa and Asia: the PERCH multi-country case-control study. *Lancet* https://doi.org/10.1016/S0140-6736(19)30721-4 (2019)

BACTERIAL PHYSIOLOGY

An effector with nuclease activity

Bacteria can interact with eukaryotic cells through contractile injection systems (CISs), which are evolutionarily related to the tails of bacteriophages. One type of CISs, extracellular CISs (eCISs), is released extracellularly, followed by binding to the surface of target cells and delivery of toxic effectors. Rocchi, Ericson, Malter et al. studied the interaction between an eCIS from *Pseudoalteromonas luteoviolacea* called metamorphosis-associated contractile structures (MACs) and insect and mammalian cells. They identified a new MAC effector, which they termed *Pseudoalteromonas* nuclease effector, that caused cytotoxicity in both cell types. They went on to show that killing was mediated by the nuclease activity of the bacterial effector protein. In sum, the study identifies the first CIS effector with nuclease activity that targets eukaryotic organisms.

ORIGINAL ARTICLE Rocchi, I., Ericson, C. F., Malter, K. E. et al. A bacterial phage tail-like structure kills eukaryotic cells by injecting a nuclease effector. *Cell Rep.* **28**, 295–301.e4 (2019)

PHAGE BIOLOGY

Phages ensure their survival

During the lysogenic life cycle, the genome of temperate phages is integrated into the bacterial chromosome. Following induction of the lytic life cycle, phage DNA is packaged into virions and phage progeny is released by host cell lysis. Thus, phages are considered to be parasites that exploit bacterial cells for survival and proliferation; however, the phage–host interaction is also mutualistic. For example, phages drive bacterial evolution by delivering bacterial DNA fragments to neighbouring bacteria by generalized transduction. This study reports that DNA transfer not only benefits the recipient host but also the transducing phage. The authors showed that transduction of antibiotic resistance genes and lysogeny contribute to the survival of transducing phages and their hosts, as recipient cells become resistant to both antibiotics and phage attack. They propose that generalized transduction is an evolved mutualistic trait whereby temperate phages cooperate with their hosts to survive.

ORIGINAL ARTICLE Fillol-Salom, A., Alsaadi, A., Moura de Sousa, J. A. et al. Bacteriophages benefit from generalized transduction. *PLOS Pathog.* https://doi.org/10.1371/journal.ppat.1007888 (2019)