From the archive

Making the connection between mosquitoes and disease, and reports of volcanic activity at Mount Vesuvius.

100 years ago

The death of Sir Patrick Manson ... has taken from the medical profession one of its most distinguished leaders ... [I]t was not until 1874 ... that he learned fully of Lewis's discovery of a microscopic filaria ... in the blood ... [H]e saw that the series of events by which the microfilariae living in the blood of one man became the adult filariae living in ... other men ... might possibly be initiated by ... a mosquito ... He ... demonstrated the essential realities of a great original conception ... that a common bloodsucking insect is *the essential factor* in the maintenance and dissemination of a ... parasitic disease. In 1894 ... Manson found his opportunity of applying this great principle to the problem of malarial infection ... Manson's mosquito-malaria theory ... inspired and guided Ross in his wonderful discovery of the sexual cycle of the malaria parasite.

From *Nature* 6 May 1922

150 years ago

The great eruption of Mount Vesuvius, with the telegraphic accounts of which the readers of the daily papers have been familiar for the past week, is undoubtedly one of the most considerable of modern times. Whether the worst is yet over seems still uncertain while we are writing; but even if this be the case, the mass of molten lava ejected, and the amount of damage done, will appear to bear comparison with those of almost any recent eruption. One account speaks of it as the grandest eruption since 1631 ... The fall of cinders, even at Naples, is spoken of as so heavy that the sky seemed hidden by them, and they fell everywhere like rain ... [P]eople were walking with umbrellas to protect themselves from the downpour ... Great credit is due to Prof. Palmieri, who has remained at his post at the Observatory to watch the eruption, and from whose observations a great advance of science may be anticipated.

From *Nature* 2 May 1872

spontaneously through interactions between the constituent molecules[13]. Another challenge would be to engineer a way of avoiding the need for bespoke illumination conditions that involve continuously switching the light on and off[14].

Although the authors showed that their artificial cilia could display complex movements reminiscent of cilia in living organisms, these structures are yet to rival their natural counterparts in terms of functionality. In biological systems, the beating of cilia is used to make a cell swim and to support the varied motile dynamics that enable the survival[15] and competitive behaviour of bacteria[16]. Moving from motion to motility requires materials to show even better performance than that reported by Li and colleagues, calling for smaller structures, faster movement and higher amplitudes of oscillation. However, the authors' work represents a crucial step towards functional artificial cilia. Along the way, it will doubtless inspire advances in microfluidics, and might even propel our understanding of cilia and cellular motility forward.

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1. Geyer, V. F., Howard, J. & Sartori, P. *Nature Phys.* **18**, 332–337 (2022).
2. Li, S. *et al. Nature* **605**, 76–83 (2022).
3. Purcell, E. M. *Am. J. Phys.* **45**, 3–11 (1977).
4. Jarrell, K. F. & McBride, M. J. *Nature Rev. Microbiol.* **6**, 466–476 (2008).
5. Groppi, J., Baroncini, M., Venturi, M., Silvi, S. & Credi, A. *Chem. Commun.* **55**, 12595–12602 (2019).
6. Gelebart, A. H. *et al. Nature* **546**, 632–636 (2017).
7. Burgert, I. & Fratzl, P. *Phil. Trans. R. Soc. A* **367**, 1541–1557 (2009).
8. Iamsaard, A. *et al. Nature Chem.* **6**, 229–235 (2014).
9. Asshoff, S. J. *et al. Angew. Chem. Int. Edn* **56**, 3261–3265 (2017).
10. Wani, O. M., Zeng, H. & Priimagi, A. *Nature Commun.* **8**, 15546 (2017).
11. Liu, L. *et al. Adv. Opt. Mater.* **8**, 2000732 (2020).
12. Pilz da Cunha, M., Debije, M. G. & Schenning, A. P. H. J. *Chem. Soc. Rev.* **49**, 6568–6578 (2020).
13. Cholakova, D. *et al. Nature Phys.* **17**, 1050–1055 (2021).
14. Lancia, F., Ryabchun, A. & Katsonis, N. *Nature Rev. Chem.* **3**, 536–551 (2019).
15. Miyata, M. *et al. Genes Cells* **25**, 6–21 (2020).
16. Gude, S. *et al. Nature* **578**, 588–592 (2020).

The authors declare no competing interests.

Human behaviour

Virtual collaboration hinders idea generation

Emőke-Ágnes Horvát & Brian Uzzi

Experiments and fieldwork show that teams working together online produce fewer ideas than those collaborating in person — a first step towards answering the question of which modes of communication are generally best for creativity. **See p.108**

Despite some awkward fumbling with Zoom, many workers have adopted videoconferencing as the new normal for interacting with socially isolated colleagues during the COVID-19 pandemic, and are increasingly demanding to work from home permanently. The resulting shift from in-person teamwork to virtual collaborations has become a central concern for employers and educators. On page 108, Brucks and Levav[1] provide fresh insight into how the creativity of teams collaborating through videoconferencing stacks up against that of teams working together in person.

Conventional wisdom holds that innovation is driven by in-person interactions that bring diverse perspectives together through a fluid, back-and-forth dialogue rich in verbal information and body language (Fig. 1). Seminal research[2] has shown that many great innovations in mathematics, science and the arts from the likes of Charles Darwin, the Funk Brothers and Marie Curie came about because of in-person interactions in teams or networks — a trend that still holds in many modern fields of endeavour[3,4]. Indeed, the scarcity of in-person meetings during the COVID-19 pandemic has been blamed for permanently denting scientific innovation[5]. With so much at stake, it is crucial to understand how computer-mediated interactions change creative thinking.

Brucks and Levav compared how two measures of creativity — ideation performance and idea-selection quality — differ when teams interact virtually or in person. Ideation performance quantifies the number of ideas generated. This is a key metric, because the more ideas there are, the greater is the potential for finding good solutions to problems. As the two-time Nobel laureate Linus Pauling was fond of saying, "The best way to have a good idea is to have lots of ideas."

Idea-selection quality characterizes how

EELKE DEKKER/FLICKR (CC BY 2.0)

Figure 1 | Brainstorming. Innovation at meetings attended in person is often thought to be driven by interactions between people that might not be reproduced during online meetings. Brucks and Levav[1] report that fewer ideas are generated by teams working together in videoconferences than by teams meeting in person.

well the best idea is chosen from a bunch. Although ideation precedes idea selection, selection is not necessarily less important than ideation, and creative treasures can easily be overlooked during selection processes. For example, Stephen King's *Carrie* was rejected 30 times by publishers, and Joseph Heller's *Catch-22* was rejected (oddly enough) 22 times.

On studying how the mode of communication affects people's creativity, Brucks and Levav made a fundamental finding: in-person meetings result in better ideation performance than do virtual collaborations. However, there is no difference between the two collaborative approaches in terms of the quality of the ideas selected.

A particular strength of this research is its scale and scope. The findings are backed up by impressive evidence obtained both from laboratory experiments and from field studies of teams at an engineering firm who work in five countries. Furthermore, the authors controlled for many confounding factors to rule out alternative explanations for their findings. For example, they recorded conversations and used eye-tracking technology to help measure the links between speech, language, gestures and creativity. They also measured a wide range of control variables in their experiments to account for factors such as variation in screen size, the similarity of ideas (rather than just the number of ideas), and the participants' internal psychological processes, facial mimicry and feelings of connection.

In addition to the well-substantiated core findings about ideation and selection, the study raises questions about creativity, which are of both theoretical and practical interest. Creativity is the recombination of existing ideas in new and useful ways within a given set of technical, financial or other constraints[6,7]. What aspects of that process could explain the different effects of virtual and in-person interactions observed by Brucks and Levav? The authors think that the use of video screens limits the amount of information that can be shared between team mates during virtual communications. This should now be tested experimentally, along with related proposals suggested by other researchers about the role of a team's demographic diversity[8] or leadership[9].

In the real world, the cost of creativity is of paramount concern. If, for argument's sake, virtual collaborations produce 20% fewer ideas than do in-person teams, but at 40% of the cost, then the cost per idea is greater for in-person teams than for virtual collaborations. From this perspective, virtual meetings would be more productive than in-person meetings. Indeed, many organizations use innovation platforms such as GitHub and InnoCentive — which mainly involve virtual collaborations — because they generate ideas as innovative as those produced by in-person meetings, but at a lower cost.

It should also be noted that people who come up with creative ideas often do not have sole responsibility for choosing their best ideas. People outside the ideation process, such as critics and audiences, can have key roles in ideation and selection, too — especially in consumer markets[10], but increasingly in research as well[11].

Working out how different modes of interaction affect the creative process is therefore complex and requires further study. Brucks and Levav's work is a sure-footed step towards understanding how two different modes of communication affect ideation and selection, and provides an exciting start for further research into the effects of technology on human creativity.

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1. Brucks, M. S. & Levav, J. *Nature* **605**, 108–112 (2022).
2. Collins, R. *Phil. Soc. Sci.* **30**, 157–201 (2000).
3. Wuchty, S., Jones, B. F. & Uzzi, B. *Science* **316**, 1036–1039 (2007).
4. Uzzi, B. & Spiro, J. *Am. J. Sociol.* **111**, 447–504 (2005).
5. Gao, J., Yin, Y., Myers, K. R., Lakhani, K. R. & Wang, D. *Nature Commun.* **12**, 6188 (2021).
6. Negus, K. & Pickering, M. *Creativity, Communication and Cultural Value* (Sage, 2004).
7. Mukherjee, S., Romero, D. M., Jones, B. & Uzzi, B. *Sci. Adv.* **3**, e1601315 (2017).
8. Vásárhelyi, O., Zakhlebin, I., Milojević, S. & Horvát, E.-Á. *Proc. Natl Acad. Sci. USA* **118**, e2102945118 (2021).
9. Asencio, R., Murase, T., Chollet, B., DeChurch, L. A. & Zaccaro, S. J. *Group Dyn.* https://doi.org/10.1037/gdn0000172 (2021).
10. Spitz, A. & Horvát, E.-Á. *PLoS ONE* **9**, e108857 (2014).
11. Priem, J. & Costello, K. L. *Proc. Am. Soc. Inf. Sci. Technol.* **47**, 1–4 (2010).

The authors declare no competing interests.
This article was published online on 27 April 2022.