The discovery of graphene marked the beginning of the thriving field of 2D materials. Many classes of these materials have since been discovered and intensively investigated, but surprisingly little experimental research has been reported in the area of new 2D carbon materials. Several 2D carbon allotropes — that is, isomers of graphene — have been proposed in theoretical studies, some of which are predicted to have remarkable properties. However, a lack of methods for synthesizing these allotropes has prevented their preparation.

This is starting to change, and graphene isomers such as a biphenylene network[4] and γ-graphyne[5] have been synthesized in the past year or so. Like Hou and colleagues' polymer, these materials might exhibit anisotropic conductivity and other exotic properties[6]. Such experimental breakthroughs are expected to revive interest in 2D carbon materials and could eventually lead to device applications.

In retrospect, it seems logical that the polymerization of buckyballs can be used to make new low-dimensional (1D or 2D) carbon materials. It has long been known that heating these molecules under pressure[7] or with alkali metals such as potassium[8] can lead to the formation of low-dimensional polymers such as 1D chains[7] or 2D sheets[9]. However, it was not possible to isolate single layers of these carbon polymers. Other work has shown that reactions of molecules in their crystals can lead to the formation of 2D polymers, which can then be exfoliated[10]. Hou and colleagues' key advance is to combine these previously reported approaches to achieve a refined synthesis, exfoliation and characterization of monolayer sheets formed from polymerized buckyballs.

The explosion of detailed investigations into 2D materials such as graphene occurred only after methods for exfoliating single sheets from the analogous layered materials became available. Hou and co-workers' findings similarly open up their 2D carbon polymer to further investigation, and the current sizes of the sheets (up to 80 micrometres) should be large enough to enable the experimental demonstration of certain applications in electronic devices. More broadly, the current study shows that the bulk synthesis and subsequent exfoliation of layered carbon crystals is a promising general approach for the production of new carbon nanomaterials, and one that could be scaled up more easily than alternative methods, such as the synthesis of 2D materials on surfaces.

J. Michael Gottfried is in the Department of Chemistry, Philipps University of Marburg, 35032 Marburg, Germany.
e-mail: gottfrim@uni-marburg.de

1. Hou, L. *et al. Nature* **606**, 507–510 (2022).
2. Kroto, H. W., Heath, J. R., O'Brien, S. C., Curl, R. F. & Smalley, R. E. *Nature* **318**, 162–163 (1985).
3. Novoselov, K. S. *et al. Science* **306**, 666–669 (2004).
4. Fan, Q. *et al. Science* **372**, 852–856 (2021).
5. Hu, Y. *et al. Nature Synth.* https://doi.org/10.1038/s44160-022-00068-7 (2022).
6. Alcón, I. *et al. J. Am. Chem. Soc.* **144**, 8278–8285 (2022).
7. Iwasa, Y. *et al. Science* **264**, 1570–1572 (1994).
8. Pekker, S. *et al. Science* **265**, 1077–1078 (1994).
9. Goze, C. *et al. Phys. Rev. B* **54**, R3676–R3678 (1996).
10. Kory, M. J. *et al. Nature Chem.* **6**, 779–784 (2014).

The author declares no competing interests.

Psychology

Offering facts can improve COVID vaccine uptake

Nina Mažar

Informing people once about physicians' views on COVID-19 vaccination improves vaccination rates by 4 percentage points after 9 months. This finding suggests that light-touch educative nudges can have lasting positive effects. **See p.542**

The development, production and distribution of an effective vaccine against the coronavirus SARS-CoV-2 was an unprecedented effort, involving billions of dollars' worth of investment. Countries now face another challenge: how to convince everyone to take it. Distrust of and misinformation about the vaccine, about health and state agencies, and about experts has contributed to vaccine hesitancy[1]. Bartoš *et al.*[2] report on page 542 that vaccine uptake can be boosted through a one-time intervention: communicating physicians' actual views on COVID-19 vaccination.

Bartoš and colleagues conducted their experiment in the Czech Republic, which as of April 2022 ranks second highest out of 53 of the world's biggest economies in terms of deaths per capita since the start of the pandemic (see go.nature.com/3n4hqzq). The authors took advantage of the fact that a large share of people in the Czech Republic (73%) agree that physicians in their country can be trusted[3].

The researchers presented around half of 2,101 participants with the results of a survey that they conducted together with the Czech Medical Chamber, which asked 9,650 physicians from around the country for their views on COVID-19 vaccination. The survey found that 90% of physicians were interested in getting vaccinated (or were already vaccinated), that 95% were planning to recommend vaccination to their healthy patients, and that 89% were trusting of COVID-19 vaccines approved by the European Medicines Agency. Participants received these results after being asked for their opinions about physicians' views on COVID-19 vaccination.

Bartoš *et al.* delivered this educative nudge[4] once, in mid-March 2021 — two months after the start of the vaccine roll-out. They followed this up with 11 more waves of data collection, involving the same participants and lasting

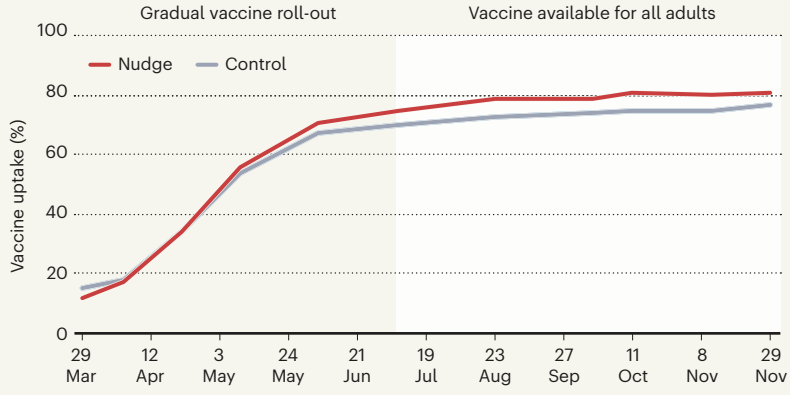

Figure 1 | Changing vaccine uptake after a light-touch intervention. In 2021, Bartoš *et al.*[2] presented people with information about physicians' views around COVID-19 vaccination, and examined how this one-time nudge affected vaccine uptake. This graph indicates vaccine uptake at 11 dates in the 9 months after the nudge, for participants who were exposed to the nudge and those in a control group. (Adapted from Fig. 4 of ref. 2, using the 'fixed sample, pre-registered controls' data points.)

until the end of November 2021. In each wave, they asked participants to self-report their vaccination status, later corroborated by the authors.

Before the intervention, participants, on average, thought that only 57% of physicians would want to be vaccinated and that 61% trusted the vaccines. But two weeks after the educative nudge, among participants who had been exposed to it, those percentages increased to 63% and 67%, respectively.

Comparing vaccine uptake in participants exposed to the nudge intervention and those not exposed revealed a gradually increasing and lasting effect (Fig. 1). The difference in uptake was negligible in the initial waves of data collection, when vaccine roll-out was limited, but in July 2021, once vaccines became freely available to all adults, uptake in the exposed group was 4–5 percentage points higher — a significant increase. The difference in vaccine uptake between groups then remained relatively stable until the end of the data-collection period. Encouragingly, the authors report a similar-sized difference (4 percentage points) for participants' intentions to get a booster shot, which were solicited towards the end of the data-collection period.

This study has several strengths that make it stand out. For instance, participants were broadly representative of the adult Czech population in terms of sex, age, education and region of residence, as well as attitudes towards COVID-19 vaccines and actual vaccination rates. This suggests that Bartoš and colleagues' intervention should be effective when scaled to the country's entire population.

Furthermore, not only is this study one of very few so far that have gone beyond measuring intentions to receive the COVID-19 vaccine, it is also the only one that has tested the behavioural impact of providing corrective positive (factual) views from a trusted and relevant group of experts. Previous studies focused on interventions such as potential monetary rewards (for example, lottery prizes for vaccine recipients) and text messages that communicated, for instance, the benefits of vaccination, vaccine effectiveness and safety or social norms surrounding vaccination[5]. In addition, because Bartoš *et al.* collected longitudinal data over different phases of the vaccine roll-out, their results allowed them to observe that the effect is lasting, and to infer that the intervention did not simply speed up uptake, but actually increased it in an otherwise hesitant subpopulation.

At the same time, the study is not without limitations, particularly with regard to how to successfully translate its insights to other contexts or scale it up[6]. First, the intervention was motivated by factors specific to the Czech Republic: widespread trust in physicians; very high prevalence among physicians of positive views on COVID-19 vaccination; and people's severe underestimation of this prevalence. However, the authors did not establish that the effect of their educative nudge was dependent on, or caused by, these factors.

Second, because of the experiment's design and the fact that participants were split into only two groups (one receiving the nudge, the other receiving no information), the authors cannot establish the contribution of each design feature to their result. For example, to what extent did it matter that participants were asked for their opinions about physicians' views before half of them received the nudge? And what was the contribution of each of the three pieces of information about physicians' views?

Finally, even though the study was conducted with a sample representative of the Czech population, it is still likely to be to successfully scale up the intervention without experiencing a drop in its effectiveness[7]. For instance, the participants agreed to join a panel that would be surveyed regularly, but it might be hard to ensure that a broader population would show similar levels of engagement — in particular, attention to and trust in the nudge[8].

Nevertheless, Bartoš and colleagues' findings are exciting, to say the least. They raise the possibility that a relatively cheap and simple one-off educative nudge, targeting misperceptions[9] of physicians' views, helps to increase the uptake of lifesaving COVID-19 vaccines. Given the relatively large effect in comparison with that of some other interventions[4], I am hopeful that researchers will add this nudge to their intervention toolkit. Going forward, researchers should consider trialling this nudge in other countries and for other public-health interventions, if the settings are otherwise similar. Ideally, this work will also inspire researchers to identify some of the mechanisms underlying the effect observed by Bartoš and colleagues, to better understand the generalizability of these findings.

Nina Mažar is at the Questrom School of Business, Boston University, Boston, Massachusetts 02215, USA.
e-mail: nmazar@bu.edu

1. Roy, D. N., Biswas, M., Islam, E. & Azam, M. S. *PLoS ONE* **17**, e0265496 (2022).
2. Bartoš, V., Bauer, M., Cahlíková, J. & Chytilová, J. *Nature* **606**, 542–549 (2022).
3. Blendon, R. J., Benson, J. M. & Hero, J. O. *N. Engl. J. Med.* **371**, 1570–1572 (2014).
4. Sunstein, C. R. *Nature Hum. Behav.* **6**, 9–10 (2022).
5. Batteux, E., Mills, F., Jones, L. F., Symons, C. & Weston, D. *Vaccines* **10**, 386 (2022).
6. Mažar, N. & Soman, D. *Behavioral Science in the Wild* (Univ. Toronto Press, 2022).
7. List, J. A. *The Voltage Effect* (Penguin Random House, 2022).
8. Kettle, S., Hernandez, M., Sanders, M., Hauser, O. & Ruda, S. *Behav. Sci.* **7**, 28 (2017).
9. Pennycook, G. *et al. Nature* **592**, 590–595 (2021).

The author declares no competing interests.
This article was published online on 1 June 2022.

Genetics

Potato genomes pave the way to crop improvement

Juanita Gutiérrez-Valencia & Tanja Slotte

High-quality genome sequences for 44 wild and cultivated potatoes will enable researchers to better study this essential crop's evolution and develop varieties that can withstand heat and drought caused by climate change. **See p.535**

Potatoes are the third most consumed food crop worldwide, after wheat and rice[1]. To safeguard crop yields in the face of climate change, improved varieties will be needed. Tang *et al.*[2] describe on page 535 the sequencing and analysis of high-quality genomes from wild and cultivated potatoes. This pangenome should increase our understanding of fundamental aspects of potato biology and guide breeding practices.

Improvement of potato crops is hampered by some of the intrinsic features of commercially grown potatoes. For instance, these crops typically have four sets of chromosomes and do not breed true (offspring do not necessarily carry the same traits as parental plants). As such, developing new varieties is complex and time consuming.

Breeding of diploid potatoes (which have two sets of chromosomes) could speed up the development of improved potato varieties[3,4] that could withstand drought and diseases. It could also allow development of inbred lines, which lack genetic variation and can be crossed to generate uniform, high-yielding hybrids[3,4]. Locally cultivated varieties (called landraces) and wild potato species (Fig. 1) could be especially useful in this respect, because most are diploid and they harbour a wealth of untapped genetic variation that could be