errors that often plague these systems — and eventually perform calculations that aren't feasible for classical computers.

Pan and his colleagues trained their AI model by showing it how various distributions of rubidium atoms could be nudged into a range of grid configurations using different patterns of laser light. Depending on the atoms' starting locations, the model could then quickly work out the correct pattern of light needed to rearrange them into a selection of 2D and 3D shapes.

The researchers used their model to assemble an array of up to 2,024 rubidium atoms in just 60 milliseconds. By contrast, another group assembled about 800 neutral atoms last year (G. Pichard *et al. Phys. Rev. Appl.* **22**, 024073; 2024), but without the use of AI, it took an entire second. For the video of Schrödinger's cat, the AI system directed laser light to move atoms to create the desired patterns. The atoms became visible when they emitted light in response to laser pulses.

Scaling up

Creating the right pattern of light, or hologram, that dictates how to arrange neutral atom arrays usually involves a slew of painstaking calculations. "And doing those calculations as you make the arrays bigger and bigger can take up a fair amount of time," says Mark Saffman, a physicist at the University of Wisconsin–Madison. That's why many of his colleagues "were really impressed by this work, as was I".

As the array gets larger, it also "becomes more challenging to calculate solutions to rearrange atoms", says Joonhee Choi, a quantum researcher at Stanford University in California.

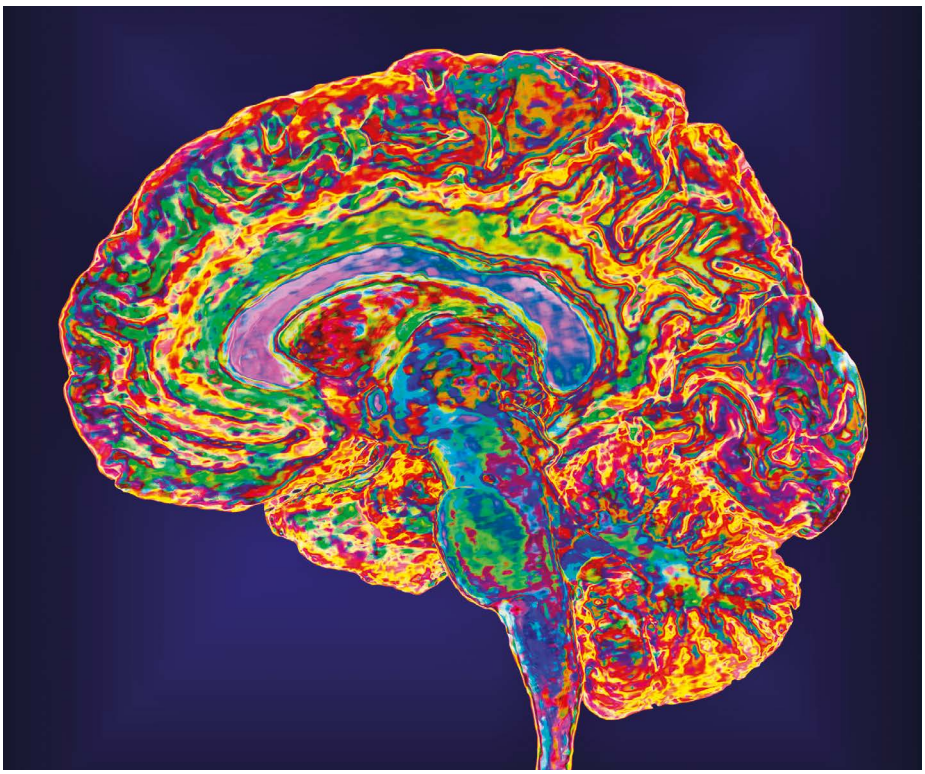
Choi says he thinks the new work is "remarkable", adding that, "thanks to this investment in AI, we can actually come up with better algorithms to rearrange large-scale arrays".

Pan says that other research teams have already reached out with questions about his group's methods and successfully reproduced the study's results.

Quantum development

But a fully functional quantum computer using neutral atoms, or any other qubit system, is still a distant prospect. To perform complex calculations with minimal error, a quantum computer would need about a million atoms' worth of information — many more than the couple of thousand pieced together in this study, Saffman says.

But, as physicists work towards those staggering numbers, Pan notes that the AI model shouldn't have a problem keeping up. Adding on atoms shouldn't create a lag in the AI's 'thought process', he says, meaning that the method is "readily scalable to 10,000 or even 100,000 atoms in the future".



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A brain scan (artificially coloured) produced by magnetic resonance imaging.

MIND-READING IMPLANT COMES WITH PASSWORD PROTECTION

A brain–computer interface decodes the imagined speech of people in near-real time.

By Gemma Conroy

A brain implant can decode a person's internal chatter — but the device works only if the user thinks of a preset password (E. M. Kunz *et al. Cell* https://doi.org/10/g9xmj7; 2025).

The mind-reading device, or brain–computer interface (BCI), accurately deciphered up to 74% of imagined sentences. The system began decoding users' internal speech — the silent dialogue in people's minds — only when they thought of a specific keyword. This ensured that the system did not accidentally translate sentences that users would rather keep to themselves.

The study, published in *Cell* on 14 August, represents a "technically impressive and meaningful step" towards developing BCI devices that accurately decode internal speech, says Sarah Wandelt, a neural engineer at the Feinstein Institutes for Medical Research in Manhasset, New York, who was not involved in the work. The password mechanism also offers a straightforward way to protect users' privacy, a crucial feature for real-world use, adds Wandelt.

Avoiding eavesdropping

BCI systems translate brain signals into text or audio and have become promising tools for restoring speech in people with paralysis or limited muscle control. Most devices require users to try to speak out loud, which can be exhausting and uncomfortable. Last year, Wandelt and her colleagues developed the first BCI for decoding internal speech, which relied on signals in the supramarginal gyrus, a brain region that plays a major part in speech and language (S. K. Wandelt *et al. Nature Hum.*

"If we look at other parts of the brain, perhaps we can also address more types of speech impairment."

Behav. **8**, 1136–1149; 2024).

But there's a risk that these internal-speech BCIs could accidentally decode sentences users never intended to utter, says Erin Kunz, a neural engineer at Stanford University in California. "We wanted to investigate this robustly," says Kunz, who co-authored the new study.

First, Kunz and her colleagues analysed brain signals collected by microelectrodes placed in the motor cortex – the region involved in voluntary movements – of four participants. All four have trouble speaking, one because of a stroke and three because of motor neuron disease, a degeneration of the nerves that leads to loss of muscle control. The researchers instructed participants to either attempt to say a set of words or imagine saying them.

Recordings of the participants' brain activity showed that attempted and internal speech originated in the same brain region and generated similar neural signals, but those associated with internal speech were weaker.

Next, Kunz and her colleagues used this data to train artificial-intelligence models to recognize phonemes, the smallest units of speech, in the neural recordings. The team used language models to stitch these phonemes together to form words and sentences in real time, drawn from a vocabulary of 125,000 words.

The device correctly interpreted 74% of sentences imagined by two participants who were instructed to think of specific phrases. This level of accuracy is similar to that of the team's earlier BCI for attempted speech, says Kunz.

In some cases, the device also decoded numbers that participants imagined when they silently counted pink rectangles shown on a screen, suggesting that the BCI can detect spontaneous self-talk.

Password protected

To address the risk of decoding sentences that users don't intend to say out loud, the researchers added a password to their system so that participants could control when it started decoding. When a participant imagined the password 'Chitty-Chitty-Bang-Bang' (the name of an English-language children's novel) the BCI recognized it with an accuracy of more than 98%.

The study is exciting because it unravels the neural differences between internal and attempted speech, says Silvia Marchesotti, a neuroengineer at the University of Geneva, Switzerland. She adds that it will be important to explore speech signals in brain regions other than the motor cortex.

The researchers are planning to do this, in addition to improving the system's speed and accuracy. "If we look at other parts of the brain, perhaps we can also address more types of speech impairments," says Kunz.

ANDRII SHEVCHUK/ALAMY

WHO SHOULD TAKE PROTEIN SUPPLEMENTS? SCIENTISTS WEIGH IN

Most people can get enough protein from food, but some can benefit from protein products.

By Mariana Lenharo

Protein has become a buzzword in health and wellness circles, with social-media influencers touting high-protein diets as the ultimate solution for weight loss and muscle gain. A search on the social-media platform TikTok for '200 grams of protein a day' yields dozens of videos offering tips on how to stay fit by reaching that target, the equivalent of more than seven servings of cooked steak. The market has responded with a flood of products promising to boost protein intake, including powders, bars, cookies, yogurt and even popcorn.

But the scientific evidence supporting the protein craze is mixed. *Nature* spoke to researchers about what's behind this trend and who might benefit from protein supplements.

It's unclear what sparked the current protein obsession. But products marketed for their protein content have been around since the 1860s, says Hannah Cutting-Jones, a food historian at the University of Oregon in Eugene. The concept of macronutrients – carbohydrates, fat and protein – had just been introduced when one of the first scientists to study them, German chemist Justus von Liebig, launched a product called Liebig's Extract of Meat as a cheap substitute for the real thing. (Its nutritional value was later shown to be negligible.)

Protein powders are a booming industry.

Since then, "proteins have been the only macronutrient that has never been vilified", says Cutting-Jones, referring to the bad reputations that fat and carbs have acquired over the decades.

In the early 2000s, scientists published a spate of studies[1,2] linking high-protein intake with weight loss. Around that time, Cutting-Jones says, a growing number of food manufacturers started turning whey, a by-product of cheesemaking, into protein powders.

More recently, social media has hyped protein supplements as a staple of the healthy lifestyle. Such promotion matters: a small survey[3] about protein-supplement use among non-professional athletes found that 40% of participants listed social media as their main source of information about the supplements. "You have these influencers who are not trained in nutrition, but are promoting these protein-rich products," Cutting-Jones says.

Protein push

Most dietary guidelines recommend that healthy adults consume around 0.8 grams of protein per kilogram of body weight per day. But many health influencers suggest that's not enough, especially for those engaged in resistance training, a type of exercise that focuses on building strength, such as by lifting weights.

In that context, consuming protein after a workout provides the building blocks that the body needs to repair and rebuild the muscles. "What you see a lot on TikTok are people suggesting a gram of protein per pound of body weight," says Ethan Balk, a clinical dietitian at New York University. That's 2.2 grams per kilogram of body weight – close to three times the standard recommendation.

"The bodybuilding community kind of swears by that," Balk says. "But there's been less, if any, support from research on that."

A large systematic review[4] found that protein supplementation was associated with increased strength and muscle size among healthy adults doing resistance training. But the benefits plateau at a total protein intake of 1.6 grams per kilogram per day. Consuming more than that offers no extra advantage, the review found. More is "just wasteful", says Nancy Rodriguez, a nutritional scientist and registered dietitian at the University of Connecticut in Storrs.