people probably have lingering problems with their sense of smell.

For these people, help can't come soon enough. Simple activities such as tasting food or smelling flowers are now "really emotionally distressing", Parma says.

A clearer picture of how SARS-CoV-2 causes this disruption should help to create better therapies for the condition. Early in the pandemic, a study showed[3] that the virus attacks cells in the nose, called sustentacular cells, that provide nutrients and support to odour-sensing neurons.

Since then, clues have emerged about what happens to the olfactory neurons after infection. Researchers including biochemist Stavros Lomvardas at Columbia University in New York City examined people who had died from COVID-19 and found that, although their neurons were intact, they had fewer membrane-embedded receptors for detecting odour molecules than is typical[4].

This was because the neurons' nuclei had been scrambled. Normally, the chromosomes in these nuclei are organized into two compartments — a structure that enables the neurons to express specific odour receptors at high levels. But when the team looked at the autopsied neurons, "the nuclear architecture was unrecognizable", Lomvardas says.

There is also evidence of lasting changes to the brain for people with smell loss. In a study published in March[5], 785 people in the United Kingdom had their brains scanned twice. About 400 people became infected with SARS-CoV-2 between scans, so the scientists were able to observe structural changes. The people who recovered from COVID-19 showed multiple changes, including markers of tissue damage in areas linked to the brain's olfactory centre. It's not clear why this was the case, but one possibility is lack of input. "When we cut off input from the nose, the brain atrophies," says Danielle Reed, a geneticist at Monell. "It's one of the clearest things we know about taste and smell."

Treatments in testing

In the meantime, many treatments are being explored, often in small clinical trials. But it's still early days, so the only thing that most researchers recommend for now is smell training[6]. Participants are given samples of strong-smelling substances to sniff and try to identify, with the aim of driving the restoration of olfactory signalling. However, the method seems to work only with people who have partial smell loss, Reed says. That means it helps about one-third of people who experienced a chemosensory disruption after COVID-19, adds Parma.

To find treatments for everyone else, many researchers are exploring steroids, which reduce inflammation. COVID-19 is known to trigger extensive inflammation, which might play a part in smell disruption. So, in theory, steroids could help — but, in practice, the results have been disappointing. For instance, a 2021 study[7] gave smell training to 100 people with post-COVID anosmia. Fifty of them also received a nasal spray with the steroid mometasone furoate, and the other 50 did not. There was no significant difference in outcome between the two groups.

Simple activities such as tasting food or smelling flowers are now "really emotionally distressing".

Another therapeutic possibility is platelet-rich plasma; this is made from patients' own blood and is rich in biochemicals that might induce healing. A pilot study published in 2020 (ref. 8) followed seven people who had platelet-rich plasma injected into their noses: five showed improvement after three months. Similarly, a preprint published in February this year[9] followed 56 people and found that platelet-rich plasma made them more sensitive to smells. But these are "really small numbers", says Carl Philpott, a nose and sinus specialist at the University of East Anglia in Norwich, UK. A US-based team is now launching a larger study.

Unlike COVID-19 vaccines, which were tested at unprecedented speed because of tremendous government support, treatments for post-COVID chemosensory dysfunction are plodding along. Philpott is in the early stages of a small study using vitamin A, which previous experiments have suggested could help with other forms of smell loss. "The reality is that the study will take the rest of this year to run, and it'll take us probably to the middle of next year before we analyse the data and report it," Philpott says. "If we find a positive benefit, our next job will be to apply for more funding to do a full stage trial."

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MAX PLANCK'S CHERISHED AUTONOMY QUESTIONED

Demoted archaeologist Nicole Boivin calls on the German government to oversee the research society.

By Alison Abbott

A former director of one of the Max Planck Society's prestigious research institutes, who says she was unfairly demoted, has called on Germany's research ministry to oversee the society's procedures for misconduct investigations. Six other Max Planck Institute (MPI) directors, some of whom have themselves been investigated or demoted for misconduct, have also told *Nature* that they feel the society's misconduct investigations lack transparency and are affected by bias.

Archaeologist Nicole Boivin at the Max Planck Institute for the Science of Human History in Jena is one of eight MPI directors who are known to have been demoted, or threatened with demotion, after investigations into allegations of non-scientific misconduct, which includes actions such as bullying and harassment. In an open letter published on 8 June, Boivin says that these investigations have been "plagued by allegations of bias, conflicts of interest, and procedural and legal shortcomings".

The run of demotions has led to an atmosphere of fear among MPI directors, says developmental biologist Herbert Jäckle, an emeritus director at the Max Planck Institute for Multidisciplinary Sciences in Göttingen. "They are concerned about how the investigations are going, but afraid to speak out," he says.

Boivin writes in her letter that she was not given the opportunity "to offer any reasonable response, evidence or witness testimony" to anonymous allegations.

The Max Planck Society (MPS) declined to answer specific questions for this article, but in an e-mailed summary of Boivin's case, a spokesperson told *Nature* that the MPS stands by all of its decisions in the affair and that

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Archaeologist Nicole Boivin was a director at a Max Planck institute in Jena, Germany.

Boivin was given all required opportunities to present her side of the case. MPS president Martin Stratmann, who made the initial decision to demote Boivin, declined to comment on the case because it has concluded. But the MPS's e-mail said that Stratmann's decision was "preceded by a extremely thorough internal investigation into the allegations levelled against Dr Boivin".

Researchers speak out

Stratmann demoted Boivin last October after an investigation that stretched over more than two years concluded that she had committed misconduct, including bullying two young scientists and taking over another scientist's research project. In December, a Berlin court suspended the demotion, but the society reinstated it in March. Boivin, who remains a researcher at the institute, denies all the allegations against her. Last April, her PhD students and postdocs wrote to the MPS president in her defence.

Boivin's open letter joins criticisms made by many other scientists of how the society handles misconduct allegations. Last November, 145 high-profile female international researchers wrote an open letter to the MPS leadership expressing concern that female scientific leaders at MPIs are being disproportionately affected by challenges to their leadership styles (the MPS has previously rejected charges of gender bias made in that letter). At around the same time, a personal letter from 24 emeritus institute directors to Stratmann, which was leaked to the press, questioned whether Boivin's investigation had appropriately heard her side of the story. It also said that the case threatened the society's reputation and called for the MPS to introduce transparent governance structures.

The MPS declined to give *Nature* official figures on the numbers of cases involving non-scientific misconduct at MPIs. But the public criticisms have fuelled a debate about whether Germany's publicly funded research organizations should have so much autonomy.

The MPS has an annual budget of around €2 billion (US$2 billion) from state and federal governments to run its 86 institutes and facilities. It enjoys the freedom granted in the German constitution to organize its own structures and procedures, without political interference.

This freedom has sometimes been a source of friction in political quarters. "This extensive autonomy is desirable for designing and carrying out research, but should not necessarily extend to aspects of personnel," says Holger Becker, a physicist who is a lawmaker in the German parliament and is on the parliament's research committee. He says that the MPS has a very strong staff hierarchy, and the president has an unusual amount of power compared with in research organizations in other countries.

Dismayed members

Boivin's case began in 2018, when she made an official complaint to Stratmann that she was being harassed by the two other directors at her institute. She charged that Stratmann had failed to address her allegations seriously. Two weeks later, Stratmann informed Boivin that she was to be investigated for misconduct; Boivin says that the details of those accusations were not made clear to her at the time.

The society established a committee to investigate the allegations made by and against Boivin. In January 2021, the committee concluded that Boivin had engaged in both scientific and non-scientific misconduct. Vice-president Ulman Lindenberger investigated further, and reported on the scientific-misconduct allegations. On the basis of those two reports and the advice of his executive committee, Stratmann decided in October to immediately demote Boivin — without waiting for the approval of the MPS senate. The senate comprises MPS directors and representatives from politics and industry and notionally oversees the workings of the society. MPS regulations allow such a step only when there is a risk of immediate damage to the society. Boivin hired a lawyer to contest the demotion through the Berlin court.

When the senate met less than a month later, some members expressed their dismay at the president's decision. "We were given no documents — only a simple statement from the MPS and no statement from Boivin's side," says Ulrike Beisiegel, who was president of the University of Göttingen until 2019 and has been a member of the MPS senate since 2011. MPS regulations require that such an action is approved by the senate; a retrospective vote on Boivin's demotion was postponed until the following senate meeting, in March this year.

Ahead of the March senate meeting, Becker says that he called political representatives on the senate and advised them to request an independent investigation into the Boivin affair. This time, the senate was given documents about the case and gave a majority vote in support of the demotion. But Beisiegel says that the documents were not discussed at the meeting. "The senate does not act like a real board, ensuring the society follows procedures," says Beisiegel. "It is a serious problem."

Boivin says that she was never given a proper hearing, and was given the details of the accusations against her only at the end of the years-long investigation. She says that the investigation did not always follow internal MPS rules and that some of the same people sit on multiple committees involved.

Nature spoke to six Max Planck directors who had been demoted, were under investigation for non-scientific misconduct or had raised concerns about procedures internally. All had similar criticisms about the lack of transparency and perceived bias in MPS investigations, which they say involve too few independent arbiters. (All the directors asked not to be named for fear of retaliation.)

Some countries, including Denmark and Sweden, have established national agencies to investigate allegations of misconduct in researchers, to avoid issues of bias and non-transparency. Beisiegel helped to create Germany's first national guidelines on good scientific practice and handling of misconduct in 1997, which all universities must adopt. The guidelines work well in general, she says, and scientists in Germany are attached to the freedom afforded to them by the constitution. "So I think in Germany it would be very difficult to come up with an external body," says Beisiegel.