

How invisible presences hijack the social counting brain in Parkinson's disease

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If you had to estimate the number of people in a room, without counting them one by one, by nature you would overcount them. That's because—simply put from a Darwinian perspective of how we have evolved—it's better to overcount potentially harmful agents and predators than to underestimate them. This [overcounting social behavior](#) is shown to be true in humans as well as animals. It's certainly better to detect too many tigers (even if absent) during a jungle excursion than to miss a hungry one.

Now, EPFL neuroscientists show that if you experience [hallucinations](#), especially when related to an illness like Parkinson's disease, then you will overestimate the number of people in a room to a greater degree. They also show that if you have hallucinations but are asked to estimate the number of boxes in a room, which are inanimate control objects, then no extra overestimation occurs, shedding light on the social nature of this overcounting.

The results are published in *Nature Communications*.

"The fact that patients of Parkinson's disease have a much higher overestimation in counting people is mind-blowing because Parkinson's disease is classically viewed as a movement disorder," says Olaf Blanke who leads EPFL's Laboratory of Cognitive Neuroscience which is part of Neuro-X. "We show that Parkinson's may also be a perceptual disorder, especially of social stimuli, and that invisible presences in Parkinson's disease may impair even more the counting social brain."

The category of hallucinations investigated by the neuroscientists is called presence hallucinations, for which people report an invisible presence next to them, even though no one is there. Such hallucinations are considered to be minor compared to visual hallucinations, for

instance. They may be experienced early on in patients with Parkinson's disease, sometimes even before diagnosis. Presence hallucinations are also a known early marker of cognitive decline in Parkinson's disease.

The results of the study support the idea that the invisible presence (and [related brain mechanisms](#)) are responsible for this overcounting of people. When presence hallucinations are experienced—either due to disease or induced artificially—this extra presence gets subconsciously translated into an over-estimation of the number of people we think we see. In essence, the invisible presence gets added in the counting process, but only in counting people.

The numerosity experiment and technodelics

To test the hypothesis that presence hallucinations lead to extra overcounting of people, the researchers merge [virtual reality](#) with robotics. The researchers refer to this unique combination of VR and robotics as "technodelics" for technology-induced altered states of consciousness, used in the present study for the special case of technology-induced hallucinations.

Virtually reality is used for the "human numerosity experiment" which consists of showing virtual, 3D scenes of five, six, seven, or eight people in an empty room for a split-second (200 milliseconds), so too many people and too little time to count them accurately one by one. Robotics is used to artificially induce presence hallucinations, which consists of a robotic finger poking the user's back out-of-sync with the user's own poking movement. In evaluating one's susceptibility to hallucinations, the scientists find that healthy individuals on technodelics indeed overcount.

"The advantage of our technodelics environment is that it gives us an objective way to measure hallucinations which are highly subjective states," explains Louis Albert, lead author of the study. "We are

essentially engineering hallucinations, inducing hallucinations and getting a clear, implicit readout of hallucination susceptibility at a given time."

The platform provides an almost automated way of determining whether someone is susceptible to hallucinations, in contrast to current methods that range from simply asking someone if they experience hallucinations, to questionnaires or other methods that involve subjective analysis by medical specialist.

Monitor hallucinations at home

For the study, the researchers also developed a simplified version of the numerosity experiment, which can be done in the lab but also online, unobtrusively, from the comfort of one's own home and without requiring extra training of medical staff.

"We now have an online test that can determine if someone is prone to hallucinations, a much-needed objective tool for measuring hallucination susceptibility in patients," continues Albert. "The test can be carried out independently by patients, directly from home on their computer or tablet, [and] thus has the potential to reach a large demographic at minimal cost. Without the need for specific equipment or specialized staff for hallucination testing and interviewing, and without the need for patients to travel to the clinic, this test is accessible and can reach people living far away from medical centers and in low-income countries."

Some 170 patients with Parkinson's disease were recruited for the online test, and 69 of them had presence hallucinations. With this version of the test, the scientists also found that patients with presence hallucinations overcount more than patients without hallucinations. Some patients with reported seeing as many as 11 or more people when only 8 were shown.

"We have strategies for determining if a patient with Parkinson's disease

experiences presence hallucinations or not, which means that in the future we should be able to identify and monitor those who are more prone to cognitive decline for early treatment," says Fosco Bernasconi, co-author of the study.

From body ownership to technodelics

Almost a decade ago, EPFL scientists designed a robotic task to do something entirely different than to evaluate susceptibility to hallucinations, a reminder of the serendipity of science. The robotic task was initially designed to explore embodiment and how the mind uses sensory information to create a feeling of body ownership.

But when participants of the task repeatedly reported spooky feelings of being accompanied by ghosts, the EPFL researchers realized—instead of brushing it off as a coincidence—that they had stumbled upon a mechanism to provoke presence hallucinations in healthy people with possible applications in people with disease. The researchers knew at this point that they had a subjective way to induce presence hallucinations, thanks to the robotic task that muddles up the user's senses.

More information: Louis Albert et al, Numerosity estimation of virtual humans as a digital-robotic marker for hallucinations in Parkinson's disease, *Nature Communications* (2024). DOI: [10.1038/s41467-024-45912-w](https://doi.org/10.1038/s41467-024-45912-w) , [dx.doi.org/10.1038/s41467-024-45912-w](https://doi.org/10.1038/s41467-024-45912-w)

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