Having trouble ignoring distractions? Pay attention to the claustrum

Being able to filter out irrelevant information is a crucial ability for any animal. Consider for a moment the number of sensations you can currently feel. Maybe someone is talking in the background, or has a new perfume, perhaps you have an itch? Even more subtle than those is the feeling of your back against the chair, or of the soles of your feet against the floor. Our senses are constantly assaulted by this barrage of information, of which only a fraction is relevant at any given point in time. And yet, until you focused on these distractions just now, the visual information of this text was at the center of your awareness. How does our brain allow us to navigate these potential distractors, managing to focus on what is important for whichever goal we are currently pursuing?

The intuitive thought is that somewhere in the brain lies a center responsible for acting on the sensory regions to suppress the neural representation of irrelevant distractions; a sort of equalizer of the brain. A central hub like this would have to have widespread connections to the rest of the sensory brain in order to modulate it, and likely would receive information from brain regions which are responsible for planning and directing attention. The claustrum, a small brain structure sitting deep within the brain, has just these properties, making it a prime candidate for the job. However, it's tiny size and hidden location (claustrum comes from the Latin word for *'enclosed'*, think *claustro*phobia), have made it very hard to study. In fact, very little is known about the function of the claustrum.

To counter this, we have identified a gene which is expressed specifically in claustrum neurons. Taking advantage of that, we could specifically target these neurons by injecting carefully engineered viruses into the brain of mice, genetically modified in a way which limits viral expression to their claustrum. Using this method, we could label claustral neurons and visualize their projections. More importantly, we could, for the first time, silence their activity while the mouse is alive, awake, and behaving, as well as ask what happens to sensory areas of the brain when claustral neurons are artificially activated. While the available genetic tools are pretty neat, the downside of using mice is that we cannot ask them directly if they feel an itch, or whether they are distracted. We had to devise a way in which we could, in mice, check if the claustrum is involved in the capability to ignore distractions. To do so, we taught mice to patiently wait for a light cue to appear, indicating which of two doors will provide access to a reward. Once mice learned this task, we tested their ability to ignore a distracting sound (a short clip of music by *Björk*).

Healthy mice could ignore *Björk* quite well, and did not show any decrease in performance. Considering that all animals, including humans, perform this kind of filtering almost at any given moment, this is perhaps not so surprising. Remarkably, the same distractor caused the performance of mice whose claustrum was silenced to drop, even though they were fine as long as no *Björk* was playing. Addressing a behavior that is more natural to mice, we measured the time it takes for mice mothers to collect their pups into the nest. Mothers of course do this very fast, claustrum or no. However, playing *Björk* during the task hampered claustrum-silenced mothers, which took an abnormally long time to retrieve their pups, compared to healthy mothers, which did not seem to be bothered by the distracting sound.

These results convinced us that the claustrum plays a role in ignoring distractors. In order to understand how it does so, we recorded electrical activity from cortical neurons responsible for auditory processing, and found that activation of the claustrum could suppress auditory representations. In other words, auditory cells in the brain were less responsive to the same sound when the claustrum was active compared to when it was not, demonstrating that the claustrum could indeed function as a filter or an equalizer.

Resilience to distraction is a critical ability that allows us to function in a sensory environment which would otherwise be overwhelming. Singling out the claustrum as important for this function has implications for the diagnosis and therapy of many brain disorders that involve disruptions of attention, such as Attention Deficit Hyperactivity Disorder (ADHD) and autism, as well as psychotic disorders in which hallucinations and delusions occur.