How the brain combines sensory stimuli

The lights and horns of a car on a foggy day, the courtship displays of a bowerbird. Perceiving biologically salient events connects very different sensory stimuli, and the brain does so only if useful and necessary. This flexibility of perception has been studied by researchers from CNRS / University of Aix-Marseille (Dr Giordano), and the University of Oxford (Mr Cao) and Bielefeld (Prof Kayser). In a study published in the journal "Neuron", they show in which areas of the brain sensory stimuli are combined and where this flexibility is localized.

To understand where sensory stimuli are integrated flexibly, they tested three possible models. While different sensory stimuli are processed completely separately in the first model, they are automatically combined in the second model. Finally, in the third "causal inference" model different sensory stimuli are combined only if they have a common source such as when you hear a sound and a picture together at the movies, but not when the movie is dubbed poorly.

Scientists presented participants with lights and sounds whose intensity could sometimes fluctuate at the same speed, and sometimes at different speeds. While participants experienced these stimuli, scientists recorded how the activity of separate parts of their brain evolved in time by using magnetoencephalography (MEG). These measurements revealed that combining sensory stimuli implicates the concerted activity of separate brain areas during a very short time, while participants experience the lights and sounds and decide how quickly they fluctuate. Shortly after they begin, lights and sounds are separated in the visual and auditory cortex. These separate representations are then quickly combined automatically in the parietal lobe, a region in the upper part of the brain. Only subsequently the brain combines sensory stimuli flexibly by filtering out, if necessary, irrelevant information. This flexibility of perception is located in the regions of the frontal lobe responsible for more abstract thought processes such as reasoning and causality judgement.

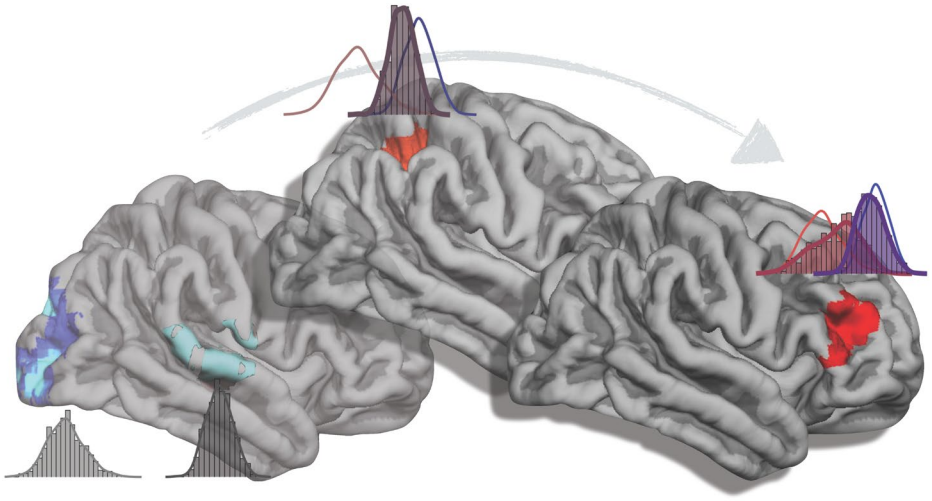

Figure: When exposed to sensory stimuli such as lights and sounds, our brain uses a flexible strategy that combines them only when necessary and useful for the task at hand. To do this, the brain first represents the sensory stimuli separately in the primary sensory cortices, then automatically merges them into the parietal lobe. It is only at the end that the frontal cortex implements a flexible strategy of "causal inference" combining sensory stimuli that share a common source according to the requirements of the tasks.

To know more:

Causal Inference in the Multisensory Brain.
Cao Y, Summerfield C, Park H, Giordano BL, Kayser C. Neuron. 2019 Apr 29 (published on line)
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