Medical Xpress

Neural noise created during binocular rivalry

June 19 2009

Neural "noise" may cause you to miss important changes in your environment when you are concentrating on something else, new research indicates.

The research by Sam Ling, a postdoctoral researcher in Vanderbilt University's Psychology Department, and Randolph Blake, Centennial Professor of Psychology, is currently in press at *Psychological Science*.

"We found that when the brain actively ignores the presence of an object in the environment, it does so in a way that weakens and degrades residual information about that object," Ling said. "We found that the brain's neural representation of an object outside your window of awareness is not only weaker, but also 'noisier.' It's as if the brain turns down the contrast on your mental television and also adds static noise into the image."

The new research explored what is happening to an ignored stimulus during binocular rivalry, which occurs when the two eyes view radically different images. The brain temporarily rejects, or suppresses, one of those images in favor of the other. The image that commands our visual awareness switches between the two over time. This fluctuation in visual awareness enables cognitive neuroscientists to study the neural correlates of awareness and consciousness.

It has been known for years that the neural representation of a visual stimulus temporarily erased from awareness during binocular rivalry is weaker in strength as a result. Ling and Blake set out to discover if there

were other consequences associated with this weakening process.

To do so, the researchers tested people on a simple task that required them to judge the orientation of a pattern, called a grating, composed of parallel contours that tilted either clockwise or counterclockwise. Ordinarily, people are able to distinguish tilts as small as a few degrees. However, when the pattern was presented to an eye that was in this suppressed state, people were significantly worse at the task, sometimes confusing orientations that differed by 10 degrees.

"The problem wasn't that people couldn't see the gratings, because we made them sufficiently high contrast so they could overcome suppression and break into consciousness," Blake said. "Nonetheless, because it was going to a suppressed eye, the grating underwent some sort of general degradation in the fidelity with which it was being registered. Neural noise could explain this."

In an attempt to identify the source of the added noise, Ling and Blake performed a second experiment where observers were asked simply to detect a grating of a given orientation presented within a band of visual noise that the investigators themselves produced on the testing monitor. Ordinarily, observers are able to ignore noise that differs in orientation from a test grating, indicating that the brain cells detecting the grating are responsive to only a limited range of orientations. During suppression, however, the range of interfering orientations was widened considerably, thereby expanding the range of noise orientations that interfered with detection of the test grating.

"We believe this temporary broadening of the 'tuning' of orientation during suppression is a prime candidate as the cause of the reduced fidelity of the neural representation of orientation during suppression," Ling said.

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Source: Vanderbilt University (news : web)

Citation: Neural noise created during binocular rivalry (2009, June 19) retrieved 1 May 2024 from https://medicalxpress.com/news/2009-06-neural-noise-binocular-rivalry.html

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