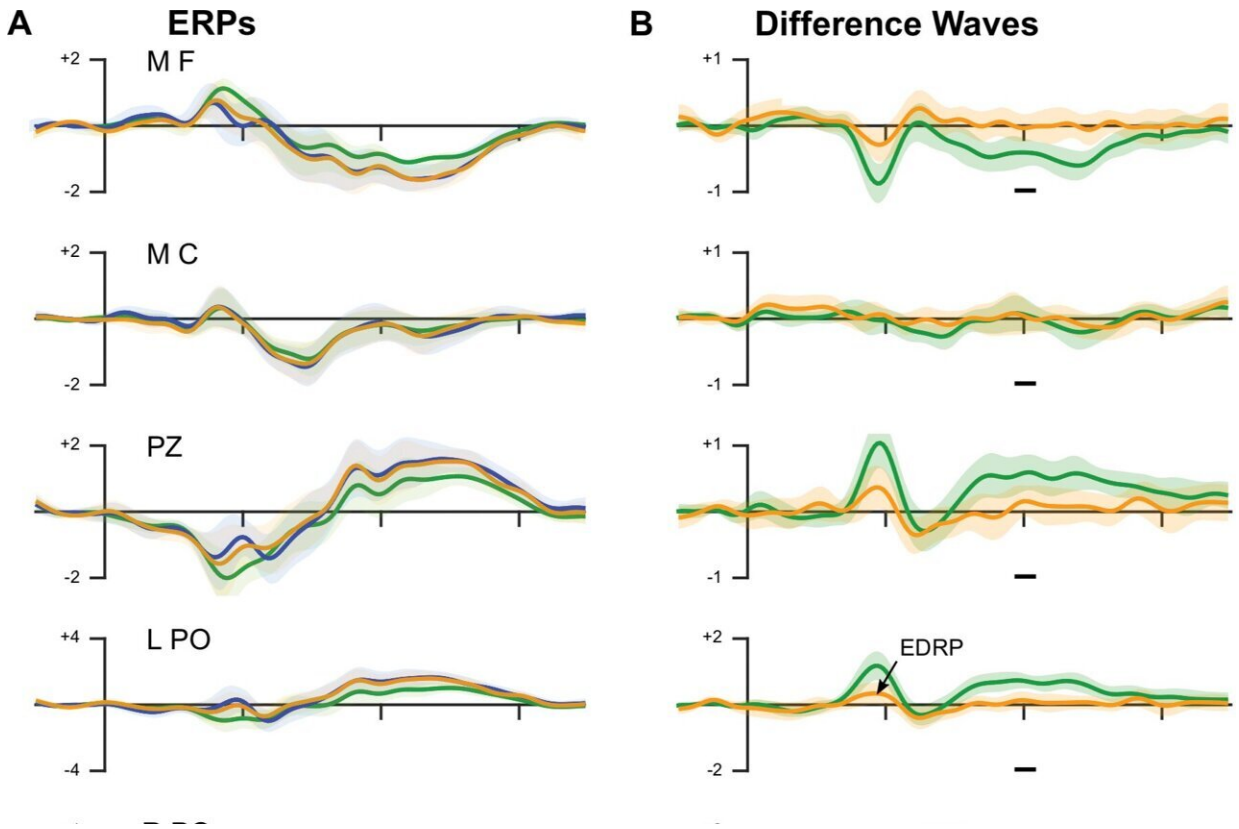
Attention is required for a popular brain signature of prediction error, researchers find

August 12 2023



(A) Event-related potentials and (B) difference waves from various electrode clusters. The arrows highlight a possible alternative marker of pre-attentive error detection in the visual system—early deviant related positivity (EDRP). The lighter colors surrounding the difference waves give ±1 standard error of the mean. Credit: *PLOS Biology* (2023). DOI: 10.1371/journal.pbio.3001866

A University of California, Irvine-led team of researchers have discovered that a neural marker of error detection in the brain's visual system previously considered pre-attentive may actually require attention and that subtle visual irregularities may be revealed by other neural markers.

Research findings were published in June in *PLOS Biology* in a new study titled, "Attention is required for canonical brain signature of prediction error despite early encoding of the stimuli."

"According to predictive coding theory, a popular theory for how the brain efficiently processes its immediate sensory surroundings, extra processing is reserved for irregularities in sensory input that are signposted by prediction errors," said Alie G. Male, Ph.D., co-author and assistant project scientist in the Department of Psychiatry & Human Behavior at the UCI School of Medicine.

For example, imagine a person's brain is a car engine; prediction errors are like a check engine light that signals something is wrong. This check engine light is crucial for beginning the process of investigation to rectify the issue.

"There are, however, an increasing number of studies that failed to show the well-known neural marker of prediction error in the brain's visual system," Male said. Because of this, it is problematic for those exploring atypical early visual processing indexed by absent or impaired prediction error signaling, she explained.

"For example, if the well-known neural marker of prediction error is not found in a patient sample, one might falsely conclude aberrant early sensory processing, namely failed irregularity detection when, in truth, the absence could be explained by the need for unmet experimental conditions, such as attention," Male said.

To explain an unmet condition with the earlier analogy of a check engine light, it is like failing to see the check engine light before the engine overheats and assume the sensors aren't working, when in reality, the overheating was signposted by another error signal, like the temperature gauge, and the check engine light only illuminates after the vehicle has been in drive for more than 10 minutes.

This study aims to qualify the electrophysiology of typical early sensory processing without attention, allowing others to later qualify the electrophysiology of atypical early sensory processing without attention, Male explained.

"We find that the well-known neural marker of prediction error in the brain's visual system does not occur for unattended, subtle, visual irregularities, despite evidence that their corresponding regularities are indeed encoded, although such irregularities may be indexed by an earlier electrophysiological signal at the primary visual cortices," she said.

In addition to this finding, their study also showed that subtle visual regularities are indeed encoded and observed via electrophysiology. Further research on the conditions needed for both indexes of error signaling will provide a more robust model of early visual processing in the visual cortex.

Male's research was motivated by the frustrations of colleagues and peers with whom she discussed the difficulty in obtaining a reliable signal of the well-known neural correlate of prediction error signaling in the visual system, she said. They concluded that if there were no signal, but did find evidence of encoding, they might further bolster the argument that the known neural correlate may not be the only index of irregularity signaling.

"We intend to further qualify the conditions needed for showing the well-known neural marker of error detection so that other researchers can adopt optimal parameters in their own irregularity detection research," she said.

Male co-authored this research with Robert P. O'Shea, from the Discipline of Psychology at the College of Science, Health, Engineering and Education at Murdoch University in Perth, Australia.

More information: Alie G. Male et al, Attention is required for canonical brain signature of prediction error despite early encoding of the stimuli, *PLOS Biology* (2023). DOI: 10.1371/journal.pbio.3001866

Provided by University of California, Irvine