Run screaming or slow retreat? New study sheds light on brain responses to emotionally-charged scenes

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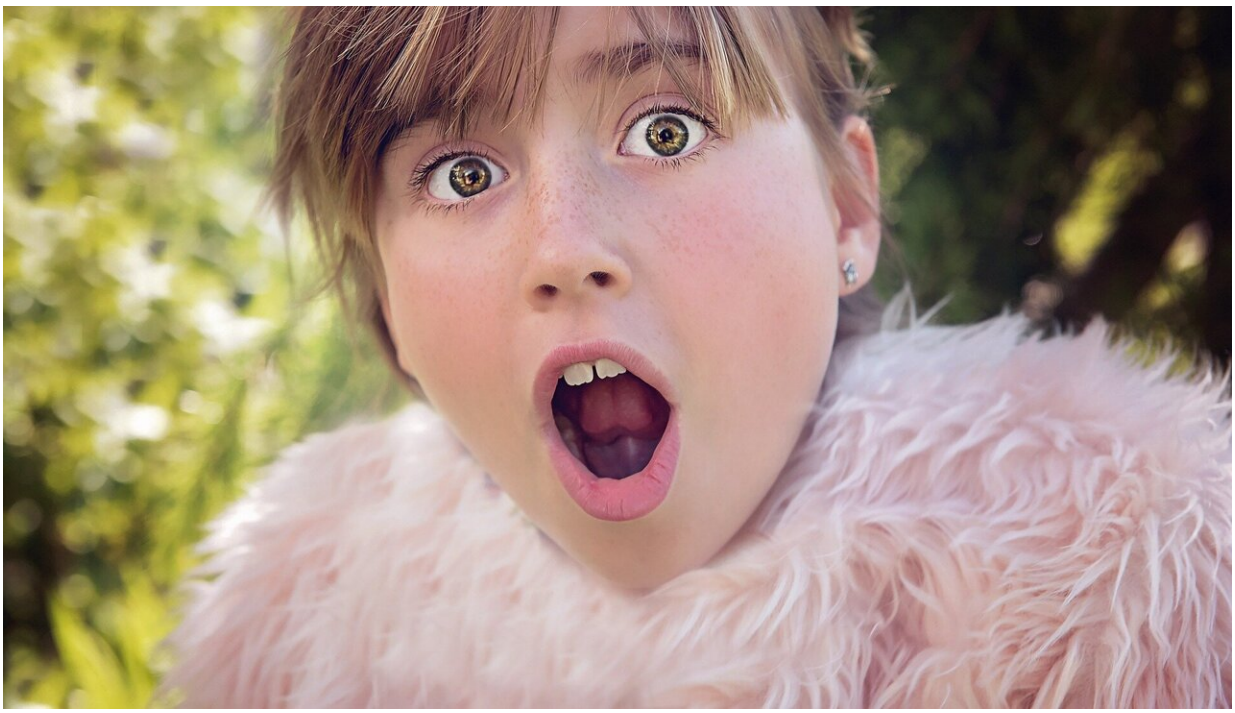

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The ability to recognize and respond to emotionally-charged situations is essential to a species' evolutionary success. A new study published in *Nature Communications* advances our understanding of how the brain responds to emotionally charged objects and scenes.

The research, led by Trinity College Dublin neuroscientist Prof. Sonia Bishop, and Google researcher Samy Abdel-Ghaffar while he was a Ph.D. student in Prof. Bishop's lab at UC Berkeley, has identified how the brain represents different categories of emotional stimuli in a way that allows for more than a simple "approach/avoid" dichotomy when guiding behavioral responses.

Sonia Bishop, now Chair of Psychology in Trinity's School of Psychology, and senior author of the paper, explains, "It is hugely important for all species to be able to recognize and respond appropriately to emotionally salient stimuli, whether that means not eating rotten food, running from a bear, approaching an attractive person in a bar or comforting a tearful child.

"How the brain enables us to respond in a nuanced way to emotionally-charged situations and stimuli has long been of interest. But, little is known about how the brain stores schemas or neural representations to support the nuanced behavioral choices we make in response to emotional natural stimuli.

"Neuroscience studies of motivated behavior often focus on simple approaches or avoidance behaviors—such as lever-pressing for food or changing locations to avoid a shock. However, when faced with natural emotional stimuli, humans don't simply choose between 'approach' or 'avoid.'

"Rather, they select from a complex range of suitable responses. So, for example, our 'avoid' response to a large bear (leave the area ASAP) is different from our 'avoid' response to a weak, diseased, animal (don't get too close). Similarly, our 'approach' response to the positive stimuli of a potential mate differs from our 'approach' reaction to a cute baby.

"Our research reveals that the occipital temporal cortex is tuned not only

to different categories of stimuli but it also breaks down these categories based on their emotional characteristics in a way that is well suited to guide selection between alternate behaviors."

The research team, from Trinity College Dublin, University of California Berkeley, University of Texas at Austin, Google and University of Nevada Reno, analyzed the brain activity of a small group of volunteers viewing over 1,500 images depicting natural emotional scenes such as a couple hugging, an injured person in a hospital bed, a luxurious home, and an aggressive dog.

Participants were asked to categorize the images as positive, negative or neutral and to also rate the emotional intensity of the images. A second group of participants picked the behavioral responses that best matched each scene.

Using cutting-edge modeling of brain activity divided into tiny cubes (of under $3mm^3$), the study discovered that the occipital temporal cortex (OTC), a region at the back of the brain, is tuned to represent both the type of stimulus (single human, couple, crowd, reptile, mammal, food, object, building, landscape etc.) and the emotional characteristics of the stimulus—whether it's negative, positive or neutral and also whether it's high or low in emotional intensity.

Machine learning showed that these stable tuning patterns were more efficient in predicting the behaviors matched to the images by the second group of participants than could be achieved by applying machine learning directly to image features—suggesting that the OTC efficiently extracts and represents the information needed to guide behavior.

Samy Abdel-Ghaffar of Google commented, "For this project we used Voxel-Wise Modeling, which combines machine learning methods, large

datasets and encoding models, to give us a much more fine-grained understanding of what each part of the OTC represents than traditional neuroimaging methods. This approach let us explore the intertwined representation of categorical and emotional scene features, and opened the door to novel understanding of how OTC representations predict behavior."

Prof. Bishop added, "These findings expand our knowledge of how the human brain represents emotional natural stimuli. In addition, the paradigm used does not involve a complex task, making this approach suitable in the future, for example, to further understanding of how individuals with a range of neurological and psychiatric conditions differ in processing emotional natural stimuli."

More information: Occipital-temporal cortical tuning to semantic and affective features of natural images predicts associated behavioral responses, *Nature Communications* (2024). DOI: 10.1038/s41467-024-49073-8

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