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Brain study explores what makes colors and numbers collide

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Someone with the condition known as grapheme-color synesthesia might experience the number 2 in turquoise or the letter S in magenta. Now, researchers reporting their findings online in the Cell Press journal *Current Biology* on November 17 have shown that those individuals also show heightened activity in a brain region responsible for vision.

The findings provide a novel way of looking at synesthesia as the product of regional hyperexcitability in the brain, the researchers say. They also provide a window into our understanding of individual differences in perception.

"Most of us tend to assume that we experience the world in the same way as everyone else, but synesthesia provides a clear example of a group that perceives the world in a fundamentally different way," says Devin Blair Terhune of the University of Oxford. "The majority of people do not have conscious experiences of color when they look at numbers, letters, and words, whereas synesthetes do. Studying these people can thus shed light on the brain mechanisms underlying conscious awareness."

Earlier studies had shown that synesthetes who experience color for numbers and letters also discriminate among colors better than those with other types of synesthesia. Those findings hinted that an overactive visual cortex might be in play.

Terhune's team, which is led by Roi Cohen Kadosh, found that average

people do indeed require three times greater magnetic stimulation to their visual cortex than synesthetes do in order to experience phosphenes, transient flashes of light or other visual disturbances.

"We were surprised by the magnitude of the difference," Terhune said. "The synesthetes in our study displayed considerably greater levels of cortical excitability than our participants without synesthesia. These results point to a very large effect that may reflect a fundamental difference between the brains of those with and without synesthesia."

It's not that the enhanced excitability of the visual cortex is directly responsible for the experience of synesthesia, however. Further experiments showed that reducing the excitability of visual cortex in synesthetes actually increased their experience of colors with numbers. Meanwhile, increasing excitability in that brain region made the synesthesia more intense.

Terhune says they now suspect that the enhanced excitability of synesthetes' brains might be related to the development of the condition, but it doesn't produce the phenomenon in adults.

Ultimately, the findings might allow for treatments designed to reduce or eliminate the experience of synesthesia or to make it even more vivid, he says. The work also raises new questions in other fields that examine atypical perceptions, such as hallucinations, he says. "Might it be that the same principle is applying also there?"

Provided by Cell Press