Brain's 'reward' center also responds to bad experiences

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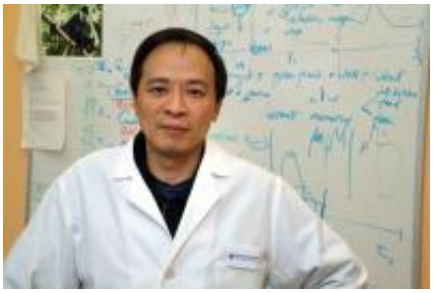

Dr. Joe Z. Tsien of Georgia Health Sciences University has shown that the "reward" center of the brain also responds to bad experiences. Credit: Phil Jones/GHSU Photographer

The so-called reward center of the brain may need a new name, say scientists who have shown it responds to good and bad experiences. The finding, published in *PLoS One*, may help explain the "thrill" of thrill-seeking behavior or maybe just the thrill of surviving it, according to scientists at Georgia Health Sciences University and East China Normal University.

Eating chocolate or falling off a building – or just the thought of either – can evoke production of dopamine, a neurotransmitter that can make the heart race and motivate behavior, said Dr. Joe Z. Tsien, Co-Director of GHSU's Brain & Behavior Discovery Institute.

Scientists looked at dopamine neurons in the ventral tegmental area of

the mouse brain, widely studied for its role in reward-related motivation or drug addiction. They found essentially all the cells had some response to good or bad experiences while a fearful event excited about 25 percent of the neurons, spurring more dopamine production.

Interestingly neuronal response lasted as long as the event and context was important, Tsien said. Scientists used a conditioned tone to correlate a certain setting with a good or bad event and later, all it took was the tone in that setting to evoke the same response from the dopamine neurons of mice.

"We have believed that dopamine was always engaged in reward and processing the hedonic feeling," Tsien said. "What we have found is that dopamine neurons also are stimulated or respond to negative events."

Just how eating chocolate or jumping off a building induces dopamine production remains a mystery. "That is just the way the brain is wired," Tsien said. He notes that genetics can impact the number of cells activated by bad events – and while interpretation of the findings needs more work – they could help explain inappropriate behaviors such as drug addiction or other risky habits.

In a second paper in *PLoS One*, Tsien and his colleagues at Boston University have provided more insight into how brains decide how much to remember good or bad. Inside the hippocampus, where memory and knowledge are believe to be formed, recordings from hundreds of mouse brain cells in a region called CA1 showed all are involved in sensing what happens, but not in the same way.

They found among most cells a big event, such as a major earthquake, evoked a bigger sensory response than a mild earthquake. But slightly less than half the cells involved logged a more consistent neural response to all events big and small. These are called invariant cells because of

their consistent firing regardless of event intensity. Tsien said these cells are critical in helping the brain remember those events.

The initial muted sensory response was followed by the cells replaying what they just experienced. It's that reverberation that corresponds with learning and memory. "If they play it over and over, you can remember it for a long time," Tsien said of these memory makers.

But these invariant cells vary in that some keep replaying specific memories while the majority focus on more general features of what occurred. "The general-knowledge cells have the 'highest volume,'" Tsien said. "So we walk away with general knowledge that will guide your life, which is more important than the details."

As with the number of dopamine cells that respond to bad or risky behavior, genetics likely plays a role in an individual's specific ratio of cells involved in encoding general versus more detailed memories, Tsien said. A person with a photographic memory likely has more of the specific memory makers while those with autism or schizophrenia, who have difficulty coping in society, may have fewer of the general memory makers that help provide correct context and understanding of complex relationships.

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