Mission

The speed of technology in neuroscience as it impacts ethical and just decisions in the legal system needs to be understood by lawyers, judges, public policy makers, and the general public. The Massachusetts General Hospital Center for Law, Brain, and Behavior is an academic and professional resource for the education, research, and understanding of neuroscience and the law. **Read more**

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Commentary
Events
News
Press
Publications
Resources
Uncategorized

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August 2017
July 2017
June 2017
May 2017
April 2017
March 2017
February 2017
January 2017
December 2016
November 2016
October 2016
September 2016
July 2016
June 2016
May 2016
April 2016
March 2016
February 2016
January 2016
December 2015
November 2015
October 2015
September 2015
August 2015
July 2015

How Pixar's 'Inside Out' Gets One Thing Deeply Wrong

By **Lisa Feldman Barrett** and Daniel J. Barrett | WBUR | July 5, 2015

Pixar's Inside Out is the latest in a long tradition of animated entertainment that teaches us about science.

Chemistry, as I learned from Saturday morning cartoons, is about mixing colorful, bubbling liquids in test tubes until they explode. "Roadrunner and Coyote" cartoons—those fine nature documentaries—taught me physics: if you run off a cliff, you'll hang in mid-air until the unfortunate moment that you look down. Computer science is apparently about robots that kill you. And now, with Inside Out, we finally have cartoon neuroscience.

Your brain, it turns out, is populated with characters for each emotion, and they press buttons to control your expressions. This is all good fun and a sweet movie. What is surprising, however, is that some scientists have taken this model seriously for a century and actually search for these characters in the brain. Not as animated creatures, mind you, but as blobs of brain circuitry.

This blob over here is your "fear circuit," they say, or this other blob "computes anger." And every time you experience an emotion, your corresponding blob of neurons supposedly leaps into action, triggering your face and body to respond in a consistent way. Your Fear blob makes you freeze with widened eyes. Your Anger blob makes you scowl and your heart speed up. And so on.

The thing is, this science of "blob-ology" is no more realistic than detonating test tubes and hovering coyotes. Today's neuroscientists finally have the technology to peer into a living brain without harming its owner, and it's clear that the brain doesn't operate even remotely in this cartoonish fashion. We might perceive Joy, Fear, and Anger as separate entities — even gloriously rendered in 32-bit color — but the evidence from neuroscience is overwhelmingly against it.

For example, my lab has analyzed nearly 100 published brain-imaging studies by other scientists, involving nearly 1,300 test subjects across 15 years, and found that no brain region is the home for any single emotion. (We do have brain circuits for behaviors like freezing and fighting, as do other animals, but not for complex mental states like fear and anger.)

In another analysis covering 22,000 test subjects across more than 200 studies over 20 years, we demonstrated that anger, happiness, sadness, and other emotions don't have consistent responses in the body either. And plenty of studies have shown that human facial expressions have tremendous variety, far more than would occur if they were automatically launched by "emotion blobs" in the brain.

The blob-ology of emotion would be cute if it weren't also so serious. The US Transportation Security Administration spent almost a billion dollars training its agents to recognize terrorists, on the assumption that their facial and bodily movements could reveal emotion. (It failed.)

Our legal system at its core treats emotion and reason like two battling characters in the brain. (They're not.) Medical researchers investigate the relationship between heart attacks and anger, as if anger has one consistent state in the body. (It doesn't.)

So many critical parts of our lives rest on the invalid assumption that emotions can be located distinctly in the brain.

May 2015
April 2015
March 2015
February 2015
January 2015
December 2014
November 2014
October 2014
September 2014
August 2014
July 2014
June 2014
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December 2011
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April 2011
December 2009
October 2009
March 2007
May 2006
October 1993

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If emotion blob-ology is wrong, how does your brain make emotions? It constructs instances of happiness, sadness, and the rest via several general-purpose systems that work together. These systems span your entire brain. One system relates to your general feeling of your body. Another represents your knowledge from your past experiences. These and other systems—which are not exclusive to emotion—converge to make an instance of emotion when you need one. So happiness and fear are not brain blobs — they are whole-brain constructions.

The inner workings of emotions in the brain are less like Joy and her pals and more like the Avengers, who save the world by working together as a team.

When space aliens attack the Earth and the Avengers need a clever plan, there is no dedicated "clever plan" hero who leaps into action. Instead, Tony Stark and Bruce Banner dream up the scientific parts and Captain America adds a touch of morality. The team also has interchangeable powers: if a situation calls for super-strength but the Hulk is unavailable, then Thor or Iron Man can handle the task. Similarly in the brain, different combinations of circuitry can perform the same task.

I suspect the Avengers model of emotion doesn't match your daily experience at all, because you're not aware of multiple team members collaborating in your head, but that's not unusual. Science is full of unintuitive truths. The Earth looks flat even though it's a sphere. The sun seems to travel through the sky from east to west, when of course it's the Earth that rotates. Physics tells us that the universe is constructed of vibrating strings in 11 dimensions. And then there's this little reality called "evolution" that causes such consternation in certain circles.

The bottom line is this: Go ahead, see Inside Out and be entertained. Learn its touching, Disney-style lesson that unpleasant experiences can be helpful guides for your behavior. Just remember this isn't really how emotions work. Joy and her lovable pals from Cartoon Neuroscience Land are the Wile E. Coyotes of our day.

*This piece was originally published by **WBUR**.*

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