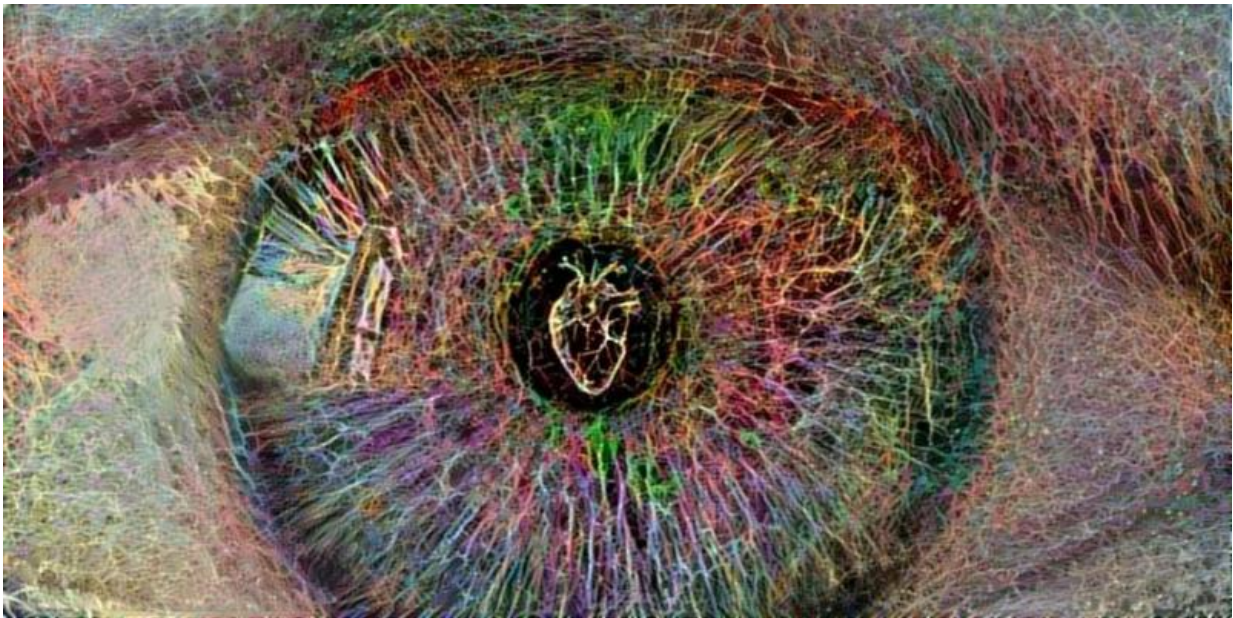


How subtle changes in our bodies affect conscious awareness and decision confidence

November 2 2016, by Micah Allen



Changes in arousal can alter introspective confidence.

How do we become aware of our own thoughts and feelings? And what enables us to know when we've made a good or bad decision? Every day we are confronted with ambiguous situations. If we want to learn from our mistakes, it is important that we sometimes reflect on our decisions. Did I make the right choice when I leveraged my house mortgage against the market? Was that stop light green or red? Did I really hear a footstep in the attic, or was it just the wind?

When events are more uncertain, for example if our windscreen fogs up while driving, we are typically less confident in what we've seen or decided. This ability to consciously examine our own experiences, [sometimes called introspection](#), is thought to depend on the brain appraising how reliable or "noisy" the information driving those experiences is. Some scientists and philosophers believe that this capacity for introspection is [a necessary feature of consciousness itself](#), forging the crucial link between sensation and awareness.

One important theory is that the [brain acts as a kind of statistician](#), weighting options by their reliability, to produce a feeling of [confidence](#) more or less in line with what we've actually seen, felt or done. And although this theory does a reasonably good job of explaining our confidence in a variety of settings, it neglects an important fact about our brains – they are situated within our bodies. Even now, as you read the words on this page, you might have some passing awareness of how your socks sit on your feet, how fast your heart is beating or if the room is the right temperature.

Even if you were not fully aware of these things, the body is always shaping [how we experience ourselves and the world around us](#). That is to say experience is always from somewhere, embodied within a particular perspective. Indeed, recent research suggests that our conscious awareness of the world is very much dependent on exactly [these kinds of internal bodily states](#). But what about confidence? Is it possible that when I reflect on what I've just seen or felt, my body is acting behind the scenes?

Setting up the experiment

To experimentally test this possibility, we devised a scenario where we could trace subtle, unconscious changes in 29 participants' physiological arousal – such as heart beat and pupil dilation. We wanted to find out

how this could impact their conscious decisions and confidence for a simple visual stimulus. Since we know that people [weight their confidence](#) by how reliable an experience is, our goal was to see if this process could be counter-acted or reversed by a sudden, unconscious change in arousal.

This required an experimental stimulus where the precision, or perceptual uncertainty, of a visual experience could be manipulated. To achieve this, volunteers had to view a cloud of moving dots and decide if they moved to the left or right. They also had to rate their confidence in this decision. Our dot stimuli were specially designed to have either high or low perceptual precision:.



On the left, the dots move clearly and relatively unambiguously to the

right of the screen. The right dots, however, wiggle and move all over the place. In statistical terms, the variance of their motion is higher. As you would expect, when participants viewed the right set of noisier dots, they were less accurate and had lower confidence. The brain, it seems, did act like a kind of statistician. However, unbeknownst to our volunteers, on half the trials we also presented a startling image of a disgusted face just before the dots, too quickly to be consciously seen.

This subtle manipulation caused participants' hearts to beat faster, and their pupils to dilate wider. This is because, evolutionarily speaking, [disgust is a powerful cue](#) that something might have gone wrong in our bodies. If someone around us looks disgusted and begins to vomit, a similar reaction will often be triggered in our own bodies. By briefly cueing participants with this signal, we could cause a kind of "[interoceptive prediction error](#)" – tricking their brain into thinking something unexpected had just happened inside their bodies. This allowed us not only to examine if confidence was correlated with the heart and pupil, but also to see if disrupting this mapping changed the way people reported their conscious experience of the dots.

Indeed, we found that these surprising changes in volunteer's arousal counter-acted the impact of the noisy dots on their confidence, slightly reducing confidence for the easier dots while boosting it for the more difficult ones. Furthermore, this reversal could be seen in the pupil and heart response themselves. The more a volunteer's body responded to unseen disgust, the greater the shift in confidence for that trial. Although the mind was acting like a kind of statistician, it was also using information from the body to shape how participants felt.

These results, [published in the journal eLife](#), suggest that our visual experiences are related to more than just what "meets the eye". Indeed it also depends on the internal state of our bodies – our heart and physiological arousal. When we introspect on our experience, turning the

mind's eye inward, it seems that the body is shaping what we find.

This is an important first step to understanding how the body shapes the mind, even when we are not aware of it. From here, our group is excited to further develop sophisticated computational models of this process. Our hope is that such models will allow us to better understand a variety of psychiatric and medical conditions, such as anxiety and psychosis, where alterations in bodily signals and self-awareness could potentially lock sufferers into an unrealistically certain or uncertain world. This may ultimately lead to new treatments targeting the impact of cardiovascular arousal on disordered confidence and self-awareness.

This article was originally published on [The Conversation](#). Read the [original article](#).

Provided by The Conversation

Citation: How subtle changes in our bodies affect conscious awareness and decision confidence (2016, November 2) retrieved 24 May 2024 from <https://medicalxpress.com/news/2016-11-subtle-bodies-affect-conscious-awareness.html>

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