What causes motion sickness? Here's how to reconcile the mismatch in what your senses are telling your brain

April 11 2023, by James Phillips

Encountering new conditions – like zero gravity in space – can be a challenge for your system. Credit: NASA/Johnson Space Center, CC BY

My first experience with motion sickness was as a college student, standing on the back of a marine research vessel looking at interesting things dredged from the seafloor off the California coast. It was a day trip, the weather was good and the sea was calm. I was unaware of the boat's gentle pitching and rolling, instead concentrating on the mud and organisms on a table in front of me.

Then, slowly I began to feel warm and to salivate. I felt exhausted, although I was well rested. There were intense waves of nausea, and I began vomiting. It was a long afternoon. Once back on shore, I felt as if I were still moving. I didn't feel back to normal until the next day.

In retrospect, this was the perfect situation for a bout of motion sickness. I was focused on my immediate environment—the table covered with ocean specimens—which was visually stable. My eyes were unaware that we were, in fact, shifting up, down and side to side with the waves. But my inner ear was signaling all of this movement to my brain. Sensory signals from the muscles and joints of my body were providing information that was like a cross between the visual input from my eyes and the balance feedback from my inner ears' motion detectors.

In short, my senses were in conflict. I was in an environment that conflicted with a lifetime of expectations about how sensory information usually combined to inform me about the world. My brain recognized something was wrong and attempted to save me from things that it was designed to deal with—poisoning or other illness. To my brain, emptying my stomach contents and forcing me to rest and recuperate seemed the perfect solution.

For me, this event preceded a lifetime of work studying the vestibular system, which are the inner ear and brain structures and functions that allow you to remain oriented and stable in space. In my laboratory, my colleagues and I reproduce these kinds of complex motions and conflicting sensory inputs and study how the brain uses them during development, in normal adult behavior and in disease. Ultimately, we hope to produce treatments for people who are disabled by a loss or disruption of these senses.

Mismatch of a great system and unusual situation

Any moving environment can trigger motion sickness. It's not usually due to illness or pathology. Instead, motion sickness is the result of your nervous system functioning optimally, based on what it's learned throughout your life.

When processing sensory information and generating motor commands, the brain constantly monitors and adjusts its inputs and outputs to perform the tasks of life efficiently. For example, to see clearly while turning your head, your brain moves your eye opposite and equal to the motion of your head. It does so based on feedback from the sensors in your inner ear that focus on balance. Your brain constantly monitors this reflex behavior, making continual adjustments to make sure that your eye and head movements match perfectly.

The efficiency of this system is based on experience and outcome, and it works well. It helps you get better at coordinating your movements and maintaining your balance while you're growing, and helps you recover from imbalance and disorientation due to injury, illness and aging later in life.

The downside of this process is that the nervous system is unprepared for things with which it has no experience. It explains in part why astronauts experience transient nausea while adapting to weightlessness, why sailors get seasick and why watching a movie on your iPad in the back seat of a car or playing an immersive virtual reality video game may become unpleasant. Human beings did not evolve as a species to do these things.

So someone who is motion sick is really exhibiting skillful and optimized functioning in a uniquely challenging and suboptimal environment.

Changes over the life span

Typically, infants and very young children do not experience motion sickness. Older children are highly prone to motion sickness as they learn typical relationships between the different senses.

As people age further into adulthood, the susceptibility to motion sickness typically dwindles again, presumably because they're able to contextualize their experiences. In older adults, such changes as loss of receptor cells in the ear and eye, fogging of the eye's lens or loss of functioning in peripheral nerves, motion sickness may either increase or decrease. Usually, though, the incidence of motion sickness in a healthy older adult continues to decline.

A simple example of this is that my balance is actually better than that of my grandniece, who is a toddler. Her inner-ear balance system and muscles are brand new. Mine are not. In fact, through normal aging I have lost many of the receptors in my ear that sense motion. However, I have learned to skillfully use the complement of sensory and motor functions that I have, and over the years I've continually adjusted to an ever-changing new normal. She is just starting this learning process.

Techniques to deal with motion sickness

If you experience motion sickness, there are several strategies you can use to feel better.

The first is to resolve the conflicting sensory information that your situation is creating. Look at an Earth-stabilized reference—focusing at the shore or horizon if you are on a boat, for example, or moving to the front seat in the car and looking out the window. This way, you align the incoming visual and inner-ear vestibular information.

The second strategy is to reduce the information that is causing the conflict. There are several medications that work by suppressing inner-ear vestibular information, and others that change the way that sensory information is processed centrally in your brain.

You can also try to prevent the output of this conflict. Essentially, you can sabotage the central nervous system's attempts to save you from your situation by short-circuiting the mechanisms that produce the motor response of vomiting. Taking anti-nausea drugs reduces nausea without necessarily resolving the sensory conflict that induced it.

You can eventually adapt, through repeated experience, to many novel situations. When your brain learns a new normal, it allows you to function with fewer unwanted symptoms in the challenging environment. For example, NASA is developing preconditioning countermeasures to allow astronauts to transition from Earth's gravity to the weightlessness of space more quickly and with fewer symptoms of motion sickness.

Studies like these will extend the range of environments in which human beings can function and allow us to explore and ultimately live in what are, to us, novel and new worlds.

Provided by The Conversation