Possible cause of mild brain damage or trauma linked to resonance

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(Medical Xpress)—A team of researchers with Stanford University has found that even relatively minor head impacts can result in resonance that could possibly lead to long term brain damage. In their paper published in *The Royal Society – Interface*, the researchers discuss how they compared MRI brain scans with a computer model they created to come up with a reasonable estimate of the amount of resonance a human

brain undergoes during minor impacts such as those that occur during sporting events.

The human brain is delicate, of that there can be no doubt, its gelatinous structure exists inside of what is essentially a bowl of water with just a few connections to the rest of the body. A lot of research has been conducted, the authors of this latest study report, on traumatic brain injuries, due to war blasts, car crashes, sports collisions, etc., but very little work has looked into what happens to the brain during less traumatic collisions. They embarked on a study to learn more.

Prior research has shown that the brain experiences resonance during a collision, whether it runs into the inside of the skull or not—it is easy to envision it as a bowl of Jello that is pushed along a table and knocked against a wall—it keeps jiggling for a few seconds—that is resonance. But measuring resonance in the brain during impact is difficult as such tests could themselves cause injury. To better understand what happens during small impacts the researchers looked at a prior study that involved volunteers placed inside of an MRI machine that had their head suddenly dropped an inch into a pillow—the imagery captured the resonance that took place. The researchers created a computer model to simulate brain movement in such a situation by basing it first on an object connected to springs. After further refinement, they compared the computer simulations they created to the real-life resonance recorded in the MRIs in the prior experiment and found them remarkably similar, suggesting their simulations were accurate depictions of what occurred inside the skull during a collision.

The researchers then ran their simulation under other conditions and found that during minor impacts, the brain tends to oscillate at approximately 15 Hertz, a finding they report, that has not been seen in other studies of traumatic brain injury. They contend that such resonance when repeated periodically, could very well lead to injuries of

the brain itself or to the parts of it that connect to the rest of the body. They suggest in future research efforts aimed at developing helmets for war, car driving or sports that such oscillations be taken into consideration to help prevent long term brain injury.

More information: Resonance of human brain under head acceleration, *Interface*, Published 10 June 2015. DOI: 10.1098/rsif.2015.0331

Abstract

Although safety standards have reduced fatal head trauma due to single severe head impacts, mild trauma from repeated head exposures may carry risks of long-term chronic changes in the brain's function and structure. To study the physical sensitivities of the brain to mild head impacts, we developed the first dynamic model of the skull–brain based on in vivo MRI data. We showed that the motion of the brain can be described by a rigid-body with constrained kinematics. We further demonstrated that skull–brain dynamics can be approximated by an under-damped system with a low-frequency resonance at around 15 Hz. Furthermore, from our previous field measurements, we found that head motions in a variety of activities, including contact sports, show a primary frequency of less than 20 Hz. This implies that typical head exposures may drive the brain dangerously close to its mechanical resonance and lead to amplified brain–skull relative motions. Our results suggest a possible cause for mild brain trauma, which could occur due to repetitive low-acceleration head oscillations in a variety of recreational and occupational activities.

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