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TierneyLab



Putting Ideas in Science to the Test

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Is Breath-Holding Hazardous to Your Brain?

By [John Tierney](#)

"He's risking heart failure, brain damage . . . even death. Paramedics are standing by . . . you'll have to see it for yourself!"

Ah, nothing like daytime television when it comes to sober presentations of science. ["The Oprah Winfrey Show" is promoting David Blaine's appearance](#) this Wednesday as a death-defying feat, which is not quite the way scientists (or Mr. Blaine) see his attempt to break the world record for breath-holding. Underwater breath-holding can lead to fatal blackouts if you do it without proper supervision, but Mr. Blaine will be carefully observed. Experts like Ralph Potkin, the pulmonologist who monitored Mr. Blaine during his training (which I described in my [Findings column](#)), say that prolonged breath-holds don't appear to cause harm to the body — at least not in the short term.

But what about the long term effects on the brain? [Chris](#) and other readers raised that question, and I'm afraid there's no clear answer yet from Dr. Potkin and other scientists who have studied veteran free divers, the competitors who regularly practice holding their breath underwater and sometimes suffer blackouts. The research results so far have been mixed.

In an Australian study, researchers looked for evidence of “brain insults” by administering tests to 21 free divers. Here’s the summary of the results from the researchers, Lynne “Ridgway and Ken McFarland of the University of Queensland, as [reported in 2006 in the Clinical Neuropsychologist](#):

Standard neuropsychological tests, with known sensitivity to mild brain insults, included speed of visuo-motor responding, speed of language comprehension, response inhibition, and visual and verbal attention and recall tasks. Results indicated that the breath-hold divers performed tasks within the average range compared to norms on all tests, suggesting that 1-20 years of repeated exposure to hypoxemia [an abnormally low level of oxygen in the arterial blood] including multiple adverse neurological events did not impact on performance on standard neuropsychological tasks.

In another study, Dr. Potkin and Michael Uszler conducted brain scans of five people who had done at least 1,000 breath-hold dives over a five-year period. One kind of scan, the well-known M.R.I., revealed no abnormalities in the structure of their brains, Dr. Potkin reports. But another kind of brain scan, called S.P.E.C.T. (single photon emission computed tomography anatomy), revealed abnormalities in their metabolism of the frontal and temporal lobes of the brain, according to the study, which was published in 2006 in the Proceedings of the Undersea and Hyperbaric Medical Society.

Dr. Potkin calls these abnormalities “troubling” but says it’s not clear whether or not they indicate a problem, particularly in light of the Australian study that found no apparent damage to the divers’ mental abilities.

“This was a preliminary study and we did not have the benefit of pre-dive scans for comparison,” says Dr. Potkin, who is the physician for the United States free-diving team. “The issue of long term brain damage is not yet settled and will require further investigation.”

Several readers asked for specific tips on how to prolong breath-holding, but I’m not going to try to answer their questions. To repeat the advice of Dr. Potkin and other authorities: Don’t try underwater apnea unless you’re being monitored by an expert — the way David Blaine will be on Wednesday.

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1.

I would be surprised if there was no neurological damage particularly from deep diving breath holding and the resulted loss of oxygen to the brain. It has already established the brain is subject to damage minutes after oxygen deprivation.

Divers pushing it to the limit are subject to blackouts. For every blackout they had, there has to be something that was pretty close a number of times.

The world of extreme physical performance is full of people who have damaged themselves pushing the limits. Distance running, football, even typing at a terminal. the question has been is it worth it. if you get a gold medal in the

Olympics or make it on opera or set for life, yes.

For mosts it is all in who they are. There is a toll. I believe it will show up in breath hold diving. There is no reason to think we are well adapted to this practice.

— *Mark*

2.

I understand your point, the gold medal makes the sacrifice worth it, but is it also worth it if the act provokes thought and science is pushed a bit further in the understanding of the human organism, or is that just too abstract?

— *Alex VF*

3.

Wouldn't be surprised if the metabolic abnormalities found in SPECT were signs of adaptations for maintaining normal function during periods of low oxygen. The brain is an incredible regulatory mechanism, and adjusts to whatever environment it finds itself in.

— *Chuckles McGee*

4.

Question is not whether it's harmful — it almost certainly is.

The real questions are:

1. Is the degree of harm measurable?
2. Is it clinically significant?

That is, is the size of the effect large enough to be meaningful for an individual, rather than a small effect that is statistically significant in the aggregate of thousands of research subjects.

3. Where does the harm rank among the almost infinite number of things that can be harmful?

A glass of wine a day is also hazardous to your brain (ethanol is neurotoxic) but few medical experts recommend going teetotal.

— *Paul Brandon*

5.

http://en.wikisource.org/wiki/You_Are_Old,_Father_William

— *Bob*

6.

This “study” is poorly conceived and executed. If one is interested in the neurological effects of repeated oxygen deprivation, voluntary apnea is not the way to go. Most people can hold their breath until they reach an O₂ saturation of 90-92%. Then they pass out or hyperventilate not because of lack of oxygen, but because of an excess of CO₂. If you want to see what happens to the brain when you stop breathing, study people who have sleep apnea. People with severe obstructive sleep apnea can experience O₂ saturation values of less than 60% every night. This condition can be lethal but people who get treated usually recover completely. If you want to isolate what happens to a chronically oxygen-deprived brain (as opposed to a O₂/deprived, CO₂-saturated brain), study people with emphysema or congestive heart failure. My dad has the former and probably hasn’t exceeded 90% O₂ saturation in years, but doesn’t seem to have much neurological impairment.

Dr. Potkin here has accomplished little more than wasting his sponsors’ money on a frivolous, uncontrolled experiment.

— *Throckmorton*

7.

mr. tierney, a few weeks back you wrote about the fallacy of those who had predicted a food crisis which of course is hogwash, as you made clear. we are much too smart to let a food crisis happen, aren’t we? can we have another article on this topic, please, for the naysayers are still at it talking about this ‘food crisis’ thing as if you hadn’t refuted them so elegantly.

[note: just because an unsubstantiated, poorly researched rant appeals to mr. tierney does not mean it’s wrong, but that’s a good working theory

— *a.thomson*

8.

As suggested by “Throckmorton,” obstructive sleep apnea is indeed the perfect model of humans who breath-hold frequently and to extreme degrees, with significant desaturations. It is not uncommon to find those who have apneic episodes over 100 times per hour for each hour of sleep for years, and with concomitant desaturations into levels we would have thought twenty years ago to be fatal.

Recovery from many of the effects of these episodes with treatment is total except in those with significant desaturations, where persistent performance

deficits on testing of intellectual function are found. This research finding has been repeated and found consistent.

Perhaps then it is the frequency of the desaturation events, not just their severity, that can cause permanent damage. One might conclude, facetiously, that the deep-divers should be discouraged from doing their dives more than 800 times in each 24 hour period.

— *Walter James MD*

9.

Sleep apnea patients obviously do recover after they are being threatened and my guess is that they suffer more from the lack of sleep than the lack of oxygen. Every person who makes a little experiment to not sleep few days in a row or to wake up on every 2 minutes will experience the power of sleep deprivation. And the fact that some people might even not know they have sleep apnea for a while and not feel disabled by it speaks that the conditions isn't so horrible from the health point of view. People are still "operating".

Yes, the lack of oxygen do destroy the brain, but if you look at yogis, they hold their breath for random periods and they don't seem to have brain damage. My own experiment on me show that if you train yourself, you really can hold your breath within certain limit and without troubles. The only problem I have is to hold my breath while doing something else, like walking, which significantly decrease my ability to not-breath. That's why I find it well, cool, that divers can swim and act while not breathing. Which implies the brain is much more surviving than we suppose. And that the lack of oxygen can be a condition the brain can be trained to ignore. Which is really cool.

Honestly, I'm rather surprised the brain don't get damaged at all by severe oxygen starvations like this. And I do believe those studies, if there was something visibly really wrong, they'll find it. Obviously even if the experience do change the brain in some way, it's far from the pathologies we know. Maybe it's not a pathology at all. Just a function we never suspected it exists. Due to the obvious empirical fact we live until we breath and if we stop breathing we're either death or heading toward it. But we all have read novels about divers for pearls. They seem not to have problem with not-breathing too.

But still, it's curious you may very well drown in as little as 5 minutes, but you can as well stay sound and safe after 15 minutes without oxygen. Is it just a matter of training and if it is, shouldn't we train ourselves for it? And what else our brain can do if it's trained :)

— *denitsa*

10.

The brain has a marvelous mechanism to prevent damage. By blacking out, your brain is preventing you from continuing to do damage. As a practitioner of Jiu Jitsu, a martial art which includes chokes which cut off blood to the brain, it is amazing how quickly you will black out if bloodflow to your brain is occluded, just like a slowly hyperextended joint causes severe pain long before there is any serious damage. This type of blackout is much less dangerous than the type experienced by a boxer who has had concussive force applied to their brains.

— Adam

11.

I wonder if human can voluntarily hold his breath to death or not.
Never try it please.

— Nick

12.

mmm many interesting comments.
some facts are

1. low O₂ and low blood flow to the brain are very different mechanisms with very different outcomes.
2. during low O₂ states blood vessels to the brain dilate - thus letting through more blood, and MORE O₂.
3. high altitude climbers and freedivers have trained their bodies and minds to tolerate low O₂ states
4. several rat studies have shown that you need long duration repeated bouts of low O₂ to build up the adaptive mechanisms.
5. more studies are required to see if some form of apnoea training could prepare/assist sleep apnoea sufferers to cope with nocturnal apnoeas.

isolated studies may seem to some to be a waste of resources but the additive effects of individual observations are great contributions to science, so keep up the interesting work.

— Dr Lynne Ridgway

13.

The problem I see with the suggestion that people who suffer sleep apnoea are a comparable study group, is that in true freediving, the athlete prepares their body, both physically and mentally with breathing exercises. A sleep apnoea

patient doesn't have this benefit. Further more the difference between oxygen starvation and free diving or apnea is that, again, the body hasn't been prepared or trained for the situation therefore it is reasonable to assume that there is likely to be damage in the "unprepared" subject.

In a freedivers dive, the metabolic rate drops, as Lynne has mentioned above, their vascular system dilates and blood shift occurs, this means that their vital organs are being delivered O₂ during their dive at the expense of the extremities, this is when hypoxemia occurs, their organs or brain are not being starved as stated dramatically quite often

Blood flow to the brain will continue until the heart stops beating (or other medical occurrences causing restricted bloodflow).

Freedivers train themselves to not react to contractions during apnea, these are signals sent from the brain to get you to breathe, I don't believe that it would be possible to hold your breath until you die, but it is obviously possible to hold your breath until you passout, this is another mechanism triggered by the brain to get you to respire, not a sign of oxygen starvation causing the brain to shut down (excluding extreme situations)

I would also like to point out that free divers do not suck on O₂ prior to a dive, whereas Mr Blaine does - Tom Sietas last week broke the world record for static apnea (pure breath hold) at 9:15 seconds, Tom has also broken 15m doing apnea in the same method as David Blaine will.

As a freediving coach and medic it is sad to see customised attempts such as Mr Blaine's being sensationalised so much

— *kelly*

14.

I love bodysurfing but run out of "air" too quickly to be able to ride large waves. Even in the pool I can only swim 20- 30 seconds underwater and if puffed from strenuous swimming it's even less. Sometimes among the waves I only have 10 seconds of breathholding capacity. How can I improve this?

— *Ian*

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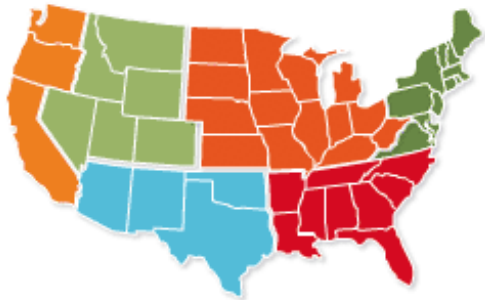
Times Magazine. Before that he covered science for magazines like Discover, Hippocrates and Science 86.

With your help, he's using TierneyLab to check out new research and rethink conventional wisdom about science and society. The Lab's work is guided by two founding principles:

1. Just because an idea appeals to a lot of people doesn't mean it's wrong.
2. But that's a good working theory.

Comments and suggestions are welcome, particularly from researchers with new findings. E-mail tierneylab@nytimes.com.

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