Deep Thoughts

DAN Takes a Quick Look at the Makeup of Nitrogen Narcosis

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"I am personally quite receptive to nitrogen rapture. I like it and fear it like doom --- l'ivresse des grandes profondeurs has one salient advantage over alcohol: no hangover. If one is able to escape from it's zone, the brain clears instantly and there are no horrors in the morning. I cannot read accounts of a record dive without wanting to ask the champion how drunk he was."
---Jacques Cousteau, in The Silent World

NITROGEN NARCOSIS
What is it?

Named by Jacques Cousteau "l'ivresse des grandes profondeurs," or "the rapture of the deep," nitrogen narcosis is an ever-present factor for scuba divers.

Why so? Divers breathe compressed gas. Usually it's air, but technical and commercial divers breathe special mixtures of other gases. And for 165 years, beginning with the work of a French scientist named T. Junod in 1835, scientists have recorded altered behavior in individuals breathing compressed gases.

Junod, for example, noted that when his divers were breathing compressed air, "the functions of the brain are activated, imagination is lively, thoughts have a peculiar charm and, in some persons, symptoms of intoxication are present."

Similar signs and symptoms have been noted by other scientists throughout the years, including Paul Bert, a scientist better known for his keystone work in decompression illness and oxygen toxicity. When tunnel workers and divers breathed compressed air, strange – and sometimes dangerous—warning signs occurred, with euphoria, intoxication, stupor, arrested activity and unconsciousness.

Later, in 1933, the British Royal Navy conducted an investigation and discovered that 17 of 58 dives between 200 and 350 feet/61.7 and 107.9 meters resulted in a 'semi-loss of consciousness." The Royal Navy scientists recognized this as a serious condition because, for example, the diver continued to give hand signals at depth but later could not recall any of the events that had taken place underwater.

The first quantitative evidence of narcotic effect of compressed air at depths came in 1937 when two United States Navy scientists, C.W. Shilling and W.W. Willgrube, tested the effects of compressed air between 90 and 300 feet/27.8 and 92.5 meters on 46 men who performed addition, subtraction, multiplication and division exercises. Shilling and Willgrube recorded the time it took each man to perform these tasks and the number of errors each made at increasing depths.

They found that experienced workers were less affected, and that the most severe signs and symptoms appeared immediately when the subjects arrived at the target pressure. They discovered that the narcosis intensified with rapid compression.

In the 1950s, a growing number of quantitative experiments began using different tests to determine subjects' intoxication levels. With studies still ongoing in nitrogen narcosis, scientists have measured slower arithmetic and motor skills in affected divers, a decrease in attentiveness and slower responses; and they have documented physical effects such as body sway, manual dexterity and disturbances in vision in "narked" divers.

Throughout the years, navigating the complexities of each successive set of experiments, the big picture comes into focus: Breathing compressed air or gas at depths can be intoxicating.

Background

Nitrogen narcosis is part of a larger syndrome called inert gas narcosis. Tracing the symptoms of narcosis specifically to nitrogen, the most common inert gas in air (79 percent), came around 1935 – a century after narcosis was first identified by Junod.

He observed that as the pressure of inhaled nitrogen in compressed air increased, warning signs of intoxication progressed, moving from an initial feeling of euphoria to drunkenness and finally to unconsciousness.

It was U.S. Navy physicians A.R. Behnke, E.P. Motley and R.M. Thomson who first attributed the narcosis to the raised partial pressure of nitrogen in compressed air. They demonstrated that when their subjects breathed compressed air deeper than 66 feet/20 meters, it caused "euphoria, retardation of the higher mental processes and impaired neuromuscular coordination."

At 100 feet/30 meters, the signs and symptoms became more apparent. Divers experienced "a feeling of stimulation, excitement and euphoria, occasionally accompanied by laughter and loquacity," signs and symptoms similar to those effected from alcohol, oxygen deprivation (hypoxia) and the early stages of anesthesia.

The subjects also experienced a slowing in their thought processes, and their responses to visual, auditory, olfactory and tactile stimulation were delayed. Concentration was difficult, memory became faulty, and the subjects experienced a tendency to fixate on ideas. Their powers of association became limited. They made errors in recording data, and mathematical exercises became more difficult. Fine movements were more difficult, but in general intellectual functions were more impaired than their physical dexterity.

In other words, moving around wasn't a big issue for them, but keeping their thoughts focused became a lot harder.

Sound familiar?

If any of this rings a bell, you've experienced nitrogen narcosis, too.

When Does It Strike?

Researchers believe the potential for narcosis exists as soon as a diver begins to descend, but generally most divers have felt the effects beginning somewhere around 100 feet/30 meters. Narcosis has hit other divers sooner, however, as shown with Behnke and associates' experiments, demonstrating that individuals have

varying levels of susceptibility. A recent test in a Navy recompression chamber, for example, showed a definite alteration in thinking skills when divers reached 33 feet/10 meters.

Nitrogen narcosis has been called “the martini effect,” or “Martini’s Law, “ because of it’s alcohol-like effect, a feeling often compared to drinking a martini on an empty stomach: being slightly giddy, woozy, a little off-balance. One rule of thumb states that divers should consider the narcotic effect of one martini foe every 50 feet/15.4 meters of seawater.

Deaths attributed to nitrogen narcosis occur mostly among sport divers who exceed recreational limits. Scientists believe narcosis results from a slowing of nerve impulses precipitated by the effect of inert gas under high pressure. How does this happen? The narcotic potency of inert gases is related to their affinity to lipids, or fat. When nitrogen seeps into the fatty substances around the brain, it slows the communication between cells, and therefore, slows down your thinking and reaction times.

Narcosis is not unique to nitrogen; however, it can occur with many of the so-called “noble” or inert gases, with the exception of helium. Add to this the fact that other inert gases each have their own brand of narcotic effects at depth, and you have a complicated picture for technical and commercial divers. One of these rare gases, argon, for example, has about twice the narcotic potency of nitrogen, but helium has very weak narcotic properties and is less soluble than nitrogen in body tissues.

This is why we find helium used in deep and saturation diving, as demonstrated by diving physiologist R.W. Hamilton in groundbreaking experiments he conducted in 1966. Mixed with oxygen and called heliox, this mixture is less likely to impair deep divers, although they still have to undergo decompression in order to prevent decompression sickness (DCS). Helium has it’s drawbacks, however: it has a high thermal conductivity, which requires the use of heated diving suits and breathing gas; it is quite expensive and difficult to store, and it distorts the voice.

What Can You Do?

As to the cause of narcosis, there is one prevalent theory that states nitrogen partial pressure is responsible. One fact that emerges from all this research is that there is a wide range of susceptibility among individuals. And individual sensitivity can vary from day to day.

The fact is that if you dive, you take the chance of getting narked. The good news is that if you do experience narcosis, the shallower you get the less you will feel the effects. And it doesn’t take long at all for the effects to wear off once you get topside.

Before you dive, however, stop and take stock of these suggestions:

· Know your limits

Exercise your discipline. Diving is a multitasked activity: You have to pay close attention to your thoughts, feelings, attentiveness – in addition to your buddy, depth and air consumption. If you notice a sudden lightheadedness or experience confusion, try to step back mentally and take stock of what’s happening to you and around you. Then slowly ascend to a shallower depth.

· Watch your carbon dioxide levels

Increased levels of CO2 can increase your potential for nitrogen narcosis. The working or swimming diver wearing a breathing device is more susceptible to

narcosis than a diver in a chamber. And the effect is synergistic: that means the effect CO2 wields can have a greater wallop.

· Avoid alcohol

When you're planning your dive excursion, keep in mind that alcohol augments the signs and symptoms of nitrogen narcosis. Why? "Because of the similar (and additive) effects to excess nitrogen, alcohol should be avoided before any dive. A reasonable recommendation is total abstinence at least 24 hours before diving; by that time effects of alcohol should be gone, " advises dive physician, Dr. Lawrence Martin.

· Be rested when you dive

Refrain from hard work and it's resultant fatigue before and immediately after your dives. Work and fatigue can cause higher levels of CO2 in the body, which results in metabolic effects on the neurotransmitters in your brain.

· Be calm before you dive

Go well prepared so you can look forward to your trip. Anxiety increases you r susceptibility to narcosis. "The exact mechanism isn't known," adds Dr. Peter Bennett, DAN Chie Executive Officer, "but it has an effect on the brain's neurotransmitters, in the same place anxiety operates."

· Descend slowly on deep dives

Experiments have shown that rapid compression affects divers more severely than slow compression.

· Stay Warm

Cold makes narcosis worse. As with anxiety, the precise mechanism is unknown, but cold can have analgesic and anesthetic effects. These reactions in turn can be synergistic, packing a greater than expected punch.

If you feel the effects of narcosis and recognize it, head for the surface and fresh air. Remember to breathe, ascend slowly, make your safety stop, then get out into the open. You'll be back to normal in no time. And if you have questions about nitrogen narcosis, call DAN Medical Information Line.

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