PHYSIOLOGY

How Sprees Ruin Nerves

Researches of Young Virginia Scientist Show Details Of Nerve Behavior Under Severe Alcohol Poisoning

By JANE STAFFORD

THOSE LONG cool drinks you sipped in this first summer of repeal—what have they done to your nerves?

The answer—learned from a study of tadpoles—depends on how you did your drinking. One mint julep at the end of a hot day or even every hot day probably did not affect your nerves, but if you went on a spree every week-end or holiday, the answer is quite different.

A little daily drinking of alcoholic beverages, even when done over a prolonged period of time, does little or no perceptible harm to your nerves. The damage, if any, is soon repaired. But the amount of alcohol consumed on a spree may permanently damage these important tissues.

These facts are the latest scientific discoveries about the effects of alcohol on the body.

Medical scientists have long known in a general way that the nervous system and the digestive tract are the only parts of the body affected to any extent by alcohol as a beverage. You don't have to be a scientist to know that alcohol dulls the senses, slows the mental processes and the coordinating mechanism between mind and muscles. Unless you are a scientist, however, you may not realize that these results of drinking alcohol are evidence of the drug's effect on the nerves. (Alcohol taken internally may be a beverage to you, but it is a narcotic drug to the scientist.)

What Alcohol Does to Nerves

Because the mental processes, the senses, the coodinating mechanism, and control of muscles and movements are intimately related to the proper functioning of the nerve cells, it is important to know just what happens to the nerves during alcoholic intoxication.

Prof. Carl C. Speidel of the University of Virginia has now found the exact changes which alcohol produces in the very structure of the nerves. His studies will probably explain why a drunken man can not walk or talk straight and is more or less insensible to pain.

For years Prof. Speidel has been watching the behavior of nerves in living organisms. He used small frog tadpoles because their nerves are constructed essentially on the same plan as man's and because the transparency of their tail fins makes it easier to study them in place. What he did was anesthetize the animal slightly and place it on a specially prepared microscope slide. Then, using very high magnification, he observed the individual nerve fibers in the transparent tail fin.

From this observation Dr. Speidel made a map of the nerves in each tadpole's tail. The animal was then put back into pond water and on the next day the same region and the same nerves were studied again. By this method he obtained histories of individual nerve fibers over a period of several months. He learned how nerve fibers grow through living tissues, how they repair themselves when injured, and, most recently, how they are affected by alcohol. He has even taken moving pictures of the nerve growth so that he could show it to fellow scientists.

Pioneers of Growth

As pictured and explained by Prof. Speidel, nerve growth is pioneered by what are known as "growth cones" on the ends of the nerve fibers. These are thickenings of the tips which probe their way through the tissues, constantly sending out and recalling tiny processes from their surfaces, like finger-tips feeling their way. As the nerve progresses special cells develop along its course. They hug the sides closely, though they take no part in its actual growth process, nor in its function as a nerve. These are known as the "sheath cells." Finally, as the nerve becomes more mature, it develops around itself a layer of fatty material called the "myelin sheath."

"A conspicuous feature of mature fiber is the myelin sheath, a fatty covering which encases the nerve fiber and protects, insulates and nourishes it," Prof. Speidel explained.

"This sheath is in the form of segments arranged somewhat like a string of sausages. As it responds quickly to irritation of almost any sort, it is an excellent indicator of alcohol effects. It may degenerate or partially degenerate even though the nerve axis within it remains alive. It never persists, however, if the nerve axis degenerates.

"It occurred to me that it might be interesting to watch nerve fibers while the tadpole was subjected to prolonged and repeated intoxication by alcohol. This proved to be entirely feasible. My records now include many case histories of nerve fibers which demonstrate that practically all gradations of irritation and injury may be induced by alcohol treatment."

Movies of Living Nerves

Prof. Speidel has made motion pictures directly from living animals showing such irritated nerve fibers.

"Poisoning of nerve cells by alcohol depends upon the concentration of alcohol in the blood and body fluids," he continued in his explanation of his latest findings.

It matters little how the alcohol enters the body. In the tadpole it was given by way of the skin. Alcohol permeates the moist skin of the frog tadpole readily, he found. In this respect the tadpole's skin can be compared in the lining of the alimentary tube of man.

Prof. Speidel sought answers to the following questions:

(1) Do visible structural changes take place in nerves during alcoholic intoxication?

(2) Can complete degeneration of myelin sheath segments be induced?

(3) Does repeated alcoholic intoxication stop the addition of new myelin sheath segments in a developing zone?

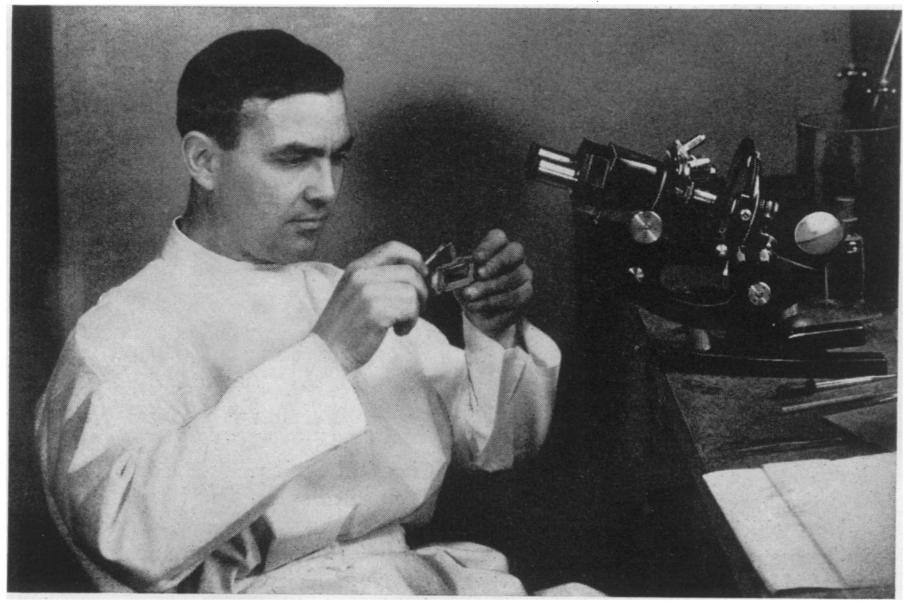
(4) Does repeated alcoholic intoxication stop nerve sprout growth?

(5) What are the relative effects of prolonged continuous intoxication (the "spree" type), and of short daily intermittent intoxication continued, however, over long periods?

In very dilute alcohol, less than five-tenths of one per cent., Prof. Speidel found that tadpoles may live indefinitely with little or no indication of any special nerve irritation. In much stronger alcohol solutions, more than three per cent., death usually ensues within an hour or two. The skin suffers direct injury in these cases.

Alcohol solutions in the neighborhood of two per cent. brought on marked changes in the nerves, such as marked swelling, undulating movements of the myelin sheath, appearance of vacuoles or spaces between the myelin sheath and the enclosed nerve axis followed by gradual separation of these structures, assumption of an irregular wavy course by the nerve axis, and formation of myelin globules and ovoids.

In one case an animal was kept in two and one-half per cent. alcohol for five hours. At the end of this period it was dazed and could be examined without the use of any anesthetic. The speed at which the blood circulated was markedly less than normal. A long nerve fiber was seen with its myelin sheath in process of degeneration. The last thirteen myelin segments were already breaking up into fragments. The ones on the side toward the body were all greatly swollen and showed definite separation of the myelin sheath from the nerve axis.



TEMPERANCE LESSONS FROM TADPOLES

Prof. Carl C. Speidel in his laboratory at the University of Virginia, preparing to watch the growth of a nerve in the transparent tissue of a tadpole's tail. If the tadpole is kept alcoholically intoxicated too long, the nerves degenerate.

Replaced in Water

The animal was replaced in pond water, and the process of its recovery watched. During the next two days, two more of the swollen myelin segments broke up into ovoids. The others slowly recovered. At many points on these recovering segments, however, small myelin globules were cut off, an indication of the strong irritation to which the nerve fiber had been subjected, Prof. Speidel explained. During the next two months, new nerve sprouts grew from the irritated fiber to make entirely new connections with the skin. New myelin segments also appeared along the nerve to which the fiber belonged, under the influence of the sheath cells of the degenerated segments.

Separation of the myelin sheath from the nerve axis is a feature of strong alcoholic intoxication. According to one theory, the surface junction of the myelin sheath and the nerve axis plays the chief role in conducting nervous impulses.

"If this be true," commented Prof. Speidel, "my observations on tadpole nerves reveal a direct structural basis for the explanation of the functional disturbances associated with strong alcoholic intoxication."

In other words, the reason why a drunken man can not walk or talk straight and is more or less insensible to pain may be that the sheath has separated from the axis of certain of his nerves.

The structural changes brought about in the nerve fibers are not specific to alcohol but are due to the irritation it produces and can be brought about by other irritants.

The complete degeneration of myelin sheath segments by strong alcoholic intoxication is permanent, but the slight irritative changes from mild daily intoxication of brief duration are quickly repaired, Prof. Speidel found. New sprout growth and new formation and growth of myelin segments may take place on fibers subjected to such lesser irritation.

One Long "Spree"

One interesting case was that of a tadpole under strong intoxication following immersion in two per cent. alcohol for 21 hours—a good long "spree," in fact. This animal showed incipient degeneration of two of the last segments on a nerve fiber. When the tadpole was replaced in pond water these segments recovered in a few days.

Thereafter for nearly three months the animal received enough alcohol once a day to stun it. Temporary irritation of the fiber was usually visible during the treatments. However, the fiber readily recovered each day between treatments and remained fairly normal in appearance. Moreover, the youngest myelin segments grew somewhat, and three new segments were added to the fiber. Some new nerve sprouts were also formed.

"This case and others of similar nature suggest that daily intoxication of brief duration is not enough to cause degeneration of either myelin sheath or nerve axis," Prof. Speidel concluded. "Nor is it sufficient to prevent the growth of nerves in regenerating zones."

It was the study of nerves in the living tadpoles that enabled Prof. Speidel a few years ago to show for the first time that nerves sprout from the spinal cord and, like telephone wire strung from a central office to a home, go directly to the muscle or sense organ they are destined to connect with the central nervous system. For this demonstration Prof. Speidel received the $1,000 annual prize of the American Association for the Advancement of Science. As a result of his demonstration, science must set about to answer a fundamental question of life; How does the nerve grow with seeming intelligence and travel unerringly to its destination?

Growth After Injury

Growth after injury as well as normal growth of nerves was studied by Prof. Speidel before he undertook the alcohol study. Unlike a telephone line, nerves can not be patched when cut, but the break must be remedied by an entirely new outgrowth from the place of the cut to the muscle or sense organ controlled. It is just as though a telephone linesman were unable to use any of the old wire between the place of a break in the line and the subscriber's telephone and had to string entirely new wire.

This explains why when a finger or leg suffers a serious cut it may take weeks and months for normal feeling to be restored in it and why muscles have to be reeducated.

How Alcohol Affects the Body

Prof. Speidel has found how alcohol affects the nerves. Other effects of alcohol on which medical scientists agree have been summed up in a recent book by Prof. Haven Emerson of Columbia University as follows:

1. Alcohol is a narcotic which, by depressing the higher centers, removes inhibitions.
2. Outside of the nervous system and the digestive tract, alcohol used as a beverage has little demonstrable effect.
3. It is a food, ultilizable as a source of energy and a sparer of protein, but it is such only to a very limited extent.
4. It is improbable that the quality of human stock has been at all injured or adversely modified by the long use of alcohol, although the effects on the individual are often devastating.
5. The therapeutic usefulness and value of alcohol is slight.
6. It may be a comfort and a psychological aid to the aged.
7. It does not increase, and it sometimes decreases, the body's resistance to infection.

Releases Inhibitions

8. By releasing inhibitions, it makes for social ease and pleasure, and herein lies one of its great dangers.
9. Its effects are best studied by changes of conduct.
10. It impairs reason, will, self-control, judgment, physical skill, and endurance.
11. It may produce situations from which crime and social lapses result.
12. It is a frequent destroyer of health, happiness, and mental stability.
13. Its use commonly lowers longevity and increases mortality.
14. It is used primarily for its psychological effect as a means of escape from unpleasant reality.
15. It constitutes an important community health problem.

Science News Letter, September 15, 1934

CHEMISTRY

New Oxy-Nitro-Fluorine Gas Is Irritating, Explosive

Warfare Use Considered Doubtful by Chemists Since Instability Makes it Unsafe to Handle

A NEW chemical substance, potentially an irritating war gas like phosgene, has been discovered at Massachusetts Institute of Technology. At the Cleveland meeting of the American Chemical Society, Dr. George H. Cady, chemist now employed by the United States Rubber Company, reported on a new compound of fluorine extremely explosive, and irritating to the lungs in a fashion similar to the war gas phosgene. The gas, never before known, was produced in a laboratory accident at Massachusetts Institute of Technology last May.

Starts Coughing

Dr. Cady said: "When one inhales a small amount of the compound one starts to cough. A deep breath, even of fresh air, taken after a coughing spell produces still more irritation of the lungs. In this respect the gas is something like phosgene. A blanket of gas over the enemy's trenches would be destructive to life, and if the concentration were high enough an explosion could easily be produced."

An official statement issued by the American Chemical Society added:

"Dr. Cady's discovery attracted unusual interest among chemists in view of rumors reaching this country of new war gases developed in the laboratories of Europe and the possibility of utilizing certain known gases in warfare. Definite knowledge of such developments, however, appear to be lacking."

The accidental creation of the new fluorine compound resulted in a substance whose molecules consist of one atom of nitrogen, three atoms of oxygen and one atom of fluorine. The gas has the treacherous property of exploding violently when heated.

"I first learned of the explosive tendency of the gas quite suddenly," Dr. Cady's report stated, "when a large flask I was holding blew up. After that, the compound was prepared in a piece of apparatus something like a gun. The reaction of fluorine with nitric acid occurred in the barrel, and occasional explosions simply blew a metal disk away from the muzzle, doing no damage.

"At present no one can predict the future industrial importance of gaseous fluorine or compounds directly derived from it. It seems probable, however, that research of a purely scientific nature will create a demand for the commercial production of fluorine, and the free element may eventually occupy a position equal to that of the other halogens, chlorine, bromine and iodine."

Minimizing the possible wartime uses of newly discovered gases, Dr. Harrison E. Howe, editor of *Industrial and Engineering Chemistry,* declared:

"I think it is fair to say that to the best of our knowledge and belief, research since the war has failed to disclose any gases for field use that are more advantageous than those known and used during the World War."

Not only must a war gas or an explosive be destructive but it must do its damage when—and only when—it is desired. It must hurt the enemy but not the homeland forces. Dr. George H. Cady in reporting on his new fluorine compound declared that only when the violent instability of the compound has been overcome will the new gas be useful in war.

Not Safe Enough

While the compound may find industrial uses, its present status as a war gas can be compared to the frequent announcements of the discovery of super-explosives more powerful than dynamite or TNT. In most cases such substances give violent explosions but are unsuitable for general use because they blow up on the slightest provocation, either from heat or shaking. Not only must an explosive or gas give violent reactions but it must be capable of being handled safely even by unskilled labor.

Massachusetts Institute of Technology officials declared that no chemical research conducted in their laboratories