The Spider's Web—Research Tool

Telltale "fingerprints," woven by drugged spiders, yield clues to the action of narcotics and other drugs on the nervous system of human beings

YOU ARE GIVEN two unlabeled bottles. Each contains an identically shaped white tablet. One bottle holds a *barbiturate* "sleeping pill." The other contains a *tranquilizer* – a "relaxing pill." How do you discover which is which without lengthy chemical analysis?

Solution: Feed the tablets to spiders and watch the animals spin their webs!

"Fingerprinting" drugs with spider webs is the specialty of Dr. Peter N. Witt of the Upstate Medical Center in Syracuse, New York. How did Dr. Witt discover and develop this unusual technique?

While at the University of Tübingen, Germany, about 20 years ago, Dr. Witt was studying the effects of certain drugs on human beings. His patients had reported that the drugs had caused fantastic reactions.

Certain of the drugs had triggered hallucinations; others, fits of laughter; still others, moods of depression. How did these drugs work? Dr. Witt did not know.

Unwilling Performer

His human subjects had told him how they *felt* when given these drugs. But the behavior and emotions of human beings are influenced by many things – such as mood – unrelated to drugs. How could the specific effects of the drugs be isolated from these complicating factors?

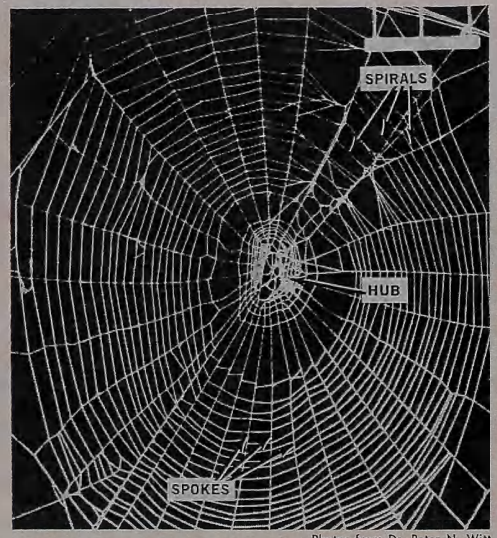
Then some of Dr. Witt's colleagues from the zoology department came to him with their own problem. Armed with a movie camera and bright lights, they had spent night after night in the biology laboratory, trying to make motion pictures of a spider spinning its intricate web. But the spider was active only at night in the dark; it would not spin while the lights blazed.

The weary scientists knew that certain drugs stimulated human beings. Would one of these drugs overcome the spider's reluctance to perform in "daylight"?

Dr. Witt knew nothing about spiders, but he was happy to supply his colleagues with samples of drugs that might work.

The results were disappointing – at least to the team of zoologists. The drugs failed to make the spider spin in the light. What's more, when the scientists switched off the light to see what would happen, the spider built a web that was strangely shaped.

As so often happens in research, this unexpected result provided Dr. Witt with a fresh approach to his own problem. The spider, whose behavior is less complicated than man's, had reacted to the drug by spinning an abnormal web. Could the spider's reaction to drugs be used in a scientific experiment?



Photos from Dr. Peter N. Witt

Photo shows normal web of garden spider. Architecture of web is record of spider's behavior during web-building period.

Web spun by drugged spider is abnormal. Spiral is irregular and not complete. Clearly, drug affected spider's behavior.

Dr. Witt set out to learn all he could about the behavior of spiders. He chose as his subject the common garden spider, *Araneus diadematus*. Easy to catch and observe, it constructs a silk web in a round pattern. (The silk is produced as a liquid in glands within the spider's body. As it is drawn out, the liquid hardens into thread.)

The spider first attaches the end of a thread to a support, such as the frame of a window. It then builds the circular framework of the web. Next, the spokes are constructed. The angles between the spokes are almost exactly equal.

Finally, the spiral is woven – from the outside inward. The threads in the spiral – the insect-catching area – are covered with a thin layer of sticky fluid. The whole process takes 20 to 30 minutes.

The spider's vision is extremely poor. It builds its web to precise measurements through its sense of touch. Its legs tell it where to weave each strand and how long each strand should be.

The spider's web-building follows a pattern that never varies. If its web is destroyed during the day, the spider will build a completely new one the following night. The new web will be an almost exact duplicate of the old one.

Suppose the spider were given drugs. Would the pattern change? Dr. Witt planned to photograph the web spun by an *undrugged* spider and compare it with the photograph of a web spun by a *drugged* spider.

Among the first drugs Dr. Witt fed his spiders was one that acts as a stimulant in human beings. He noted that the web spun by the drugged spider was normal – with two important exceptions. The spiral did not make smooth turns. Also, many spokes were bent or short.

Next, Dr. Witt gave a spider a drug that produces hallucinations in human beings. This time the spider appeared to lose all sense of direction. The spiral ran in the wrong directions.

Spider-Web "Fingerprints"

As Dr. Witt continued his experiments, he found that each drug affected the structure of the spider's web in a different way. Each left its own "fingerprint."

Armed with this new technique, Dr. Witt helped to resolve a great controversy about tranquilizers, which were then new drugs. Some scientists suspected that these drugs affected the nervous system in the same way as barbiturates. Others disagreed.

When a person is given heavy doses of a barbiturate, he fails to function properly. He is unable to do simple things like tying shoelaces. He behaves in a dazed and confused way. In addition, he finds it impossible to translate commands or wishes into action.

Heavy doses of some tranquilizers, on the other hand, seem to make it difficult for a person to make a decision. But the person *can* carry it out in an orderly and normal fashion.

One of the great problems in drug research is that every drug affects different people differently. Some people have typical reactions. Others do not. Apparently, the reaction depends partly on one's state of mind.

But spiders do not vary in their drug reactions. Dr.

Witt and his colleagues gave barbiturates and tranquilizers to different spiders. Slowly, the spiders given the barbiturates began to weave their webs. When they were finished, the catching areas were smaller than usual. Angles between the spokes were unequal. The positions of the hubs were abnormal. As in human beings, the barbiturates affected the spiders' movements.

What happened to the spiders given the tranquilizers? They appeared to have lost their drive to build – and did not weave as many webs over a given span of time as they would normally. But once started, the work proceeded efficiently and normally. Clearly, a tranquilizer's effect was different from that of a barbiturate.

Web tests have since been used to uncover the properties of *combinations* of drugs. Such information can be of vital concern to medical researchers and physicians. For example, the alcohol in a glass of wine is not likely to harm the average man, nor will the few milligrams of barbiturate in a sleeping pill. The combination, however, can be deadly.

On the other hand, two drugs that are of no help to a patient when given separately may work wonders when administered together.

Dr. Witt found that a central nervous system stimulant, *amphetamine,* did not affect web-building when given to spiders in relatively small doses. However, the same dose given to a spider after it had been fed a "psychic energizer," *iproniazid,* caused the animal to construct an abnormal web. (A dose of iproniazid alone, equivalent to that often given to reduce mental depression in human beings, had no effect on web-building.)

Dr. Witt's spider-web test has progressed far beyond the study of drugs. It is permitting scientists to deepen their study of mental disease. Many researchers have uncovered evidence that abnormal molecules may be the cause of such illness. If the web of a spider can display the "fingerprint" of the molecules of a drug, perhaps it can reveal "diseased" molecules.

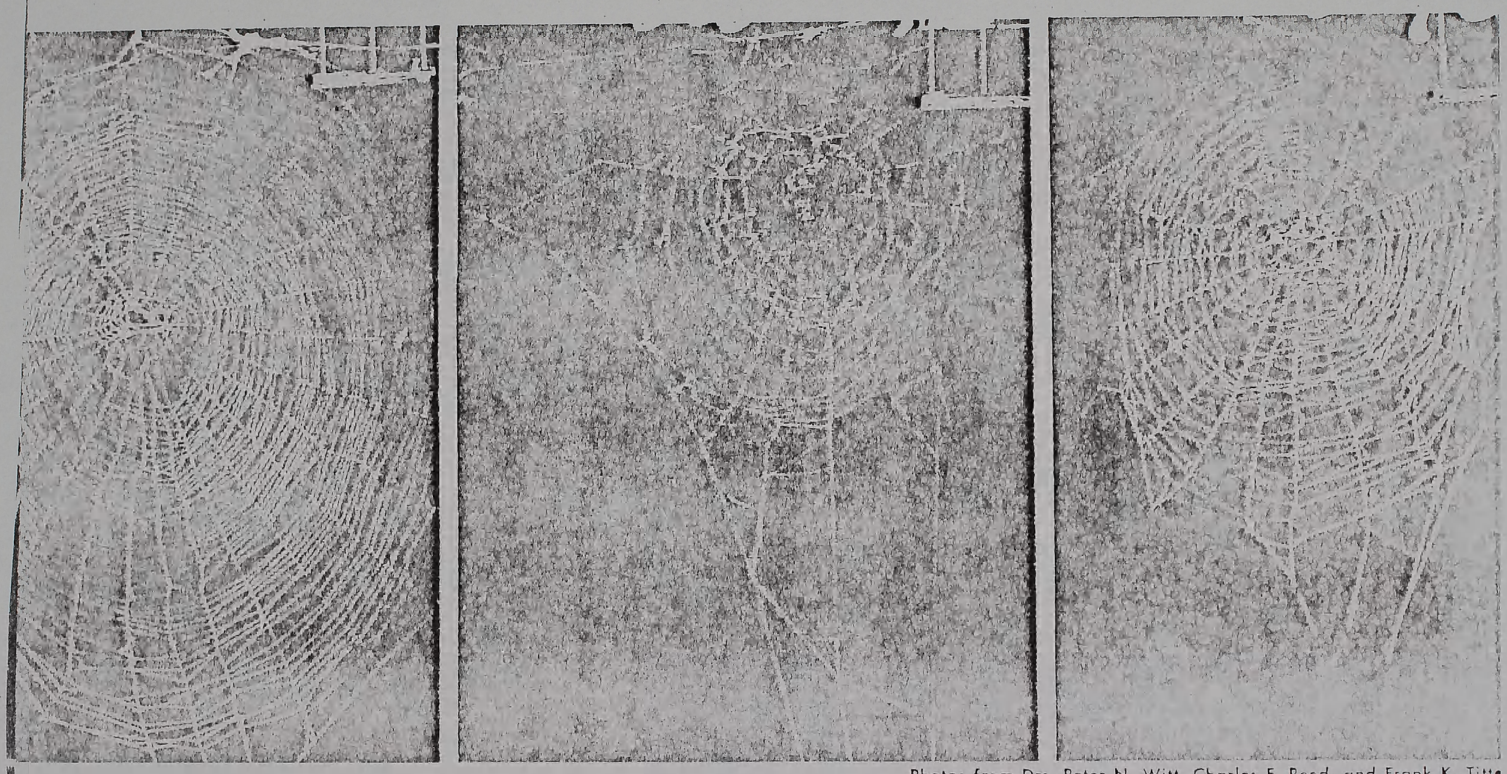
Body fluids taken from mental patients have driven spiders to weave strange and unusual webs. But much research must be done before the guilty molecules can be isolated and identified.

In another series of experiments, now under way, Dr. Witt has "operated" on the central nervous system o spiders using the high-energy light beam of a lase as his scalpel. The laser beam can be carefully controlle so that it will not damage any other part of the anima

Dr. Witt believes that by using this method, he ma be able to map the functions of the spider's centra nervous system. He has already discovered that whe certain parts of a spider's "brain" are operated upon, th animal will build alternately abnormal and normal web Perhaps some other undamaged part of the "brain" ca substitute for the lost function.

This kind of research may lead to a better unde standing of how behavior is affected by nerve damag And, perhaps, even how such damage can be repaire

— Carl Prouja



Photos from Drs. Peter N. Witt, Charles F. Reed, and Frank K. Titte

Three photos above show how behavior of spider is affected by laser beam. Web at left was spun before laser surgery. Abnormal web (center) was spun one day after "operation." Web spun 2-3 weeks later (right) is almost normal, indicates recovery.