The Cat can juggle this in a hat

FAU studies balance, the brain and all that

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It's a scientific problem straight from the pages of Dr. Seuss.

Around the laboratory where researchers study the deepest mysteries of the human brain, it's known as "The Cat in the Hat problem."

Inspired by the mischievous, intrusive cat, Florida Atlantic University psychologists are trying to discover how people learn to balance objects.

The research might be applied to such situations as learning to ride a bike, controlling bouts of epilepsy and being able to predict instability in political systems.

The idea for the experiment came to researcher J. Scott Kelso when he was reading his daughter's *The Cat in the Hat* book. Kelso was inspired by a picture of the Cat balancing a fishbowl on a rake, a milk bottle on his tail, three books on one paw and a birthday cake and teacup on his head. Moreover, the Cat managed these tricks while hopping on a ball and cooling himself with a fan clutched in his tail.

That picture, Kelso said, raised a scientific question: "How does a biological system stabilize an unstable system?"

In other words, how can we balance unsteady objects?

Kelso is head of the Center for Complex Systems. The center, founded at FAU in 1985, brings a multidisciplinary approach to studying the brain. Researchers at the center are applying advanced mathematics to try to understand how the brain controls behavior.

The balance research is part of a $360,000, three-year grant from the Office of Naval Research. The research is aimed at learning how the nervous system can learn to stabilize unstable objects.

One potential application is in the field of robotics, where balance is crucial. Engineers have studied the problem of balance before, looking at factors such as the amount of force required to keep an object's mass centered.

But the FAU scientists want to know how the brain sorts out such problems.

Staff photos/JILL GUTTMAN

Paul Treffner demonstrates with a balancing apparatus what he and other FAU researchers call The Cat in the Hat problem.

An engineer can write equations about how a bicycle is balanced, for example, but researchers don't know how the brain approaches the task.

For non-feline, non-cartoon subjects, FAU researcher Paul Treffner designed a simple test.

The experiment consists of a straight track about 8 feet long. A pole is fitted into a bracket that slides along the track. Left alone, the pole will fall onto the track.

But by wiggling and sliding the bracket back and forth along the track, the person taking part in the experiment can keep the pole upright. The

PLEASE SEE **BALANCE** /4B

FROM PAGE 1B

Psychologists seek to learn how people balance objects

activity is similar to balancing an umbrella or a baseball bat on the palm of your hand. To keep the object balanced, you have to move your hand back and forth.

Sometimes a series of small, rapid movements keeps the object balanced. Sometimes slower, more sweeping movements are needed to keep the object under control.

"We don't know exactly how we do it," Treffner said.

A computer tracks the movements of the pole during the experiment, showing how much the rod sways to and fro, as the subject struggles to maintain balance. The information is plotted on a graph. Using that information, scientists have formed three general guidelines for how the activity is done.

"You can go with the flow," Treffner said. "You can go against the flow. Or you can jiggle it."

> **A computer tracks the movements of the pole during the experiment, showing how much the rod sways to and fro, as the subject struggles to maintain balance. This information is plotted.**

In other words, sometimes the subject moves his hand in the same direction the pole is tipping, sometimes in the opposite direction. And sometimes the hand stays in one small area, moving the bracket back and forth.

The scientists then analyze the motions, looking for patterns that repeat themselves. For example, are the sweeping motions merely a repetition of the jiggling motions on a larger scale?

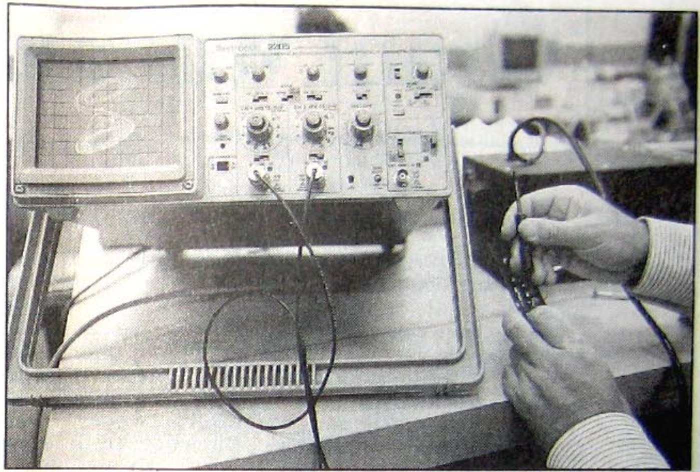
At first, the motions seem random. But when they are plotted on a graph, similarities become visible. If the scientists can detect and understand the patterns, they might be able to uncover the laws governing such behavior.

Those laws might be applied to a variety of situations, from designing industrial robots that can walk to finding out exactly how humans learn to walk.

Treffner is particularly interested in learning what information is required for the brain to balance the object. The key could be watching the pole, with the brain being triggered into action when the rod reaches a certain angle. Or the key could be a sensitivity to the weight distribution of the rod.

The experiment brings up a mystery that is a favorite of Kelso's. In order to keep the pole from tipping over, the brain must anticipate the pole's position. Yet in scientific terms that means the brain is reacting to something that hasn't happened. The laws of physics, for example, don't allow for such a thing.

"What we're looking at is how does the brain predict instability," Kelso said. That might some day even be applied to predicting events, such as when a political regime could become unstable.



Staff photo/JILL GUTTMAN

J. Scott Kelso, director of FAU's Center for Complex Systems, demonstrates the evolution of chaos using a circuit board.

While the balancing experiment may seem simple, it involves a great deal of complexity. The brain not only has to predict how the pole will tip, but it also has to predict how the motion of the hand will change the angle.

"This is always the case," Kelso said. "The apparently simple actions are the hardest to understand."

No word on whether Kelso is planning a "Yertle the Turtle" experiment.