

Monkeying with **STRESS**

The distinct stress responses of two primate species may provide clues to understanding human coping styles and psychosomatic illnesses

By BRUCE BOWER

Squirrel monkeys and titi monkeys have about as much in common as Mick Jagger and Donny Osmond.

Yet, whether scurrying through lush South American jungles or exploring environments devised by primate center researchers, this simian odd couple (not Jagger and Osmond) may provide scientists with a research model that throws light on human stress responses and psychosomatic illness.

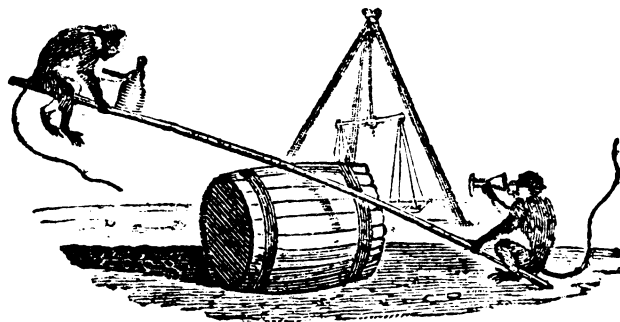
"My initial interest in these monkeys had nothing to do with stress," says psychologist William Mason of the California Primate Research Center in Davis, Calif. "I wanted to study social behavior and pair bonding in the two species."

Watching the species in controlled environments was a reasonable approach, given the monkeys' differences. Squirrel monkeys (*Saimiri sciureus*) are rolling stones, roaming through the jungle in noisy groups of up to several dozen. They are excitable and restless, jumping from treetops to spiny palms to the ground as they eat small fruits, insects and even frog eggs. Pilfering food from plantations also keeps them occupied.

Stable sexual relationships are uncommon among these nomads. Squirrel monkeys mate with numerous partners, and child rearing is left to the females.

Titi monkeys (*Callicebus moloch*), on the other hand, are low key homebodies. They settle down in swampy areas of the jungle where roving bands of squirrel monkeys are unlikely to tramp. Titi monkeys carefully choose and methodically consume their food, are wary of strangers and do not stray far from their defended territories. Sexual partnerships are monogamous; the young are cared for by both sexes.

As Mason developed colonies of the species during the 1970s, he found that they also respond differently to change and challenge. Squirrel monkeys are bolder and more impulsive than the titis. They adapt more quickly to new settings, are quicker to approach unusual objects, are more persistent in solving problems and get less upset when separated from companions or confronted by strangers.



Since 1979, using 32 titi and 60 squirrel monkeys, Mason and his colleagues have repeatedly measured heart rates and levels of cortisol, a hormone associated with stress, in adults and their youngsters. At rest, the squirrel monkey's heart is about 100 beats per minute faster than the titi monkey's heart. The squirrel monkey also has 10 times more cortisol circulating in its blood.

"It seems likely that each species has a basic psychophysiological profile that determines its stance toward the environment," says Mason. Temperament characteristics, observable as early as six months of age in both monkeys born in the wild or in the laboratory, are obvious tip-offs.

But differences in autonomic nervous system balance are at the root of the profiles, according to Mason and colleagues Sally Mendoza, a psychobiologist on leave from the National Institute of Child Health and Human Development, and Gary Moberg, an endocrinologist at the Davis center. The nerves in the autonomic system operate automatically to control basic life-sustaining functions such as heart rate, breathing and digestion. The sympathetic component of this system revs up the body's physiological processes and prepares an animal for action. The parasympathetic part cools the animal down and returns basic functions to normal. While both systems are always working, one is dominant at any given time.

The titi monkey's lower heart rate and blood cortisol levels, notes Mason, point to parasympathetic dominance of its autonomic nervous system. When placed in a new cage or exposed to unfamiliar companions, its heart rate rises quickly, but

parasympathetic activity rapidly returns the beat to normal. Even so, in these situations titi monkeys often freeze or withdraw and look depressed.

Squirrel monkeys, however, have high heart rates and cortisol levels that are consistent with sympathetic dominance of the autonomic nervous system. In new situations they become active, restless and excited. They adjust quickly thanks to a natural curiosity, although their heart beat shoots up and stays elevated for several hours. The lowest heart rate and cortisol measurements for squirrel monkeys still surpass the highest measurements for titis.

To explore further the inner balance of the two species, the researchers tested the monkeys' reactions to novel environments after either sympathetic or parasympathetic activity was blunted with drugs. Over the past three years they have run through the procedure numerous times: Six to ten male-female pairs of each species are put into a new cage with various food sources, travel surfaces and play structures, or they remain in the same cage and are given unfamiliar cage mates of the same species. Just before the experiment begins, each monkey is injected with either atropine, a drug that blocks parasympathetic activity, or propranolol, a drug that decreases sympathetic actions. Heart rate is measured continuously after the injection and for the first 15 minutes in the novel environment.

The results, which are being submitted for publication, have been consistent. When the parasympathetic system is blocked, the squirrel monkeys' heart rates rise slightly, by about 10 beats per minute.

But the effect on the titis is "phenomenal," says Mendoza; their heart rates rocket up by about 100 beats per minute. When sympathetic activity is thwarted, squirrel monkey heart rates plummet by more than 100 beats per minute, while titi heart rates drop by 50 beats per minute. No significant effects are found in monkeys injected with a saline solution.

"This supports our idea that the two species have a different autonomic balance under normal conditions," observes Mendoza.

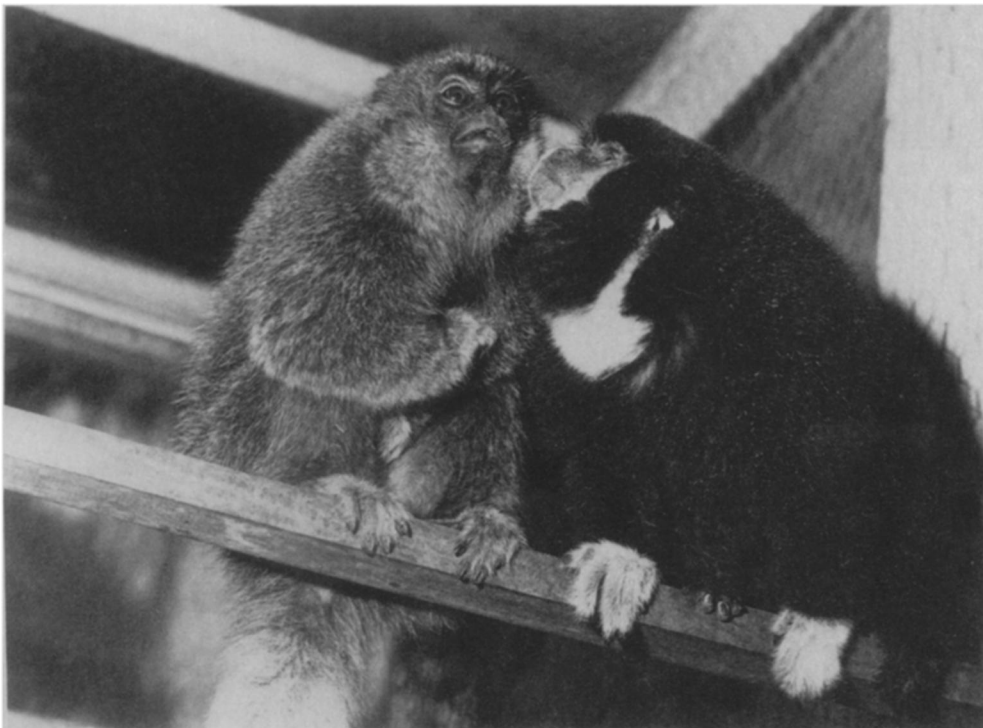
When the same monkeys are given dexamethasone, a drug that suppresses cortisol secretion, and are physically restrained for 15 minutes the following day, their autonomic profiles are again apparent. Cortisol levels decrease only slightly in the squirrel monkeys, whose strong sympathetic system counteracts the drug. But cortisol production falls off sharply in the titis, who do not have a sympathetic buffer. Mason and Mendoza hypothesize that the species-typical behavior helps to maintain the monkeys' autonomic "signatures" through a feedback mechanism. In other words, the way the monkeys live their lives could be a result of, and also act to strengthen, a characteristic underlying balance.

"We also believe that these two patterns of responding to the environment are likely to be associated with different psychosomatic dispositions," says Mason. Pathology reports for several generations of each species in captivity suggest that withdrawal-oriented titi monkeys tend to contract diseases associated with immune system breakdown while high-intensity squirrel monkeys are prone to hypertension and heart disease.

The titi monkey's potential as a model

for studying the effects of stress on the immune system is bolstered by its reactions to quarantine. After capture, the animals are kept in cages separated from the existing colony for 90 days to prevent the introduction of new disease. Over half of the titis succumb to pneumonia or gastrointestinal problems caused by infectious agents present in the environment. The monkeys' normal immune mechanisms may break down under the stress of quarantine and separation from familiar surroundings, says Mason.

It takes a long conceptual jump to generalize about human beings using stress research on monkeys. But Mendoza, who has participated in human psychosomatic investigations, says that primate work will add to the knowledge of how people react to stress. "It's not too much of a leap to say that our monkeys represent two different coping styles," she explains. "If they do, they represent extremes in the human population. But looking at extremes can be a good way to study responses to stress." □



Photographs: G. Eppie

*Even squirrel monkeys, top, need to take a breather; they are usually boisterous, excitable and on the move. Their behavior is linked to the sympathetic nervous system and results in a predisposition to stress-induced hypertension and heart disease. The titi monkey at the far left, perched next to a member of a closely related species, *Callicebus torquatus*, cautiously stakes out a home base and stays put. Its behavior is linked to the parasympathetic nervous system and a tendency toward immune system breakdown in response to stress.*