

Scientific American Frontiers
Show #1310, "Worried Sick"
will premiered June 3, 2003.

The Primates' Stress Club
Angry at Heart
To Heal or Not to Heal
Just Relax

THE PRIMATES' STRESS CLUB

ALAN ALDA (NARRATION) This is the Masai Mara game reserve in Kenya -- 700 square miles of rolling grassland, filled with classic African scenes. When our cameras came here a few years ago, we were looking for these. Baboons are all over the Masai Mara. They're smart and successful primates, with no real enemies -- except perhaps themselves. In this respect, they're much like humans. Baboon troops have a lot of rules, which would have remained known only to baboons if it hadn't been for a Stanford University biologist, Robert Sapolsky. In thirty years of study, he's learned not only the complex rules of baboon social life, but also how those rules can place many members of the troop under immense stress. He's now a leading expert in what stress does -- to animals and humans. OK now don't be fooled. We've jumped from Africa to the San Francisco zoo, and these are blackbuck, antelope from India. Recently I caught up with Robert Sapolsky here, to find out some of the basics of stress.

ALAN ALDA How does an animal like that experience stress? What happens?

ROBERT SAPOLSKY Well, it's your basic sort of crisis in the savanna there. You're running for your life, something's coming after you, this is no time to plan for next winter's growth spurt, no time to reach puberty. It's no time to repair last week's injury. You mobilize energy to deliver at whichever muscles are going to get you across the grasslands there. You increase your blood pressure so you get the oxygen going there in two seconds instead of three. So basically you shut down all the long term projects and you just divert all your physiology to getting away from that tiger.

ALAN ALDA When they're stressed because a predator's coming after them, how long does that tend to last? Might not they be always attacked by predators? Or is it really just a few seconds?

ROBERT SAPOLSKY No. I mean, that's the key difference between them and us. They are not thinking about predators. They are not thinking about any long

term -- they're probably not thinking about much of anything, but that may be sort of my primate bias -- but they're certainly not having long term psychological stress. Something happens and it's over with in thirty seconds or else they're over with. It's very short-term acute stuff. They're not getting stressed, you know, worrying about the ozone layer or the rain forests or whatever is that is psychologically stressful to us. They're not worrying about the long term stuff.

ALAN ALDA Every once in a while, one will pick up its head and thinks it hears something. And then they'll all get a little bit like that. And then maybe they'll take off. Now, in those moments, aren't they going through some beginning of this process even if there's nothing really out there bothering them?

ROBERT SAPOLSKY Oh yeah, absolutely. They're mobilizing... there's a whole physiology of not yet using all that energy but getting ready to do it and yeah, they're probably doing that fifty times a day for five seconds at a time.

ALAN ALDA But the thing is, when they're munching the grass, before they hear a sound or smell something that alerts them, they're not having this kind of anxiety thinking about it, "Even though I'm eating grass, something's liable to come along any minute now."

ROBERT SAPOLSKY None of them are sitting there thinking, "Oh my God, I'm gonna die someday." There's not that anticipatory sort of angst stuff. They're not sophisticated enough. They're not cognitively complex enough.

ALAN ALDA (NARRATION) All animals -- including us -- have this "fight or flight" stress response as it's called, whereby we shut down everything except what we need to survive. The problem is that big-brained primates get stressed constantly, by all kinds of things-- like the stock market, or for baboons like competing for social position. Antelopes, on the other hand, turn off their stress the moment the danger has passed, and their physiology comes back into balance.

ALAN ALDA You know that they're not in that physiological state of stress most of the time.

ROBERT SAPOLSKY And the best way to get a sense of that is the whole notion, stress-related diseases -- stuff you get by just turning on the stress response all the time, all the time. That's a primate invention. That's an invention of species that are smart enough to just get themselves sick with psychological nonsense. They're not up to that level. That's our specialty.

ALAN ALDA Boy, are we lucky. We got it...

ROBERT SAPOLSKY What a deal. What a deal we got there with that cortex of ours.

ALAN ALDA (NARRATION) Here's an example of baboon psychological nonsense, as Sapolsky calls it. The guy on the left is very worried. He knows he'll lose a fight, but it's a purely psychological clash, humiliating and stressful for the loser. Sapolsky sees baboons play out these kinds of mind games all the time. Sapolsky's been able to match up his knowledge of individual baboons' psychological stress with what's happening in their bodies. In blood samples, analyzed in the field, he measures the stress hormones that trigger the fight or flight response. They should be present only briefly, but in psychologically stressed baboons they can be there over the long term, with serious consequences.

ALAN ALDA When a baboon is under stress and it's this kind of this long term thing, similar to what we go through, what's the baboon going through physiologically?

ROBERT SAPOLSKY Bad news. I mean, you go back to the antelope running away from the tiger. You mobilize energy to power your leg muscles to get you across the savanna. Instead, you're sitting there for hours each day thinking about that scary guy on the other side the field, or the mortgage payment due at the end of this month. Chronically, you mobilize energy. You don't store it. Your body wastes a lot of it. There's a bunch of metabolic diseases you're more likely to get. You're that antelope running for your life. You increase your blood pressure and deliver the oxygen, glucose in two seconds, blah, blah. Do that chronically and what you're suffering from is high blood pressure. You're that antelope short term. You shut down, digestion, growth, reproduction, immunity, tissue repair, all of that -- no problem, do all that stuff 30 minutes from now when it's all over with; do it chronically like a psychologically stressed primate, you get ulcers, you get colitis, you get reproductive problems, your immune system doesn't work as well, you get more infectious diseases. And those same stress hormones which, short-term, can make you think more clearly, alertly, a very good thing for that ten-second sprint -- do it chronically and they can be, in fact, very damaging to the nervous system.

ALAN ALDA (NARRATION) In the rest of the program we're going to look more closely at some of the ways stress can undermine health, and we'll also see if there's anything we can do about it.

ANGRY AT HEART

ALAN ALDA (NARRATION) We're at Wake Forest medical school in North Carolina, in the lab of Jay Kaplan.

JAY KAPLAN Who do you think is dominant in that pen?

RESEARCHER Oh, I'd say--.

ALAN ALDA (NARRATION) Kaplan has conducted a series of experiments that shed some light on the interactions among personality, stress and heart disease. His subjects are macaque monkeys. In the wild macaques, like baboons, live in large groups filled with competition and contention. Social hierarchies are established, with dominant and subordinate animals.

JAY KAPLAN If I look in this pen now, I see the two monkeys on the right who look to be sitting exactly where they want to be sitting. One of them is now threatening three monkeys who are huddled off on the upper left hanging off the bars which is a less preferred position. So I would say that these two guys are the dominant monkeys in this group and the other three are more subordinate, just by the nature of the way they are using the space in here.

ALAN ALDA (NARRATION) The relationships the monkeys establish are not an accident. They are determined by interactions of their personalities. Some are just naturally more aggressive, and they come to dominate. Primate personalities are stable over the long term, as Robert Sapolsky discovered with his baboons. Personality is the key to understanding their lives, he says.

ALAN ALDA Does a difference in personality have something to do with how well they're able to handle stress or how much stress they experience?

ROBERT SAPOLSKY Yeah. Absolutely. Sort of my initial assumption that I sort of squandered my first 15 years on with them was dominance rank. That's the thing. If you're a low-ranking baboon you're gonna have the stress-related diseases. And what I've learned since then is, yeah, rank's important. Far more important is what sort of society you have that rank in. Is it a troop that treats its low-ranking animals miserably? Is it a troop whose hierarchy is unstable? Those are both much more stressful situations. And then even more important than your rank in the sort of society in which it occurs is your personality. Which is basically saying, What's your filters with which you see the world around you? And that's the single-biggest predictor. You look at a single question, How often -- if you're a male baboon -- How often do you sit there, in contact with another baboon, grooming another baboon, being groomed back? Get sort of an aggregate measure of that, a sociality score, and that's the single strongest predictor I have ever found of stress hormone levels in these animals.

ALAN ALDA (NARRATION) In the macaque monkey experiments, the kind of social complexity which macaques and baboons show in the wild has been stripped away.

RESEARCHER Go on, go on.

ALAN ALDA (NARRATION) Here a group of five males, all strangers to each other, are placed together. They immediately set about establishing who's dominant, and who's subordinate. Macaques do exactly this in the wild, but here everything's exaggerated. Groups are unnaturally small, and their members are switched often, so here complex social relationships aren't as important as just the relative aggressiveness of the personalities. This is a stressful time, but the question is, Who's under most stress -- the top monkeys, or the subordinates? Some groups are remotely monitored for vital signs -- heart rate, for example.

RESEARCHER Hi guys.

ALAN ALDA (NARRATION) The dominance hierarchies within the groups are constantly reinforced, with the leaders confirming their leadership. And as they do so, a surprising fact emerges. It's not subordinate, but dominant monkeys that are most stressed -- with higher heart rates, blood pressure, and stress hormone levels. Maybe in the wild it wouldn't be so simple, but here dominance equals aggression equals stress. Food is the next ingredient in the macaque experiments. The monkeys get a nutritious diet, but with about 30 percent fat. That's high fat for monkeys, and about average for Americans. So the dominant males lead the same kinds of lives that many humans do -- plenty of stress, with plenty of fat to eat. During the course of the experiments the monkeys get regular checkups of their cardiovascular systems. This is an angiogram procedure, to look at the coronary arteries, exactly like a human patient would receive. Some of the experiments run for two years, and over that time the dominant, stressed monkeys develop twice the artery clogging atherosclerosis as the subordinate animals.

JAY KAPLAN Animals who maintain their dominance under these conditions experience arousal of the fight-flight response. Whereas animals who immediately become subordinate under these conditions don't experience those same cardiovascular changes. And it's the cardiovascular response that accompanies the behavior of maintaining dominance under these provocative conditions that we think is damaging when combined with a high fat diet.

ALAN ALDA (NARRATION) Males whose aggressive personalities compel them to keep a cage-full of subordinates in their place experience constant surges in heart rate and blood pressure -- enough to damage their blood vessels and provide sites where artery-clogging deposits can build up.

THOM HANEY Good morning.

THERESA AND CARLTON Morning.

THOM HANEY I'd like for you please to fill out some questionnaires for us. These are some standard psychological questions.

ALAN ALDA (NARRATION) So does aggressiveness damage arteries in people, too? Aggressiveness, along with mistrust and anger, define what psychologists call a hostile personality. The qualities are assessed with this standard questionnaire.

VOICES No one cares much what happens to you. True or false? I have at times had to be rough with people who were rude or annoying. True or false? When people do me wrong I feel I should pay them back if I can. True or false?

ALAN ALDA (NARRATION) 30 year ago it was thought that "Type A" personalities -- dynamic, always in a hurry -- got heart problems. But that wasn't always reliable. A few researchers thought hostility was a better match, so they went back through old personality test records, and tracked down the people who'd taken them. Redford Williams takes up the story.

REDFORD WILLIAMS What we found was that those people who had high hostility scores back in the 1950s were two to three times more likely to develop heart disease. And in one study, those with high hostility scores were about seven times more likely to die.

THOM HANEY The first time it inflates it might be a little tight.

ALAN ALDA (NARRATION) In Redford Williams' lab they've been studying how hostile and non-hostile personalities react to stress. NURSE I'm just gonna put a syringe on here because we're gonna be drawing bloods periodically...

ALAN ALDA (NARRATION) Blood stress hormone levels, blood pressure and pulse rates will be tracked while subjects remember, and re-live, a stressful event. First un-stressed, resting levels are measured. Terry's blood pressure is normal -- 136 over 72. The blood sample, analyzed later, will show low stress hormone levels.

THOM HANEY Now I want you to recall a time, sometime in the past when you felt very angry towards another person. This should be a situation or incident that still makes you angry right now when you think about it.

TERRY MILLER I was an assistant teacher...

ALAN ALDA (NARRATION) Terry's blood pressure increases a little as her anger rises -- about 10 percent.

TERRY MILLER ...and we had a small girl and she had been abused by her mother. But she had gotten to the point where she couldn't even speak any more. So they put her in our autistic classroom...

ALAN ALDA (NARRATION) Blood pressure is up another 5 percent.

TERRY MILLER ...she would come into class with bruises on her body. We called the social services and...

ALAN ALDA (NARRATION) Although Terry's now clearly upset, her blood pressure and stress hormone reactions are mild.

TERRY MILLER ...and we couldn't get anybody to do anything about it. That made me angry.

ALAN ALDA (NARRATION) Now a different kind of stress, and a new subject, Theresa.

THOM HANEY Your start number is 13,485.

ALAN ALDA (NARRATION) Theresa has to keep on subtracting, in steps of nine, as quickly as possible.

THERESA LEWIS OK that would be thirteen thousand four hundred and... did you say eighty five? Um, seventy six?

THOM HANEY That's correct.

ALAN ALDA (NARRATION) The experimenter signals for Teresa to speed up. Now she's getting really flustered, but her blood pressure's hardly up at all.

THOM HANEY Last correct number, thirteen thousand four hundred and seventy six, minus nine.

THERESA LEWIS ...seventy six minus nine, Theresa, is...

THOM HANEY OK now, remember, accuracy counts.

THERESA LEWIS Sixty four, no it's not...

CARLTON GUDD I got a phone call at work. My co-worker answered...

ALAN ALDA (NARRATION) Now here's Carlton, doing the anger recall test.

CARLTON GUDD ...and it was the alarm company at my house. And my burglar alarm was going off, and police were called. Well, instant panic set in. I was scared to death. That's about the time my kids come home, my little girl and my little boy get home from school.

ALAN ALDA (NARRATION) Already Carlton's blood pressure has shot up, his pulse is racing.

CARLTON GUDD I yelled at my boss, "I'm leaving." Made the fastest ride home that I've ever made in my life. I got to the house and the police officers were leaving. So I grabbed a great big Maglite flashlight that I have in my truck, opened the door, stormed into my house, yelling the whole time, "I've got a gun. If you're in my house, come out." I jump through the doorways, intending to crack the skull of anybody that was in there. I was so mad..."

ALAN ALDA (NARRATION) Unlike the others, Carlton scored high on the hostility questionnaire.

REDFORD WILLIAMS Even low hostile people do get angry. I mean, everybody gets angry if provoked enough. And the fascinating thing is that when high hostile people get angry, they have this very large fight-flight response. But when low hostile people get angry, their response, their biological response is much smaller. It's as though they are wired in a different way. The connection between anger and that arousal, that biological arousal for fight or flight is not so tight in low hostile people as it is in high hostile people.

ALAN ALDA (NARRATION) The lesson of the lab stress tests is that personality really matters. Just as with Sapolsky's baboons and Jay Kaplan's macaques, hostile, aggressive personalities experience more stress over the long term -- and that's bad for their health.

CARLTON GUDD ...I was so mad, thinking about my kids and what could have happened...

REDFORD WILLIAMS The one person that we had today who had a higher level of hostility on the hostility questionnaire showed a much higher level of blood pressure, both systolic and diastolic during the test, during the anger, than the other three who had lower levels. And this is probably what's happening with us - and I include myself in this group -- us high hostile people. Day in and day out

we're getting angry at little things. Our blood pressure is going up more than people like Thom here who don't have a high hostility level. And that's probably what's clipping off our arteries, and damaging our arteries and causing the increased atherosclerosis. Now it's not the only thing, obviously. We have our cholesterol levels, our health habits, our exercise habits, and Lord knows, a multiplicity of genes that feed into this. But this is one thing that does feed in. And you know, it doesn't mean you're for sure going to have a heart attack. It means that you have a slightly but reliably increased risk.

ALAN ALDA (NARRATION) This is New York City -- urban living at its most hectic, and its most stressful. You may be surprised to learn that walking around, hidden inside the chests of hundreds of New Yorkers are tiny stress measuring devices. Charles Harmon has one. He's an office worker, and also a heart patient who carries an automatic, implanted defibrillator. When clogged arteries reduce blood flow to the heart, heart muscle can be damaged. Damaged hearts can lose their steady rhythm. Extreme arrhythmia is called fibrillation, and the defibrillator shocks the heart back into action.

JONATHAN STEINBERG Have you had any racing heartbeats?

CHARLES HARMON A little bit. I could feel it.

JONATHAN STEINBERG Enough to set off the defibrillator?

CHARLES HARMON Not quite. No, it never did that.

JONATHAN STEINBERG Did it make you feel dizzy or pass out?

CHARLES HARMON I didn't pass out but I got a little dizzy.

JONATHAN STEINBERG So let's interrogate the device. We'll talk to it.

ALAN ALDA (NARRATION) Implanted defibrillators are pretty smart. Not only do they constantly monitor heart rhythm and deliver shocks when appropriate, they also record everything they do.

JONATHAN STEINBERG Nothing's happened since we last saw you a few weeks ago.

ALAN ALDA (NARRATION) Stress, with its surging blood pressure and pulse rate, can overload a damaged heart and disrupt its rhythm.

JONATHAN STEINBERG Everybody is susceptible to stress. And everyone can have a physiological response to stress. It's the interaction of that response and a damaged, diseased heart that leads to dangerous arrhythmias.

ALAN ALDA (NARRATION) September 11, 2001 was the beginning of a time of extreme stress for New Yorkers. All over the city, implanted defibrillators were sitting in the chests of heart patients, monitoring hearts, firing off when they detected dangerous arrhythmias, and recording their actions. Charles Harmon's cardiologist collected together records downloaded from 200 implanted defibrillators.

JONATHAN STEINBERG We found the results were quite striking. There was about a two and a half fold increase in the number of patients who experience these arrhythmias in the period, the 30-day period after the attack, compared to the 30-day period before the attack.

ALAN ALDA (NARRATION) Stress can be the final trigger for a heart attack. 40,000 heart attacks a year are triggered by stress, it's estimated -- as many as strenuous exercise. And as we've seen, chronic stress clogs up arteries as well, damaging the heart and making it more vulnerable to an attack. So stress is a major risk to cardiovascular health. Next we're going to see how stress undermines another of the body's essential systems.

TO HEAL OR NOT TO HEAL

ALAN ALDA (NARRATION) We're in Columbus, Ohio at the Ohio State University's Clinical Research Center. The couple on the left, Eve and Bud, are going to let the researchers probe into the most private areas of their marriage. LOIS GRINSTON Now I usually just start like right here in the middle.

ALAN ALDA (NARRATION) The researchers are trying to see if the psychological health of the marriage has any effect on the physical health of the couple. LOIS GRINSTON OK, great.

ALAN ALDA (NARRATION) It's a gruesome but ingenious technique. The couple's given superficial skin wounds on the arm -- eight small blisters, produced using a suction pump.

LOIS GRINSTON OK, now I'm going to turn this on. EVE OK.

LOIS GRINSTON Now, do you feel that? EVE Yeah, I feel it.

LOIS GRINSTON OK, OK.

ALAN ALDA (NARRATION) It's an uncomfortable process, but not painful. Bud'll get his blisters next.

TIM LOVING You're just got to do the best you can to fill out the bubbles. It's not a big deal.

EVE OK. BUD She cheats on all tests, you know that don't you?

ALAN ALDA (NARRATION) Psychologist Tim Loving asks Eve and Bud to assess how much they disagree in typical sensitive areas, like money or in-laws. A zero score means no disagreement, so it seems Eve and Bud, who've been married 13 years, get along pretty well. After ten minutes, nurse Lois Grinston checks her handiwork.

LOIS GRINSTON Oh those are lovely. Just lovely.

ALAN ALDA (NARRATION) The idea is to follow how well Eve and Bud's lovely blisters heal over the course of the next month, and to see if the stress levels in their marriage have any effect. Ninety couples are in the study. The healing process will be monitored visually, and by measuring the rate the blisters dry out. Also during the first 24 hours, fluid placed in little chambers above the wounds will be drawn off. The fluid will be assayed for the chemicals which the body's immune system sends to wound sites, to get healing started.

LOIS GRINSTON OK guys we're getting ready to get started now. And I'm gonna close the curtain.

ALAN ALDA (NARRATION) With the blisters in place, and Lois Grinston ready to draw blood samples, Eve and Bud are supposed to start arguing. Likely hot topics have been suggested by the researchers, after exploring with the couples the questionnaires they had filled out. For Eve and Bud, they've zeroed in on Bud's hearing aid -- or rather his lack of a hearing aid.

BUD When they put me in the casket you can go ahead and put the hearing aid in my ear.

EVE The bad thing is, we even have a hearing aid at home that you could wear so that you won't have to keep saying, "What? What? What?" even when we're watching a movie.

ALAN ALDA (NARRATION) As with the hostility study we saw earlier, blood samples will show what levels of stress hormones the argument stimulates.

EVE ...keep rewinding the movie so you can hear what they said, which is aggravating.

BUD Well, you should put the hearing aid in your ear and listen to the news...

EVE Listen to the movies...

BUD ...for a while and see what the hearing aid sounds like.

EVE You've never had it in, how do you know? You've never tried to watch a movie with it.

BUD I watch a movie with it once in a while.

ALAN ALDA (NARRATION) I think we can tell their hearts aren't really in this argument.

EVE When sometime?

BUD Next time we watch a movie.

EVE Okay, I'll go rent one tonight.

BUD I didn't say that...

ALAN ALDA (NARRATION) In fact Bud and Eve are pretty good friends. Their argument provoked no stress hormones in the blood, their immune systems responded strongly to the blisters, and healing was close to complete by around Day 12. They're a typical unstressed couple, with healthy immune systems. Now let's follow Deb and Mike through the same procedure. They've been married ten years, they don't regard their relationship as terrible, but neither has any difficulty coming up with multiple areas of disagreement. The researchers have several topics to suggest for discussion. For Mike and Deb, how to divide time between chores and relaxation is a contentious area. Observing this session is Janice Kiecolt-Glaser, the psychology professor who developed these tests.

DEB Alright, well I... MIKE Now wait, number one...

DEB We can start talking... MIKE Number one. Two hours. You know, I put my workout schedule together for you on the fridge so you could see what days I'm gonna run. Number one, you need a healthy heart. And number two...

ALAN ALDA (NARRATION) As before, blood samples are taken to measure stress hormone levels.

DEB ...talk about excessiveness. I talk about, in our lives right now...

MIKE That's how you accomplish things.

DEB ...we are so busy from the minute we wake up 'til the minute we go to sleep. Take for instance the morning. When I wake up, you wake up, you get yourself ready, and you go to work.

MIKE Yup. DEB I get myself up. I get myself ready. I do a load of laundry. Check the emails. Pack the kids' lunches. Put the dishes away... If you guys get together once in a while, whether it be in the evenings...

MIKE How long is once in a while?

ALAN ALDA (NARRATION) Obviously Deb and Mike don't have a perfect relationship, but as with almost all the couples in the study, it's still a marriage that works. In fact, Deb and Mike don't regard this argument as especially stressful. MIKE ...you got to do it the way I like it.

JANICE KIECOLT-GLASER The couples who tended to be nastier or more hostile toward each other had higher elevations in stress hormones, particularly the women. And they had greater changes 24 hours later, in terms of a whole battery of different immunological assays. We were surprised because the conflicts, the discussions of disagreement, weren't what you'd call heated or nasty, by and large -- it's only a relative kind of thing. These were very happy couples. They only represented, among the sample we had only 3% would be what we would call distressed couples based on the way they described their marriages. And yet we could find these reliable relationships between physiology and behavior.

ALAN ALDA (NARRATION) Here are the blisters, unhealed at Day 6, in one of those mildly stressed marriages. And here they are -- nearly healed -- at the same day in an unstressed marriage. It's a dramatic contrast, given the relatively low stress levels involved.

DR. POOLES Hey guys, how you doing?

BEN TAYLOR Good.

DR. POOLES Dr. Pooles. Nice to meet ya. So what are we supposed to be doing today?

BEN TAYLOR Today is head and neck.

DR. POOLES Head and neck exams.

ALAN ALDA (NARRATION) These are medical students in the last few weeks before important exams. It's the kind of high stress situation we all find ourselves in from time to time.

BEN TAYLOR You could look through the scalp, see if there's...

ALAN ALDA (NARRATION) This is another Ohio State study, this time to see if it's possible to deliberately counteract the effects of stress. John Stauffer and Ben Taylor are second year students just coming up for their first clinical exams. A total of 57 students receive the same blister wounds the married couples got, with the progress of healing to be tracked in the same way.

NURSE We place it just on top like that...

ALAN ALDA (NARRATION) Soraya Rofagha is just completing her neurology specialty, and has a big final exam in two weeks.

SORAYA ROFAGHA Well she's a 21 year old white female with a 15-month history of weakness in her lower extremities which began in July 2001, when she noticed increased difficulty when she was walking to and from work. She has had increased weakness...

ALAN ALDA (NARRATION) The students continue with their routines as the blisters on their arms heal.

SORAYA ROFAGHA ...so functionally, she's really decreased, and they're thinking of putting her in a wheelchair.

ALAN ALDA (NARRATION) The students were randomly assigned to two groups. John Stauffer was in the group that was simply left to cope with the stress in their own ways. But Ben Taylor's group got something extra.

CATHIE ATKINSON Breathe slowly and deeply. You let tension go. And you let yourself go deeper. Begin by relaxing your right foot. Just letting the tension flow out...

ALAN ALDA (NARRATION) Throughout the pre-exam period, all of Ben's group attended frequent sessions in which they received standard relaxation therapies.

CATHIE ATKINSON ...down into your fingertips. Every muscle fiber just letting go.

ALAN ALDA (NARRATION) All the students were tested again to compare healing during a relaxed, exam-free period. That ensures it was really the stress of exams being assessed, not simply the stress of receiving the blister wounds. The study showed that students under a pretty common kind of stress suffered the same effects as the stressed married couples -- increased stress hormones in the blood, reduced immune system function and delayed wound healing. But it also showed that the simple relaxation therapies that Ben's group received were remarkably effective. Their blister wounds healed up as rapidly as everyone's did during the relaxed, non-exam period. The conclusion that our immune systems don't work so well when we're under psychological stress is completely consistent with what we know about the fight or flight stress response. After all, the whole point of the stress response is to briefly shut down non-essentials, while we make a quick getaway. You can afford to put off fighting infections for 30 seconds. But that means long-lasting stress makes us more vulnerable to disease. Exactly which diseases, or how severe they might become, is still controversial, but the basic conclusion that chronic stress and disease go together is beyond doubt. Next we're going to explore further what we can do about stress.

JUST RELAX...

ALAN ALDA So that's picking up what?

RESEARCHER This is the photo-plathismograph, and this is picking up your skin conductance, which is another way of saying your skin sweating.

ALAN ALDA You sweat enough to indicate a change in, I mean a subtle change in...

RESEARCHER Oh yes. Every time you experience any kind of emotional change, your circulation changes.

ALAN ALDA (NARRATION) I always seem to be the guinea pig on Frontiers. This time they want to see if I can relax.

RESEARCHER What I'm going to do now is just wipe off your forehead, just to get any extra oil off, and put the muscle tension monitor on you.

ALAN ALDA How do you measure muscle tension on my forehead? I'm not known for the muscles in my forehead.

RESEARCHER Well, there's not a lot of fatty tissue on the forehead, and it's considered to be a good indicator of the muscle tension in the rest of your body.

ALAN ALDA What happens? What are you measuring?

RESEARCHER Well, it actually measures the electrical impulses put out by the muscle.

ALAN ALDA Oh, I see.

RESEARCHER I'm just gonna put the lead up. It's not going to be the most comfortable thing, but, er...

HERBERT BENSON How many years have you been doing this?

ALAN ALDA This show, we've done, er... I've been doing it about seven or eight years now.

ALAN ALDA (NARRATION) Now I'm supposed to get into a normal, even state of mind as I make small talk with Herbert Benson. For 35 years he's been a leading advocate of relaxation as a useful medical therapy. He even coined the phrase "relaxation response" to describe what I'm about to do. But first, just to make a nice contrast, I get to be totally frantic while everyone watches my numbers go off the charts.

LORI THIBEAULT If I give you the number 113, I'd like you to subtract 13 so that you have 100, and then you subtract 13 again to have 87.

ALAN ALDA I see.

LORI THIBEAULT I'm going to be testing you for speed and accuracy, so it's very important that you're accurate, but also very quick.

ALAN ALDA Right.

LORI THIBEAULT OK? Do you have any questions?

ALAN ALDA No, but I know my needle is jumping right now.

LORI THIBEAULT OK. OK. I would like you to say the numbers aloud and as fast as you can. OK? So I'm gonna have to start from the number six thousand forty six.

ALAN ALDA And subtract thirteen.

LORI THIBEAULT That's right.

ALAN ALDA Six thousand forty six minus thirteen. Six thousand thirty three.

LORI THIBEAULT Right. Faster. Keep going.

ALAN ALDA Oh, I keep going. Oh, I'm sorry.

LORI THIBEAULT Yes, keep going.

ALAN ALDA Six thousand thirty three. Six thousand twenty. Six thousand three. Six thousand six. No.

LORI THIBEAULT Wrong.

ALAN ALDA Six thousand seven.

LORI THIBEAULT Could you just start over from the beginning. Six thousand forty six.

ALAN ALDA OK, start over.

LORI THIBEAULT Six thousand forty six subtract...

ALAN ALDA Six thousand forty six minus thirteen. Six thousand... I'm sorry. Six thousand forty six minus thirteen.

ALAN ALDA (NARRATION) As I'm flailing around, it's not just these measures that are jumping. The stress hormones in my blood must be surging, too. Mercifully Herbert Benson comes to the rescue.

ALAN ALDA Six thousand twenty. Six thousand seven.

LORI THIBEAULT Faster.

ALAN ALDA Five thousand seven...

LORI THIBEAULT Faster if you can.

HERBERT BENSON Okay, that's enough. Let me show you how to evoke the relaxation response, so if you will, just close your eyes. And relax all your muscles, starting with your feet, your calves, your thighs. Shrug your shoulders around. Lower your head and neck around. Great. Wonderful. Now sit without movement and just focus on your breathing, but breathe oh, so slowly. Each time your breath is coming out, say silently to yourself, the word, "Calm." You're going

to find all sorts of other thoughts coming to mind. Those thoughts are natural. They should be expected. But when they occur, don't be upset, but simply say, "Oh, well," and passively come back to the word, "Calm." On each out breath, "Calm," and as the other thoughts come to mind just, "Oh, well," and back to, "Calm."

ALAN ALDA (NARRATION) This is a simple, basic form of meditation. The sensors confirmed what I was beginning to feel -- that I was more relaxed.

HERBERT BENSON Now just slowly, slowly open your eyes. How was that?

ALAN ALDA It was nice.

HERBERT BENSON You got into it nicely. What did the physiologic changes show?

RESEARCHER I think the most dramatic one was your muscle tension, measured right here. Before it was so high it was off the screen. And after about a minute and a half it came down quite nicely.

HERBERT BENSON This is how you can use the mind to effect the stresses of the body. And to the extent that any disorder is caused or made worse by stress, to that extent we can use this as a therapy.

ALAN ALDA Is there a difference between what you might call chronic stress and momentary stress? I mean is it good for you to have short bursts of stress that you can handle?

HERBERT BENSON The more the stress, the more efficient you are, the more productive you are, but to a point. When it gets too chronic, then performance and efficiency start dropping off. And that's what most people are experiencing.

ALAN ALDA (NARRATION) John Goddard is one of the beneficiaries of Benson's relaxation therapy. Once a victim of panic attacks, depression and high blood pressure, he's now mentally stable and off his blood pressure medication. He says his daily meditation is responsible.

JOHN GODDARD It's given me my life back. I was hiding in my house for twelve years, I was so frightened. And now I'm out in the world, I'm actually working again. It's just so fantastic.

ALAN ALDA (NARRATION) Gina Francis failed for years to get pregnant. After learning relaxation techniques, she now has one child, and there's another on the

way. Elisa Toledo had a stress-induced heart attack. Her cardiologist recommended yoga-based relaxation for stress management.

ELISA TOLEDO When I used to feel stressed I would do very shallow breathing. And that really is a sign of stress. And by telling yourself the same word all the time or focusing on the same sound, you can de-stress yourself very quickly. I mean, it doesn't happen like within seconds, but you can, over a period of a few minutes de-stress yourself, where before I didn't know to do that. You know, I would be stressed, and I would just probably stay stressed for the day.

ALAN ALDA (NARRATION) It makes sense that reducing stress lowers blood pressure, or increases the chance of pregnancy, because the fight or flight stress response does the opposite -- increases blood pressure and shuts down reproduction. But exactly how meditation and yoga function to reduce stress is still something of a mystery. This is northern India, the foothills of the Himalayas, and the year is 1981. These scenes were filmed on visits led by Herbert Benson to track down experts in Tum-mo yoga. It's practiced by Tibetan monks who had followed the Dalai Lama here when he was exiled. Benson, knowing of the Dalai Lama's reputation for openness, got permission to investigate.

HERBERT BENSON For years the practice of Tum-mo has been a secret within Tibetan Buddhist practice, and you allowed the West to have studies of this for the first time. Why is that?

DALAI LAMA Yes, as you mentioned, this is a practice usually regarded as a secret doctrine and also as a private thing. But I feel, as usually I believe and also explain to people, that we are believing or -- emphasis on reasons and facts. If this is something true, something fact, then the investigation taken through meditation, and investigation taken through instrument, may reach the same point.

ALAN ALDA (NARRATION) The Tum-mo meditation experts live alone in unheated stone huts at high altitude. Benson was able to bring some into town for tests. He was astonished to learn what they are capable of.

HERBERT BENSON What their monks can do in Tum-mo yoga is essentially naked in mid-winter in 40 degree Fahrenheit temperatures, take a sheet measuring six by three feet, dip it in icy water, wrap themselves in that sheet -- you and I will go into uncontrollable shivering and perhaps even die. They can get that sheet steaming within three to five minutes.

ALAN ALDA Steaming!

HERBERT BENSON We've been studying that for 20 years.

ALAN ALDA (NARRATION) Benson brought back now famous film of the Tumo monks drying their ice-cold sheets. For them it's of course an essential religious ritual, designed to create a fire which burns away all traces of improper thinking. For Benson it was simply astonishing, and in fact he found with his tests that monks could, at will, raise the temperature of their extremities -- fingers and toes -- by as much as 15 degrees. At the same time they don't increase their heart rates, he found. So somehow they must be deliberately opening up their blood vessels, increasing the flow. I'm no Tibetan monk, but after my relaxation session the idea of warming yourself up didn't sound out of the question to me.

ALAN ALDA Three quarters of the way through trying to repeat the word "calm", I felt warmer.

HERBERT BENSON Exactly. That's a common response. You see, the stress hormones lead to vasoconstriction. That's just what we were measuring -- muscle tension. When you evoke the relaxation response that way, what then occurred, that hormone was counteracted, and that led to a warming of the skin.

ALAN ALDA (NARRATION) But how exactly are the stress hormones counteracted? Usually the fight or flight stress response is beyond our conscious control. It just starts and stops automatically. Somehow meditators tap into the part of the brain that controls the switches. And you don't have to be a Tibetan monk to do it.

YOGA GROUP Hah, hah, hah, hah...

ALAN ALDA (NARRATION) We're in a community just outside Boston which follows the Sikh religion, and practices a kind of yoga called Kundalini -- which literally means coiled like a snake. Kundalini yoga aims to uncoil the snake, unleashing the energy of body and mind. Harimandir Kur Khalsa has practiced Kundalini for about ten years. She's come here to the Mass. General Hospital so researchers can look into her brain while she meditates. The study's being run by Sara Lazar, a psychologist, assisted by Katie Killilea.

KATIE KILLILEA So this should be just a little snug. It should definitely not restrict your breathing, but you should feel it move upon inhalation and exhalation.

ALAN ALDA (NARRATION) Harimandir's going to be wearing uncomfortable wires and tubes, and she'll be inside a noisy MRI machine, so she needs to be an expert meditator to avoid distraction.

SARA LAZAR Would you like something underneath your legs?

HARIMANDIR KUR KHALSA Yes.

SARA LAZAR OK.

ALAN ALDA (NARRATION) There's a frame to hold a mirror so she can read an instruction screen. The operators line up the thirty thin slices in which the machine will picture brain activity. TECHNICIAN OK we're going to get started. This one's going to be a little bit loud, and it's going to last 32 minutes. Go.

ALAN ALDA (NARRATION) First, in this control period, Harimandir's screen tells her to think randomly -- to run through an arbitrary list of animals, for example -- to show what a brain that's not meditating looks like. Right now her breathing's about as expected.

SARA LAZAR At this point, she's breathing at a fairly fast rate. This is about 12 breaths per minute.

ALAN ALDA (NARRATION) When she starts to meditate, Harimandir's breathing should change. Now her instruction screen switches.

SARA LAZAR Begin meditation. Begin meditation.

ALAN ALDA (NARRATION) A common type of Kundalini meditation involves coordination of breathing with repetition of mantras. Breathing rate drops dramatically, without the meditator forcing it to.

SARA LAZAR So you can see, now it's getting much wider, so she's beginning to meditate. Before she was going about 12 breaths per minute, and now, she's going... these are much longer, slower breaths, slower exhalations.

HARIMANDIR KUR KHALSA As I inhaled, I thought "sat-nam" and as I exhaled I thought "wahe-guru". So it involved a focus, and also... with the breath. And I just kept focused on that and then allowed whatever changes would come about to happen.

SARA LAZAR This is one particular slice to the brain, and here we see a bit of the limbic system called the amygdala circled in blue. And this time course is the average activity of that bit of brain during the experiment. This bit of brain becomes more active during meditation than during the control period. So there's something going on during meditation which is not happening during just sitting there repeating the words of animals.

ALAN ALDA Do you know other stuff about that part of the brain that throws light on what functions are otherwise performed by it?

SARA LAZAR M-hmm, it's involved in vigilance, so paying attention to things. And so certainly, events which provoke fear, i.e. lions and tigers and snakes, would activate the amygdala. But also other things, and so since, when you're meditating, you're being vigilant on yourself, on your mantra, and on your body, and on your subjective state, that's why we think we see the amygdala during meditation.

ALAN ALDA What other kind of vigilance are you talking about?

SARA LAZAR If you're hungry and you're driving down the street and you want to pay attention to which restaurants are there, that might be something similar. So it's vigilance to things which are biologically relevant, I guess that's a better...

ALAN ALDA Ah, I see.

SARA LAZAR ...more precise. But probably not vigilance of say, you're reading a book, or watching a movie. It's not the same attention. It's more-- it's got to be biologically relevant, they think.

ALAN ALDA Isn't that interesting, that meditation which is supposed to be so spiritual, lights up the part of your brain that a sirloin steak does.

SARA LAZAR Exactly.

ALAN ALDA (NARRATION) People once thought meditation was a bit like dozing off, so the detection of vigilance in Harimandir's brain is especially interesting, and it matches what she feels.

HARIMANDIR KUR KHALSA There's a complete awareness, and in a way even a more heightened awareness of everything. And then with the particular sounds, "sat-nam" felt like it was very focusing for me. And then "wahe-guru" had a very kind of expanding feeling of awareness. So I felt more unified in my experience of the MRI and of myself.

ALAN ALDA (NARRATION) I did think of a very straightforward way to explain the brain activity, but Sara Lazar, in her latest tests, got there first.

ALAN ALDA Let me ask you a kind of a dumb question.

SARA LAZAR M-hmm?

ALAN ALDA How do you know they were meditating, if they can just bring their breath down...

SARA LAZAR ...to four breaths per minute.

ALAN ALDA ...to four breaths a minute, mechanically, then maybe you get this kind of... maybe these part of the brain light up any time you bring your breath down to four times a minute.

SARA LAZAR Very good question. That's another experiment we're doing this time, is we're having them go down to four breaths per minute, we're showing them arrows and telling them when to breathe. And so far, what we've seen is that, no, this is not the pattern you see

ALAN ALDA Oh, really?

SARA LAZAR ...when you just change your breathing rate... Right. So there's something more to it. So, no.

ALAN ALDA (NARRATION) Sara Lazar's experiments have shed some light on how meditation and relaxation reduce stress -- the part of the brain that was active in the meditators is also involved in sending signals that control the fight or flight stress response. But we still don't know how meditators change those signals more or less at will. Regardless of how it works, meditation does help people deal with the stress of life. This is how Harimandir puts it.

HARIMANDIR KUR KHALSA Life presents situations and most of these situations, I'm not going to know what they're going to be, and so by encountering my own self, my own mind, through meditation in meditation practice, then when I'm out in the world, whatever confronts me I've already confronted my own self and my own reactions, so then I can confront it squarely.

ALAN ALDA Let's say you're worried about your health, or you're worried because your boss is stressing you all the time. Can simply meditating relieve you of that stress, or do you have to go through an involved psychotherapy?

HERBERT BENSON It's very important to try and change the situation itself. In other words, if it's a social situation, recognize it for what it is and try and rectify it. But if you can't, as many of us can't, change a situation, then you can protect against the harmful effects of stress, or at least lessen them by regularly evoking the relaxation response. And people should do that regularly. Just think of the numbers of people who have told you, without my yoga, without my daily exercises, many will say without my prayer, I don't feel as calm as I do otherwise. And although this isn't speaking to the inherent value of the beliefs in these various things, it certainly shows their effects.

ALAN ALDA (NARRATION) So can we be worried sick? No doubt. Can we be less stressed, and less sick? Yes. Can we reduce stress? Yes -- and don't forget what Robert Sapolsky found. His least stressed baboons were the guys who just got along with others the best.

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