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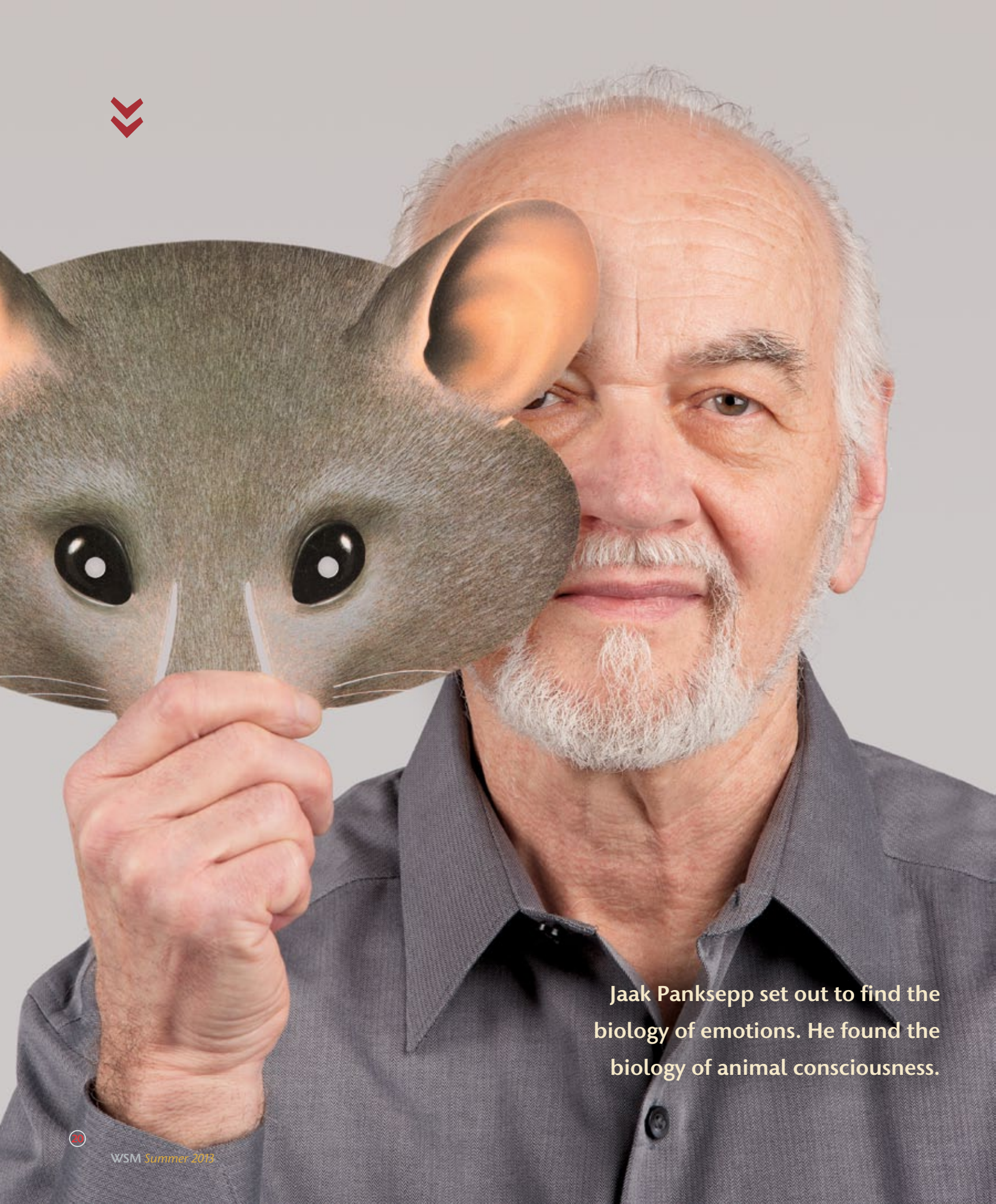
Animal mind reader

THE BIOLOGY OF MAMMALIAN CONSCIOUSNESS *ALSO:* SOMETHING OLD, SOMETHING NEW :: AN EXCERPT FROM *WE NEVER KNEW EXACTLY WHERE: DISPATCHES FROM THE LOST COUNTRY OF MALI* BY PETER CHILSON



Jaak Panksepp set out to find the biology of emotions. He found the biology of animal consciousness.

by Eric Sorensen :: photos by Robert Hubner

The *Animal* Mind Reader

LAST JULY, an international group of scientists with "neuro" in their titles convened in Cambridge, England, to give good weight to a radical idea. The conference participants, including the theoretical physicist Stephen Hawking, sat through some 15 presentations and closed the day by endorsing 612 precisely struck words that, in effect, said many of our fellow animals, including all mammals and birds, also have consciousness.

It's an underwhelming notion taken on faith by those who commune with pets or embrace the fight for animal rights. But scientists hold to a tougher standard than the baleful look in a dog's eyes. The question of animal consciousness has bedeviled them for centuries and drawn speculations from the likes of Charles Darwin and Nobel laureate Francis Crick, the Cambridge conference's namesake.

Now an accomplished core of scientists cited the next best thing to a smoking gun—"the weight of evidence"—to say, "humans are not unique in possessing the neurological substrates that generate consciousness." When it comes to the anatomy, chemistry, and physiology of our brains and the way they play into our consciousness, they said, we are not alone.

The keynote speaker that day was Jaak Panksepp, a proper, white-bearded figure with an accent that seems to blend his native Estonia and the New Jersey of his youth. The words the scientists endorsed could have easily come from his pen; as it was, roughly half had. The flag they were planting, while largely unnoticed by the outside world, was for Panksepp a career milestone, following several decades and countless hours documenting the nexus of activated brain regions, an animal's behavior, and its attendant emotions.

At the start of his career, that third element, the animal's emotional life, was terra incognita to psychologists, particularly the behaviorists who dominated the field.

"The 'emotions' are excellent examples of the fictional causes to which we commonly attribute behavior," said B.F. Skinner.

"Because subjective phenomena cannot be observed objectively in animals, it is idle to claim or deny their existence," said Niko Tinbergen, who won the Nobel Prize for work on animal behavior.

But Panksepp, WSU's Baily Endowed Chair of Animal Well-Being Science, helped pioneer a new field of affective neuroscience. In the process he helped map out seven core emotional systems that lie deep in our brains. A stickler for language, he capitalized the systems, lest they be confused with their ordinary uses: SEEKING, RAGE, FEAR, LUST, CARE, SADNESS, and PLAY. For millions of years, these affects, or feelings, have guided animals to find food, fight off enemies, avoid predators, reproduce, raise young, cling to caregivers, and engage with others.

"These are our tools for living and they have consciousness as part of the endowment," he says one morning in his McCoy Hall office, a two-room lair crowded with books, papers, and artistic prints of animals. "Feelings are useful. They help us survive. If they can't help us survive, then by evolutionary theory they wouldn't be there. But why people still debate, 'Do other animals have feelings?' is crazy because feelings are a very primitive form of survival."

Every good feeling, he adds, "tells you that you are on the probable path of survival. Every bad feeling anticipates the probability of destruction."

Perhaps as much as any scientist could—"there are only 24 hours in a day"—Panksepp has observed and documented the emotions on display in hundreds of experiments with chickens, rats, guinea pigs, cats, dogs, and other animals. In perhaps his most well known experiment, he found that rats emit hypersonic chirps akin to laughter when they are tickled. The work earned Panksepp the nickname "the rat tickler." More to the point, Panksepp calls it "the first validated indicator of social joy that we've ever had in animal science."

His work inspires a litany of ramifications beyond the already impressive notion of animal consciousness, which Panksepp calls the "capacity to have experience." It has philosophical implications, not only for how we should treat animals, but whether we have free will and where we might search for the meaning of life. It suggests that our most basic

values are biological in nature. That we've been encoded to anticipate the future. That our fundamental consciousness is thought *and* feeling, heart *and* head. That we're innately optimistic. That some of our most vexing psychological problems, like depression, might be addressed through these emotional systems.

Panksepp himself has seen the raw power of the emotions he has fathomed. Twice, he's lived through the up-at-4 a.m. existential fear that comes with a cancer diagnosis, including one that gave him less than a year to live. He's endured the crushing grief of a lost child. Perhaps more than anything, he's personified the life of a seeking animal, pulsing with enthusiasm over the prospect of new discovery.

EMOTIONAL TRAUMA CAME EARLY TO JAAK PANKSEPP.

He was born in Tartu, the intellectual center of Estonia, in 1943, shortly before the Soviet Army broke the siege of Leningrad and began pushing German troops back south. For Estonians, this was not a good thing, as they had looked at the German invasion as freeing them from Soviet occupation and rule.

"When the German army was being pushed back, right through my father's farm pretty much, the battle lines were moving back and forth, so the people living on the land had no idea what the hell was happening," says Panksepp. "And once it was very clear that the Russians were going to push the Germans south, a lot of people felt they would not survive another occupation."

The family packed what they could, headed to the Baltic Sea, and caught a boat to Poland. On board, a relative was pouring hot water into a jar when the jar broke. The Panksepp infant was underneath it and got third-degree burns.

"It was bad enough," says Panksepp, "that there was every indication that I was going downhill and was going to die."

Landing in Gdansk, an uncle found medicine on the black market. Years later, Panksepp's mother told him it was morphine. He suspects it would have stemmed an infection-induced diarrhea, a major killer of sick children, while easing his pain enough to let him rest and fight the infection.

The family eventually emigrated to the United States and settled in an Estonian community in Delaware, then moved to the piney exurbs of Lakewood, New Jersey. His father bought land and planned a home in the mid-'60s; the teenage Panksepp designed it and helped build it. He went to the University of Pittsburgh, studying electrical engineering, trying his hand at writing fiction and poetry, and talking philosophy with a crowd of humanists that included the author-to-be John Irving.

"I had no conception of being a scientist," Panksepp says.

But he did work as a night orderly in a psychiatric hospital. He saw residents with chronic psychosis, acute psychosis, in padded cells and straightjackets. At night, after putting patients to bed, he would read their charts and life stories. He developed an interest in psychology and the burning question that would go on to illuminate his life: What is an emotion?

Panksepp spent his senior year at Pitt powering through psychology courses and went to the University of Massachusetts for graduate studies in clinical psychology. The program was more focused on "behavioral modification" than treatments of specific emotional disorders, as mid-'60s therapies often attempted to change maladaptive behaviors through structured learning.

"Emotions weren't even talked about," says Panksepp. "There might be anxiety disorders, but that was a behavioral problem, being scared of spiders or something."

But he got a Veterans Administration traineeship outside mainstream clinical psychology, seeing a range of medical issues at a local veterans hospital. He landed in an electroencephalography lab, at the time the best way to get close to the human brain. Plotting surges of electricity in general brain regions, it was like a low-resolution lens, "Galileo's telescope compared to the Hubble."

The chief of the lab, Arnold Trehub, asked Panksepp what he wanted to do.

"I'm really interested in emotion," said Panksepp.

"At that moment I got the very best advice I'd ever gotten in my career," he recalls, "which is, 'Well, just do it.' I knew what he was saying: 'We've got the resources. That's not my interest but if it's your interest, do it.' That's the way education should be. Students should be allowed to ask the questions they really want to ask, which is much harder these days. It's much more regimented."

He had at his disposal rooms full of surplus electronics: relays, resistors, transistors, vacuum tubes. Remember: He had originally majored in electrical engineering. A lab tech, high school dropout, and World War II vet who had picked up surgery secondhand taught Panksepp how to precisely place electrodes into a rat's brain.

"After that, it was do it myself," he says.

In one of his first experiments, Panksepp stimulated a rat's medial forebrain bundle, which researchers were exploring for its role in how an animal pursues a reward. Panksepp made an apparatus that would send a current into the bundle when a rat pushed a lever. The rat not only kept pushing the lever, it would energetically explore its environment. Panksepp wondered if this was different than a food reward, so he arranged to have sugar water injected into the rat's stomach when it pushed the lever. If the animal was trying to satisfy its appetite, he figured, it would let up on the lever as it became full.

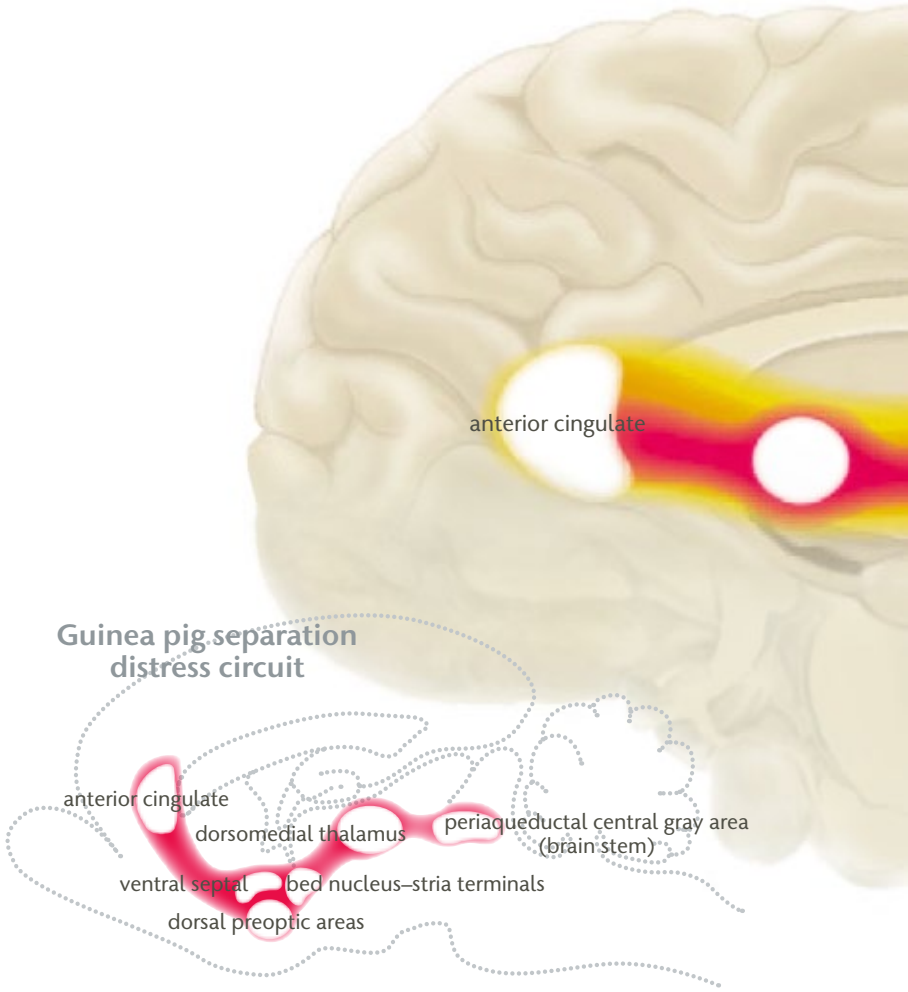
He then went to lunch. When he returned, the rat had overdosed on sugar. Clearly, it was motivated by something else.

That something else was SEEKING, a system that encourages foraging, exploring, investigating, curiosity, and expectancy. Paradoxically, it operates independent of what it might actually find, "a goad without a fixed goal." It's like radar that never turns off, or a party guest who keeps scanning the room while holding a conversation, or a web surfer who finds a right-priced pair of Air Jordan 11 Retro shoes on Amazon, but keeps looking.

"The Internet is the perfect metaphor for the SEEKING system: endless, endless seeking," says Panksepp. "Remember, these animals pressed the lever until they crashed from exhaustion. No other reward does that."

The biology of emotions has intrigued scientists back to Charles Darwin, author of *The Expression of Emotion in Man and Animals*, which featured the illustrations at left.

The hypersonic chirps of tickled rats, says Panksepp, are the "first validated indicator of social joy" in animal science. *Video frames courtesy Jaak Panksepp*



FOR HIS DISSERTATION, Panksepp studied anger and rage in rats, again by stimulating specific areas of the brain via a lever, letting them turn the current on and off. This let Panksepp see if they liked the stimulation or not.

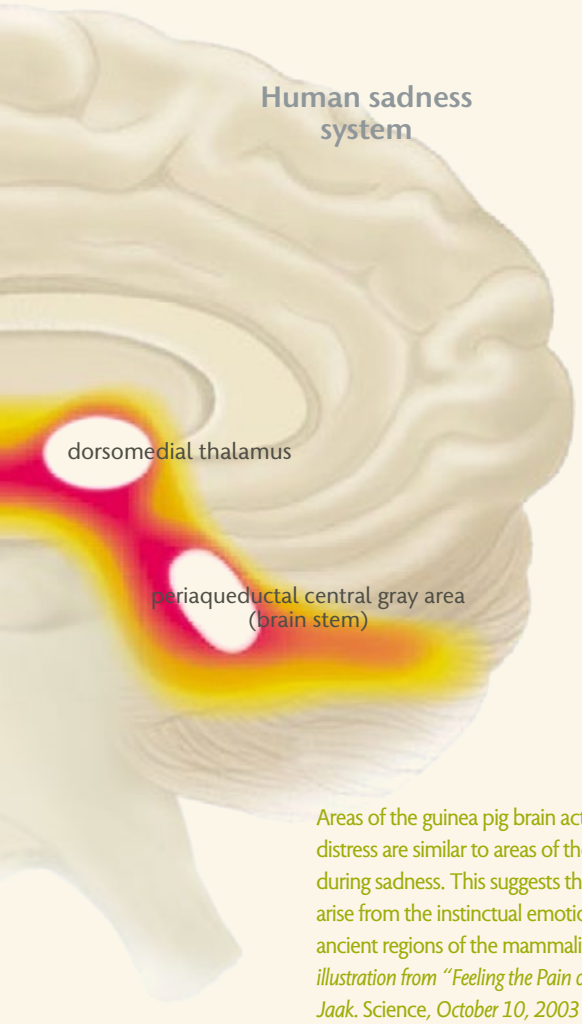
They liked predatory behavior, accompanied by stalking and certain modes of a "quiet biting-attack." Panksepp realized this was a form of SEEKING.

But they would turn off the more aggressive, agitated "affective attack" that resembled anger. This, reasoned Panksepp, was a RAGE system, a phenomenon both physiologically and psychologically different from hunting other animals. It's "a wonderful way to get your resources, get your way," he says. But it also feels bad, as do the arousals of FEAR and PANIC, two other states animals turn off.

The persistence of SEEKING, reasons Panksepp, is an indication that evolution itself, the driving force behind these emotional innovations, is optimistic.

"The positive emotions carry life forward," he says. "It's the negative emotions that have to deal with crises. So our basic nature biologically is positive. I think that's true. Think about it. If the negative emotions were prevailing, we'd be wretched creatures from the outset."

Panksepp's work took a more positive turn, so to speak, when he joined the faculty of Bowling Green State University in Ohio in 1972



Areas of the guinea pig brain activated during separation distress are similar to areas of the human brain activated during sadness. This suggests that human feelings may arise from the instinctual emotional action systems of ancient regions of the mammalian brain. *Based on an illustration from "Feeling the Pain of Social Loss," Panksepp, Jaak.* Science, *October 10, 2003*

and turned to the relatively upbeat CARE, PANIC, and PLAY systems. CARE is essential for raising offspring, a sort of built-in Spock manual. Rearing techniques and results will vary, but the drive to care will be there, particularly in females. And as Panksepp learned from some of his earliest work on bonding, measured by separation-distress or PANIC calls, CARE is backed by brain opiates. He administered tiny doses of opiates to dogs, guinea pigs, and chickens and recorded some of the most robust effects described in the research literature.

He also found that young animals given tiny doses of opiates like morphine cried less or not at all when separated from their mothers. The same could not be said of anti-anxiety medications, suggesting anxiety grows more from FEAR circuits than the PANIC circuits involved in social separation, loneliness, and sadness.

In other words, social bonds are mediated by brain opioids, says Panksepp.

"That appears to be one of the main sources of opiate addiction," he says. "People that are isolated, they've got a lot of psychological pain, they learn to treat themselves."

But when Panksepp tried to say as much in a paper submitted to a leading journal, the editor, without necessarily disagreeing, said it was "too hot to handle."

The idea didn't go over well elsewhere in the scientific community. In an interview last year with the magazine *Discover*, one of several large media outlets to have tapped Panksepp for his thoughts, he said, "we simply got rejected as being crazy."

Funding dried up, forcing the closure of the canine lab he inherited. He was disappointed, but not necessarily daunted. Turning to guinea pigs, his lab demonstrated connections between the brain's ancient periaqueductal gray, the medial thalamus, and the basal ganglia and separation calls. In 1982, he laid out four affective systems—EXPECTANCY/SEEKING, FEAR, RAGE, and PANIC—in an article titled "Toward a general psychobiological theory of emotions."

PLAY was just around the corner as he studied rats gamboling about in various contexts: alone, with family, after being separated certain lengths of time, bouncing, touching, jumping on one another, wrestling, often in front of cameras used to tease out measurable behaviors.

In one experiment, he removed their neocortex, the most recently evolved part of the brain. They continued to play, showing that the PLAY system, like the other core emotions, is a primitive process embedded deep in the ancient parts of the brain. But it also goes a long way to develop a sophisticated, social animal. It's not all fun and games.

One day at Bowling Green, then-postdoc Brian Knutson asked if rats might somehow be vocalizing during play. He and Panksepp set up equipment to listen for it and soon detected playful chirps well above the range of human hearing, at 55 kilohertz. They later found that, after about 20 minutes of play, the positive chirps were outnumbered by negative, 22-kilohertz "complaints."

It's as if they were tired children, griping about this slight or that. It also suggests that play helps animals engage in a potentially positive way, negotiate rules and limits, and establish group dynamics in a world that changes too fast for genes to keep up.

Panksepp's thinking on this extends to humans.

"If we're taking real play away from our kids, what do we have?" he asks. "We don't have fully socialized children. We also don't have the benefits in the brain, and we know play activates all kinds of genes up in the cortex. That brain area is not needed for play but play programs the cortex. And the children will have a terrible desire to play. What do we call that desire? At least in some of the kids it's ADHD, attention deficit hyperactivity disorder."

LATE IN HIS TENURE at Bowling Green, Panksepp was rounding out his list of seven affective systems, adding LUST, as in sexual excitement, and CARE, or nurturance. Around the same time, trauma returned to his life.

On Good Friday in 1991, a car driven by his 16-year-old daughter was broadsided at an intersection by a drunk driver. She and three friends were killed.

Panksepp writes about the moment in his recent book, *The Archaeology of Mind* (Norton 2012), bringing a personal perspective to a chapter on the GRIEF/PANIC system.

"That night, I cried for the first time since I was a child," he writes. "For a long while I experienced deep grief and depressive sadness with

little hope of resolution. It did not help, indeed it perplexed my mind, that this was happening to me, as I was a neuroscientist who was trying to empirically illuminate the ancient brain mechanisms of separation distress, one of the major emotional sources of our earliest social bonds."

Panksepp softened his "descent into darkness" with antidepressants, but in limited doses, fearing the drugs could cause long-term changes in his brain chemistry. For the most part, he says, he avoided chronic depression through the love and care of his wife, the poet Anesa Miller, and friends.

Other people might someday get help for depression thanks to other Panksepp efforts and insights. Two years ago, he and graduate student Jason Wright '09 reported in *Neuroscience & Biobehavioral Reviews* that they induced depression-like behavior—fewer high-frequency chirps, eating less, exploring less—in rats who received electrical stimulations in the dorsal periaqueductal gray. The midbrain area controls perceptions of pain and the fight-or-flight response, as well as emotions of grief, panic, and social loss.

Panksepp and Wright wrote that similar efforts could pinpoint the brain systems and chemistries underlying depression and lead to more effective medicines. The study was funded by the Hope for Depression Research Foundation, where Panksepp was a research co-director.

In a six-year stint at Northwestern University after Bowling Green, he helped with the development of GLYX-13, a fast-acting antidepressant now in Phase II clinical trials. The GLYX molecule is probably amplifying positive feelings of brain regions that are chronically underactive and get disengaged in depression.

"SEEKING is the thing that you want in a healthy mind," says Panksepp. "And depression is amotivational. People describe that they no longer have the enthusiasm to do things, and they also describe a special negative feeling, a psychological pain. We thought that this PANIC system is the source of this psychological pain that leads to an amotivational state. It gradually takes away the urge to explore in the world."

AT THE START OF HIS KEYNOTE ADDRESS at the Cambridge conference on animal consciousness, Panksepp mentioned that he has trouble maintaining his blood-glucose levels after a bone marrow transplant a few years ago.

"So if I kind of sit down at some point, I won't be unconscious," he said. "But if I fall down, I will be unconscious. So if I sit, just chuckle. But if I fall, go for help."

It's been a tough road for Panksepp, but he's still standing.

The bone marrow transplant came after the second of two lymphoma diagnoses. The first was discovered in his lung just as he left Bowling Green in the late '90s. He was given a year to live, reacting to the doctor's prognosis, he says, "just like anyone else. It's an existential crisis. You feel like your legs have been knocked out from under you. You feel like it's the crisis of your life."

A person who has not wondered about his or her feelings, says Panksepp, has not lived a full human life. But those very feelings, no matter how well understood, can nonetheless be torture, as they were during the bleak moments in which Panksepp wondered about his demise.

"You get up at four o'clock in the morning, saying, 'Oh my god,'" he says. "You can't get back to sleep. Emotions are so powerful that no matter how much you understand them, they will still be incredibly powerful forces in your life, everyone's life."

His first tumor, it turns out, was a treatable lymphoma, not the small-cell carcinoma that was diagnosed at first. He beat that, and then about ten years later, after joining the WSU faculty, he endured several ineffective chemos before getting a stem-cell transplant at the Fred Hutchinson Cancer Research Center and beating another bout of lymphoma in his stomach and bones.

The outcomes of his long-fought scientific battles have been more mixed.

Over more than four decades, he has authored or co-authored more than 400 papers. His h-index, a measure of productivity and impact, is higher than most every other WSU scientist and comparable to members of the National Academy of Sciences. Douglas Watt, a colleague at the Boston University School of Medicine, calls *Affective Neuroscience* "brilliant and groundbreaking" and a "seminal publication" on emotion and the brain.

Writing in the journal *Consciousness and Cognition*, Watt notes that science has struggled to establish tests to characterize the links between neural processes, emotions, and consciousness.

"Although this question gets much explicit and even at times rather hot debating," Watt says, "there are few hypotheses generated that lead directly to testable predictions, and Panksepp has done a great service in outlining some here."

Three years ago, Paul Sheldon Davies, a philosophy professor at the College of William and Mary, compared Panksepp to Darwin, "the nineteenth century's most audacious naturalist of the history of life on earth."

"Panksepp is one of today's most audacious naturalists of the mammalian mind," Davies wrote, adding: "his discoveries and innovations in affective neuroscience are changing our knowledge of the minds of all known living things."

"My field still says you cannot study the mind of an animal," Panksepp says one afternoon. "And I said you can in the emotional realm, because we can ask whether the actual brain circuits are rewards and punishments. And that was the first experiment I did at the VA hospital."

From then until now, he followed that fundamental question: What is the biological underpinning of an emotion? The techniques have improved. Science will bring more refinements. But for the first time, says Panksepp, science has "a rather thorough understanding of the primal network structures of emotional life" and the animal world's shared foundation of affective consciousness.

To this day, Panksepp will talk freely about scientific disagreements large and small but in a nearly objective, rancor-free way. He understands he is working in an inherently conservative area of science filled with skeptics. Still, he's chafed by scientists moved more by the weight of history and their own idiosyncratic points of view than the weight of evidence.

"Simply saying animals have emotional feelings puts you into the radical camp where no one wants to be unless they have the conviction that they're on the right side," he says. "Certainly I always thought I was on the right side. The times are moving with me." ⊗

Watch a video of Jaak Panksepp explaining the "primal power of play" and his serendipitous discovery of rat laughter at wsm.wsu.edu/extra/primal-play.