BRAIN SCIENCE PODCAST

With Ginger Campbell, MD

Episode #65

Interview with Dr. Jaak Panksepp, Author of *Affective Neuroscience: The Foundations of Human and Animal Emotions*

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Jaak Panksepp, PhD

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INTRODUCTION

This is the Episode 65 of the *Brain Science Podcast*, and I'm your host, Dr. Ginger Campbell. Today we will be talking with Dr. Jaak Panksepp about affective neuroscience.

Before I tell you about today's guest I want to remind you that you can find show notes and transcripts for all episodes of the *Brain Science Podcast* at brainsciencepodcast.com. If you want to send me feedback, send email to docartemis@gmail.com.

Dr. Jaak Panksepp is the author of the highly respected book, *Affective Neuroscience: The Foundations of Human and Animal Emotions*, which was published in 1998. In his book Dr. Panksepp examines the extensive evidence that both human and animal emotions begin in subcortical circuits of the mammalian brain.

He challenges two common assumptions about emotions. First he challenges the so-called James Lange hypothesis, which said that emotions are our brain's interpretation of signals coming from the body, such as interpreting a racing heart as fear.

More importantly, he challenges the idea that emotions are primarily a function of the human cortex. I could devote an entire podcast to the implications of Dr. Panksepp's work, but this interview is focused on introducing you to the evidence for his position.

I'll be back after the interview to summarize the main ideas, and to tell you about how you can get a CD version of this episode.

One final comment: This is a rather technical interview. If you are new to the *Brain Science Podcast* you might want to go back and listen to Episode 11, which is an introduction to the neuroscience of emotion. That will give you the background to get the most out of this episode.

Now, on to the interview.

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INTERVIEW

Dr. Campbell: My guest today on the *Brain Science Podcast* is Jaak Panksepp. Dr. Panksepp—I'm going to call you Jaak, if that's OK—it's great to have you on the show today.

Dr. Panksepp: It's great talking to you, Ginger.

Dr. Campbell: I thought we might start out by letting you tell us just a little bit about your background, and how you came to spend your career pioneering the field of affective neuroscience.

Dr. Panksepp: Sure. My tradition goes back to Europe. I'm one of the war babies—World War II. I was born in Estonia in The Women's Clinic at the University of Tartu—the second oldest university in Northern Europe, opened by one of the Swedish kings in 1642. It's just a stone's throw away from Emil Kraepelin's laboratory. He was the father of biological psychiatry. He wrote the first textbook of psychiatry.

I didn't think there ever would be a connection, or that I would realize I came from such a background. But as I went through my education—I started in electrical engineering and shifted to chemistry—as an undergraduate at the University of Pittsburgh I was struggling to find something that really turned me on.

I was working as a night orderly in a back ward of a psychiatric hospital. Things were not as closed in those days as today, where you need privileges to look at other people's charts, and I could spend hours and hours reading the charts of

people that I was dealing with—putting them to bed and helping them get adjusted in the evening. And I became fascinated by human emotions that had gone astray.

I decided in my last year as an undergraduate I would major in psychology. I didn't have the prerequisites for medical school, but I wanted to go into clinical psychology and learn more about these people, and how to help them and understand them. So, I went into the clinical training program at the University of Massachusetts in 1965.

I had an appointment to the North Hampton State Hospital, and I was getting quite dissatisfied with the level of conversation about emotions in clinical psychology. Those were the days of behavioral modification, and people did not talk about the emotions that psychiatric patients go through. Emotions in general were a taboo topic.

In one of my rotations in the VA hospital I ended up in the EEG Clinic with Arnie Trehub, and he had an animal laboratory back there. One day, after I got accustomed to what the unit did for the patients, he said, 'Jaak, what are you really interested in?' I told him I was fascinated by the recently-discovered phenomenon of self-stimulation in the brain. And he said, 'Well, why don't you do an experiment,' and he let me loose in his lab.

That's how it started. I shifted into behavioral neuroscience—or, as it was called, physiological psychology, in those days. And I never turned around. But I found that working on emotions was not a popular topic, and I sort of had to prove myself with more traditional things. And that's what I did.

Dr. Campbell: And then, as I understand it, once you got your tenure you started working on what you really were passionate about.

Dr. Panksepp: Absolutely. I got tenure very early. My first academic position was in the Ohio State system at a wonderful campus—Bowling Green State University—in Northwest Ohio, about 75 miles south of Ann Arbor. I had worked as a student on self-stimulation, on feeding behavior. I did my dissertation on aggression—mapping the brain circuits of aggression.

Then I did a postdoc in England on energy balance—learning the biochemistry of how animals regulate their weight. And then I had another postdoc back in America in a sleep lab with Peter Morgane of Worcester Foundation. Then I went to my first position, and I opened a sleep lab and an energy balance lab. And as soon as I got tenure I almost dropped that research. I finished off a couple of grants, and started mapping the emotional brain.

Dr. Campbell: That's what tenure is supposed to be for—giving people academic freedom. I think that idea has kind of gotten lost in recent years.

Dr. Panksepp: It has been totally lost. I was fortunate to have laboratories where they gave me total freedom to do what I wanted, because they saw me as a motivated guy that could take charge of an experiment and run it, and didn't need any outside help. I was a bench guy through and through. Many scientists these days get their first job and they're no longer bench guys—they're writing grants endlessly.

And when you do that, you get locked into a certain way of living, where your capacity to do research depends upon getting funded—if you don't have a fund, you can't do anything. And then students get locked into that pattern. Advisors have to force their students to pretty much follow in their tracks, as opposed to giving their students liberty. And I think in a sense it poisons the system.

Dr. Campbell: Yes, I was exposed to that early in my career, and it totally turned me off of research.

Dr. Panksepp: Oh, my. What area was it?

Dr. Campbell: Well, the thing was I didn't even have a chance to find my area, because, ironically, I had a master's degree in biomedical engineering before I went into medical school. And when I got out I got a basically PhD-level job, but I had no funding. I was supposed to write grants that were supposed to get me funding de novo—which of course didn't work, because I figured out right away that it's a moving hamster wheel; that if you haven't already gotten something funded, you can't get anything funded.

Dr. Panksepp: Absolutely.

Dr. Campbell: But, let's not get distracted on that. Before we get into the details, I want you to give us just a brief overview of your life's work.

Dr. Panksepp: Well, after I shifted into emotions I decided to try to map a system that wasn't on anyone's intellectual map, but I knew had to exist; because we had been doing behavioral experiments isolating young animals, and as soon as you separate them from mom, they begin to cry.

John Bowlby, a psychiatrist-psychoanalyst, had pretty much built the theoretical scheme of how depression emerges from this kind of a system. He hadn't done any research himself, but he saw that the separation response was a very important emotional thing that you could measure concretely.

And no one had mapped it out. So, we started mapping it with local electrical brain stimulation, and trying to figure out what were the main chemistries that controlled it. In a sense these were the first experiments in what people now would call social neuroscience—which really emerged from, I think, the concept of affective neuroscience.

One of the revolutionaries of social neuroscience, John Cacioppo, at University of Chicago was the first person to use my book in a course. And, soon after that he developed the concept of social neuroscience—but, losing contact with the roots where it came from, because now that is human brain imaging, whereas my work is still primarily with animals.

I've done plenty of human research, also. But my feeling is that the social brain has many levels. If you don't understand the foundational level, then you can do brain imaging until you're blue in the face, but you still will not understand the process at a deep causal level.

Dr. Campbell: And you're talking about the deepest level of the brain.

Dr. Panksepp: Yes. I think in order to understand the mind—especially the emotional mind—there's no alternative but to take an evolutionary perspective. The only organ we have in the body that is clearly evolutionarily layered is the brain. We can see hallmarks of an ancient heritage right within the structure of the brain.

You can't see that in the structure of the heart or the kidneys, even though at a genetic level you can track down ancestry. But in the brain you can actually see those levels. How many levels, how you conceptualize those levels is a discussion that has hardly been engaged. But my own personal feeling is that there is a very foundational level where mind started. And I would not be surprised if the first glimmers of mind were affective.

Dr. Campbell: Maybe you could define what you mean by the word 'affective.'

Dr. Panksepp: I chose that word for coining the term 'affective neuroscience' to highlight that neuroscience has yet to deal with the nature of our positive and negative experiences—the many ways we can feel about things instinctually. Why does sugar taste wonderful on our tongue, but not a cat's?

We all get cold, but I think we humans get cold more rapidly than many other animals that have to live in the wild. But we share all these very ancient feelings that come in many different forms. And for psychiatry, if we don't understand the emotional feelings, we're not going to have a solid science of psychiatry ever.

Dr. Campbell: Under the term 'affective' it really includes emotions, but then other subjective feelings like hunger and thirst?

Dr. Panksepp: Oh, absolutely. I think affective neuroscience essentially is an umbrella concept for people to try to discuss and investigate what is this mysterious thing called feelings. These feelings come in many different categories, one could say. There are sensory feelings like taste and cold. There are bodily feelings—homeostatic feelings—like hunger and thirst.

And then the greatest mystery is the internal feelings of the brain, which are emotional feelings of anger, fear, loneliness. Those emotional feelings do not have a clear pathway from the body or the periphery—the external senses. Those can modulate it and trigger things, but the actual feeling emotional state is built into the brain in some way.

Dr. Campbell: And your work is arguing that these emotional feelings are in the ancient parts of the brain, that we share with all other mammals and probably some other animals?

Dr. Panksepp: Well, that's the conclusion we have reached. And the conclusion is based on data; it's not based on speculation or philosophy. The way you approach emotional systems, you have to first identify their neuroanatomies in some way. If you just do pure neuroanatomy you can't ever identify a function for a brain system. You might get glimmers for sensory systems—hearing and touch—coming into the brain.

But for emotions, really the gateway to understanding was the discovery of Walter Hess in Switzerland, back in the '30s, that you could stimulate a cat brain with electricity with an indwelling electrode deep in the hypothalamus, and the cat would show an anger display—a behavior that every reasonable person would say, 'The cat is just irritated, and angry, and lashing out.'

Now, Hess decided not to go to this subjective level until near the end of his life, when he was long retired and he regretted his decisions. But he did not ask the question, was there a psychological component—he did not ask that empirically.

But that is very askable. And that's one thing we did with the aggression system that he mapped in cats. My PhD dissertation was mapping that system in rats for the first time. And the electrode locations were essentially identical, and they have been identical in primates and every mammal that has ever been studied.

But I proceeded to go to the next step, and ask, 'Do you like to turn this on, if given a choice, or do you prefer to turn it off?' And it turned out there were several different kinds of aggression. One was the Hess-type anger display; and every animal that was provoked into that emotional display would voluntarily turn off the electricity if given the choice.

There is another kind of aggression—predatory aggression. Some people call it 'quiet biting attack.' Whenever we applied that stimulation, the animal was willing to turn it on. We had animals that were not predatory, but they went and turned on the brain stimulation, and then they attacked—in a predatory, quiet biting attack, stalking way—a prey species. Now we have affect.

And now we have many other measures of affect, like conditioned place preferences: Will an animal go back to a place where this brain stimulation came on; will they avoid the place where this brain stimulation came on?

So, we have good empirical ways to say whether the animal likes it or dislikes it. The big problem is saying that if there are several dislikes and several likes, how do you distinguish them? But maybe we can get to that later.

Dr. Campbell: Yes, we will; in a few minutes. Before we get into some of the specifics, I wanted to talk a little bit more about the importance of recognizing that if we're studying any kind of brain process—be it consciousness, or emotions, or whatever—we have different levels of analysis, and we need to keep these straight. Could you talk a little bit about that?

Dr. Panksepp: Absolutely. I think we have had so many controversies across the last couple of centuries on these topics that it's a veritable and conceptual jungle out there.

But as soon as you recognize that the brainmind—or the mindbrain; I use it as a single word with no hyphen—is an evolutionarily layered organ, if you want to understand consciousness you have to go to the foundational level. And I call that the primary process level. Other people, like Endel Tulving at the University of Toronto, have called this 'anoetic' consciousness—experience without knowing.

The next level would be where these systems connect up with learning about the world. And there's a lot of work at that level—lots of people doing learning. I call it secondary level affect, or emotion, or consciousness. Tulving called that 'noetic'—knowledge-based—consciousness.

And then at the highest level you have all the complex human mental abilities—thoughts, planning, intuition, creativity—a menagerie of complexities that you can never really study in animals. We don't know whether they even have those. I call that tertiary process consciousness, or emotions.

Tulving called it 'autonoetic;' which is basically autobiographical memories. You as a human being, being able to time-travel, he said—moving forward and

backward in time, keeping it in memory, and seeing what the future holds and how the past influenced you.

These are all very important levels. The least amount of work right now—almost no work—is at the primary process level. And I think that's an intellectual tragedy in Anglo-American science.

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Dr. Campbell: Jaak, I know that a lot of my listeners are aware of the work of people like António Damásio and Joseph LeDoux. When I was reading your description of these levels I was struck by the feeling that they are working at different levels from the level that you're working at.

Dr. Panksepp: Absolutely. I mean they have done wonderful work. Joe LeDoux operates completely at the secondary process level. He has decided to use our fine behavioral learning tools—classical conditioning in his case.

And you have tone-shock, tone-shock and rats get scared. After awhile, a couple of parings of the tone itself produces a very scared animal. And he has shown in a wonderful way how this linkage occurs within the amygdala.

Now, Joe and I have had controversies across the years. He does not want to accept that animals feel anything. He once said, 'Perhaps they feel pain.' And here I am trying to make the case that animals have a rich emotional life; which the evidence supports. But, we still have this hangover of Cartesian dualism that we are the complex thinking and conscious creatures, and the other creatures are kind of zombies and robots—which is nonsense.

But that's the way you had to get funding in the '80s, and LeDoux decided to play the game. He has explicitly acknowledged that at meetings. Now, Damásio is a neurologist, so he has to deal with human experiences as they present themselves in a clinic. So, he has to operate at a tertiary process level.

And he has had wonderful theories. I thought that it was too close to a James-Lange theory. In *Descartes' Error*, his 1994 book, I said, 'Oh, my goodness; we have to go back to James-Lange? That was pretty much disproved a long time ago.'

Dr. Campbell: For my listeners will you remind them what that is? Because I think a lot of them don't know.

Dr. Panksepp: Sure. James-Lange basically says that when you are confronted by a life challenge—the bear is the classic example—and you say, 'I'd better run out of here,' and you run away from the bear, and your heart goes pitter-patter, and your blood pressure goes up, you experience these bodily changes later as a feeling. That has been a very popular theory. A lot of people still buy into it.

Now, all of these peripheral things do control your feelings to some extent, but your feelings do not primarily originate there. They originate in the organization of the brain. But I think Damásio has been moving in that direction, because he did one of the finest brain imaging studies in humans.

You cannot image feelings with fMRI very easily—functional magnetic resonance imaging that everyone is using, because it's available relatively inexpensively. Damásio used the right technique, which was PET scanning, where you can take a slower picture. And he asked people to get into four primitive emotional feelings —angry, scared, happy, and sad.

And when they were finally in those deep feelings, he injected them with radioactive water to see which areas of the brain were active. And, of course, I was totally delighted that the old foundations—the primitive areas of the brain—lit up. And he acknowledged that it looks like these feelings come from deep in the brain. But he has yet to write a real book on that. His 1999 book was close.

Dr. Campbell: That's *The Feeling of What Happens*.

Dr. Panksepp: Yes, indeed.

Dr. Campbell: So, basically the old James-Lange theory—which was a combination of ideas from William James and Carl Lange, a Danish physiologist —was the idea that your emotions came from the body. But your experiments have shown quite convincingly that emotions come from the brain—the lower parts of the brain.

Dr. Panksepp: Yes. The evidence is overwhelming, ever since Hess –

Dr. Campbell: – made those angry cats.

Dr. Panksepp: Yes, angry cats. And you find many other emotional behaviors that you can turn on in animals. Every time you turn on an emotional behavior, the animal tells you it likes it or dislikes it: it's never neutral about it. So, they carry the affective message.

And we finally made the simplifying assertion that the affect is fundamentally built into this neural complexity that we don't understand; and if you ever want to really understand what affect is, you have to spend time studying those neural circuits very closely. And I am the only one left in America doing that.

I can't believe what's happening. The money is elsewhere—it's learning, it's memory. Now, Kandel got a Nobel Prize for working out classical conditioning in *Aplysia californica*, the sea snail. Now he's correcting and refining all that, working some more on rats.

But people accepted that with open hearts—that now we understand neural mechanisms of learning. But when it comes to emotions, it seems like everyone responds to that with a very different attitude—because emotions are something you experience; memories can be unconscious.

And we have such great difficulty dealing with this aspect of the brain called experience, and granting it to animals. Now, of course, we're not some kind of gods that can grant something to animals—we have to follow the evidence as scientists.

The evidence has been there for a very long time. But, because of the history of the field, the kind of research that I thought would be the most revolutionary for understanding emotions got smaller, and smaller, and smaller, largely because of the cognitive revolution and the behaviorists that never wanted to talk about experience.

Dr. Campbell: We might come back to that a little bit later, but I want to get into some more of the evidence, because my goal is to get this evidence out there where people will be aware of it—especially to my younger listeners who might be the future researchers of the world.

Dr. Panksepp: Great.

Dr. Campbell: Let's start out by letting you just give us an overview of what you have called in your writing, 'the big seven.'

Dr. Panksepp: I decided that the only way to make a science of this is to drop theory and follow the facts; because we have so much theory in emotional studies it will just make people's heads spin. And most of it is at the tertiary process level. For instance, all philosophers deal up there. But they pretend that that is the final answer—which it is not.

So, we said whatever emotional behavior you can turn on by applying electrical stimulation to specific parts of the brain, those are emotional systems. Because you're putting garbage in—you're not putting neural information in—you're just activating blindly a neural circuit. And if coherence comes out behaviorally, that means that emotional coherence was built into the circuits.

As a matter of fact, Williams James, of the James-Lange theory, actually had another theory. He said that whenever an animal has an instinctual response it has a feeling also. So, he had a leitmotif type of theory—a minor theory.

So, how many things can you turn on? Well, it's debatable—you know there's one close to another, and there's only one thing. But in my reading and actual experience observing animals there is a seeking urge—the animal looking for resources. There is the rage that Hess originally described. There is lust—you can turn on adult animals to display sexual behavior.

There's a fear system, where you stimulate in the central amygdala, the medial and lateral hypothalamus, in the periaqueductal gray, and you get a very scared-looking animal. This is what people are conditioning—like LeDoux. They're conditioning that system, but they don't give the animal a fear system.

There's care. For lust and reproduction the mother is prepared to take care of the kids—in some species, like Titi monkeys, where the mother has to live on very

nutritionally poor food, so she has to go foraging, the father becomes the main caretaker. So, there's a nurturant type of system.

We mapped what we call the panic system, which is the separation distress call when a little one gets lost from mom or dad—it falls out of the nest, goes wandering too early, and can't find the way back home. It begins to cry and cry to signal to the parents, 'Find me! Take me back!'

And the last system that we postulated was the play system. Which is truly a miracle, I would say—an underused miracle in our educational system, and also understudied as a brain process.

So, these seven I can defend. That's very conservative. No one has challenged me on any of these, really. But they have disregarded them fairly prominently in emotion.

Dr. Campbell: So, what do these circuits have in common?

Dr. Panksepp: They have a common aspect of coherence. They seem to be built as instinctual systems in the brain, so once you activate them the animal acts out an ancient scenario of behavior. Actually the behaviorists called these 'unconditioned responses.' And they just left it there.

And that's what they condition. When you have a tone and an unconditioned response, the tone develops the capacity to turn on the response, and then they call it a conditioned response. That's what LeDoux has been doing.

Dr. Campbell: But they don't ask why do you have an unconditioned response.

Dr. Panksepp: Exactly. Why no one spent a lot of time studying the essential brain mechanisms that allow conditioning to occur is a total puzzle to me. And it still desperately needs to be worked out in great detail.

The other thing about these circuits, besides the coherent instinctual behavior, is that there is a psychological component, which we call 'affect.' Whenever you turn on one of these systems, the animal unambiguously tells you it either likes it or dislikes it.

Some future scientists will be able to then ask (we could ask this already, but who would fund it, I don't know) is this feeling different than that feeling? We have the techniques to ask these questions, but no one is asking them. And to me, this type of knowledge is the foundation of psychiatry, because these are the systems that get so imbalanced and destroy people's lives.

Dr. Campbell: Right. And all of the circuits that you've described are subcortical circuits, right?

Dr. Panksepp: They are; there's no question. And the same locations have to be stimulated across mammals.

Are there more? Some friends with a philosophical bent say, 'Well, you forgot about disgust.' And I say, 'No, I haven't forgotten about it. Disgust is a sensory emotion that emerges from feelings of nausea and illness, and then it gets symbolized in the social domain as social disgust.

So, that's a different type of feeling, and it's not all that important for psychiatry. Maybe for obsessive-compulsive disorders where people feel like they've got too much dirt on their hands always, and they're continually washing them. That might be a disgust part. The fact that feelings are built into each one of these systems finally allows us to deal with a foundational aspect of consciousness.

Dr. Campbell: How do you prove that these systems are being stimulated from the bottom up, rather than from the top down?

Dr. Panksepp: No one can get these types of responses by stimulating higher parts of the brain. And you can do radical surgery on some laboratory animals, and take away the whole top of the brain. You literally take away the whole neocortex.

It's not difficult surgery, because the animal in a laboratory doesn't need the neocortex to live. That's for reason and for intelligent responses to the world—complex memories—and a rat in a lab doesn't need those. And, lo and behold, you cannot tell the difference.

Once I had an undergraduate laboratory class on animal behavior and the brain. I had 16 students, and I said, 'The last experiment you are going to do is I'm going to bring two animals into the lab; one of them is missing the whole neocortex—taken away at three days of life—and the other animal will have gotten sham surgery. And the mother takes care of them, and they grow just like normal.'

'Your job is to tell me who's who. You have spent a semester studying animal behavior, and you make your choice in whatever way you wish.' When the two-hour lab was finished, 12 of the 16 students had selected the decorticate animal as being the normal one. That was a statistically significant error. Unbelievable! I did not expect that—I expected a coin toss.

When I debriefed the students and we discussed what they were basing their decision on, the bottom-line answer was that the decorticate animal was more interesting. It was moving around, looking, poking its nose here and there. It was lively. Its emotional systems were disinhibited.

And that's what they based their decision on—that an interesting animal must have its full brain. Well, the intact animal was sitting in a corner, kind of scared, acting a little stupid. What this tells us is that the emotional system simply cannot be upstairs.

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Dr. Campbell: Just to review: You first isolate them electrically, and then you can stimulate them by stimulating any place along that same track—that's how you tell that that's one particular circuit?

Dr. Panksepp: Exactly.

Dr. Campbell: And where do the neurotransmitters or chemicals come in?

Dr. Panksepp: They come in as the most valuable way to eventually connect this animal research to human concerns. We have all kinds of psychotropic drugs in psychiatry these days, and they do their job the best they can right now. The future is understanding these emotional systems in detail. That was the reason I got into it in the first place.

And as I was shifting into affective neuroscience after tenure, the neurochemical revolution was blossoming. The first receptor in the brain had finally been identified in 1972, 1973, and that's the opiate receptor. And, lo and behold, we were starting to map the separation system.

And we said why do people have opiate addiction? It's not just pleasure in some general sense; it's a positive affect. But maybe human bonding—the loving bond between mother and child—is actually an addictive bond; the brain is using these chemistries to reinforce that we stick together as a unit, and that facilitates survival.

So, we tested this, simply by asking when you isolate a little animal and they begin to cry, will opiates eliminate the crying the way mommy does? And the answer was unambiguously yes—and very powerfully and very sensitively. That was pretty exciting for a lot of people in developmental psychology, etc.

But then all of a sudden the rat people got into it. We didn't do this research in rats, because rats, as far as I know, don't show a real separation call. But rats are so easy to run, and so common, and everyone started using rats. And they did get opiate control.

But the director of the National Institute of Mental Health—Tom Insel—claimed that all it was was a sedation. And I think he was probably right that in little tiny rats it's a sedative, because they're premies, basically. The mother has up to 12—sometimes even 16—pups, and she only has 8 teats. So, it's a real competition. Those little premies have a very permeable blood-brain barrier, and much lower doses can sedate animals.

But we did all our work initially with dogs, because we said, here's the species that's perfect for social bonding. We have had a bond for tens of thousands of years, if not longer. Then—we never could get funding for that—we went to guinea pigs. And guinea pigs are also a very bonded species.

We couldn't get funding for that, so we went to chickens. And chickens are also very bonded—the mother and the flock, so to speak. And we mapped the separation system in the guinea pig brain and in the chicken brain, and the anatomy was similar, and, as far as we can tell, the chemistries are similar. But when you look at the chemistries that control the rat vocalization, they're often different.

So, what's the dilemma? Well, the rat has a call that is not a real separation call. It's a signal to tell the mother, 'I've rolled out of the nest.' They can't get lost, you know—they're premies. But the mother sometimes, going foraging, drags them out of the nest, because they're latched to the teats. So, the mother has to have a signal, 'Bring me back.' So, that's simply a 'bring me back,' rather than an 'I'm lost' signal.

We're trying to prove that right now, and I think the data is in the right direction. I won't go into that; but a lot of people will be displeased. But I think it's what's called a teasing mimicry—you know, a butterfly that has eye spots on it—that this little sound is actually coming from the sound that we later discovered occurs in play. And we can tickle and produce it.

This is just the infantile form of that positive sound. And it attracts the mother's attention, and the mother says, 'Something interesting there,' it goes, 'Oh, I see, you're our out of the nest,' and brings it back. Those vocalizations stop as soon as the animal is old enough to get lost.

Dr. Campbell: But then rats don't have a separation call?

Dr. Panksepp: Well, we're checking that out—if they have a real separation call. Here is what the real separation call does in the little animals that are lost: When they detect that mother is nearby, they start to call louder and more frequently. Dogs do that.

Dr. Campbell: Babies definitely do it.

Dr. Panksepp: Human babies do. Absolutely. We just had a couple of grad students that did a wonderful study on big domestic pigs. Pigs do it. We've got a wild animal that we brought to Washington State University when I came here about four or five years ago—the Degu; a wonderful pet species that has real bonding. They show the same kind of facilitation. Right now we are doing the experiment in rats, and we're not seeing that facilitation.

Dr. Campbell: So, that means that if you were trying to isolate one of these primary affective circuits and you had the bad luck of starting with the wrong species, you might miss one. That means you really need to look at more than one species when you're trying to figure this kind of stuff out.

Dr. Panksepp: Absolutely. If you're taking an evolutionary approach, and it's a tool for living that is in the genome, so to speak (and I love the words 'ancestral voices of genes' for these feelings), if it's shared across a lot of animals, you've got great confidence that it must have evolved a very long time ago. But if it's unique to one species—like the little rat separation chirp—then you've got to worry whether there is generality to it.

And I do believe that every animal has its emotional strengths and weaknesses. Some systems are stronger. Surely a rabbit has a stronger fear system than a lion. Big predatory cats probably get enraged more easily than the antelope they chase. So, there are always differences.

And some people criticize me, saying, 'You know you're saying it's all the same among the species.' I say, 'No, no. It's a long and complex story, but you have to listen to all aspects of it to really understand it.' There are always differences at the biological level, but the principles appear to be the same. Now, when it comes to the separation call, the principles in the rat are different.

Dr. Campbell: OK. We are not going to have time to get into all of these in very much detail, but I really do want to talk about the seeking system, because that's one I think is a good paradigm, and also rubs up against some of the more deeply entrenched ideas.

Dr. Panksepp: Yes, the seeking system has been a blessing in disguise; and a curse explicitly, because it's such a radical departure from traditional thinking in the field. People still call this system 'the brain reward system,' which someone developed as a moniker to simplify things. There's no question this system is rewarding, but there are other brain systems that are also rewarding.

So, we decided that you have to look at the animal's behavior when you stimulate this system—not just lever presses. And when you look at the animal's behavior,

every animal that goes into exploratory mode—looking around, poking its nose in corners, doing interesting things—that is what the system actually produces for the animal. That's how it's used in the real world.

You cannot have an animal that does not like this subtle feeling. Well, I don't think it's subtle, I think it's intense, it's ecstatic; 'I'm living, I'm engaged, I want to find what I need, and I can do it.' It's that kind of can-do system. And, of course, animals are going to turn that on. But it's not a pleasure system; it's not a traditional reward system. We cannot get this across to people—except clinicians.

Clinicians love it, because they understand that if they can enliven a person's seeking system, then they're on their way to recovery. This is where one kind of depression occurs—when this system gets chronically low, and you can't get up the energy to do stuff. Life doesn't seem worth living; you don't have that kind of psychic energy. That's one kind of depression. There are other kinds.

When you bring this ethological concept, people just glaze over—'Isn't it the reward system?' Because that's a simple way to look at it. But we know experimentally there are other reward systems. And I can get into a very long story about how to distinguish that. This is the granddaddy of the positive systems. All the other positive systems in the brain, such as care, nurturance, lust, sexuality, and play, they use this system as a common substrate. That's what it looks like.

Dr. Campbell: Where is this system?

Dr. Panksepp: This system is in this enormous pathway that runs from the midbrain, up into the medial frontal cortex, through the lateral hypothalamus. So, it doesn't go into the thalamus, where all your external senses get distributed

into the cortex. It is a cross-hypothalamic system; you get it best in the hypothalamus. And the circuit classically is called the medial forebrain bundle.

Dr. Campbell: And this is a subcortical circuit, right?

Dr. Panksepp: Yes, it is. But it reaches all the way into the cortex. And one of the important transmitters for addiction, dopamine, is a chemistry—but only one of the chemistries of this system—that kind of tunes it up. Whenever dopamine becomes active, the whole system becomes active. So, dopamine is an orchestral leader. It's like a command transmitter in the system.

Dr. Campbell: I was reading about this, and if I understood what you wrote, this system is on while you're seeking something, and it turns off when you get to the reward?

Dr. Panksepp: It diminishes. But it is not necessarily a dopamine part. The neurons along the lateral hypothalamus that are part of this system, if you actually record from those neurons—which are not dopaminergic neurons—they become active whenever the animal is going after the stuff they want; and as soon as the animal has it, they stop firing.

In an experiment done quite a while ago, the animal actually had food in its mouth, and it was eating, and these cells were quiet. And they pulled the food away from the animal's hands, and even though its cheeks were full of food, the activity of the neurons came right back. So, it's a go-get-it system. It's the object in the world that I have to get, and when it's taken away from me, I go after it.

Dr. Campbell: So, these circuits get aroused by stimuli that predict rewards, rather than the rewards themselves.

Dr. Panksepp: Eventually. Initially they are activated by hunger and your bodily needs. That's when you have to seek. Everyone knows that a hungry

animal just gets more active, and then it has to get connected to the world. The animal doesn't know what it wants; that's the amazing part about this system.

If the animal is a laboratory animal like a rat, and it has all the food and water it needs, and you turn this on, it just starts exploring and it starts showing strange behaviors. Like one animal might start to just tear up a piece of something—you know, gnaw an old piece of wood. Another animal might start picking up its tail and running around. An animal might start eating its own poop.

And so, every animal solves the problem of, 'I've got to do something, I'm so energized.' And different animals often produce different behaviors that are completely interchangeable if you play the game of asking the question: Take away the preferred object and see what they start to do—if they pick up another behavior.

That has been the dilemma; that a lot of different behaviors emerge from this common system via individual learning. It's sort of like Tulving said—your autobiographical autonoetic consciousness; that is molded by this system, and it can be delusional. So, it helps us understand why schizophrenics have delusions and false beliefs; because animals develop false beliefs with this system.

Dr. Campbell: In the lab with the animals, they will choose to self-stimulate this system?

Dr. Panksepp: Yes. They love it. They really go for it. And the bizarre thing is, they always show more pressing of the lever than they need to. For food they sort of gage their press to get all the food they can get. They don't over-respond. All the animals stimulating this system just keep banging away at the lever, and sometimes press it three times more than they need to, to get a single reward.

Dr. Campbell: Is there any way we can study this system in people?

Dr. Panksepp: Sure. People who take amphetamine and cocaine are turning on this system. You have to ask them, 'Does it feel like pleasure; like you're sucking on a piece of candy?' They'll say, 'No. This feels like I'm really energized, and excited, and interested about all kinds of stuff.' Even really boring stuff becomes interesting. We've got plenty of human data on what it produces psychologically. We just haven't used those concepts in the animal, describing the animal feelings.

[music]

I want to take a moment to thank those of you who are helping to support the *Brain Science Podcast* with donations—especially those of you who are monthly subscribers. If you are interested in helping to support the *Brain Science Podcast*, just go to the website at brainsciencepodcast.com and click on the tab at the top labeled Donations and Subscriptions.

[music]

Dr. Campbell: What is the relationship between this system and learning and memory?

Dr. Panksepp: That's very important, because this takes you to places where there are resources, and you have to learn the way to get there and what signals that resources are located here or there. So, this is a general-purpose find-it system, and when you find it, then the animal lays down memories related to that.

And that's why the earlier stuff I was talking about becomes so interesting—each animal learning something different when you don't impose anything onto the animal. If you make the animal hungry and then you have a signal indicating food is there, this system will help the animal learn that. And that's useful, because now the animal knows stuff in the world.

Everything about the world, pretty much, we learn—except how our senses come into our eyes and ears, and so forth. Everything else has to be learned. This system helps do that. But the same goes for every other emotional system.

Every emotional system down in the subcortical areas is a special-purpose learning system. The seeking system is simply the broadest. It's for all resources, including safety—finding safety in a dangerous situation. The animal has to seek safety.

These are, I think, fairly straightforward concepts, but these concepts have never penetrated psychology, neuroscience…

Dr. Campbell: And I guess in psychology, one of the problems is this whole idea of learning and memory being totally behavioral, that just completely ignores what's happening in the brain.

Dr. Panksepp: Yes. Well, those days are gone now.

Dr. Campbell: Yes. But we've had that sort of replaced with this whole idea of the brain's reward system. You're saying that this approach is really at a deeper level.

Dr. Panksepp: I think this is probably at the level that evolutionarily determined the creation of these systems. They serve problems in living that every animal has. And one of the problems in living is simply finding resources.

And you don't build many different systems for different resources, you build one system for looking for resources and then maybe a sensory reward—like a pleasant taste for the food system, the coolness and refreshingness of water for the thirst system, bodily warmth for the thermoregulatory system.

There are many specific rewards, but there's one looking-for-reward system. So, you can call it 'the seeking system.' That makes conceptual sense. It covers all the known facts. As soon as you say 'the reward system,' you put yourself in a conceptual corner.

Dr. Campbell: Yes. One of the problems I have with that system, that's sort of the ruling paradigm we're being taught right now, is that we were told that you get a good reward in the brain if what you get is better than what you expected; and if it's less than what you expected, you're disappointed. But the hole in it that seems obvious to me is, well, what about when you get exactly what you expect?

Like, when people do the same thing over and over again—like watching their favorite movie, or whatever—and they know exactly what's going to happen, and yet that's a pleasurable activity. It seems like if it was all about having more reward than you expected, doing anything more than once would be selected against, so to speak.

Dr. Panksepp: It should be. But if you have to compete and do it in a hurry, then you might over-respond. Over-response would be built into a system. It's more competitive.

Science is very conservative, and bringing new concepts into science is very, very difficult—especially when things have crystalized in certain ways. I had a wonderful postdoctoral student, Brian Knutson, who now has got tenure at Stanford. And he is pretty much the granddaddy of neuroeconomics—which is brain imaging of this system when you're buying things, or winning big money, etc.

Whenever you have an anticipation of getting good stuff, this system becomes active. And Brian can even identify when a person is going to buy something.

When this system becomes active, the person will buy it. If another system, the insula—which mediates sensory disgust—becomes active a little bit, the person is not going to buy it.

Now, Brian knows the seeking system concepts in and out, because he was in my lab. As a matter of fact, he discovered rat chirping during play in my lab, but left for greener pastures before the tickling started. To this day, I ask him, 'Brian, why don't you use the seeking concept when you discuss these things?'

He says, 'You know, I like to get my papers published. If I use such radical concepts, people will not accept these papers.' And he's probably accurate. Science is very conservative. New ideas often take a long time, and there's a history of good ideas just falling between the cracks.

Dr. Campbell: Yes, your work reminds me of the plight of neuroplasticity, say 20 years ago, when perfectly good evidence was being discounted because it didn't fit into the prevailing dogma.

Dr. Panksepp: Oh, yes; absolutely. I mean plasticity, now, is hot, hot, hot—epigenesis, and everything is plastic.

These emotional systems are plastic, too. Now, people sometimes criticize me and say, how can the genes produce the final product? I say, no, we're not saying it's the final product: It has established a system where the final product can be refined by living in the world; and there are always happy qualifications.

You can unambiguously say everything in the brain is plastic. It's fascinating. There are so many different forms of plasticity. Is emotional plasticity different than memory plasticity? No one is asking those questions, and that's because they're locked into their grants.

Dr. Campbell: There is so much else I could ask you about, but I think we're just about out of time. Is there anything you think is important that I have left out that you'd like to mention?

Dr. Panksepp: I think the general principle is that we're deeply emotional creatures—all mammals. And it goes further than that: We as a civilized society have to come to terms with our animal nature. That will give us a philosophy of life where the lives of other animals will be improved, and human lives will be improved.

Ultimately the quality of our life is affective. If our affective systems become imbalanced, we have these things called psychiatric problems and disorders. And there will be new and very specific medicines, once we understand these systems. We have medicines that probably would be better for depression right now than the ones that are being sold.

So, in a sense we have to open up the doorway to intellectual honesty at all levels of our society. And that's a big job.

Dr. Campbell: If you were starting out right now—and assuming that funding was not a problem—what question would you want to pursue?

Dr. Panksepp: There's one question I've always wanted to pursue, which would have been the ancestry of how these emotional systems work between animals. Each animal is either resonating with another animal's emotional system the positive social emotions, or they're activating other emotions—fear and anger—between animals that might be competing.

I proposed in the '80s that there were resonances between emotional systems. When you feel sad and I see your sadness, I understand where you are, because my emotional system gets activated. And right now the mirror neurons are hot, hot, hot.

But I think they are making the story even hotter by using that concept that the emotion is what's being communicated between individuals. No, those mirror neurons in the cortex are not communicating emotional feelings. The mirroring of feeling is, I think, operating at a more primitive level.

And those questions could be asked. That requires big bucks to do it. There is not a single person in the world working on that topic. That's what I would work on if I had plenty of money and plenty of young spirited investigator students that just wanted to explore the nature of the world—the mental world, the brain world.

And they're very doable projects now, because we know where the location of the systems are, and we know some of the chemistries. So, it's a wide open ball game. I don't think that anyone will do those experiments in my lifetime. I will not.

Dr. Campbell: What advice do you have for young people that are interested in getting into this field?

Dr. Panksepp: Take courses from the most interesting and engaged professors, get turned on, and recognize that your education is totally your responsibility. There are only people around you to inspire you, and then you take that inspiration that's inside and you try to find a place where you can do the kind of work that you want to do. And it's harder and harder to find these places, because everything is grant-driven, and you become a kind of a serf to the system.

I don't think there's any way to change that, because science is so important, and it requires so much hard, time-consuming work. But I would also tell any young person that, once you're inspired, be ready to commit yourself to some of the most difficult work one can do: difficult because, not only do you have to keep so many skills tuned up, but it's repetitive—over and over doing the same thing.

So, you have to have a very profound work ethic. You have to be like a brick layer. You have to be willing to build a cathedral; and a cathedral that's not finished in your lifetime, but that you had established a certain beautiful perspective on things that other people are tempted to follow off. So, when I say that, I wonder how come only my own students are following me.

Dr. Campbell: But you've got plenty of material there in the literature. And I hope it will be more appreciated in your lifetime; but you've got it out there for the future.

Dr. Panksepp: Well, there's quite a bit of appreciation, especially among psychiatrists, psychotherapists, and people that need this kind of evidence—this kind of knowledge. That whole community of people that deals with human problems finds this to be on the right track. It's just within the neuroscience community that it needs cultivation.

The bottom line is that when scientists stop talking about ideas, intellectual tragedies happen. The conversation about these issues has to be opened up. And I'm delighted that you're opening up the conversation a bit.

Dr. Campbell: Well, I really appreciate you taking the time to talk with us today. I know this is going to be very interesting material to everybody. And I'm going to try to get as many of the papers that are available online as I can. I will link to them, as well as to your book.

Dr. Panksepp: Wonderful! I appreciate having had a chance to talk to you.

Dr. Campbell: That's great. Thanks a lot.

Dr. Panksepp: You bet!

[music]

I want to thank Dr. Jaak Panksepp again for being my guest on the *Brain Science Podcast*. I want to take a few minutes to review some of the key ideas, because while it may be awhile before the implications of Dr. Panksepp's work penetrate mainstream neuroscience, I have no doubt that in the long run they will have an important impact.

Dr. Panksepp's main message is quite straightforward. Based on his decades of work with a wide variety of animals, he has isolated at least seven subcortical circuits that are the origin of affective experience. This means that emotional experience originates in the subcortical parts of the brain that evolved before humans, and even before primates. Other animals may not be able to analyze their emotions the way we do, but there is no doubt that they have feelings.

The evidence is also quite straightforward. When these circuits are stimulated, animals show predictable, reproducible behavior. When given a choice, they will choose self-stimulation or avoidance, depending on whether the experience is pleasant or unpleasant. When people have these same areas stimulated, they are able to describe their emotions in just the way one would expect.

The other half of the evidence is equally compelling. Most of you know that various motor and sensory experiences can be elicited by stimulating the cortex, or the surface of the brain. This is often done prior to neurosurgery. However, one does not get pure affective, or emotional, experiences by stimulating the cortex. In fact, as Dr. Panksepp mentioned, an animal without a cortex still has emotions.

Unfortunately, there is currently little-to-no research funding for exploring questions at what Dr. Panksepp calls, 'the primary level.' The research being done at the secondary, or memory and learning level, and at the higher cortical levels is important. But I agree with Jaak that it is a tragedy for the primary level to be ignored—especially when you consider the potential for helping people with

psychiatric illnesses.

Why should you, as a listener, care? For those of you outside of science, I hope this discussion will give you some insight into how science is really done. It's not a story of linear progress. It's a story of a very human endeavor, where sometimes very valuable work is not appreciated until many years later.

On the other hand, I know many of you have a passion for neuroscience. So I want to encourage the readers among you to get Dr. Panksepp's book, *Affective Neuroscience*. It is older than the books I usually recommend on this podcast, and quite technical. But it will give you a thorough foundation in this area. Today we just touched on the highlights.

I will be putting references in the show notes at brainsciencepodcast.com. There you will also find a link to Dr. Panksepp. I would like to encourage you to send him feedback and questions.

If you would like to get show notes automatically, please sign up for the new *Brain Science Podcast* newsletter.

If you have an iPhone or iPod Touch, you can get transcripts right on your device using the new *Brain Science Podcast* iPhone application.

I would love to see someone start a discussion about this episode, either on the Discussion Forum, or on our Facebook Fan Page.

And, of course, you can send me email at docartemis@gmail.com.

Since this episode has run so long, I will try to keep my other closing comments to a minimum. Next month's episode is an interview with Dr. Randy Gallistel, co-author of *Memory and the Computational Brain*. In that episode we will be talking about some more fascinating animal research.

If things go as planned, the next *Books and Ideas* podcast will be an interview with Dr. Bruce Hood, author of *SuperSense: Why We Believe in the Unbelievable*. I hope you will check that out at booksandideas.com.

Finally, I am working on making CD versions of the *Brain Science Podcast*, starting with this episode. I will be adding features that aren't possible in the podcast format. The episode will be broken down into about 25 tracks, which will make it easy for you to find parts you want to listen to again, or to find your place if you get interrupted. Also, based on requests from listeners, most of the announcements and music will be removed.

Eventually I hope to have a CD available at the same time I release each new episode, but there will probably be a slight lag until I can get the process perfected. I hope those of you who are regular listeners will buy the first CD, and then send me feedback. If you want to know when the CD is available, be sure to sign up for the newsletter at brainsciencepodcast.com.

I will be back with another *Brain Science Podcast* next month. Until then, don't forget to visit sciencepodcasters.org if you are looking for more science podcasts, and booksandideas.com to hear my interviews with people from a wide variety of fields. *Books and Ideas* comes out on the fourth Wednesday of every month.

Thanks again for listening. I look forward to talking with you again very soon.

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Transcribed by Lori Wolfson
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