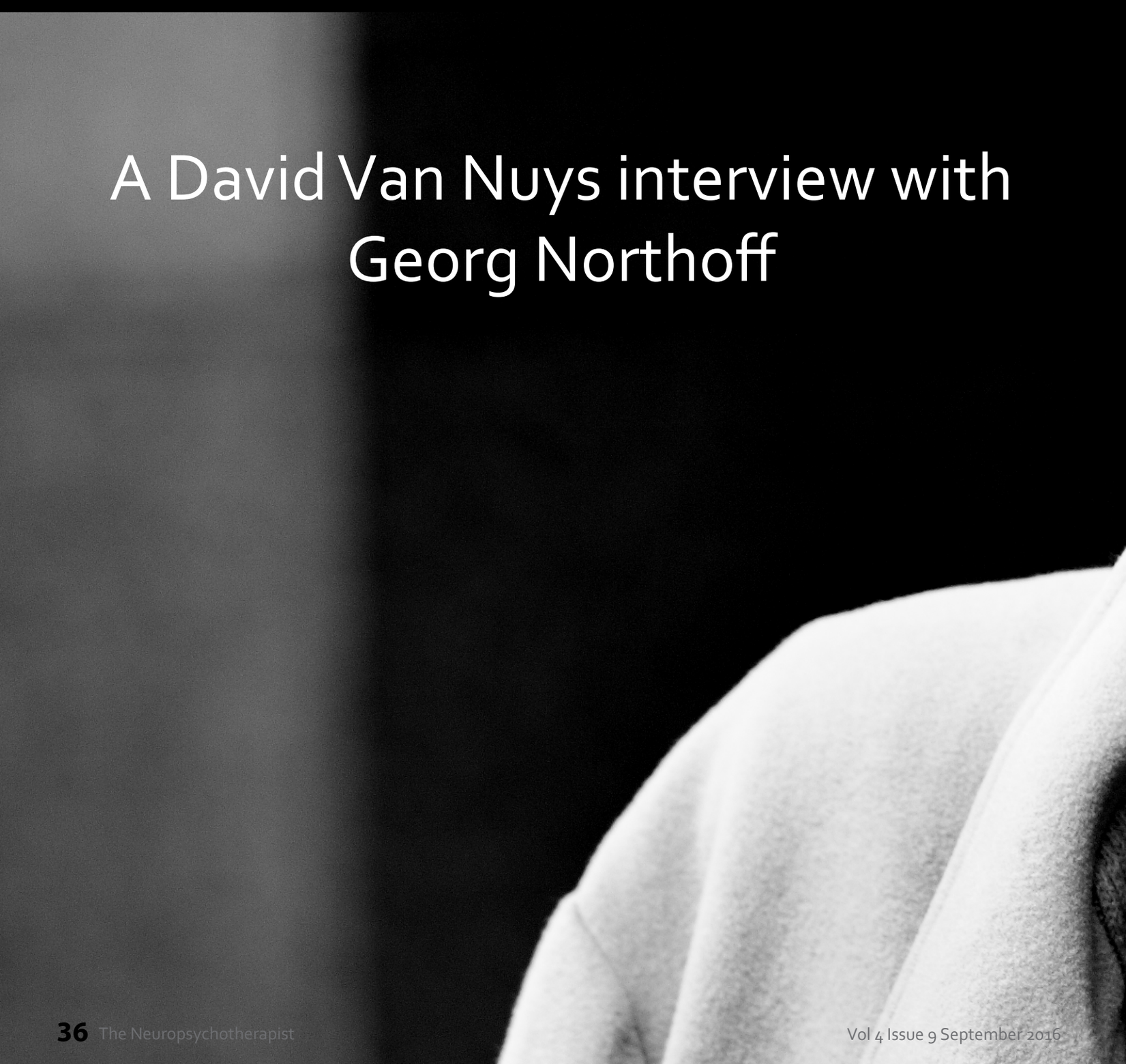
Exploring Neuro-Philosophy

A David Van Nuys interview with Georg Northoff



Dr. Georg Northoff is a philosopher, neuroscientist, and psychiatrist, holding degrees in all three disciplines. Originally from Germany, he now works in Ottawa, Canada, where he researches the relationship between the brain and mind in its various facets, focusing on the neural and biochemical mechanisms related to higher-order mental functions like consciousness and self both in healthy subjects and in psychiatric disorders like depression and schizophrenia. "The question driving me is, why and how can our brain construct subjective phenomena like self, consciousness, emotions?" Northoff is one of the leading figures in linking philosophy and neuroscience in a non-reductive way and has authored 260 journal articles and 15 books, including *Neuro-Philosophy and the Healthy Mind: Learning from the Unwell Brain* (2016, Norton).

Dr. Dave: Dr. Georg Northoff, welcome to Shrink Rap Radio.

Northoff: Hello, thank you very much for your introduction.

Dr. Dave: I'm glad to have you here. And I'm especially pleased to have you on the show because of your credentials as a philosopher. I know we won't get into this, but I had run across the notion of applied philosophy and people who are essentially functioning as counsellors or psychotherapists whose credentials were "applied philosopher". And so that's something I meant to look into. However, I think your direction, your expertise, is quite different than that.

Northoff: Yeah, I am a philosopher, neuroscientist, and psychiatrist; you can see already by the triangle of my education and also the work I am doing. And applied philosophy would have a very different sense in my context. It would really mean that I try to bring in some empirical evidence which we gather. In sciences, I try to link that with the kinds of questions we have in philosophy which usually concern questions of knowledge—what can we know; epistemological questions, and knowledge of existence and reality, ontology, and metaphysics. And of course there are also other domains of philosophy. And I'm not really trying something new: when you look back into the history of philosophy and the beginning of modernity, people like Descartes, Spinoza, Leibniz, Kant always linked the conceptual, the ontological, with the empirical. It's only in the 20th century that the two really diverge from each other. I am trying to bridge the gap. And the bridge is of course the brain.

Dr. Dave: Yeah. Now as you pointed out, you've got degrees in psychiatry, neuroscience, and philosophy. In what order did you get them, those degrees? Which came first?

Northoff: See, at my time there was no neuroscience yet, so when I finished high school (the beginning of the 80s) there was no neuroscience program yet. Young people can't even imagine that, because it's so evident these days. It's completely natural.

So in order to deal with the brain you had to study medicine. So that's why I studied medicine. But I always wanted to study philosophy. I never wanted to study philosophy alone without science. So probably nowadays I would have studied philosophy/neuroscience, but at the time I studied philosophy/medicine. I did this early. And when you finish medicine you have to do some kind of residency, because otherwise your degree is worthless. So what is closest to the brain is psychiatry, and then I became a psychiatrist. And then I continued all three, and now I don't care anymore about the distinctions.

Dr. Dave: Yeah. Some people might wonder, "Well, what's the relevance of philosophy in today's scientific world? Science tells us everything. Why do we need philosophy?" Of course I don't think that, but . . . [Laughs]

Northoff: [Laughs] Yeah. Good question. I start with the sentence by Albert Einstein: "You only see what your theory tells you," meaning your theory and your concept dictate how and what you see and observe in your science. And every good scientist in history and nowadays knows that data, empirical facts, experiments go closely hand-in-hand with concept, theory, and certain predispositions.

Real progress in science comes when you combine; that's the genesis. Now with regard to the brain, you can't be really . . . many fellow neuroscientists might contradict me, but nevertheless we don't really know how this brain works. In the case of the heart, we really know it's a pump, and pumps blood—that's the purpose of the heart, and everything revolves around it. Once you know that then it's very easy to know, OK, it's a muscle structure and it's pumping and all of that.

In the case of the brain, we really don't know yet. And so what you need to develop is different models and theories of brain and then the corresponding empirical experiments. That's what we're trying to do.

Dr. Dave: Would it be fair to say that philosophy is good at generating the questions, and science is good at testing out alternative answers? Or is that too simple?

Northoff: If you want to bring it down, one could probably say it like that. But I cannot generate a proper question without some empirical data, and I can't have an answer without a proper concept or theory.

Dr. Dave: They kind of interlock. We need them both.

Northoff: It's really going back and forth. It's interactive movement. So while I can see this here, I can see certain empirical data which we generate, then I have certain theories and philosophy, then I go back up here; this requires this kind of experiment, and it goes constantly back and forth interactively.

Dr. Dave: And your book really portrays that, because it goes back and forth between what the classical philosophers had to say about such questions as mind, consciousness, self and what contemporary philosophers who are still wrestling with some of those same, very basic issues—what they have to say. And one of the issues that you bring up, and that runs throughout the book, gets at what you were just saying about the heart versus the brain. It's the "hard question". The hard question—it's funny, preparing for this interview, just yesterday in *The New York Times* there was a whole article about the hard question and a neuroscience conference, one that had happened in New York, one that had happened in Tucson, where people were talking about the hard question. Bring our listeners up to speed here. What do you mean by

the hard question?

Northoff: The hard question, or "hard problem" as it's often called by philosophers, is why is there consciousness at all? So, why does consciousness exist rather than non-consciousness? We could also imagine the brain may be exactly the same way as ours without consciousness. This is often called the zombie argument: we could be a zombie. And the question, what makes the difference between consciousness and unconsciousness . . . but this is where it already starts. You can understand the hard problem in a philosophical way, and in a scientific way. In the scientific way it's basically the question for the kind of mechanism by means of which the unconscious state transforms into the conscious state. That's what neuroscientists call neural correlates of consciousness. The philosopher of course wants much more. They want to say how is it possible that we have consciousness at all rather than non-consciousness. So that includes also an unconscious state, because the unconscious state can transform into the conscious state.

Dr. Dave: Yeah. So you point out that we can look at the objective brain. We can see that there are neurons and white matter and so on. We can see all of these objective things to our senses but what we refer to as mind or consciousness, that subjective experience, we can't see except in ourselves. [Laughs]

Northoff: That is one of the backdrops against which the hard problem is set. Yeah. What we observe from the outside in an objective way is the brain; that's what we observe in the functional brain images. We will never see consciousness or what the philosophers like to call qualian subjective qualities—a certain "what it is like" or color of experience. Experience and consciousness are intrinsic, the subject. Yeah? You cannot share your consciousness of boredom about my answers. I can't feel your boredom or the listeners' boredom; I can maybe see it in the face but I can't experience it. I cannot feel it. And that's really the big philosophical backdrop. There's an objective view on the brain, and a subjective view of consciousness. How can you reconcile that?

There's a lot of conceptual work to be done. A lot of philosophical marriage.

Dr. Dave: Now, the title of your book is *Neuro-Philosophy and the Healthy Mind: Learning from the Unwell Brain.* And what you propose there for your task is to look at broken brains, people who have neurological problems of one sort or another, and from that to deduce the various elements of consciousness: what's lost when there's brain damage. And in a way that strikes me as an old approach, isn't that right? And in a way that was surprising to me at first because I would have thought, "Oh, don't we already know all that stuff?" I mean, we have all those neurological problems, and that's how we've learned a lot about the brain. What causes you to feel that you can find out more through that approach?

Northoff: Of course, you're right. It's really an old . . . it's the way neuroscience got off the ground. At the beginning of the 20th century . . . I start the book with the Broca lesion, the Broca language center in the brain. What we haven't really understood yet—and these are paradigmatic disorders of the mind—are psychotic disorders. We have no idea where and why people become schizophrenic, meaning they show auditory hallucinations, they hear voices, they have delusions, they feel persecuted. Some feel that they are another person in the most extreme cases. I have encountered many "Jesuses". In China you encounter people who think they are Mao, the former president over there.

The kind of identity you take depends on the context. We have no idea. Depression—why you're seriously depressed, sad, you think you have to take your own life, or develop suicidal ideation. Or the opposite, mania: we call it bipolar disorder—depression, mania—bipolar. We have no idea, and I think in order to understand the brain and why it brings forth and contributes to consciousness, we need to understand psychiatric, psychotic disorders. This is why I take the psychotic disorders here as a starting point to understand the mind.

Dr. Dave: OK. You have chapters on both of those disorders towards the end of the book, and you spend a lot of time working up to that by examining some of the fundamental substrate, if you will, of that question having to do with, What is consciousness? What is the Self? What is Mind? And it's a lot of wrestling with those basic issues. And you are actually a researcher, and it seems like your tool, to a large extent, is fMRI, which lets you explore some of these questions without needing to have a damaged brain. Is that right?

Northoff: Yeah. Both. The damaged brain—when you ask these patients, What do they experience? How do they experience their own body? How do they experience time and space? How do they experience their own selves?—that tells you what must go on in their brain. And then you can develop proper experiments in the healthy brain as well as the diseased brain to test those hypotheses. For me it is extremely important to listen to what the patient has to say, and ask her or him questions along the lines of how you imagine certain neuronal states transforming into mental states.

Dr. Dave: Yes, yes. Do we have a good definition of consciousness? I know to start things off you started with a very basic description of consciousness. I want to see . . . I have a note about that: ". . . that were awake and able to respond to the environment." So that was kind of a starting place, although your definition expands and expands, actually, as we go through the book?

Northoff: Yeah. Ultimately you experience yourself as part within the spatial, the wider spatial–temporal

context of the world. And you experience yourself as located at a particular place/spot in the world, but you still experience yourself as related to the other—even though we may be wired to the Internet, a completely different relationship—but somewhat related to each other. We do this because I have consciousness. If I have no consciousness, I am not able to develop this sort of virtual spatial–temporal relationship to you. I'm cut off. And when I'm cut off, of course I don't behave anymore. That's what you see in these patients who have lost consciousness: a vegetative state or coma.

Dr. Dave: You hypothesize a sort of thought experience, speaking of Einstein—a thought experiment, which is to imagine two young people have a motorcycle accident, a man and a woman, a young man and a young woman. They both go into what are called vegetative states—and this is particularly close to home, I have to say. When I was a young man, I was in a motorcycle accident, and in your hypothetical example a truck turns in front and they hit the truck. In my real-life example, I had a young woman on the back of the motorcycle and a car turned in front of us; I flew up in the air, landed on my head and shoulder on the car. Fortunately I didn't get a concussion or brain damage . . . that I know of [Both laugh], and neither did the young woman, so your example is close to my experience. But I came out lucky.

Another element of consciousness aside from the ability to respond to the environment is self-consciousness, as a kind of unique and particular aspect of what it is to be conscious; that is, that I have a sense that I know who I am. And I am aware of myself. And a person who suffers a brain injury in which they're not self aware, that does exist, right?

Northoff: Self-consciousness is a really hard nut to crack. And indeed, for instance in schizophrenia, you can have the feeling that they don't have self-consciousness any more, which we usually take for granted—when you get up in the morning, you look into the mirror and you recognize . . . and then you feel, yeah, it's me. And despite all the physical changes over the last 20 or 30 years, one still says, "Ok, it's still me." The schizophrenic patient looks in the mirror and says, "It's not me anymore." Common things or what you take for granted are somewhat disrupted.

Dr. Dave: To leap ahead a little bit in the book and the theory that you develop, it seems that, in terms of brain structures, that is I think what you call the cortical-medial system. I'm not even sure how to picture that. Is it between the two halves of the brain, but lower?

Northoff: Right in the middle.

Dr. Dave: Right in the middle and going down.

Northoff: Exactly. Right in the middle—an extension of the top sub-cortical region beneath the surface—the cortex.

Dr. Dave: Would that be the corpus callosum, or . . .?

Northoff: It's right in the middle which binds the hemispheres together. These midline structures are basically on top of the corpus callosum. Or around if you want to say it's around. So let's say this is the corpus callosum. The cortical midline structures go on top of it.

Dr. Dave: Oh! I had it the other way around. That's good to know. Tell us about the work that you've done there and how you're able to make that connection between self-awareness and no self-awareness.

Northoff: That's an interesting point. And it started with empirical findings, actually. There were a lot of experiments, 10 to 15 years ago—and still are—where people compare, let's say, what are the neuronal effects of stimuli related to your own name or certain trait adjectives, with stimuli or tasks that are not at all related to you. Let's say, if I show you a picture of San Francisco, that has a high degree of personal relevance to you. I assume because you live in San Francisco, as I recall.

In contrast, if I show you a picture of Ottawa where I live—minus 30 degrees and a snow storm—I'm sure it has no relation for you. There's no relevance for you. For me, in contrast, this picture of Ottawa and a minus 30-degree snowstorm in winter is highly relevant, because I have to survive the winter here. And interestingly, these experiments showed that when you compared these two similarities, activity changes in particular in these cortical mid-lines.

Dr. Dave: This was fascinating because I'd never heard anything like this before. I forget: what are the names of the two people, your two hypothetical people? What were their names? Just so I can refer to them easily. John and Julie, was it?

Northoff: John and Julie, yep.

Dr. Dave: OK, John and Julie. So I was shocked—here are John and Julie; they're both in what we would call a vegetative state, or a coma. They seem to have no consciousness at all. But you were able to—I'm trying to remember how you got the stimulant to them—their brain would respond to stimuli that they knew about: "Describe your house," or "Think about your house and the rooms in your house." Then you would see their brains start activating, as if that's what they were doing.

Northoff: Right—they have to navigate the house. We'd see the same regions activated as in the healthy subjects.

Dr. Dave: And you're saying this to them verbally?

Northoff: Auditory.

Dr. Dave: Auditory, yes, so they're getting the auditory stimulation of . . .

Northoff: Autobiographical sentences to them. So, auditory. Then you can see the auditory cortex, the auditory region lighting up, so that you know they've really listened. And then you also see some activity in the midline regions. Most interestingly, the degree of activity in the mid-line region predicted the degree of consciousness—meaning the more activity difference between the own and other name, the higher your level of consciousness.

Dr. Dave: How can you say the higher the level of consciousness if they are still in the vegetative state?

Northoff: Because we measure that with a behaviour scale. And you can have different stages: you can have a vegetative state; you have a minimal consciousness state. Minus minimal consciousness plus . . . So you have different sort of grading or stages of levels of consciousness.

Dr. Dave: Now, this would make it ethically a very challenging decision to pull the plug, right? This is something that people face—relatives—is this person dead, or not dead, if the brain is still being active?

Northoff: Yeah, yeah. That's for sure. It changes all our views of the model of brain and of the self and causes real ethical decisions. Yeah. It is clear that the brain is still functioning in these ways in these patients, but it's not processing the stimuli in such a way that they can be associated with consciousness. And we're currently trying to find out . . . and apparently the self-related processing as we call it—stimuli related to your own self, like your own name or the picture from San Francisco for you, or for me the picture from Ottawa—that this processing capacity is highly relevant to consciousness. Why? And so, we don't know. And that's a very interesting thing, because ultimately it leads back to some philosophical theories that maybe the self is the driving force of consciousness.

This is not only philosophically relevant, because it also gives us a new understanding of the neuroscience of the brain; and also clinically, because maybe we can use this kind of self-related stimuli as a clinical marker for the level of consciousness—whether the patient will wake up or not.

Dr. Dave: Let me jump to a thought, a question that I had: you know how in hospitals we have the crash cart? Somebody has died, they rush in, they give electrical shocks to the heart to stimulate it, and the person comes back. And your book got me to wondering if the same thing might be done at a cortical level to somehow shock the brain back into a fuller range of consciousness.

Northoff: That's a difficult question. These vegetative state patients have huge brain lesions. I mean it's unbelievable—very wide ventricle—the brain lesions are quite huge. How that exactly is related to the loss of consciousness is unclear.

How that predicts the possible recovery . . . and there are now some experiments; they don't do electrical shocking, but they do do transcranial magnetic stimulation. There seem to be some positive findings but not as clear-cut as one would like to have. Probably because each patient is different. There is a huge variety or heterogeneity around patients.

Dr. Dave: Yeah. And when you talk about these lesions, that would probably depend upon the condition. I would think lesions would take some time to develop, and so, for example John and Julie, I wouldn't expect that their brains would necessarily have that kind of "physically observable by the naked eye" kind of changes.

Northoff: Right. You'd need, indeed, some high-resolution imaging techniques, and of course we hope that we can improve the resolution. With better imaging techniques you'd see more, yeah—and definitely we're just at the beginning.

Dr. Dave: And another thought I'm having just as we're speaking is that these levels that you talk about, that's likely to have some implications for the law as well, right?

Northoff: Yeah, yeah. For sure, if we as neuroscientists, clinicians, can give exact markers . . . I mean, when you have cancer you can have clear diagnostic markers for the kind of prediction you have, yeah? A certain number of lymphocytes and so on and so on, and according to that you select the chemotherapy, and according to that you stage your prediction. Yeah. And according to that you tailor your treatment. If you fail, you have cells, way too many—the treatment makes no sense anymore. It's a decision with high-ranging ethical implications.

At some point, let's say maybe in 10 to 15 years, I hope we can distinguish different levels of neuronal mechanisms, predispositions, prerequisites, neural correlates. Maybe in 15 years we'll have 10 to 15 different levels.

Dr. Dave: One of the things that seems to characterize the higher levels is, as you point out, that consciousness—what we would consider full consciousness—is a global phenomenon. It's a whole-brain phenomenon rather than . . . and we might have thought that, oh, there's this little place in the brain that's the seat of consciousness. But you and others have found that it's really associated with massive activity across the whole brain.

Northoff: Right, yeah. There's no doubt, it's not . . . I mean when you look into the history of neuroscience, it always oscillates back and forth between very localized, localization of mental function in spe-

cific regions on networks, and the more holistic approach—the whole brain. And there's no doubt that in consciousness, the whole brain is involved.

Even if only certain regions are activated, that activation depends on the rest of the brain. So it's the holistic phenomena you want to look at now.

Dr. Dave: Yeah. Now another important concept that you've been working with experimentally is the idea of the resting brain. And so of course that raises . . . and the resting brain as you use it is not a dead brain with no activity at all, but rather, as you point out, actually a lot of activity. So how do you decide what is . . . and that sort of becomes the baseline in your model for a lot of your work—the resting brain, to kind of compare it to the resting brain. So what do we know about the resting brain?

Northoff: Yeah. Good question. So we can call it the resting brain—actually pointed out very nicely, because it's really a deceiving term. Yeah, it deceives you, because it's never at rest: if your brain is at rest—meaning zero—then you're brain-dead. So that's something I think neither of us wants.

Dr. Dave: Right. [Both laugh]

Northoff: So we call it sort of spontaneous activity. And it is clear that spontaneous activity has always been somewhat on the sidelines in neuroscience, but the predominant view is always that the brain is shaped by the stimulus or task, external task, involved in that activity. But now it becomes more and more clear that this spontaneous or resting-stage activity has certain features which are very central. And it has a certain temporal feature: continued fluctuations in different frequency ranges from very slow, very fast, gamma rhythm might be known. And it also has a certain network structure: different networks, regions which are very extensively characterized these days.

But the exact function and role of these spatial–temporal structures—sort of a virtual temporal structure—is really unclear. So my hypothesis is based on trying to inspect what I see in psychotic patients and the neurologic patients. It's really which spatial–temporal structure is central for mental features and for subjective nature. So it is the continuous activity which adds something to your perception, let's say of me. And that makes you have a certain feeling, a certain experience. When you perceive me, I will probably investigate your activity prior to your perception of me and see how much that impacts.

Dr. Dave: I would think that this resting brain would relate to the very deepest structures. I was wrong about that with the CMS—the cortical system. But wouldn't we be talking about things down in the deeper structures, the thalamus and so on—that part of ourselves that runs automatically?

Northoff: Yes, the spontaneous activity is throughout the whole brain. There's no doubt. Any region has spontaneous activity, including subcortical and thalamic. However, there are certain differences. Let's say, for instance, in the degree of change: there's a lot of change in the amplitude—we call it variability or temporal variance—but in the neuronal spontaneous activity particularly in the midline region, whereas in the subcortical region, the sensory cortex, there's less variability in spontaneous activity.

Dr. Dave: I'm thinking of a metaphor of a car, idling—would that be an apt metaphor?—that your car is idling; it's ready to go if you step on the accelerator, if you turn the steering wheel, but in order to be ready to go, it's got to be turned on and be idling, in an idle state.

Northoff: Yeah, one can say that. I usually like to go even stronger: let's say imagine you open your garage door, your car moves back and forth. It doesn't stand still. Yeah?

Dr. Dave: [Laughs] OK, yeah.

Northoff: And then it has space changes and it has time changes and state changes. And now what do you do?

Dr. Dave: If we ever develop a biological car. Right? Then we can expect that characteristic of biology.

Northoff: You can go to Google with that idea. [Both laugh] So, what do you do now? In order for you to enter the car and to make the car move in the direction you want, you have to somewhat adapt. You have to come at the right time, at the point in time and space, so that you can open the door and get into the car and steer in the direction you want.

Dr. Dave: That's getting at another thing that I thought was very interesting, towards the end of the book where you start talking about rhythms, the temporal aspects of the brain: some years ago there was a book called *Biorhythms* that was quite popular. And it really brought into popular awareness the fact that we have these different rhythms going on in our body. We've got the menstrual cycle; we've got the sleep cycle; we've got the cycles within the dream, the 90-minute cycle of REM sleep and so on. And you point out that in the brain there are lots of little cycles that are going on, that are very important. We don't know all of them. But they're going to have an impact on things that we call mental illness and probably on all of the drugs that we use. We never know: if I give this person a drug, how are they going to respond? It may be just the reverse of the other person I gave it to, and so on. There's all this variability between human beings, and so a lot of that very variability is temporal and is happening in the brain.

Northoff: Correct. There are continuous fluctuations in the activity, as you said, cycles. And these fluc-

tuations can occur very fast, let's say 50–60 Hertz or even faster, or very slow at 1 Hertz—extremely long cycle duration—like 15 seconds or 100 seconds. And interestingly, the strongest power in the brain is the very slow frequencies. So the brain spends a lot of energy and power on the slower stuff—not so much on the faster stuff, which is somewhat counter-intuitive.

We try to make sense of that. So we really, really go into these particularly slow or infra-slow fluctuations, as they are called, with long cycle durations of 100 seconds. And we consider them the temporal basement of the brain. Now, consider the analogy of a house: if you look at the very ground floor—the basement—the basement has to carry all the load of the upper floors. In particular, if you build a skyscraper in New York or San Francisco [Laughs], it has to be very stable. Yeah? Against the wind and all kinds of storm and all kinds of things.

If your basement cracks, everything else, all the upper floors, will also crack—and ultimately fall down, even if the floors themselves are functioning properly. That's why we assume, if the basement is very infra-slow it may provide a certain sense of stability for the rest of the brain. If these themselves are altered then you have a problem.

Dr. Dave: This helps makes sense for me of a statement you made in the book that I thought was rather strong, which basically said that . . . you speculated that the major mental disorders, such as depression, schizophrenia, and so on, might have to do with a problem in the resting state of the brain—which, as you say, is kind of the reverse of what we would first think of: "Oh, this has got to be problems with the higher-order thinking."

Northoff: Exactly. You've said that very nicely. This is a heritage of Western philosophy—cognitive mental features are higher-order features. The highest pinnacle are features of the mind. They cannot be features of the body, because we don't see them. So they must be features of something higher like illustrated here with my hands [Gestures], of the mind that goes back to Descartes' dualism, if not further back in philosophy. And interestingly, this somewhat has been conveyed to neuroscience. Yeah? So that research papers say, OK, these are cognitive disorders, neurocognitive or cognitive function.

But when I see my patients and when I see now more and more data coming in, maybe these are not higher-order cognitive dysfunctions or dysfunctions of the higher floors of the building but basic structure dysfunction of the ground floor.

And if your ground floor is altered, everything else—the higher-order functions, emotions, cognitions, social functions, motor actions, perceptions—are abnormal. That's what we're seeing. We've just had a paper in PNS on exactly this in bipolar disorders, where we showed that happening in certain networks in the brain: abnormal balance in the resting state, in the variability in exactly these very slow frequency ranges. Yeah. In exactly the temporal basin.

Dr. Dave: OK, that's what I was going to ask you: I understand the metaphor, but what happens in the science? The science shows that there's a disruption of the rhythms of those very long frequency cycles in the resting state?

Northoff: Exactly, in those rhythms and variability. There is not enough power. Yeah?

Dr. Dave: Aha.

Northoff: There's not enough power in . . . your basement is not strong enough. So it affects everything else.

Dr. Dave: OK. Let's see, I'm looking at some of the questions that I thought about to see where we should go next. One thing is . . . going back to consciousness, you say that another characteristic of consciousness is that it has to have contents. Say more about that.

Northoff: Let's say, if you had done science 30 years ago, and you'd mentioned that you were doing the neuroscience of consciousness, everyone would have looked at you and said you're crazy.

Dr. Dave: Because?

Northoff: Because consciousness was not a subject matter of neuroscience. It was considered subjective and not eligible for objective neuroscientific research. Fortunately that changed a lot with Francis Crick, who was very interested in the DNA (the discoverer of the structure of DNA with Watson). He was very interested in consciousness, and he developed a series of papers that spoke of the neural correlates of consciousness. And then some philosophers like David Chalmers, too, mentioned mechanisms of the contents of consciousness. Because when you are conscious, it's about contents.

But now when you see, for instance, John and Julie in my book, the two who lose their consciousness—vegetative state—they lose the contents, but also they lose their level of consciousness: there is no arousal; they cannot change their arousal. That has led to the view that consciousness has maybe yet another dimension: not only contents but also levels. And maybe those two have different neuronal features.

Dr. Dave: This is making me wonder about Buddhist meditators—advanced Buddhist meditators and some of the states of consciousness they are able to produce that they describe as pretty much free of content.

Northoff: Exactly. So . . .

Dr. Dave: What does that do to your theory? [Laughs]

What does that make you think?

Northoff: This is a beautiful example. These people still have . . . often in Asia—China, Taiwan, Japan, and so on—I'm often confronted with that. Indeed, these people do still have consciousness, but they have no contents because the cognition of the contents somewhat disrupts you. So what do these people experience, if they don't experience contents?

I would argue that they experience a certain form of spatial–temporal structure: pure time—what William James called the "stream of consciousness"—where you immerse yourself in the pure flow of your continuous flow of time or your frequency fluctuation and do not attach a particular content to it. So you don't get stuck by this content. Just yesterday I had a severely depressed patient who told me the depression . . . he glues himself to content and then just ruminates about his content, and then it drives himself crazy, makes him depressed.

The only thing which he said helps him is that he knows it is a continuous process, and it will go. Yeah, it will eventually. That means we learn from meditation the flow will go on and it will go past its current attachment to a specific . . .

Dr. Dave: Yeah. That's a lot of what mindfulness meditation tries to train people to do, is to not get attached to, as you say, the contents, and it's kind of developed a larger view—OK, waves come and waves go, you know. And the experience of what people refer to as enlightenment that . . . personally I don't subscribe to the idea that a person can become enlightened permanently, but I do believe that people can have moments of what's called enlightenment or illumination. And a chief characteristic of that is—interestingly flowing from this non-attachment—is a feeling of connectedness to everything, connectedness to the Universe.

Northoff: Right. The way you describe that, I would probably share that. And I believe that consciousness . . . and actually, really schizophrenic patients have exactly this experience. Yeah. Their own sense of self is dissolved somewhat. They become unified with their experience with the Universe; that is a transcendental, spiritual-like experience.

And I would probably speak here of a certain form of consciousness. A certain structure. You have a certain spatial–temporal structure which connects you with the world, and you're part of that. I would associate consciousness not only with contents and level, but also with a certain form of structure, which is a very traditional concept that goes back to Kantian philosophy.

Dr. Dave: Yeah. Yeah. Looking through my notes here . . . we've covered a lot of what I had in my notes. Let's see, one thing I started to think about, in your discussion about self, is that comment: "recently become aware of the extent to which self is a social construction". In other words, we tend to think of self as all being in here. [Laughs] It's all in the envelope of my body, or the envelope of my head. Even when we get really, really holistic, we say, "It's distributed not just in my brain but distributed throughout my whole body." But the evidence is suggesting that other people support this thing that we call self—the expectations they have of me and how I've behaved in the past. They sort of, more or less, demand characteristics of the situation, that I continue [Laughs] to behave in that way. And that's one of the elements of my experience of self. Do you want to comment on that or add to it or subtract from it? [Laughs]

Northoff: Yeah, traditionally, philosophers considered the self as the highest-order mental or cognitive entity. Yeah? And that has often been preserved in neuroscience as the cognitive view of the self in specific higher-cognitive-order regions such as the prefrontal cortex. That has been somewhat criticized by other people who say maybe it's not only the brain but it's also the body, so then we speak of embodied self. And the self is not only cognition but it's also action and perception.

My idea of self goes even more basic and deeper. I would argue that what makes it possible for you to have this relation between brain and body is ultimately that your brain is intimately connected with the world—it's how your brain processes certain stimuli from the environment. Because, as you said at the very beginning—you said it very nicely at the beginning of the interview—the resting state of the spontaneous activity of the brain provides a certain baseline standard. And every stimulus is set or compared or matched against this baseline. If the baseline is very high, the same stimulus is processed in a very different way compared to when the baseline is very low. Your brain can very much impact via its resting state how stimuli are processed. And that's what I ultimately mean by degree of self-relatedness. It's a very basic function between brain and world, brain and body, because the stimuli of the body are also stimuli filtered by the brain and its resting state. And basically it really acts like a filter: if the filter has very big holes, everything can get through; if the holes are very small, nothing can be caught, meaning then—in depression it's probably the case—because the resting state is so high, your stimuli cannot change it, but then you feel disconnected from the world.

Dr. Dave: You have a really nice formula where you say MIND = BRAIN + GENES (we haven't talked about genetics) but then MIND = BRAIN + GENES + INTERACTIONS WITH THE ENVIRONMENT, so that gets the environmental piece into it. You just made reference to depression. And let's talk about that some more. I was really intrigued by some of the information in there. For example, you said that . . . you referred to two principle ways that we have of intervening in depression, right now. One is the use of SSRIs—drugs, and you say those suppress serotonin, that the de-

pressed person suffers from an excess of serotonin, which I didn't know. So that's interesting. But you point out that those drugs take maybe 60 to 90 days, or 30 to 90 days, before they really kick in. And we've sort of known about that part. And that's got a big problem, because a person might commit suicide before they can get the benefit of that. That's an effective intervention but very slow.

And then you refer to ketamine, and then again, like my motorcycle story, that's close to home, because one of my sons has been suffering from neurological pain. And as a result we discovered that ketamine is not used only in depression but also to treat neurological pain. So he went through a 30-hour infusion, 30 hours of getting this ketamine into his blood stream. We just did this a couple of weeks ago. He seems to have responded to it really nicely. So the advantage there, if I understood it rightly, is that ketamine raises the level of glutamate, which is a sort of [Laughs] up-leveller. It increases the excitatory activity of the brain. Is that right?

Northoff: Not exactly. It is probably the opposite. It blocks an apparent exit of glutamate, by means of certain doors or receptors, as we call them. And it rebalances the relation between excitation and inhibition towards inhibition.

Dr. Dave: Oh, towards inhibition. Yeah. That's one of the paradoxical things, I think, in neuroscience: that we often discover the value of inhibition. [Laughs]

Northoff: It's really this excitation/inhibition balance, as we call it, mediated by two central substances: glutamate (you already mentioned), which is mainly excitatory, and GABA, which is mainly inhibitory.

We don't really know at this point in time how this balance exactly functions. We know a lot on the cellular level, but we don't know much on the regional and network and whole-brain level. And of course all this leads to pharmacological interventions in cases like you mentioned: depression, neurological pain. We need to understand the exact balance. So you might have, let's say, the same level of excitation, but you might have different levels of inhibition. So the same level of excitation will have different effects in the presence of different levels of inhibition. That's the balance that's relevant for this disorder. But the details of this are elusive.

Dr. Dave: OK. Is there anything more you want to say about depression before we move on to schizophrenia?

Northoff: Yeah. What happens in depression . . . there's more and more evidence that your resting state particularly in these mid-line regions is abnormally high. That's too much variability, so you have all these racing thoughts because there's too much activity going on, too much internal thought initiated, and those you cannot escape. And then of course that goes at the expense of your external orientation. So you're just completely consumed by your internal thoughts; all your attention, cognition is directed towards that. At the same time you're completely disconnected from the external world. Of course that makes you sad.

Dr. Dave: What about bipolar, what's going on there? There are all kinds of theories psychodynamically on what that's about, but we know that lithium is important for the manic part of it. What's your understanding, at this point from neuroscience, of that alternation between depression and mania?

Northoff: Yeah—as I said, in the mid-line region in depression, you have too much activity, you have too much variability. In mania it seems to be the other way around: not enough activity. There's not enough variability in that region. And just yesterday a patient told me, "In the mania, I'm not thinking." That's exactly what's predicted on the basis of the findings with manic patients: not enough activity, not enough variability in the mid-line.

Dr. Dave: "I'm not thinking, I'm impulsive, I'm just doing?"

Northoff: Exactly. That's what the patient said very nicely yesterday. He said, "I'm just scanning the environment, constantly scanning the environment, just looking in parts, of following this, of following this; you do this, so I follow this," and so on and so on.

Dr. Dave: "I'm surfing."

Northoff: Yes, surfing. [Both laugh] But at some point it becomes too much. There's too much going on—your central motor network, too much variability in your brain, too much going on, so constantly picking up external stimuli following them. And this one, and this. That's a true disposition by your resting state. That's why I like to think of the neural pre-dispositions of these disorders of consciousness.

Dr. Dave: Yeah. We've been talking a lot about consciousness and levels of consciousness. What about the psychodynamic unconscious: you know, the unconscious of Freud and Jung and their successors. Does your work comment on or shed any light on that notion that? We know the unconscious isn't dead, right? We agree on that. It's not a state of deadness. What can you say about this concept of the dynamic unconscious—one that is actively dealing with hopes and fears and traumas and all of that?

Northoff: You may remember from my interview when I said this notion of self-relatedness in a very basic sense relates to certain contents from the environment to your own brain in its spontaneous resting-state activity. Spontaneous resting state always serves as a baseline. This is standard. That's one thing. At the same time, it's very clear . . . and we had

a study last year on that: early childhood trauma or early life events are somewhat encoded or encrypted in the spatial–temporal structure of your resting state—for instance in entropy, in the degree of disorder. Meaning the more traumatic life that you've had as a child, 20 years later, the more entropy you have in your resting state of spontaneous activity. So now, putting these two observations together, it means that the kind of structure you have in your spontaneous activity is strongly biographical. It's biographical and self-related. Self-related means what is important to you. Biographical means your past life. And now these are two central dimensions of the dynamic unconscious. Yeah? And so that's what can make a bridge to psychoanalysis. The contents in your dynamic unconscious tells you something about yourself, your ego, and your biography, your past history.

Dr. Dave: What about the dreaming state, would you say that that is . . . is that getting close to the resting state? Is there a similarity between those two?

Northoff: Yeah. That's a very, very interesting question. Because in dreaming we have consciousness, so you need to explain that just your resting state itself, independent of any external stimuli or content, can have consciousness. That's a really hard nut to crack for many cognitive people. My assumption on all of this is that in order to have consciousness—let's say in order to associate consciousness with certain content—you need a certain degree of change in your neuronal activity. That change can be either triggered by external stimuli in daily life . . . when I see you it triggers a lot of change. That's why I become conscious—at least I think so, [Laughs] and maybe in dreams you also have certain biochemical changes . . . and these changes are stronger to trigger spontaneous consciousness. You have, for instance, the same auditory hallucinations: you suddenly hear internal voices like in the schizophrenic patient, just on the basis of your resting state. So you have a certain degree of change, and that's associated with the respective "virtual" content coded in your resting state with consciousness.

Dr. Dave: OK. What more do you want to say about schizophrenia, in the context of the neuroscience that you have been doing?

Northoff: Schizophrenia is so complex, you can't imagine. [Both laugh] You can't imagine the amount of literature . . .

Dr. Dave: I know, huge.

Northoff: When you have the patient in front of you, each one is different. And there's all kinds of literature about schizophrenia. And they really haven't understood it. Meaning we haven't found the key to it. So for me, it is really very basic, and again I come back to the self-relatedness. So you set a stimulus, an external stimulus from either the body or the environment against the baseline of your spontaneous activity. And by that you change how the stimulus is processed. So it's a very basic process. It's the first encounter of the stimulus with your brain. And my hypothesis is that this most basic process is changed in schizophrenia, for whatever reason.

And then of course any kind of subsequent process—sensory, emotional, cognitive—is abnormal. Yeah? So the patients have major perceptual abnormalities. They perceive things as much more intense. There's not enough inhibition, speaking of inhibition, and that's probably due to the fact that they cannot be filtered, not set against the baseline. Then there's this relation of self-relatedness missing, what you take for granted: you're related to the world, you know that when I do this . . . you know what it means when I shake my head, when I do this or nod my head. For the schizophrenic patients all this is questionable; they don't know this: Why is the guy there on Skype constantly doing this? What does he want to do? Maybe he wants to kill me tonight at 8 pm.

Dr. Dave: Does this imply any sort of an intervention? A cure, a treatment?

Northoff: My main idea is to find out what is wrong with the spatial–temporal structure of the resting state: Why can't it fulfill this function any more, processing [Makes knocking sound] stimuli in a self-related way? So that it can serve as referent or standard, a baseline.

Dr. Dave: When you say spatial–temporal, that gets a little confusing for me. What exactly do you mean?

Northoff: By temporal I mean . . . remember you had the cycle, the fluctuations. By spatial I mean different networks. Some networks are the default networks. So that's the image. Then, OK, what is wrong with the function of these spatial–temporal structures, that it cannot serve its usual traditional role as a baseline standard or reference?

Dr. Dave: So can you imagine a way to intervene neuroscientifically, in the future, that might be effective?

Northoff: Let's say that I gave you the example of depression: that you have too much variability, too much change, too high activity in these mid-line regions here. Maybe you can inhibit the variability, yeah? So you don't have these racing thoughts. Depressed patients don't usually walk, don't usually move. They sit in the corner and are depressed. We call it, as psychiatrists, psychomotor retardation, which seems to be related to decreased change and variability in the sensory-motor network. Maybe we can stimulate that. But each patient is different. That's what we are trying to do, what we are targeting in the future.

Dr. Dave: Yeah. OK, I'll get a bit more speculative here. Are animals conscious?

Northoff: Yes. I think so, but not to the same degree of spatial–temporal extension. I would look at the resting stage. I would look at the spatial–temporal range. How do you slow the frequencies up? How fast they are? And from that I would predict the degree of spatial–temporal extension. I discussed some of that in my major academic book Unlocking the Brain [2014].

Dr. Dave: OK. Are there people who are working on that, trying to understand animal consciousness?

Northoff: Animal studies. And I think it is a great topic, but how much you can you experimentally tackle that? I know there are some studies about self-consciousness, with monkeys recognizing themselves in the mirror. But otherwise not. Not aware of others. I'm not an expert. For the next century.

Dr. Dave: That will be the next 100 years? [Laughs]

Northoff: But I'm not aware of it.

Dr. Dave: What about plants? Are plants conscious? A plant . . . I read something in The New York Times just the other day; I didn't read it that closely, but it seemed that plants were being somewhat "plan-ful" in terms of whether or not to spread their roots, depending on the quality of the soil that they were put in. And this was an experimental paradigm. It would suggest that . . . and reading about one of these conferences that I didn't go to but maybe you did, there's a movement towards something called panpsychism. Right?

Northoff: Yeah. Yeah.

Dr. Dave: That consciousness is everywhere in little tiny atoms—atoms of consciousness.

Northoff: Yeah. That's the latest rage. I think . . . 10 to 15 years ago it was all about physicalism, materialism—that consciousness is some physical properties. Now they're saying, OK, now the philosophers say there are no longer physical properties but maybe "psychic" properties. I think its variations of the same. What you need to understand is that, I think, there are no specific properties, intrinsic properties in the mental or physical. What there is, is relationships. A structure. There is a structure between world and brain. Based on the spatial–temporal features of the brain, that relation between brain and world can be different in different species. We need to have more of a sort of a structural or relation-based approach, I think, to address mental features. And that's when exactly you look at consciousness. This is what consciousness is about. You experience yourself and events in the environment as part of the world. So how is it possible, your own "situatedness"or situation within the world, yeah? So I perceive you as the Gestalt psychologist spoke about figure and background . . .

Dr. Dave: Yeah.

Northoff: . . . the world, always the background, serves as the background for the figure/content. And that's for me the construction of the virtual spatial–temporal structure between the world and myself and the event which I perceive.

Dr. Dave: Do you believe that artificial intelligence could get to the place where consciousness would be achieved in a machine?

Northoff: If it has the right neuronal code, and can crack the code of the brain. I would argue it's a spatial–temporal coding. And if it could reconstruct this virtual spatial–temporal coding structure, let's say, between the machine and the environment, and constant dynamic change, I would say it shouldn't be excluded in principle.

Dr. Dave: OK, interesting. Well. [Laughs] Is there anything else that you would like to add that I haven't thought to ask?

Northoff: I think we've covered a lot of ground. [Laughs]

Dr. Dave: We did.

Northoff: I think we end up where we started with "the hard problem". Yeah, I said consciousness rather than non-consciousness. I would argue because there is always the spatial–temporal structure, there's always a relation between world and brain, world and body. We cannot escape that. That's the way our brain functions by default. So we have no chance of escaping it. So ultimately we should not speak of a mind–body problem but of world–brain relationship problem. That might be better formulated, getting into all the metaphysics of the philosophy.

Dr. Dave: OK. We'll save that for another time. [Laughs]

Northoff: Yes, save that. [Laughs]

Dr. Dave: Dr. Georg Northoff, I want to thank you for being my guest today at Shrink Rap Radio.

Northoff: You're welcome. Thank you very much.

David Van Nuys, PhD ("Dr. Dave"), is Emeritus Professor of Psychology at Sonoma State University and served as that department's Chair for seven years. He has also taught psychology at the University of Montana, the University of Michigan, and the University of New Hampshire. He has been a dissertation advisor for doctoral students at Saybrook Institute and the Institute for Integral Studies, among others. Dr. Dave hosts a popular psychology podcast called Shrink Rap Radio. He is on the advisory board for *The Neuropsychotherapist*.