
A Polymath at Play

An Interview with Margaret Boden

Margaret Boden is Research Professor of Cognitive Science at the University of Sussex, where she was the founding dean of the university's School of Cognitive and Computing Sciences. Trained originally at the University of Cambridge and at Harvard University in medicine and the history of philosophy, she has since pursued and published in related fields such as psychology, social psychology, linguistics, neuroscience, cybernetics, control engineering, computer science, and artificial intelligence. A frequent interviewee on television and radio in the United Kingdom, she lectures widely in Europe, North and South America, and Asia. Boden is known best for two widely translated books, *The Creative Mind: Myths and Mechanisms*, where she draws on computational ideas to explore human intuition, and the two-volume history of cognitive science, *Mind as Machine: A History of Cognitive Science*, in which she investigates in a computational frame the range and latitude of consciousness itself. In this interview, Boden reflects on her diverse interests with special reference to the relationship of combinatory play to creativity and invention in science and technology, art and architecture, mathematics, philosophy, and literature. **Key words:** artificial intelligence; combinatory play; creativity; interdisciplinarity; invention; neuroaesthetics

American Journal of Play: How did you come by such far-flung interests—in medicine, psychology, philosophy, neuroscience, and artificial intelligence?

Margaret Boden: When I was still at school, even before the sixth form, I was fascinated by the human mind and how it worked, what happened when it went wrong in mental illness, and how it related to the brain and evolution. Because of those early interests, later on, when I decided to study medicine, I was going to focus on psychiatry. Of course I knew about philosophy, because I had discovered Bertrand Russell as a teenager and found myself so absorbed in his fascinating writings. I remember when I went up to Cambridge for my interview at Newnham College and saw all the noticeboards. One read “moral sciences,” and I said to someone, “What are moral sciences?” And they replied, “Oh, that’s philosophy.” “You mean you can study philosophy at university?” I said.

I did the medical exams in two years instead of three, and I decided, just temporarily, and against everybody’s advice, to study philosophy for my final year in Cambridge. I enjoyed it so much that I decided to stay for a fourth year to pursue it further. And I convinced Tommy’s [St.

Thomas's Hospital], which had offered me a clinical scholarship, to put it back for a year.

AJP: What happened to psychiatry?

Boden: When I first went up to Cambridge, I had intended to do psychology after medicine, but when I arrived and gate crashed some of the lectures, I found the course of study very, very rat oriented, which was not my interest at all. They had only a single course of lectures in clinical psychology, all of which I attended, but they clearly were not that interested in it. They were doing wonderful work on perception and vision, but it was very optics based and, again, that was of no particular interest to me. At that time, Cambridge was probably the best place in the world to do neurophysiology, which I found absolutely fascinating. But doing it for the whole of my third year would have meant sticking adrenaline into a moribund cat from nine to five, two days a week, and I did not want to do that.

That is why I decided to stick with philosophy and carry on with medicine and psychiatry later. But just a few weeks before I was due to take my philosophy finals and then move to Tommy's to do my clinical, I received a telegram on a Friday afternoon from my professor of philosophy saying, "Come to see me immediately." I went to see him, he offered me snuff, and I said, "No, thank you." Then he offered me sherry. I said, "Yes, please," and he said they were interviewing for an assistant lectureship in philosophy at the University of Birmingham on Tuesday and would I be interested. Such an option had never occurred to me! But I decided I would go to the interview, and they offered me the job on the spot. Before I accepted, I asked whether I could have forty-eight hours to think about it, because I was not at all sure what I wanted to do.

AJP: Did philosophy point you toward your interest in artificial intelligence?

Boden: Funnily enough, I had already encountered artificial intelligence in a sense at Cambridge, because my philosophy supervisor was Margaret Masterman, who was one of the first people in the world to do work on machine translation. But, although I thought it was very fascinating, I could not see at that time how it related to areas that interested me most—basically the structure of personality and mental illness of various sorts. I did not make the connection. So I went to the University of Birmingham and taught philosophy for a while. I was very happy there personally, but I rapidly grew very bored, because although the philosophy was very good, it was also orthodox.

AJP: You studied in the United States after that?

Boden: Yes. My career took another turn when I received a fellowship to study psychology at Harvard Graduate School. As soon as I arrived, even before term started, I was standing in a bookshop on Massachusetts Avenue, and I picked up a book that absolutely changed my life—I think it changed a lot of other people’s lives too—George Miller’s *Plans and the Structure of Behavior*. This was the first book to take the idea of programming and try to apply it to the whole of psychology—not just to things like memory, perception, planning, problem solving, and language, but also to animals, human personality, hypnosis, and so on. I found Miller’s study exciting because it seemed to be answering questions I had been asking myself for years. Of course, it was hugely simplistic, but it was talking about programs and how you follow the instructions in a program and how the program has to say exactly what has to be done next, or nothing will happen. I got the point immediately, probably because I had encountered Margaret Masterman in Cambridge. Ever since then, I have been trying to pull all these things together, through everything that I have done.

AJP: Could you pull them all together?

Boden: It may look as though I’m an intellectual butterfly, but I am not; if you want to understand the human mind, all of those disciplines—philosophy, psychology, medicine, linguistics, cognitive science, and computer science—are necessary. I came to all of them, really, from interests that I already had as a schoolgirl, and in my two-volume book, *Mind as Machine: A History of Cognitive Science*, I discuss and link them all, along with anthropology as well.

AJP: What was the response to this kind of linking?

Boden: What I did was very unusual, indeed, and everybody told me not to do it. I was very lucky that the structure of the medical degree at Cambridge made it possible. The university turned out to be just the right place for me. Had I gone to Oxford, for example, it would not have been possible.

AJP: Did the way you played as a child have anything to do with the way you pursued links between disciplines?

Boden: I have no idea. I was an only child, so I spent most of my time playing by myself. I also did a lot of reading, because, of course, there was no television when I was a kid—radio, but no television.

AJP: Can you give an example of the kind of problem that requires several disciplines before it can be approached usefully?

Boden: Yes. One of the puzzling phenomena that really bothered me as a medical student was hysterical paralysis. Patients who cannot move an arm and who claim it is paralyzed will be able to move the limb under hypnosis. You could explain that by saying, “There’s some sort of switch somewhere in the body controlling the movements of the arm, and hypnosis turns it on, and when you are out of hypnosis, it is turned off.” The explanation, however, is obviously much more interesting than that, when one considers how spinal nerves work. Each spinal nerve goes to a particular group of muscles that can be mapped out, and there is no spinal nerve, or set of nerves, that stops innervating at what we would normally think of as the limit of the arm, namely, the line of a sleeveless shirt. The layman thinks of an arm as starting at the fingers and ending at that line. But that is anatomical nonsense. There is no such boundary. And yet, in hysterical paralysis, what seems to be happening is not just that the mind is affecting the body, which it does every time you decide to move your arm up and down. The mind is in some way overcoming the body, because it is not the anatomy that determines the nature of the paralysis. So what on earth is going on? The minute I got the point about artificial intelligence and programs, I understood what was happening, and quite soon I wrote a paper on this phenomenon, and how a robot, too, could have hysterical paralysis.

AJP: So the mechanical anatomy helped you understand the natural body?

Boden: One way to answer this question is to think of a robot whose anatomy of levers and wires mimics the muscles and nerves of the human body. If you built this robot, how would you give it hysterical paralysis? You would need also to equip it with a concept or a representation of “arm” defined in terms of the sleeve-line boundary. You would have to give it a certain amount of vision, and then put in some sort of program that says, “Do not move your arm,” as defined in that way and not as, “Do not carry out any movements powered by these wires and levers,” because the latter would give you the sort of paralysis you get if you cut or anaesthetized spinal nerves. So you could give a robot hysterical paralysis if the instructions were coupled with some sort of conceptual representation of an arm in the brain. Things that were previously very puzzling could, in principle, be explained in this sort of way.

AJP: Is there something in particular about the approach to learning in the UK that encourages such work across disciplines? Does it, for example, involve a playfulness in approach as well as in subject matter?

Boden: There used to be; whether there is now, I am unsure. I think it is in danger of being kicked into the long grass by Research Assessment Exercises (RAE), subject panels, and leading journals, which are by definition those journals that publish stuff about the currently accepted problems. There is nothing wrong with that; however, if people are asking completely new questions, then those journals are very unlikely to publish their research. So those scholars have to publish in new journals, which do not have the same status. The RAE especially has not just worked against intellectual creativity and interdisciplinarity; they have also worked against playfulness, which is particularly troublesome, because it is very important for intellectual creativity to be able to make mistakes, certainly for scientists. In research councils, there has been this constant attempt to push the funds into research which has an obvious payoff, as opposed to what is called blue-skies research. But it is actually the blue-skies research, some of it at least, that is going to turn out what is really important. So playfulness is very important, and it is not anywhere near as strong as it was.

AJP: Do you regard this as uniquely a problem for the sciences?

Boden: Humanities scholars used to be able to spend their time doing what they liked, and that was fine; no one was breathing down their neck, saying, “You have to publish so many papers or so many books.” And still less was there anybody breathing down their neck, saying, “You have to publish in this area, not in that area.” You did what you thought was important, what you wanted to do. In the sciences, it was not quite like that, because you needed money and you needed equipment. And your department would provide that. And the better your department was, the more money they would have to give, on the one hand, to people who had already shown that they were very special, and, on the other, to the youngsters who had not yet had a chance to show whether they were special or not. The latter had access to funds nonetheless. They did not have quite the freedom the people in the humanities had, but they could, more or less, do what they thought was important. All they needed to do was persuade the department chair that it was an interesting topic, and he would say, “Get on with it, go away and do it.” If it did not work out, that was a shame, but you had been given the chance. Nowadays, that is much less likely.

AJP: Do all your interests share a preoccupation with thinking itself, in some way?

Boden: It is not just thinking, it is emotion, motivation, and cognition, all of these working in an integrated way that I was always interested in. From

when I was first at school, I was interested in free will—freedom of choice and purpose—and in creativity, the issues I wrote my first book about. Emotion and motivation were also very much part of this cluster of interests. I was interested in psychopathology and in phenomena like so-called multiple personalities that are largely a syndrome of upset motivational structures.

AJP: Who inspired you most?

Boden: William McDougall, a psychologist who made his greatest contribution in the early twentieth century. His approach to personality and psychology focused on emotion and instinct in contrast to the rising behaviorist approach of the day. I actually disagreed with a lot of the philosophical claims he made. But that made him more interesting, because I could show that the insights that he had about purposive behavior and personality—and even the philosophical mistakes that I thought he made—were actually reflecting things which could be, in principle, modeled in an artificial-intelligence system. I did not follow Freud, because he always said that the mind/brain is a materialistic system, whereas McDougall denied this. Freud also did not write about animal psychology, whereas McDougall embraced the whole range of psychology.

AJP: Do people and animals all think alike?

Boden: Yes and no. On the one hand, there are fundamental commonalities that can be followed in all those different systems; for example, associations—mental association and learning by association. That is the “yes.” The “no” is that different species have very different sorts of intelligence and individual human beings can think differently. On the one hand, over the past thirty or forty years or so, we have become increasingly aware of how some animals are more similar to human beings than we had realized before—I’m thinking particularly of the great apes. On the other hand, we are also learning how very different some animal intelligence is from human intelligence. I am thinking, for example, of insect navigation. We have learned a huge amount about navigation in ants. The research is extremely interesting and has been put to great practical use in robotics. So there are lots of different ways of thinking, many different sorts of intelligence, and the notion that intelligence is just one thing that you can have more or less of—an ant has less of it than we do, and you and I have less of it than someone else—is a huge oversimplification.

AJP: How should we regard intelligence, then?

Boden: It is better to think of intelligence as a range of very different types of information processing, some of which are only exploited by this species, some by that species, and some of them are so basic, they are employed by very many species. There are researchers here at the University of Sussex who work on memory in snails because there is good reason to believe that some aspects of the mechanisms of memory in snails are closely comparable to those in mammals and even human beings.

AJP: Would you describe your typology of creativity—combinational, exploratory, and transformational?

Boden: The type that most people talk about first and almost exclusively is combinational creativity, which is a matter of coming up with unfamiliar combinations of familiar ideas. The most obvious example is poetic imagery, but it's also common in visual collage, or many political cartoons in the newspaper. It is also clear in William Harvey comparing the heart to a pump, or Niels Bohr and Ernest Rutherford likening the atom to a solar system. There are a tremendous number of examples of this type of creativity.

AJP: What about the other two?

Boden: Exploratory and transformational creativity. Exploratory creativity comes up with new structures, new ideas, concepts, paintings, musical compositions, or new chemical formulas that fit within an already accepted style: another Impressionist painting, another benzene derivative, another fullerene. These are innovations that take place within an accepted style of thinking—be it in art or in science—that is valued by the peer group and is sufficiently complex that it generates an indefinite amount of new structures, many of which are unexpected. It is more like chess than noughts-and-crosses. You may be surprised by a particular new structure, be it a molecule or painting; because you were not expecting or predicting it, you are surprised by it. Yet once you have seen it, you can say, “Yes, I can understand this.” There is a sense that it was waiting in the wings, that it had not yet had a chance to emerge and reach the stage. I would say 97 percent, maybe more, of professional artists’ and scientists’ creative output is of the exploratory type. In fact, it is vital that people spend a long time engaging in exploratory creativity, since it allows them not only to get a good idea of the potential of the space but also to realize what its limits are; they discover not just what you can do within the space, but what you cannot do.

Without mapping out a particular space, I think you would never come up with the third type, transformational creativity, which alters one or more

of the defining constraints of a conceptual space. This is what enables the generation of structures that literally would have been impossible before.

AJP: Can you give examples of transformational creativity?

Boden: If you are doing Euclidean geometry, for instance, and you come up for the first time with a theorem about isosceles triangles, you are going to be spending an awfully long time—it took mathematicians centuries—before you realize that if you drop Euclid’s last axiom, you arrive at a different sort of geometry, a non-Euclidean geometry. It defines space in a way that is impossible in Euclidean geometry, but necessary, for example, for Einstein’s theory of relativity. He did not come up with non-Euclidean mathematics; he merely picked it off the shelf. Mathematicians had discovered it a long time after Euclid, of course, but they did not realize it had any relevance for the real world; they shelved it as a mathematical game. But the game proved very important as Einstein picked it up and used it.

AJP: In effect, Einstein broke the rules of the game.

Boden: Yes, and the non-Euclidean geometers before him. This kind of transformational creativity, depending on how fundamental the constraint or rule is that has been changed and how great the change is, can come up with something that—at first sight, and sometimes at second, third, fourth, fifth, sixth, and seventh sight—is deeply shocking, unintelligible, and seemingly impossible. It may even appear to have no relation to what was going on before, but of course it always does, because it is a transformation of what was going on before. It just may not be easy to see that.

AJP: How did a polymath like you become interested in play?

Boden: I have read a lot of Piaget; in fact, one of my early books was about him. This connected to my interest in the notion of play as a way of developing the mind, finding out about the world, and building representations. When I talk about creativity, I very often refer to the fact that you have to be able to experiment, to risk making mistakes.

AJP: Does play assume a different role in each of your three types of creativity?

Boden: Yes, I think play is most useful and fruitful with combinational creativity, because with combinational creativity there has to be some shared structure; randomly putting two ideas together is not, in general, going to result in something valuable, it’s not going to make any sense. So there has to be enough semantic structure, shared conceptual structure, shared associations for someone to get the point. It is important to recognize that something is a new combination, and that it is interesting for that reason,

but also that it makes sense. When Gerard Manley Hopkins wrote about thrushes' nests as "little low heavens" it makes sense, because they have little blue eggs in them; the structure here is the general conceptual equipment and world knowledge that you have. You can actually imagine a situation where people put things together pretty randomly and then look to see whether they have something interesting or not. The judgment itself is not random, but the putting together can be, provided you have enough judgment to see whether it is worth keeping or not.

AJP: What about play in the other two types of creativity?

Boden: The case of exploratory and transformational creativity is quite different. Combinational creativity can be (although usually it isn't) random, whereas exploratory and transformational creativity cannot be, because the whole point about exploratory creativity is that there is a nonrandom structure, which is being followed, nonrandomly, in ways that are accepted and are evaluated nonrandomly—though, as I mentioned earlier, the latter also applies to combinational creativity. So play, I think, has much less room to function in exploratory and transformational creativity; it has by far the most helpful role in combinational creativity.

AJP: Does exploratory creativity depend less on creativity than on analytic problem solving?

Boden: In some cases, it probably does—for example, where you have very clear rules and constraints about what can and cannot be done, and what things can go together and so forth, something like chess, or mathematics, or a particular well-understood area of chemistry.

AJP: What happens when the rules are not so clear-cut?

Boden: For something like an Impressionist painting, or certainly for a sonata, and I would suspect even for something like a fugue, you do not have sufficiently clear and explicit rules. So, although up to a point you could think to yourself, "Oh, let's try fooling around with inversion today," or, "Let's try fooling around with iteration today," in attempting to do things deliberately and systematically there would be limitations. The extent to which you can do that depends on the extent to which you recognize the rules. At times, they are difficult to consciously recognize even by people such as art historians or musicologists who spend their entire professional lives trying to sort out what those rules are. My favorite example of this is Frank Lloyd Wright's Prairie School houses. Henry-Russell Hitchcock, in his book *In the Nature of Material*, devoted a whole chapter to these houses

and was trying very hard to say what a Prairie School house was, but he could not. Ultimately, he concluded that their principle of unity was occult, by which I do not think he meant, “I have not tried hard enough; I have not found the principle of unity.” What Hitchcock meant, I suspect, was, “I have not found it and nobody else will ever be able to find it either,” because he was referring to the Romantic notion of creativity as being inherently mysterious and occult.

AJP: Was Hitchcock right about creativity stemming from mystery and magical sources?

Boden: No, he wasn't. In the early 1980s, Georg Stiny, now Professor of Design and Computation in the Department of Architecture at MIT, wrote a “shape grammar”—rules for generating three-dimensional structures—that generated Frank Lloyd Wright houses. Every single one of the structures it generated was acceptable to someone who was an expert and recognized them as Prairie School structures. In other words, it looks as though their principle of unity is not occult at all, but that is not meant to say it is easy to find, as Hitchcock's unsuccessful quest lasting over many years exemplifies. The notion that people can apply analytic problem solving to explore a really rich conceptual space may work in principle, but in practice, I think, it is successful only to a very limited degree. Of course, it would be interesting to widen the question not just to the space, but also to the personality of the person, whether they would want to be creative in such a systematic and analytic way. Some people might not want to do that, even if you told them they could go about it in this manner, because of their views about art and the lingering romantic notions of creativity.

AJP: Is creative play an important component of the life of the mind?

Boden: Children learn by playing and need play for their minds to develop, so, in that sense, it is crucial for the life of the mind. They also have to be able to learn to experiment and to not be afraid of making mistakes in a safe environment. One of the great things about play is that you have the freedom to try something out, and if it does not work, you go on to something else. We are prepared to put up with this in a five-year-old, but we are not prepared to put up with it in a twenty-five-year-old, or a fifty-five-year-old, and we should.

AJP: To ask the question the other way around, do you have to be playful to be creative?

Boden: I think if you look at the people who are really creative, they do not

necessarily have playful personalities. You would not describe Alan Turing, often called the “father of computer science,” for example, as a playful person. You would not cite his most famous paper as an example of play or intellectual play. Yet he was one of these very rare people who came up with fundamentally new ideas on at least three different occasions. Picasso is another one who was capable of genuinely transformational creativity, not once but several times, which is very rare, but he is an example of the plainly playful creator. Most people do not come up with the big, creative idea; or if they do it once, they concentrate on developing it and engage in exploratory creativity for the rest of their career—and that’s fine, it has to be done, nothing wrong with that. But they do not go on to make further fundamental changes, while both Turing and Picasso did. I think you have to have a questioning approach for that to happen, and I am perfectly happy to call it playful.

AJP: What would you identify as Picasso’s transformative moments?

Boden: Think of cubism and *Les Femmes d’Alger* (1907), which even his close artist friends thought was rubbish. He would not show it; he kept it rolled up in the attic of his studio for a couple of years because no one appreciated it. So that would be one. The portrait of Dora Maar, with the two eyes on the same side of the face, is another. You could say it is Cubism in the sense that we do know that there are two eyes, and he put them so you can see them both at once, which you cannot normally do; similarly what he was doing with the violin in the more Braque-like pictures, but I do not know whether you would call that a different style or not. I think I would, there seems to be something different.

AJP: What are your favorite examples of transformational creativity in art?

Boden: Take Cubism again. Prior to Cubism, you basically painted the sort of thing you could see from a single viewpoint, and Cubism fundamentally altered this age-old and elementary principle of painting. The first time you look at one of Picasso’s paintings of a violin or guitar—and you do not have the title—it may seem completely unintelligible. What is it supposed to be? Until you see the frets, they sort of give it away, or maybe you just distinguish the broad outlines of the instrument. To understand what is going on there, and to understand what is going on with the Dora Maar portraits, you just have to take on board that this is still representational painting, this is not abstract painting. It is representational painting, but it is not single viewpoint representational painting. There is nothing in there

that we did not know about already. We know people have two eyes! We just do not normally put them both in if we can see their nose in profile.

So, transformational creativity can come up with things that are very, very difficult to understand, and it may take many years for people to become familiar and happy with them. It is not just a question of familiarity, it is also a question of having somebody point out—or maybe recognizing for yourself, or with somebody's help—the links between this and the previous style. If you can point out those links, then you understand that it is not so unintelligible as you had thought and that it does relate to the patterns you were already familiar and happy with.

AJP: Which contemporary artists do you regard as particularly creative?

Boden: That's a difficult one. That invisible installation, Walter de Maria's *Vertical Earth Kilometer* (1977), strikes me as such a wacky idea, such a delicious absurdity, of going to all that effort and all that expense of making that absolute high-precision engineering tube. And then what do you do? Bury the bloody thing, cover it up. Nobody ever sees it; there's merely a plate on the top of the lawn saying this is where it is. If I had to pick an example from conceptual art, that would be one of my favorites. I also like that cockerel that's just been put up on the fourth plinth in Trafalgar Square. It is a genuinely beautiful thing—and in my favorite color, aquamarine. It is almost as beautiful as those Medici lions at the Loggia dei Lanzi, which I think are absolutely wonderful. But would I call that creative? I would not, really, even though it is also not noncreative. It is difficult.

I actually think some computer art is creative, because it is doing things in new ways that could not be done before without computers and, in particular, some interactive art. It depends whether computers are being used as a tool or as a medium.

AJP: In art that elicits creative engagement from the audience, are we looking at creativity or play?

Boden: Here again, I would not say it is either or. It depends on whether the participants realize that they are having an effect on the artwork, which in some cases they do not, and if they realize it, whether they understand. I do not mean understand in the techie sense, but whether they are sufficiently aware of the relationship between what they do and what will appear in the artwork, so that they can actually direct it to do such and such. If they can do that, if the thing enables them to get that knowledge, perhaps by playing around with it for a long time, they can then have a creative idea

and get the thing to come up with Vladimir Tretchikoff's *The Chinese Girl*, also known as *The Green Lady*. The artist who could write a program that would enable them to do that would be very creative. I would not want to say that participants were necessarily being creative in doing that. If they use it to come up with something that is new and interesting, then yes. So you very much have to look at the details of the installation.

AJP: Tell us how you would define neuroaesthetics and whether research on neuroaesthetics holds any implications for creativity.

Boden: People mean different things by neuroaesthetics. I take the word to mean "an account of aesthetics that tries to explain certain aesthetic judgments in terms of certain properties of the brain." I think in the case of combinational creativity, yes, we can talk about how the brain makes associations between certain thoughts, how it is able to link concepts which superficially look rather different. We can even offer some computer models. I do not mean that computer models work in the same way as the brain does; the point is, we can show that this sort of thing is not magic, and this is an idea that people have had for hundreds of years, that this is what is going on in combinational creativity, it can now be given a good degree of neurological back-up. We are finding out more of this sort of thing all the time, but even with combinational creativity, I do not think the problem is anywhere near a concrete solution, because we remain confronted with the problem of relevance. We could get people randomly putting ideas together, we could get novel combinations, but the question is, do they make sense? Are they relevant to one another? And the notion of relevance is an extraordinarily slippery one, and it certainly is not one that neuroscientists have any way of explaining at the moment. They do not even ask the question! So, even in the case of combinational creativity, and why we value certain combinations more than others, I think there are huge gaps.

AJP: Are we close to answers for the other kinds of creativity?

Boden: In the case of transformational and in the case of exploratory creativity, I think that neuroscience has virtually nothing to say at the moment, because, to give just one reason, exploratory creativity is usually, or at least very often, involved with a hierarchical system, a hierarchical style. Not only do people not know how the brain implements hierarchy, so far they cannot even implement it in connectionist systems to a good degree. They have certainly been trying, but if you want hierarchy, you have to refer to good old-fashioned artificial intelligence. In some sense, the brain seems to be

capable of simulating the sorts of processes that go on in a von-Neumann computer, which can cope with hierarchy. But we do not know how that is done, and there is no one even asking the question. In the work of scholars like Semir Zeki, who discuss visual illusions, for example, or talk about responses to certain sorts of color, or say that part of what is going on when we respond to a portrait is grounded in the facial recognition processes in the brain—in these cases, it is true, we actually do understand some of the underlying processes. However, if you take an example that has a strong hierarchical structure, and the creation of which involves sensitivity to hierarchical structures, then these scholars do not say anything about that.

AJP: What is the relationship between creativity and aesthetics?

Boden: It depends what you mean by aesthetics. Creativity, to me, seems the ability to come up with ideas or artifacts that are new, surprising, and valuable. They may be new to you, or they may be new to the whole of human history. They can be surprising in one of three ways, which correspond to the three different types of creativity, and they must be valuable. Valuable can mean infinitely different things, some of which may well be based in our evolutionary history, like our response to shiny things, for example. But some of them are highly culture specific and highly changeable. Fashion, for example, can change very quickly. Apparently, when Kate [the Duchess of Cambridge—ed.] stepped out of hospital with her baby wearing a blue-spotted dress, the website of that dress designer crashed, because so many wanted to buy it. Fashion can literally change overnight. So some values, particularly in the arts, are highly variable. In science, they are not so culture specific, and they are not so changeable, because the value is based in much more highly constrained procedures, namely experiment and testing and the scientific method in general.

If aesthetics means the study of value, I suppose it is the study of beauty. If creativity has to be defined in terms of value, which I think it does, and if you mean by aesthetics the study of value, then, yes, creativity involves aesthetics.

AJP: Then let me ask: How can computers encourage creative design?

Boden: In a nutshell, in two different ways. They can help generate random combinations, if that is what you want. The other thing they can do, but only if someone has managed to understand the domain well enough to put the rules into the computer, is to engage in exploratory creativity. Take the Prairie School house as an example. Say you are a young architect and you

have a client who comes to you and says, “Please build me a Prairie School house, only I don’t want one that’s a copy of any the forty-two that Frank Lloyd Wright actually designed. I want something of that ilk.” You would be very pleased if you had that system available to you, because you could use it to come to design a brand new Prairie School house. But the point is that somebody would have had to understand that style well enough to do that. Similarly, CAD (computer-aided design) in manufacturing or architecture—someone has to put all the physics in there, to constrain this and that, and then, yes, if you are the architect, you can use it to design a balcony that not only looks good, but is not going to fall down, or is going to hold the weight. But you are reliant on how good the program is. If the person who wrote the program has forgotten to put some of the physics in, then, of course, there can be problems.

AJP: Can you give us an example of someone who is creative this way?

Boden: A lovely example of this is Karl Simms. At one point he wrote a program to evolve creatures with different anatomies and different behaviors. They had no bones and fingers; they were made of different blocks of different shapes jointed together. Their behavior was to move along, getting from a to b, but also getting to a and b so as to avoid disguised predators. It was very interesting indeed, because he had to build physics into it, otherwise no movement would have been possible. He found that every single one of the movements he got was lifelike, either in the sense that it was very close to a movement we are very familiar with, whether it is a snake or a cockroach, or, if it was one that we had not seen before, you could see that there could be an animal like that. Imagine seeing your first kangaroo, before Captain Cook, and you had never seen an animal that hopped; you may have felt surprised because of its unfamiliarity. Yet once you saw such a movement, you immediately realized that there could indeed be a creature that moved like that, even though no one had ever seen one. That is because it was lifelike and believable.

AJP: Were Simms’s creatures always so graceful?

Boden: Not always. On one occasion, he forgot a bit of the physics, I think it was something to do with inertia, and being an evolutionary program, it exploited this lack of constraint. And the result was utterly impossible creatures—impossible in our terrestrial world—doing things with movements that were utterly unlikelike because the program did not concern itself with inertia. In conclusion, when you ask if computers can encourage

creativity, my answer is yes; however, both in combinational and exploratory creativity, but especially in the latter, this depends to a great extent on the knowledge and sophistication of both the program and programmer.

AJP: If creativity does not arise from negative emotions and disturbed states of mind, what do you make of the legendary irascibility of original thinkers?

Boden: It depends what you consider psychopathology. If, like Howard Gardner, you look at great creators like Stravinsky, Picasso, Freud, Martha Graham, Ghandi, and others, you will find that they were all horrible people to live with, completely selfish, self-obsessed, ruthless in following what they wanted to—and their families just had to put up with it. These were not nice people. But if you think about it, there's a lot of logic to that. If you are somebody who is coming up with something that is really radically new—so new that not only the man in the street is not going to appreciate it and think you are nuts, but actually your very own friends and colleagues are going to think the same—then you have got to have enormous self-confidence, and you need to have enormous determination. So you have to be the sort of person who is prepared to do what you think is important, even though everybody tells you not to.

AJP: Is self-absorption on such a high order a personality disorder?

Boden: A lot of people would say that is a personality disorder. But I do not really know what personality disorder means; there are so many psychiatric labels thrown around now, they do not mean very much. But I certainly think there can be a great deal of angst of various sorts and self-questioning involved in creativity, and you have to be able to get through that and cope. Of course, there is also huge joy if you do think you are one who has managed to solve the problem that you were thinking about in the first place. As for schizophrenia being linked to creativity, I am a bit skeptical about that. Hans Eysenck, who spent his career thinking about personality and intelligence, pointed to the creativity of the schizoid personality and schizoid thinking, which he construed to mean somebody who applied their concepts much more widely than most people do. And that meant that they would apply a concept to an instance where other people would not. But that is not the same thing as schizophrenia.

AJP: Do canonical works of art and literature represent the most original and creative milestones?

Boden: I do not think that the choice of a canon in literature is about just creativity. I think it is also about truth and relevance. I do not think one can say

that the canonical works are the most creative sorts of literature that have ever existed. For example, you cannot say that George Eliot's *Middlemarch* is more creative than any of the important but less well-known writing from Latin American literature. *Middlemarch* was showing what was happening before and after the Industrial Revolution and how different people were reacting to it, which remains of tremendous interest to us even now.

AJP: Can you point to some novels that are both creative and canonical?

Boden: James Joyce's *Ulysses* and certainly *Finnegan's Wake* are much more creative than any of the books in the canon, but I have not read either of them all the way through. You could say this is because I am being lazy. Joyce's work is a sort of literary Schönberg, and I ought not to throw it aside in disgust. I ought to be prepared to battle through to the end. Well, maybe, but, life is short, you cannot do everything, and you have to make judgments.

AJP: Do highly creative individuals think in especially different ways?

Boden: Well, we do not know enough about it. But no, I suspect that they do not. I suspect they think in the same ways we do, only, for some reason, better. Part of that reason, as I said earlier, is motivation. Another part of the reason may well be, in some cases—and this brings up the schizoid scale again—that their conceptual slippages are more inclusive. So, they are doing the same thing as we are, but they are doing it less exclusively. I do not see any reason to believe that they are doing something fundamentally, essentially different from what we do, no.

AJP: Does the ability to tolerate ambiguities distinguish a highly creative individual's cognitive style?

Boden: Everyone is capable of that, but to different degrees. We do not understand enough about just how we do think to be able to answer that question with any certainty. I would bet that the answer is no, they are not doing something that is fundamentally different, but they are doing what we are doing better. They also have, in many cases, a great store of knowledge about one thing or another.

AJP: Is neophilia, or a craving for novelty, a hallmark of a creative person?

Boden: Take somebody like the philosopher Immanuel Kant. I think you would have to say he was hugely creative, but I suspect that he was pretty low on the neophilia measure and not very spontaneous. You could set your clocks by him when he went out on his walk. I do not think he was someone who had much sense of humor, and I think humor would raise an eyebrow at any new thing. I do not know that Kant would. He raised an eyebrow at

humor and incongruity, of course, and in his book on the subject, *Critique of Judgment*, thinking laughter through got him going. But novelty for its own sake? I think this is a sort of very modern idea and not entirely helping matters, and it is largely commercially driven, so that we can sell more things.

AJP: Are children particularly creative?

Boden: One of the reasons I am suspicious of people who idealize children's creativity and insist that one must not smother their creativity—and certainly one must not—is those people's tendency to make children think they are stupid when they make a mistake, which is an inevitable part of any creative endeavor. I also believe that the notion that teaching children rules, whether it is the multiplication tables or grammar, smothers their creativity, is fundamentally mistaken. In fact, it is not even clear to me that children *are* especially creative. Of course, they are creative in the sense that we all are. They are *playful*, but that is not quite the same thing, because they might come up with a new idea, which we can see is creative, but they do not yet have enough knowledge to follow up. If you were to say, "Oh, that's an interesting idea, what else do you want to say about it, little Johnny?" there is no guarantee he is going to say anything of any great interest. So children come up with lots of new stuff—which is a reason for saying they are creative—but there is no discipline, elaboration, or careful evaluation there. They simply have not learned enough yet.

AJP: To what extent is creativity a social process?

Boden: Well, we all get ideas from other people, of course, and also, we all depend to some extent on other people's approbation. That goes back to what I was saying earlier: if you are going to come up with something that is really different, you have to be prepared to do without other people's approbation.

AJP: Do you think it is harder to be creative today than a generation or two ago?

Boden: Yes, I would agree to some extent. What was so wonderful about the humanities in particular was that you could do your own thing in the old days. Nowadays at the university, especially if you are a scientist, you really cannot do research by yourself; you have to collaborate with other people. In the old days, biscuit tins and string could suffice, while today, for various reasons, you cannot quite do that anymore, really.

AJP: Is it difficult to be creative today because so much has already been discovered, because there is so much to know and understand that it is much harder to become expert?

Boden: There is some truth to that, but there are still very many examples where big steps are taken by people coming from other, outside disciplines who throw a fresh light on a problem. James Dyson did something absolutely revolutionary by inventing the now famous Dyson bagless vacuum cleaner that uses centrifugal force. His background was not in physics; it was in furniture and interior design. But upon visiting a sawmill he observed how centrifuges were used to expel dust, and he related that technology to the realm of vacuum cleaners, which until then would clog up easily and lose power. So, to be good at combinational creativity, as Dyson was, does not necessarily require you to be an expert.

AJP: A final question—can a philosopher-psychologist-physician-cognitive scientist find time for play?

Boden: Well, I hope so, I'm soon off to Rarotonga in the Cook Islands to try and do some playing, as I do every year! I do not do any work whatsoever there. Just drop everything. No emails, nothing. Of course, when I get back, I have to pay for it. Last year there were seven thousand emails waiting for me when I returned!