

ena seen in real biological networks. Kaneko and Tsuda also seek ways of measuring the complexity of their systems. They define an information flow and entropy derived from the number and size of synchronized spatial clusters. And they make analogies between information storage, flow and processing in the brain and the many possible states of the coupled map lattice and the dynamical correlations among these states. Spatiotemporal dynamics of nonlinear coupled map lattices is a new field of study, and much remains to be done to determine whether it will be a fruitful approach to biological problems.

This is not a book for novices, but experts looking for stimulating discussions on spatiotemporal chaos and an in-depth tour of coupled map lattices will find it profitable. ■

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Thinking the unthinkable

The Origins of Creativity

edited by Karl H. Pfenninger & Valerie R. Shubik

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Richard Gregory

Although we recognize creativity in the arts and sciences it is extraordinarily hard to define or explain. Why are some people — Mozart, Beethoven, Newton, Einstein — far more creative than almost everyone else? Is it a matter of genes — perhaps lucky combinations of inherited characteristics — or does it flower from a nurturing or challenging environment? What brain processes create creativity? These and many more questions are discussed here, by a dozen experts, with a useful introduction and analysis by the editors. The contributions vary from personal reminiscences to summaries of a life's work. The very wide variety of approaches — experiences in art and science, the biological basis and brain mechanisms of creativity, emotion and reason, the role of the environment, perception of patterns — reflects the lack of an accepted paradigm for considering creativity.

Thomas Cech starts the discussion with charm and generosity, by relating his Nobel-prizewinning discoveries on self-splicing RNA and its implications for the origin of life, to the combined creativity of his laboratory team. This emphasizes the importance of secure long-term support for creative science, to nurture shared confidence and loyalty. These are not bought cheaply, but yield results.

Dale Chihuly, a remarkable artist who works with glass, also stresses the importance of teamwork, together with the inspiration



Inspiration from new technology: *Macchia Forest* (1994) by Dale Chihuly.

and possibilities of new technologies. Physician and wood-carver David Rogers sees leading a group as a creative activity, even though his female-form art is private. Relations between art and science are discussed by Gunther Stent, pioneer in molecular biology and philosopher of science, who points out interesting parallels, and some non-parallels, between discovering and creating.

The distinguished neuropsychologist Antonio Damasio reverses the long philosophical and scientific tradition of separating reason from emotion by suggesting that emotion is essential for creative rational thinking. He presents a detailed account of brain anatomy and cognitive processes at the leading edge of brain research. The emphasis is on novel and tentative representations in working memory, for trying out possibilities and new combinations, driven by emotional pushes and pulls. This is eloquent and compelling.

The composer Bruce Adolfe discusses musical imagination related to brain activity and working memory, with advice on how to be creative. Karl Pfenninger looks at how the nervous system might generate the 'higher function' of creativity, stressing the brain's plasticity and the importance of early environment and learning. The importance of early experience is developed by Janina Galler, using the interesting results from lengthy experiments on the effects of malnutrition on intelligence and creativity.

Howard Gardner, the well-known expert on the psychology of intelligence, discusses his 'multiple intelligences' experiments and ideas, using the example of seven exceptional people who have affected other people's lives. The 'cases' are few but the analysis is deep, with detailed biographical scholarship. Gardner relates effects of society to brain function and to different kinds of intelligence. The cell biologist George Palade discusses "the interactions between the arts and

sciences in the context of Western civilization as a function of time in history", stressing the advantage of affluence in the society and a Protestant work ethic in the home background.

Introducing the subject of patterns of perception, painting is discussed by the artist Françoise Gilot, who describes her relationship with Picasso and her own experience with paint and canvas. The theme of vision is steered by the neurobiologist Charles Stevens into how eyes and brains work. Structures and mechanisms of the retina and visual cortex are important, but perhaps limitations of space prevented him voyaging into cognitive (knowledge-based) processes of vision, which seem more directly relevant. Indeed, is human creativity just a simple extension of the creativity of all perception — as even everyday perceptions are so much richer than the available information?

This leads the reader to the essay from the great Benoit Mandelbrot, and fractals. They evoke feelings of creative art — but are they works of art? Where is the artist in a computer algorithm? This intriguing discussion might have led to the subject of creativity — or the lack of it — in computers, but, perhaps sadly, it does not.

The book ends with an editorial synthesis and critique of the contributions. Perhaps this will make the reader question the notion of creativity. Is creativity so specifically human, as implied here? Will computers beat us at science, even at art? Surely, darwinian evolution, though lacking in emotion, is the most creative process we know? Shouldn't this rather well-understood process be discussed here? Admittedly, natural selection takes its time, but just look at the results. ■

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