

## Preface

Until recently, human creativity had been treated as a mysterious process of brain activity, since we had neither the tools to measure brain activity precisely nor the theories to analyze and synthesize creativity. However, the quick advancement of brain science these days — thanks largely to the development of various measurement tools such as electroencephalography (EEG), electromyography (EMG), and functional magnetic resonance imaging (fMRI), and to new attitudes which view the brain as a system — has enabled us to discuss creativity in the context of science. Hence, we organized a workshop for the exchange of ideas among distinguished scholars who have been contributing to the understanding of creativity in different fields and from different viewpoints.

The workshop was held from April 27–30, 2004, in an ancient castle located in a small village called Bertinoro, near Bologna, Italy. We invited the following distinguished scientists from around the world: Professor Nobuo Masataka (Kyoto University, Japan), Professor Ernst Poeppel (Ludwig-Maximilians University, Germany), Professor Philippe Rochat (Emory University, USA), and Professor Allan Snyder (Director, Centre for the Mind, Australia). We also asked the following researchers from Sony Computer Science Laboratories (Sony CSL) to participate: Dr Hiroaki Kitano (Director, Sony CSL, Tokyo), Dr Takahiro Sasaki (Researcher, Sony CSL, Tokyo), and Dr Luc Steels (Director, Sony CSL, Paris).

As expected, many brilliant and ingenious ideas were presented at the workshop, and we felt that it was important to record and share these

ideas with those who are interested in this area. Thus, we decided to publish a book based on the discussions we conducted in the workshop. We also decided to publish the book not as a conference report, but as scientific literature to widen the audience while simultaneously maintaining scientific depth. For these purposes, we asked a science writer, Dr Kaoru Takeuchi, to participate in the workshop and in our editorial work. He has provided a short introductory note for each lecture/chapter.

This book is composed of eight chapters. In chapter 1, titled “A Genius Within,” Professor Allan Snyder, a brain scientist and multitalented genius, presents the notion of “mindset.” A mindset is composed of an individual's past experiences, so that most of his or her decision making and actions can be done in a routine manner. Snyder claims that creativity lies in breaking the routine. He has built a device that emits very weak electromagnetic pulses to the left temporal lobe in order to mask one's mindset to show how creativity emerges.

In chapter 2, titled “A Story of Brain Clocks,” Professor Ernst Poeppel, a neurophysiologist, shows that the temporal resolution of causal relation in the human brain cannot be shorter than 30 milliseconds. This is the resolution of the perceptual process. He also shows that the brain can remember or perceive events that last less than 3 seconds. This is called the chunk of conceptual process. These numbers come from the brain's physical structure. He hypothesizes that creativity lies in the relationship or complementarity between the perceptual and conceptual processes.

In chapter 3, titled “In Search of Achilles' Heel,” Dr Hiroaki Kitano, an advocate of systems biology, explains that interesting phenomena occur on the border of stability and instability, and that a complex system incurs fragility in order to be robust. He cites diseases such as cancer and diabetes as examples, but the discussion can also be applied to the brain system and creativity.

In chapter 4, titled “Do Infants Dream of Baby Sheep?” Professor Philippe Rochat, an expert on the developmental psychology of infants, explains the developmental stages of infants' brain. Babies less than 2 months of age are similar to prenatal babies. Then, babies begin to realize that their bodies belong to them. After 9 months, they become somewhat social. A human being is a social animal; however, Rochat claims

that creativity emerges when people stop worrying about what other people think.

In chapter 5, titled “Baby Talk,” Dr Nobuo Masataka, an expert on the communication of primates, talks about physical development and its relation to expressional ability, based on his study of apes. He also discusses the problem of learning words. He points out some common elements in the learning of humans and apes based on social relations and interactions with the environment, culminating in human language.

In chapter 6, titled “Dr Jekyll, Mr Hyde, and Qualia” Ken Mogi, an advocate of systems brain science, shows that every cognitive process is necessarily metacognitive, using the homunculus as a means for explanation. He argues that creativity is an inherent property of the brain system, in view of the way the brain realizes the coexistence of dynamical adaptability and perceptual stability, the latter correlating with the qualia in conscious experience.

In chapter 7, titled “Computer and Creativity,” Luc Steels, a computer scientist and an expert on complex systems, claims that creativity emerges from the interaction with others. He believes it is important for a group of people or for society as a whole to be creative. He also claims that the expression of meaning is creative, rather than a realistic drawing.

Chapter 8, titled “Dialog by Editors,” is a sort of addendum to this book in order to help readers re-experience the atmosphere of the workshop and deepen their understanding of the lectures. Mario Tokoro and Ken Mogi, with the help of Dr Takahiro Sasaki, present discussions on each lecture. They also discuss the relations between the lectures, so that the whole picture of the workshop can be easily drawn.

This book is part of a long-term effort, initiated by Mario Tokoro, to weave a web of researchers and practitioners that are dedicated to advance the quality of education in the 21st century. The initiative intends to stimulate multidisciplinary discussions, which contribute to improving education and learning for children and adults of all ages everywhere in the world, based on an improved understanding, methodology, and policy for education and human learning.

This book follows up on two previously published books. The first book, titled *The Future of Learning: Issues and Prospects* and published

by IOS Press in 2003, sets the scene for our discussion. The second book, titled *A Learning Zone of One's Own* and also published by IOS Press in 2004, discusses in-depth issues concerned with grounding, optimal experience and emotion, and pedagogical methodologies. We hope that the current book on creativity and the brain, together with the other two books, provides a whole new aspect and sheds light on the problem of learning and creativity in the cognitive and brain sciences as well as education.

We are much indebted to all the distinguished scientists who participated in the workshop. We thank Dr Takahiro Sasaki of Sony CSL, Tokyo, for his valuable suggestions in organizing the workshop and in editing this book. We also thank Ms Yumiko Kitamori for her help in organizing the workshop. We are grateful to Miss Ho Sheo Be, Senior Editor, World Scientific Publishing Company, for her effort in preparing the final form of this book.

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