



MIND & LIFE
INSTITUTE

PRESENTS
Mind and Life XII

Dialogues between Buddhism and the Sciences

NEUROPLASTICITY
The Neuronal Substrates
of Learning
and Transformation

WITH
**HIS HOLINESS
THE DALAI LAMA**

DHARAMSALA, INDIA
OCTOBER 18 - 22, 2004

The Mind and Life Dialogues and the Mind and Life Institute

Science is the dominant paradigm in modern society for understanding the nature of reality and providing a knowledge base for improving lives and conditions on this planet. Buddhism began 2,500 years ago with largely the same goals – to understand the nature of reality and to use that understanding to improve lives and conditions on the planet. Buddhism uses the human mind, refined through meditative practice, as its primary instrument of investigation into the nature of reality. While this method of investigation is based on observation, very rigorous logic and experimentation, science has traditionally viewed it as subjective and at odds with the objectivity of the scientific method.

In 1987, recognizing that there was no orderly way for science and Buddhism to share their findings, and convinced that a rigorous scientific dialogue and collaboration between these two powerful systems would be beneficial for humanity, neuroscientist Francisco Varela and entrepreneur Adam Engle started the Mind and Life Dialogues with the Dalai Lama. Over the years, the subject matter of the Mind and Life meetings has become more focused on topics that provided opportunities for collaborative research between scientists and Buddhists, studying the effects of mental training on human health and well-being. This meeting on Neuroplasticity is the twelfth such Mind and Life dialogue.

What sets the Mind and Life dialogues apart from other meetings between science and Buddhism is the focus on in-depth dialogue. While we do have scientific presentations during the morning sessions, their purpose is to provide background for the ensuing discussion during the afternoon sessions. These discussions have been the central focus of each Mind and Life meeting, and the proceedings of each meeting have been edited into its own book. For a full listing of the previous Mind and Life dialogues and publications, please visit our web site: www.mindandlife.org

In addition to the Mind and Life dialogues and publications, the Mind and Life Institute has two other programs to advance our mission. One program initiates collaborative research studies between scientists and contemplatives, focused on determining the effects of meditation and other contemplative practices. To date, such studies have been initiated at the University of Wisconsin; UCSF Medical Center; Princeton; Harvard; UC Berkeley and Reed College.

Another program to help promote new research in this emerging area is the Mind and Life Summer Research Institute, which is an annual week-long meeting specifically for young scientists with an interest in this area. This Research Institute combines scientific presentations; in-depth discussion on how to advance this emerging field of science; and meditation practice.

Neuroplasticity: Transforming the Mind by Changing the Brain

Neuroplasticity refers to structural and functional changes in the brain that are brought about by training and experience. The brain is the organ that is designed to change in response to experience. Neuroscience and psychological research over the past decade on this topic has burgeoned and is leading to new insights about the many ways in which the brain, behavior and experience change in response to experience. This basic issue is being studied at many different levels, in different species, and on different time scales. Yet all of the work invariably leads to the conclusion that the brain is not static but rather is dynamically changing and undergoes such changes throughout one's entire life. The scientists assembled for this meeting represent the various levels of analysis in which these questions are being pursued. Research on structural plasticity will reveal how the literal composition of the adult mammalian brain is constantly changing and will show the factors that influence these changes.

Other studies at the molecular level reveal how the chemistry of DNA can be changed by experience in ways that affect the expression of our genes. Moreover, such effects on the chemistry of DNA can be produced by social experience, which in turn modifies gene expression in ways that can persist for the duration of a lifetime. These findings have radical implications for conceptualizing the dynamic interplay between nature and nurture. At more macro levels of brain systems, research will be discussed that demonstrates how sensory, perceptual and language functions are modified by experience and how the neural systems that underlie these complex behaviors are transformed through experiential alterations that occur early in life. Emotional function is also importantly shaped by experience and adult's social relationships are shaped in part by early life experience. The ways in which these influences occur will be discussed and the brain mechanisms that might underlie such changes will be examined. Individuals differ in their characteristic ways of reacting to emotional situations.

Such individual differences may be importantly shaped by experience and by certain types of training. The role of contemplative training in transforming the emotional mind will be considered. A major question to be pursued over the course of this meeting will be the nature of mental training and its potential impact on the brain and behavior. Mental training appears to be emphasized much more in the contemplative traditions than it is in the Western scientific tradition. Another important issue for consideration is the optimal developmental periods to intervene to produce plastic changes to promote healthy functioning. Finally, the philosophical implications of this domain of science will be considered. Specifically, how should we conceptualize the impact of voluntary mental activity as influencing brain function?

Participants

Tenzin Gyatso, His Holiness, the XIV Dalai Lama

Richard J. Davidson, Ph.D., Vilas Research Professor and William James Professor of Psychology and Psychiatry, University of Wisconsin-Madison

R. Adam Engle, J.D., M.B.A., CEO and Chairman of the Mind and Life Institute, and General Coordinator of the Mind and Life conferences

Fred H. Gage, Ph.D., Adler Professor, Laboratory of Genetics, The Salk Institute, San Diego

Michael J. Meaney, Ph.D., James McGill Professor, McGill University, Montreal

Kazuo Murakami, Ph.D., Emeritus Professor, Tsukuba University, Tsukuba, Japan

Helen J. Neville, Ph.D., The Robert and Beverly Lewis Endowed Chair, University of Oregon

Matthieu Ricard, Ph.D., Author and Buddhist monk at Shechen Monastery in Kathmandu and French interpreter since 1989 for His Holiness the Dalai Lama

Philip R. Shaver, Ph.D., Professor and Chair of the Department of Psychology, University of California, Davis

Evan Thompson, Ph.D., Canada Research Chair in Cognitive Science and the Embodied Mind, York University, Toronto

Interpreters

Geshe Thupten Jinpa, Ph.D., President and chief editor for The Classics of Tibet Series produced by the Institute of Tibetan Classics in Montreal

B. Alan Wallace, Ph.D., President, The Santa Barbara Institute for Consciousness Studies

Monday, October 18

- **Richard J. Davidson**, the scientific coordinator of ML XII, will briefly introduce the week's framework and objectives. He will give a brief overview of the perspectives to be brought to bear on neuroplasticity, and act as meeting moderator.

- **Presentation: Structural Changes in the Adult Brain in Response to Experience**
- **Fred H. Gage**

For those of us who study the nervous system, the brain is the organ of the body that controls our behavior. This belief means that what we think and what we do, while obviously influenced by the experiences we have, are the result of the brain's processing of information and directing action. Given this basic assumption, the most common model or analogy of how the brain works is that of a computer. While this analogy may have some heuristic value, it is likely wrong or at least very limiting. The brain is an organ, like the liver, heart and kidney; it is made of chemicals, cells and tissue. The brain functions through individual cells communicating electrically and chemically. The real challenge for the neurons in the brain is calculating (interpreting) this temporally and spatially transmitted information and sending that interpreted message on to the next neurons in a circuit. The aggregation of this information passing and processing results in thinking and behaving.

One of the main arguments for developing the analogy of the brain as a stable machine or computer was that it helped to explain how we can remember things from one instance to the next. How could we do that if the underlying structure of the brain were changing all the time? For that matter, if the brain is the seat of consciousness (F. Crick), how can we maintain a self identity if the brain is not stable. However, we have learned that the brain is not physically stable, and that is probably a good thing. The structural instability that we have documented in the brain may be required to provide the extra capacity that is necessary for dealing with complexity and to provide the underpinning for the adaptability and flexibility, or "plasticity" (as neuroscientists refer to it), that is required for dealing with the variety of ever-changing challenges that we are faced with throughout our entire life.

I will summarize our current understanding of the structural plasticity that persists in the adult mammalian brain and discuss the experiences, behavior patterns, and drugs that can change our brain and, therefore, our behavior.

Tuesday, October 19

- **Presentation: Experience-Induced Alterations in Gene Expression: The Impact of Early Experience on Emotional Functioning**
- **Michael J. Meaney**

The "nature-nurture" debate, which so preoccupies Western science, is essentially an argument of the relative importance of genetic versus environmental (or perhaps experiential) in the definition of individual differences among members of the same species. It is also an argument that is based on a fundamental misunderstanding of cell biology, for adherents commonly ignore the simple fact that neither genes nor experience can influence develop-

ment independent of context. Experience requires translation through processes associated with bodily function that commonly includes brain activation. Such functions are inevitably influenced by the genome. Likewise, genes operate within cells, the activity of which is constantly regulated by external events. Alas, gene and experience are inseparable.

The nucleotide sequences that comprise the genome exist within a dynamic context that is constantly subject to modification. DNA is commonly found wrapped around histone proteins, and individual nucleotides are modified by the addition of various chemical groups. Hence, we speak of the chemistry of the DNA. Such chemical modifications of the DNA can permanently alter the activity of individual genes. The chemistry of the DNA in some cells will differ from that of others, which is why, despite containing exactly the same genes, liver cells function very differently from brain cells. Variations in the chemistry of the DNA can explain not only why cells within the same body operate differently, but also why the same cells in two different bodies vary in their function – the issue of individual differences.

Differences between individuals in the chemistry of the DNA are influenced by environmental events occurring early in development. An example of such effects is found in the study of DNA methylation, in which a methyl group is added onto individual cytosines within selected DNA sequences. This chemical modification is commonly associated with the stable silencing of the gene within that cell. In the rat, maternal care of pups over the first week of life directs the process of DNA methylation in specific cells in the brain, thus permanently altering the activity of neurons, and thus cognitive and emotional functions.

These findings provide but one example of the interaction between gene and environment. We know little about whether such effects are resistant to reversal through experience at later stages of the lifespan; however, the basic elements of the process whereby maternal care alters the DNA and its activity suggest that such effects could occur at any stage of life, under the appropriate levels of stimulation. Such a continuous process of DNA modification could provide the functional interface between a static genome and a dynamic environment, allowing for adaptation within functional gene networks in a manner comparable to way synaptic plasticity forms the basis for adaptation within neuronal networks.

Wednesday, October 20

- **Morning Presentation: Human Developmental Plasticity**
- **Helen J. Neville**

"Experience shapes human brain development and function"

In this talk I will describe:

- 1) the structure and function of the human brain and methods scientists use to study the human brain
- 2) the long time course over which the human brain develops
- 3) several studies that show how experience (i.e. input from the environment) affects the brain systems important for sensory processing, language processing, learning, intelligence, social and emotional skills
- 4) the implications these discoveries have for health, education and support programs for children.

Scientists who study the brain have made many discoveries recently about how the brain works and how it develops. At birth the brain is very immature. In fact, the human brain is not fully mature until at least twenty years after birth. Moreover, during this long development the human brain is highly dependent on and is modified and shaped by experience. For example in people born blind the parts of the brain that normally process visual information are rewired and come to process sounds, including language. In those born deaf the areas of the brain that normally process sounds come to process vision.

The language relevant brain systems are also shaped by experience. In people who learn a language later than 6 years of age, the brain systems that normally process grammar are not recruited. However the brain systems that process the meanings of words are normal in late language learners. Children whose caregivers talk to them regularly display good language skills and well organized language brain systems. However children who are rarely spoken to have stunted language development and immature language brain systems.

Typical human and animal environments are complex and research has shown that such stimulating environments lead to enhanced brain growth, learning and intelligence. Furthermore, studies of animals and humans have shown that nurturing caregivers and low levels of stress are important in producing appropriate levels of the brain chemicals that are necessary for healthy emotional control. High levels of stress and the absence of nurturant caregivers result in high levels of the chemicals that are harmful to these systems.

In summary, contrary to what many people used to think, the human brain is a constantly changing, highly dynamic organ. Brain research can help guide people who care about children to design programs and services that optimize human development. Discussion will focus on the issue of sensitive developmental periods for the induction of specific forms of plasticity, the role of sensory, attentional, cognitive and social/emotional experience in producing plastic changes in the structure and function of the cortex. We seek input from the Buddhist scholars on the time periods during human development when different types of attentional/mindfulness training might help to optimize the development of the human potential in order to make the world a better place.

■ Afternoon Philosophical Presentation: Neuroplasticity and Neurophenomenology

■ Evan Thompson

For many years, Western mind science investigated cognitive processes, such as reasoning, perception, imagery, and attention, with little or no concern for subjective experience. In recent years, however, this attitude has begun to change, so that today there is increasing scientific interest, especially in affective-cognitive neuroscience, in understanding the experiential aspects of mental processes. For real progress to be made in this area, however, scientists must rely on detailed first-person reports about subjective experience. Yet exactly how such reports should be integrated into the conceptual framework and experimental procedures of mind science is still not clear.

Research on plasticity offers an important context for considering this issue. On the one hand, it stands to reason that people vary in their abilities as observers and reporters of their own mental lives, and that these abilities can be enhanced through mental training of attention, emotion, and metacognition. Contemplative practice is a vehicle for precisely this sort of cognitive and emotional training. On the other hand, it stands to reason that mental train-

ing should be reflected in changes to brain structure, function, and dynamics. Hence contemplative practice could become a research tool both for developing better phenomenologies of subjective experience and for investigating the brain and neuroplasticity. This incorporation of contemplative practice into neuroscientific research would constitute a kind of experiential neuroscience or "neurophenomenology."

This neurophenomenological approach raises several important questions for Western mind science and the science/Buddhism dialogue. First, it is well known in Western psychology that first-person reports, especially introspective or metacognitive ones, are subject to certain sorts of systematic biases. Is there reason to think that contemplative training can modify these biases? Second, if observing one's mental life changes the character of one's experience, then is there not a kind of "measurement problem" in using mental training to investigate experience? For instance, if metacognitive monitoring of first-order experience changes that experience, then how can one use metacognition to draw conclusions about experience independent of the monitoring act?

Finally, what is the best theory or model to explain how sustained voluntary activity on the part of the person (the whole embodied being aware of the world) can be causally efficacious at the level of neurons and neural assemblies? This last question is an aspect of the well-known, outstanding "explanatory gap" in the neuroscience of consciousness: On the one hand, the assumption that mental processes are brain processes both regulates (or guides) scientific research and constitutes the overall scientific view of the mind. On the other hand, there is still no adequate explanation of how brain activity gives rise to consciousness and of what causal role consciousness may play in the brain's workings.

Thursday, October 21

- Morning Presentation: Altering Attachment Security to Enhance Compassion and Altruism
- Phillip R. Shaver (with Mario Mikulincer)

Over the past 30 years, developmental, personality, and social psychologists have been extending and testing attachment theory, a psychological theory first proposed in the 1960s and 70s by John Bowlby, a British psychiatrist, and Mary Ainsworth, an American developmental psychologist. The theory, rooted in both psychoanalytic psychiatry and primate ethology, deals with what Bowlby and Ainsworth called "attachment" (or emotional bonding) between infants and their primary caregivers (usually, but not necessarily, the biological mother). Depending on parental sensitivity and responsiveness (or insensitivity and unresponsiveness) to an infant's distress signals, children can become relatively securely or insecurely attached to their primary caregivers, and if insecurely attached, can exhibit anxious, avoidant, or disorganized attachment behavior. The pattern of insecurity displayed during infancy has been shown to persist in many cases over periods of years, with continuing effects on mental health and success or failure in close personal relationships. Despite the tendency toward persistence, developmental and clinical researchers have successfully designed early intervention techniques to increase children's sense of security.

In my work with Mario Mikulincer and our students, attachment theory is being applied to the study of adolescents' and adults' mental health and close relationships, such as friend-

ship, romantic love, and marriage. We have found it possible to activate what Bowlby and Ainsworth called "the attachment behavioral system" experimentally, increasing a person's sense of security by both conscious and unconscious means. By showing that a person's "attachment style" (i.e., his or her characteristic pattern of security or insecurity) can be modified experimentally, we have been able to suggest ways to alter personality in the direction of increased security, even during adulthood.

Besides postulating the existence of an attachment behavioral system, an idea that has now been extensively researched, Bowlby also discussed other core behavioral systems, including exploration, caregiving, and sex. The caregiving system, which is most evident in parental sensitivity and responsiveness to young children, is the one that responds generally to other people's needs and distress. Theoretically, therefore, it is the locus and source of compassion. Bowlby claimed that attachment-system activation (in response to threats or stressors) interferes with the optimal operation of the other behavioral systems, so that creating a boost in attachment security might foster, or allow, greater compassion (i.e., caregiving). New evidence related to this will be presented and similarities and differences between attachment theory and Buddhist psychology in conceptions of attachment, compassion, and personal plasticity (i.e., constructive personality change) will be explored.

■ Afternoon Presentation: Laughter Regulates Blood Glucose Levels and Gene Expression

■ Kazuo Murakami

It is well known that genes have the function of transmitting information necessary for the existence of living things from one generation to the next. An important role of the gene is to transcribe DNA information into RNA (mRNA), which is translated into protein. The rate-limiting step in the entire process from DNA to protein is from DNA to mRNA; thus, increase or decrease in the expression level of mRNA is called ON or OFF of the gene, and this ON/OFF of the gene is regulated by many factors. Many factors, such as physical factors (heat, pressure, tension, training, and exercise) and chemical factors including nutrients in food, alcohol, smoking, and endocrine disruptors are well known. Based on the fact that genes are switched ON/OFF by physical or chemical factors, I have proposed the hypothesis that mental factors are also involved in switching genes ON/OFF. I consider that these mental factors include not only negative mental stress, but also positive factors such as positive emotion, excitement, joy, gratitude, affection, belief, and spiritual feeling.

To confirm my hypothesis, we study the effect of laughter an indicator of positive emotion, in terms of gene expression (ON/OFF) changes. We found that laughter lowered the increase in post prandial (after meal) blood glucose (PPBG) in the patient of type II diabetes in which only 23 genes out of 18,716 genes were up-regulated by more than 2-fold, however, no gene was down regulated by less than 0.5 fold in the peripheral blood leukocytes.

Contrary to expectations, these up-regulated genes did not include genes directly involved in blood glucose regulation, but included a candidate for suggesting the mechanism for suppressing the increase in blood glucose level. Dopamine D4 receptor gene (DRD4), which is linked to inhibition of adenylyl cyclase, was characterized by up-regulation on an average of 2.5-fold in the group with suppressed increases in PPBG. We speculate that the up-regulation of DRD4 by laughter leads to not only the deterioration of the increase in blood glucose via adenylyl cyclase, but also the improvement of poor glycemic control due to negative emotions.

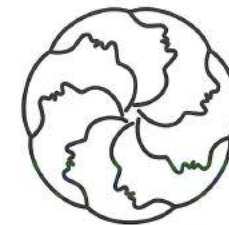
Friday, October 22

- **Presentation: Transforming the Emotional Mind: Perspectives from Affective Neuroscience**
- **Richard J. Davidson**

Our emotional reactions to events and our daily mood form the basis of our personality and color virtually all our behavior. Adult personality is traditionally regarded as relatively fixed and immutable. Research over the past decade on the brain mechanisms that subserve emotion and individual differences in emotional reactivity that we call affective style, have provided a new avenue to explore the possibility of emotional transformation in light of brain plasticity.

This presentation will begin with a discussion of what we mean by affective style and how it can be measured. Rather than being conceptualized as a fixed trait, affective style is regarded as a trainable skill. Evidence that exposure to adversity can actually help to cultivate resilience will be presented. One of the specific characteristics that can be learned is emotion regulation. Even very short-term training in emotion regulation can produce demonstrable effects on brain function. Other forms of affective plasticity will also be described. The presentation will end with a consideration of whether purely mental training can be used to transform emotion. New evidence from studies with highly skilled meditators will be presented to show that they can voluntarily alter brain function through mental practices.

Questions that will be considered in discussion include the role of mental training versus behavioral training in transforming the emotional mind; whether particular developmental periods are optimal for training emotional skills; the matching of specific training regimes to individual differences in affective style; and whether training that results in increased contentment dampens motivation for social change.



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Participant's Biographies

Tenzin Gyatso, His Holiness the XIV Dalai Lama, is the leader of Tibetan Buddhism, the head of the Tibetan government-in-exile, and a spiritual leader revered worldwide. He was born on July 6, 1935 in a small village called Taktser in northeastern Tibet. Born to a peasant family, His Holiness was recognized at the age of two, in accordance with Tibetan tradition, as the reincarnation of his predecessor, the XIIIth Dalai Lama. The Dalai Lamas are manifestations of the Buddha of Compassion, who choose to reincarnate for the purpose of serving human beings. Winner of the Nobel Prize for Peace in 1989, he is universally respected as a spokesman for the compassionate and peaceful resolution of human conflict.

His Holiness has traveled extensively, speaking on subjects including universal responsibility, love, compassion and kindness. Less well known is his intense personal interest in the sciences; he has said that if he were not a monk, he would have been an engineer. As a youth in Lhasa it was he who was called on to fix broken machinery in the Potola Palace, be it a clock or a car. His Holiness has a vigorous interest in learning the newest developments in science, and brings to bear both a voice for the humanistic implications of the findings, and a high degree of intuitive methodological sophistication.

Richard J. Davidson is the Director of the Laboratory for Affective Neuroscience and the W.M. Keck Laboratory for Functional Brain Imaging and Behavior at the University of Wisconsin at Madison. He was educated at New York University and Harvard University, where he received his B.A. and Ph.D., respectively, in psychology. Over the course of his research career he has focused on the relationship between brain and emotion. He is currently the William James Professor and Vilas Research Professor of Psychology and Psychiatry at the University of Wisconsin. He is co-author or editor of 13 books, including *Visions of Compassion: Western Scientists and Tibetan Buddhists Examine Human Nature*. Professor Davidson has also written more than 250 chapters and journal articles.

He is the recipient of numerous awards for his work, including the Research Scientist and MERIT awards from the National Institute of Mental Health, the Distinguished Scientific Contribution Award from the American Psychological Association, the Distinguished Investigator Award from the National Alliance for Research on Schizophrenia and Depression and the William James Award from the American Psychological Society. He was a member of the Board of Scientific Counselors of the National Institute of Mental Health and was recently elected to the American Academy of Arts and Sciences. In 1992, as a follow-up from previous Mind and Life meetings, he was a member of a scientific team doing neuroscientific investigations of exceptional mental abilities in advanced Tibetan monks.

R. Adam Engle is the Chairman and co-founder of the Mind and Life Institute. He was educated at the University of Colorado, Harvard University and Stanford University, where he received his B.A., J.D., and M.B.A. degrees respectively. Over the past 40 years, he has divided his professional life as a lawyer and entrepreneur between the for-profit and non-profit sectors.

In the for-profit sector, Mr. Engle began his career as a lawyer, practicing for 10 years in Beverly Hills, Albuquerque, Santa Barbara, and Teheran. After leaving the practice of law, he formed an investment management firm, focusing on global portfolio management on behalf of individual clients. He also started several business ventures in the United States and Australia.

Mr. Engle began working with various groups in the non-profit sector in 1965. In addition to the Mind and Life Institute, he also co-founded the Colorado Friends of Tibet, a statewide Tibetan support group based in Boulder, Colorado; was a founding member of the Social Venture Network; and has advised numerous other non-profit organizations.

Fred H. Gage is Adler Professor in the Laboratory of Genetics at Salk Institute. He joined The Salk Institute in 1995. Prior to that he held positions at the University of California, San Diego, and the University of Lund, Sweden. He received his Ph.D. in 1976 from The Johns Hopkins University. Dr. Gage's work concentrates on the adult central nervous system and unexpected structural plasticity that the brain retains throughout the life of all mammals. Surprisingly, this structural plasticity is regulated by experience; thus his studies also focus on the cellular, molecular, and environmental influences that regulate structural changes in the adult and aged brain. He is a Fellow of the American Association for the Advancement of Science and a member of the National Academy of Sciences and the Institute of Medicine. Dr. Gage also served as president of the Society for Neuroscience in 2002. Dr. Gage has been the recipient of numerous prestigious awards, including the 1993 Charles A. Dana Award for Pioneering Achievements in Health and Education, the Christopher Reeve Research Medal in 1997, the 1999 Max Planck Research Prize, and the MetLife Award in 2002.

Michael J. Meaney is James McGill Professor of Medicine at Douglas Hospital Research Centre of McGill University. He is the Director of the Maternal Adversity, Vulnerability and Neurodevelopment Project and of the Developmental Neuroendocrinology Laboratory of McGill University. Dr. Meaney was educated at Loyola College of Montreal and received his Ph.D. from Concordia University (Montreal) with post-doctoral training at The Rockefeller University in New York. Over this period Dr. Meaney's primary research interest was on the effects of early experience on gene expression and development. His research is multidisciplinary and includes studies of behaviour and physiology, to molecular biology and genetics.

The primary objective of these studies is to define the processes that govern gene environment interactions. He has authored over 225 journal articles and has been the recipient of a Scientist Award from the Canadian Institutes for Health Research (CIHR) and a Distinguished Scientist Award from the National Alliance for Research in Schizophrenia and Affective Disorders. He currently holds a CIHR Senior Scientist Award. Graduates from Dr. Meaney's lab hold faculty appointments across North America and Europe, including Queen's University, University of California at Berkeley, University of British Columbia, University of Michigan, and the RIKEN Institute. Research in the Meaney lab is funded by grants from Canadian, American and Japanese agencies.

Kazuo Murakami is the director of a research team on mind/heart and genes and an emeritus professor at the University of Tsukuba (Applied biochemistry) in Japan. He was educated at Kyoto University in Japan, where he received his B.A. and Ph.D. in biochemistry. His professional fields are 1) biochemistry, molecular biology of cardiovascular disease; and 2) the relationship between mind and genes. Professor Murakami has also written more than 400 chapters and journal articles in the above fields. He is the recipient of numerous awards for his work including the Max Planck Research Award (Humboldt Foundation, Germany) and the Japan Academy Prize (Japan Academy). He has proposed a hypothesis on the interaction between mind/heart and genes and is focusing on the relationship between positive emotion and gene regulation.

Helen J. Neville was awarded the B.A. degree from the University of British Columbia, an M.A. from Simon Fraser University and Ph.D. from Cornell University. Her postdoctoral training was at the University of California, San Diego in the Department of Neurosciences. Her major research interests are the biological constraints and the role of experience in neurosensory and neurocognitive development in humans. Methods include behavioral measures and event-related brain potentials (ERPs), and structural and functional magnetic resonance imaging (fMRI). Her work experience includes Director of the Laboratory for Neuropsychology at the Salk Institute and Professor, Department of Cognitive Science, UCSD. Dr. Neville is currently The Robert and Beverly Lewis Endowed Chair and Professor of Psychology and Neuroscience, Associate Director of the Institute of Neuroscience, Director of the Brain Development Lab, and Director of the Center for Cognitive Neuroscience at the University of Oregon in Eugene. She has published in many books and journals including *Nature*, *Nature Neuroscience*, *Journal of Neuroscience*, *Journal of Cognitive Neuroscience*, *Cerebral Cortex* and *Brain Research*. She has received many honors and is a member of the Board of Governors of the Cognitive Neuroscience Society, the Academic Panel of Birth to Three and is active in many educational outreach programs.

Matthieu Ricard is a Buddhist monk at Shechen Monastery in Kathmandu and French interpreter since 1989 for His Holiness the Dalai Lama. Born in France in 1946, he received a Ph.D. in Cellular Genetics at the Institut Pasteur under Nobel Laureate Francois Jacob. As a hobby, he wrote *Animal Migrations* (Hill and Wang, 1969). He first traveled to the Himalayas in 1967 and has lived there since 1972. For fifteen years he studied with Dilgo Khyentse Rinpoche, one of the most eminent Tibetan teachers of our times. With his father, the French thinker Jean-François Revel, he is the author of *The Monk and the Philosopher* (Schocken, New York, 1999), and of *The Quantum and Lotus* with the astrophysicist Trinh Xuan Thuan (Crown, New York, 2001). He has translated several books from Tibetan into English and French. As a photographer, he has published several albums, including *The Spirit of Tibet* (Aperture, New York) and *Buddhist Himalayas* (Abrams, New York, 2002).

Phillip R. Shaver, a social and personality psychologist, received his Ph.D. in psychology from the University of Michigan in 1970 and is currently Professor and Chair of the Department of Psychology at the University of California, Davis. He has served on the faculties of Columbia University, New York University, University of Denver, and SUNY at Buffalo. He is associate editor of *Attachment and Human Development*, a member of the editorial boards of *Personal Relationships*, *Journal of Personality and Social Psychology*, and *New Review of Social Psychology*, and a former member of study sections for NIH and NSF. He has received numerous research grants and published several books, including *Measures of Personality and Social Psychological Attitudes*, *Measures of Political Attitudes*, and *Handbook of Attachment: Theory, Research, and Clinical Applications*, and more than 150 scholarly journal articles and book chapters.

His current research focuses on emotions, close relationships, and personal development, especially from the perspective of attachment theory. In recent years he has been collaborating with Professor Mario Mikulincer, of Bar-Ilan University (Israel), on questionnaire, observational, and experimental studies of attachment security, compassion, and altruism, focusing especially on the ways in which attachment security (increased experimentally) fosters compassion and virtuous behavior, such as helping others in need and forgiving people who have been hurtful. He has made notable contributions to the scientific literatures on human emotions, close relationships, and the psychology of religion. In 2002, he received a Distinguished Career Award from the International Association for Relationship Research.

Evan Thompson is Associate Professor of Philosophy at York University where he holds a Canada Research Chair in Cognitive Science and the Embodied Mind. He received his B.A. from Amherst College in Asian Studies, and his Ph.D. in Philosophy from the University of Toronto. He has published numerous articles in cognitive science, phenomenological philosophy, the philosophy of perception, and the philosophy of mind. His books include *The Embodied Mind: Cognitive Science and Human Experience* (with Francisco Varela and Eleanor Rosch), *Colour Vision: A Study in Cognitive Science and the Philosophy of Perception*, *Between Ourselves: Second Person Issues in the Study of Consciousness*, and *Vision and Mind: Selected Readings in the Philosophy of Perception* (with Alva Noë). He is currently finishing a book titled *Radical Embodiment: The Lived Body in Biology, Cognitive Science, and Human Experience*. Professor Thompson held postdoctoral fellowships at the University of California, Berkeley, and the Center for Cognitive Studies at Tufts University. He is a member of the McDonnell Project in Philosophy and the Neurosciences, and a member of the Scientific Advisory Board of the Mind and Life Institute. In 2003 he was a visiting Maître de Recherche at the Centre de Recherche en Epistémologie Appliqué (CREA), at the Ecole Polytechnique in Paris.

Interpreter's Biographies

Thupten Jinpa was trained as a monk at the Shartse College of Ganden Monastic University, South India, where he received the Geshe Lharam degree. In addition Jinpa holds B.A. Honors in philosophy and Ph.D. in religious studies, both from Cambridge University. He taught for five years at Ganden and worked also as a research fellow in Eastern religions at Girton College, Cambridge University. Jinpa has been a principal English translator to H.H. the Dalai Lama for nearly two decades and has translated and edited numerous books by the Dalai Lama including *Ethics for the New Millennium*, *Transforming the Mind*, and *The World of Tibetan Buddhism*. His own publications include works in both Tibetan and English, the most recent book being *Self, Reality and Reason in Tibetan Philosophy*.

Jinpa teaches as an adjunct professor at the Faculty of Religious Studies at McGill University, Montreal. He is currently the president of the Institute of Tibetan Classics and heads its project of critical editing, translation and publication of key classical Tibetan texts aimed at creating a definitive reference series entitled *The Library of Tibetan Classics*.

B. Alan Wallace trained for many years in Buddhist monasteries in India and Switzerland, and has taught Buddhist theory and practice in Europe and America since 1976. He has served as interpreter for numerous Tibetan scholars and contemplatives, including His Holiness the Dalai Lama. After graduating summa cum laude from Amherst College, where he studied physics and the philosophy of science, he earned a doctorate in religious studies at Stanford University. He has edited, translated, authored, or contributed to more than thirty books on Tibetan Buddhism, medicine, language, and culture, as well as the interface between science and religion. His published works include *Tibetan Buddhism From the Ground Up*, *Choosing Reality: Buddhist View of Physics and the Mind*, *The Bridge of Quiescence: Experiencing Buddhist Meditation*, and *The Taboo of Subjectivity: Toward a New Science of Consciousness*. His anthology of essays entitled *Buddhism and Science: Breaking New Ground*, which he edited, was published in 2003 by Columbia University Press. His forthcoming book, *Genuine Happiness: Meditation as the Path to Fulfillment*, will be published in the spring of 2005 by John Wiley & Sons.

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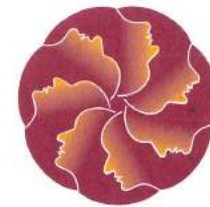
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