

University of Groningen

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Published in:
Neuroscience and Biobehavioral Reviews

DOI:
[10.1016/j.neubiorev.2004.11.002](https://doi.org/10.1016/j.neubiorev.2004.11.002)

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Document Version
Publisher's PDF, also known as Version of record

Publication date:
2005

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):
Sgoifo, A., Coe, C., Parmigiani, S., & Koolhaas, J. (Eds.) (2005). Individual differences in behavior and physiology: Causes and consequences. *Neuroscience and Biobehavioral Reviews*, 29(1), 1-2.
<https://doi.org/10.1016/j.neubiorev.2004.11.002>

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Editorial

Individual differences in behavior and physiology: causes and consequences

Individual variation in behavior and physiology is a driving force in evolution and speciation because it directly allows selective factors to act on and shape the fitness of the individual through differential survival. Understanding the causes of individual differences and their consequences in terms of adaptive capacity and vulnerability to disease is a major challenge of modern life sciences. Rapid advances in molecular genetics are enlightening us on the role of genetic factors in guiding in behavior and physiology and the way that traits are maintained in a natural population of animals. However, we have also come to appreciate that genetic potential and the way that is expressed phenotypically are strongly modulated by factors in prenatal and neonatal environment. Recent discoveries have revealed the significance of the mother as the first mediator of the relationship between environment and offspring development, opening up a fascinating new area of research on phenotype plasticity.

Indeed, the combined influence of genotype, rearing conditions and environmental context of the adult ultimately determines the adult phenotype and the way individuals deal with everyday challenges. In terms of evolutionary ecology, these processes determine fitness and, through their actions on the health of the individual, effects on reproductive physiology and responsiveness to stressors. When viewed from a biomedical perspective, we more typically characterize these differentiation processes and the variation in individuals in terms of differences in the capacity of coping with stressors and the potential impact on vulnerability to disease.

This special issue presents an integrative overview on the causes and consequences of individual differences in behavior and physiology. It includes original contributions by scientists who were lecturers at an international conference entitled 'Individual differences in behavior and physiology: causes and consequences', held at the Ettore Majorana Center for Scientific Culture (Erice, Sicily, Italy; October 2003). The presentations and discussions followed the pedagogical style workshop model espoused by the International School of Ethology chaired by Prof. Danilo Mainardi.

This issue begins with an introductory paper by S.M. Korte, J.M. Koolhaas, J.C. Wingfield and B.S. McEwen. They discuss different strategies of adaptation to stressors employing an integrated perspective that spans evolutionary pressures to causal explanations, and addresses cost-benefits issues to different trade-offs for health and disease.

C. Coe reviews a number of his studies performed in rhesus monkeys, which were aimed at providing information on the role of the in utero environment in shaping the ontogeny of physiological systems. The behavioral, neurobiological, neuroendocrine and immunological data presented indicate that events during fetal life can persistently influence physiology after birth and tilt the balance away from health and toward illness.

In line with this important topic, D. Maestriperi presents data obtained in female rhesus monkeys suggesting that the neurobiological consequences associated with infant abuse (including increased corticotropin releasing hormone and monoamine metabolite concentrations in the cerebrospinal fluid) play an important role in the occurrence of maladaptive behavior in adulthood, including the perpetuation of infant abuse across generations.

The paper by A. Sgoifo, T. Costoli, P. Meerlo, B. Buwalda, M.A. Pico'-Alfonso, S. De Boer, E. Musso and J. Koolhaas extend these types of psychobiological analyses to the adult organism. Their research underscores how important it is to carefully consider individual differences in aggression and the context in which aggression is expressed, when studying cardiovascular consequences of social interactions in rodents.

A. Bartolomucci, P. Palanza, P. Sacerdote, A. Panerai, A. Sgoifo, R. Dantzer and S. Parmigiani combine together their respective expertise in ethology, physiology and immunology to review a multifaceted set of data, and to share their thoughts on the role of social factors in determining individual susceptibility to express maladaptive stress responses.

B. Buwalda, M. Kole, A. Veenema, M. Huininga, S. de Boer, M. Korte and J. Koolhaas provide compelling evidence from research on rats documenting individual

differences in the long-lasting effects of social defeat on emotional behavior, physiological stress responsivity, and serotonergic function. In addition, they describe the impact on hippocampal structure and neurophysiological remodeling.

T. Steimer and P. Driscoll focus their paper on inter-individual differences in neuroendocrine and behavioral responses to environmental challenges using the Roman High and Low Avoidance rat lines. They analyze their findings from the perspective of psychogenetic selection, and suggest that environmental influences (notably early environmental factors) are the main cause of variability, with the genotype only constituting a ‘blueprint’.

A genetically modified mouse line, namely the NPY Y1 knockout mice, is the tool used to investigate behavioral/physiological differentiation by T. Costoli, A. Sgoifo, D. Stilli, G. Flugge, W. Adriani, G. Laviola, E. Fuchs, T. Pedrazzini and E. Musso. Their paper depicts somatomotor and cardiovascular responses to social and non-social challenges and relates them to central alpha2-adrenergic rearrangement due to NPY Y1 receptor deletion.

Employing a more theoretical and conceptual model, C. Hemelrijk and J. Wantia suggest that differences in dominance and the likelihood of individuals to be spatially central within a group may arise through lawful rules of self- and group-organisation. According to their computer simulations and statistical analyses, the models they generate resemble phenomena described for societies of birds, mice, pigs, and primates.

G. Groothuis and C. Carere provide a unique contribution to our understanding of the nature, epigenesis and function of behavioral profiles in birds. They focus on both social and non-social behavioral differences and suggest that variation in selection pressures in time and space and assortative mating are plausible mechanisms accounting for the maintenance of different behavioral profiles within the same population.

E. Natoli, L. Say, S. Cafazzo, R. Bonanni, M. Schmid and D. Pontier examine behavioral and immune variation in feral domestic cats living in semi-natural groups in an urban environment. Their data show that the ‘bold’ attitude is linked to the benefit of a high annual reproductive success, but also poses a high risk to be infected by the feline immunodeficiency virus (FIV).

A. Troisi brings the concept of alternative strategies into the fields of psychiatry and clinical psychology, and applies these ideas to advance our understanding of psychopathology. Behavioral syndromes such as the antisocial personality and insecure attachment, usually classified by traditional psychiatry as mental disorders or emotional disfunctions, are viewed as different strategies potentially oriented toward resource acquisition and even reproduction. Troisi suggests that the application of this innovative point of view can offer us a powerful alternative perspective to the growing tendency to medicalize many normal aspects of human diversity.

M. Battaglia discusses the role of the cholinergic cortico-lymbic circuitry and that of the hypothalamic-pituitary-adrenocortical axis in anxiety and panic disorders. His review underlines the importance of considering endophenotypes of biological and evolutionary relevance when approaching individual variation in psychological health.

The paper by M.A. Picó-Alfonso deals with the effects of intimate partner violence on women mental health. It shows that the risk to develop posttraumatic stress disorder varies among individuals depending on the relative amount of physical, sexual and psychological abuse. In particular, the author provides data supporting the idea that the psychological component of intimate partner violence is the major predictor of this anxiety disorder.

A. Salvador examines neuroendocrine and autonomic effects of competitive social situations in humans and suggests that it is the coping style displayed by the person that influences the hormonal changes, even more than the actual outcome of winning or losing the competition.

We are truly grateful to the authors for their contributions to our collective enterprise and to the director of the School of Ethology—D. Mainardi—for his enthusiasm in supporting the planning of the workshop. We also want to express our gratitude to F. Cirulli, E. D’Angelo, S. De Boer, D. Ely, H.P. Lipp, P. Palanza, P. Sacerdote, R. Sapolsky and T. Weaver who helped reviewing the manuscripts.

It is far beyond this special issue to provide a complete overview of present day knowledge on these important and diverse subjects. Nonetheless, we sincerely hope that the readers will be able to reap as many stimulating ideas as did the workshop delegates—lecturers and PhD students—through the insightful observations and passionate discussions in the magical atmosphere of the ancient town of Erice in Sicily.

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