The impact of early life environment and (epi)genetics on animal cognition using a neuroepigenetic approach

Cognition has a major influence on species' ability to adapt to environmental circumstances and thereby may affect their reproductive success and survival. Cognitive development is strongly influenced by the amount of cognitive stimulus experienced, especially during early life. The environment may determine the opportunities to learn as well as what is important to learn given the circumstances. Besides the environment, cognitive ability is also partly genetically determined. Genetic variation in cognitive ability may explain part of the cognitive differences within and between populations. Additionally, the environment may alter gene expression, resulting in epigenetic chromatin modifications that can influence behaviour and physiology, including cognition. Many domesticated species have for generations been artificially selected to cope with stimulus poor conditions such as cages, and this may have reduced some of their cognitive complexity in order for them to cope with their environment. Cognition may therefore also be subject to an interaction between genetics and the environment, i.e. genotype-by-environment interactions. How cognitive ability relates to fitness may thus depend on the environment, (epi)genetics and their interaction. The extent to which these factors affect cognitive development is largely unknown or inconclusive; especially for large mammals including those used as model for human neurological disorders. The **project goal** is to assess the effect of environmental conditions, (epi)genetics, and their interaction on the cognitive abilities of a model species (Sus scrofa), and its subsequent association with traits related to fitness. The main **hypothesis** is that a stimulus poor environment and strong domestication have an additive effect on each other which results in reduced cognitive ability, in particular reduced spatial memory. This effect may be mediated by epigenetic changes. Cognitive neuroepgenetics is a relatively new and interdisciplinary field of science that combines cognitive sciences, epigenetics and neuroscience, and is a suitable approach to address this hypothesis. The **research topic** of cognitive neuroepigenetics is timely and novel, and will allow to extrapolate research outcomes across different fields of science and thereby increase the study's relevance. Pigs (Sus scrofa) are frequently used as a model for human physiology, especially in neurosciences. Using pigs enables to create a strong genetic and environmental contrast while maintaining translational value. The first aim (**Aim 1**) is to assess how the early life environment influences cognitive performance in a spatial memory test and a social cognition task. A contrast will be established by keeping animals (n=80) in either a stimulus poor or stimulus rich environment. The epigenetic profile of these animals will be analysed, while 48 of the females will continue to have their own offspring, which will be subjected to the same epigenetic analysis. This allows to assess genetic variation, as well as potential epigenetic effects on cognition (**Aim 2**). A separate trial aims to investigate the genotype-by-environment interaction on cognition (**Aim 3**). Here, a contrast in genetics will be created by comparing the cognitive performance of offspring (n=80) from strongly contrasting breeds. Piglets will be born in the same environment but raised in either a stimulus poor or stimulus rich environment (creating a 2×2 design). Cognitive performance will be related to later life reproductive success and telomere length (which reflects longevity and relates to cognition) as measures of fitness (**Aim 4**). A strong international collaboration with experts on epigenetics, cognitive sciences and neuroscience, including a six month internship, will provide a solid foundation for the interdisciplinary approach. The **expected results** are databases, scientific publications, conference abstracts and media exposure. The large volume of data and samples that will be collected will allow to address many related questions in the future and therefore provides a base for continued research. Overall, the project is expected to result in increased knowledge on how the interrelation between the environment, genetics and epigenetics affects cognitive abilities, and how these relate to fitness traits.