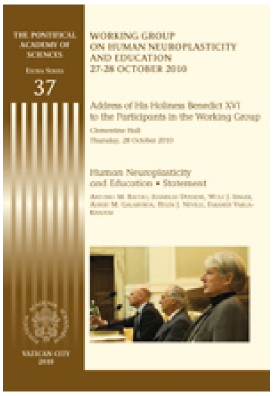
Human Neuroplasticity and Education



Statement of the Working Group on Human Neuroplasticity and Education (27-28 October 2010)

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Statement – The methods of brain and cognitive sciences have reached a stage such that we can now objectively monitor the developmental trajectory of the child's brain and document how this trajectory is being shaped by parenting, education and other environmental influences. Non-invasive brain imaging methods can now be used, together with behavioral measurements, to examine the development of infant cerebral and mental organization and its growth. The results reveal both a highly structured early organization of brain networks for language, with hemispheric specialization, and its very fast maturation in the first months of life, which can now be indexed by objective measurement. Brain maturation continues in adolescence and early adulthood, with remarkable changes in the dynamic interactions of distributed brain regions. The initially rather diffuse networks become more segregated and focused. The genetically determined layout of the connection architecture provides a universal neural platform, shared by all humans, but which will be later shaped by specific cultural experiences. Schooling, in particular, is a major event in children's lives. Brain imaging results reveal the great impact caused by early education to domains such as language, literacy, arithmetic and reasoning. For instance, the brain of illiterate adults differs in several clearly identifiable features from the brain of alphabetized adults. The brain changes induced by education are made possible by the remarkable adaptivity that characterizes the developing brain. It results from the fact that brain development is associated with a continuous formation and removal of neuronal connections, whereby experience determines which connections get consolidated. This extensive neuroplasticity is revealed in a particularly salient way by extreme cases such as hemispherectomized children. Another example comes from studies of blind children, where the intact but deprived visual cortex begins to respond intensely to touch, including Braille reading. Even in the normally developing brain, similar processes of "cortical recycling" are occurring also during normal development, as the novel acquisitions of reading and mathematics invade evolutionarily older cortical regions and reorient their operation towards the specific processing of new human inventions such as numbers or the alphabet. Plasticity is massive in the child's brain, but continues to exist in many if not all brain pathways throughout life – brain-imaging shows, for instance, that adult alphabetization courses lead to brain changes that are similar to those seen in schooled children who learned to read during childhood. Recent evidence indicates that neural pathways, dendritic trees, synaptic pruning and even gene expression are being modified in millions of neurons as a function of learning experience. The conditions under which learning occurs in young children are being clarified. Experiments in second-language learning demonstrate that passive exposure to language is ineffective – social interaction with an active tutor is essential. These experiments emphasize the importance of teachers and families as providing a social environment optimally conducive to learning. Early intervention programs that teach both children and parents the principles of attention focusing can be highly effective. These early interventions seem to be particularly effective for socially and economically deprived children and therefore have

a potential to bring greater equity and justice to the education system. Synaptic and genetic mechanisms of mental retardation are being elucidated in specific genetic disease such as fragile X, to such an extent that the tools of molecular medicine begin to open new strategies for possible intervention. Neuroplasticity begins at the point when the brain is beginning to be formed, before birth, and genetic variations or mutations, as well as early environmental influences, can lead to brain changes that may explain why some children develop learning disabilities. The cognitive science of education is leading to novel tools for assessing the progress of individual children and for detecting possible difficulties, hidden disabilities as well as individual differences. This can lead to new interventions specifically tailored to a given child. The use of adaptive computer software and online tutoring, carefully adjusted in difficulty, can play a special role here. In summary, the bridges between brain science and education are numerous and quickly developing. Neuroplasticity is the key bridging process, and its molecular, neuronal and brain-wide mechanisms should be better investigated in the future. However, the state of scientific knowledge is already sufficient to conclude that investment in early education can have a profound impact on brain organization throughout life and therefore on health, economy, and social justice. While these insights concern mainly the development and acquisition of instrumental abilities, little is known to date about the mechanisms through which moral values, rules of social conduct and dispositions for ethical behavior are installed by education. Since these properties and abilities are also of utmost importance for the future of mankind, intensification of research in this domain is considered an important desideratum.

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