



**Karolinska  
Institutet**

**Institutionen för Neurovetenskap**

# Probing and pushing potential genetics, development and training of cognitive functions

**AKADEMISK AVHANDLING**

som för avläggande av medicine doktorsexamen vid Karolinska  
Institutet offentligen försvaras i Andreas Vesalius, Berzelius väg 9.

**Fredagen den 8e juni 2012, kl 9.00.**

av

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**Stockholm 2012**

## ABSTRACT

Capacities of cognitive functions increase considerably during childhood and adolescence. This development is of importance as poor development can predict lower performance on academic skills. Furthermore, severe impairment is related to symptoms of many neuropsychiatric disorders such as attention deficit/hyperactivity disorder (ADHD). These observations have led to a great interest within the research community to understand 1) underlying mechanisms that influence cognitive development, and 2) factors that can improve cognitive capacity. This thesis aims to increase understanding of these topics, focusing on two specific cognitive functions: working memory (WM) and non-verbal reasoning (NVR).

**Study I** investigated the effects of polymorphisms within certain candidate genes on WM performance and also brain function and structure in a sample of typically developing children and adolescents. We found that a polymorphism within the *SNAP25* gene was significantly associated with WM capacity, ADHD symptoms in males as well as activity and grey matter density within the posterior cingulate cortex. This brain activity in turn correlated with degree of ADHD symptoms. Brain activity significantly predicted ADHD symptoms two years later.

**Studies II and III** investigated how reasoning ability and WM can be improved with training. Study II assessed a newly developed NVR training programme in combination with a previously studied WM training programme in a sample of typically developing 4-year-old children. Training NVR resulted in significant improvements in performance on a measure of fluid reasoning and training of WM significantly improved performance on WM measures. There was limited transfer between the two different functions. Study III assessed the same training programme in children with intellectual disability. In this group, there was a large variance in progress observed during training and we found that this variance was important for predicting improvements following training. Baseline capacities, gender, and co-morbidity with additional diagnoses predicted the degree to which the children with intellectual disability improved during training. The study findings highlight the importance of inter-individual differences for understanding the effects of cognitive training.

Finally, **Study IV** showed that variations within a gene coding for dopamine transporters is associated with inter-individual differences in the degree of improvements observed after cognitive training.

Together, these studies illustrate that the genetic variants we are born with influence the development of our brains and cognitive abilities, and that this development can be influenced by environment and experience such as cognitive training. Importantly, genes and environment interact, with our pre-determined genetic setup influencing our susceptibility to environmental influence.