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Genes and Behavior in Preschool Children: The Relation between Dopamine Genotype and Latent Executive Control

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Dopamine and Executive Control

- Dopaminergic neurotransmission is implicated in the executive control of cognition and behavior (Braver & Cohen, 2000).
- The prefrontal cortex is thought to modulate activity in other brain regions through “bias signals” boosting activation of task-relevant neural pathways, likely through the action of dopamine (Montague, 2004).
- A number of studies have found associations between executive control and dopamine-related candidate genes, likely because of variation in the availability of dopamine in the synapse and/or efficiency of dopaminergic neurotransmission (Casey, 2002; Roess-Ely, 2005).
- Furthermore, dopamine genotype has been found to relate to attention problems and attention deficit/hyperactivity disorder (ADHD; Faraone, 2005).
- A better understanding of how variation in dopamine genotype relates to children’s regulation of attention and behavior has significance for clinical practice and possible intervention.

Dopamine Gene Alleles associated with Risk

- **COMT** (catechol-O-methyltransferase): The low-activity genotype is a risk factor for ADHD and other attention problems.
- **DRD2** (dopamine D2 receptor): Low activity and non-competitive activity are risk factors for ADHD.
- **DRD4** (dopamine D4 receptor): A long allele is associated with impulsivity, higher risk of ADHD, and lower cortisol levels.
- **DRD5** (dopamine D5 receptor): Low activity is associated with lower attentional control and negative affect.
- **DRD3** (dopamine D3 receptor): Low activity is associated with lower attentional control and negative affect.

**Genes and Executive Control: Model 1**

- **First**, a summary variable was calculated by simply adding up “risk scores” for all dopamine genes of interest.
- **This risk score was used to predict latent executive control.**
- **Age** was also included as a covariate, to account for age differences in executive control.

**Genes and Executive Control: Model 2**

- To look at the contributions of individual genes, individual dummy variables were used to create a latent Genetic Risk variable, in a Multiple Indicator Multiple Cause (MIMIC) model.
- **This model also demonstrated good fit to the data, as evidenced by a non-significant chi-square test.**
- **As shown by the loadings of the individual genetic risk dummy variables on the Genetic Risk latent variable,** the effect can be largely attributed to DRD2 and COMT, as model results do not change substantially when DRD4 and DAT are dropped.

**Discussion**

We observed a relationship between dopamine genotype risk score and latent executive control in preschool children:

- Children with alleles of dopaminergic genes that have been previously shown to relate to poorer outcomes had lower values on an Executive Control latent variable.
- This effect seems to be specific to DRD2 and COMT.

This study also further demonstrates the utility of a latent variable approach in the study of preschool executive control.

**Method**

- **133 preschool children (mean age 4 years 1 month, range 2.5 to 6 years)** were administered an executive control battery that included the following tasks: Delayed Alternation, Continuous Performance Task, DAS Digit Span, Delayed Response, Six Boxes, Shape School, and Tower of Hanoi.
- **Children were assigned dummy codes of 0 or 1 for each gene, where 1 indicated the presence of the “risk allele.”**

While this model demonstrated good fit to the data, the effect of genetic risk did not reach significance (p = .15), although the effect was in the predicted direction (higher genetic risk was related to poorer executive control).