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Genetic Bases of Executive Control in Preschool Children: Trails-P Performance is Related to DRD2 Genotype

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Dopamine and Executive Control

Miller and Cohen’s (2001) model of executive control emphasizes the prefrontal cortex’s modulation of activity in other brain regions through “bias signals” boosting activation of task-relevant neural pathways, likely through the action of dopamine (Montague, 2004).

Miller and Cohen’s (2001) model of executive control

For errors, there was a significant interaction between condition and genotype: F(2, 88) = 3.92, p < .05

The effect of genotype was insignificant for the Control condition (p = .44), marginal for the Switch condition (p < .10) and reached significance for the Inhibit condition (p < .02)

Main effects of genotype and condition were not statistically significant (p > .20)

Method

91 preschool children (mean age 4.3 years, range 2.5 to 6 years) were administered the Trails-P task as part of an executive control battery

Children were genotyped on the DRD2 TaqA polymorphism from cheek swabs obtained using a preschooler-friendly “lollipop game” procedure (Espy, 2002)

Children were classified as DRD2 A1 carriers (A1A1 or A1A2) or non-carriers (A2A2)

Demographic information for the full sample and the 2 genotype groups is presented in the table

Results: Errors

For errors, there was a significant interaction between condition and genotype: F(2, 88) = 3.92, p < .05

The effect of genotype was insignificant for the Control condition (p = .44), marginal for the Switch condition (p < .10) and reached significance for the Inhibit condition (p < .02)

Main effects of genotype and condition were not statistically significant (p > .20)

Discussion

DRD2 genotype contributes to variation in executive control in young children, as indexed by the Trails-P task.

Deficits in executive control in DRD2 A1 carriers may be related to lower availability of dopamine receptors associated with this genotype.

For errors, gene-related differences were observed only for the Inhibit and, to a lesser degree, Switch conditions.

However, for response latencies, gene-related differences were seen across all 3 conditions, even though the Control condition was intended as a non-executive baseline

It is possible that, for young children, even the control condition (sequencing dogs based on size) involved executive control.

Problematically, faster latencies were observed for more challenging conditions; this may be because children with strong executive control deficits may have been less likely to complete the later conditions because of difficulties understanding or complying with task instructions.

Furthermore, genotype groups differ somewhat in SES and parental education.

More work is necessary to test for replication in a larger sample, examining the contributions of gene-environment and gene-gene interactions to executive control development

References


The Preschool Trail-Making Test

In the Trail-Making Test, subjects connect stimuli on a page in sequence

Condition A (Control): Subjects connect letters only

Condition B (Switch): Subjects alternate between letters and numbers

This task is sensitive to frontal dysfunction (Reitan, 1955)

Because preschool children are still learning literacy skills, the adult version of the test is not a valid test

In the Preschool Trail-Making Test (Trails-P), stimuli are a family of 5 dogs that vary in size (Espy, 2004)

Children complete the task by using a happy face stamper to mark stimuli in order from smallest to biggest

Condition A (Control): Children stamp dogs only

Condition B (Switch): Children “feed” dogs by stamping dogs and bones alternately

Condition C (Inhibit): Children stamp dogs only (ignore bones on page)

Results: Response Latencies

For latencies, there was a significant effect of genotype: F(1, 88) = 4.14, p < .05

There was also a main effect of condition: F(2, 88) = 6.76, p < .005

Tukey tests revealed that all the Inhibit condition differed significantly from the Control condition (p < .005), and marginally from the Switch condition (p < .10). The interaction between genotype and condition was not significant: F(2, 88) = 1.91, p > .15

All analyses included age as a covariate to control for developmental differences in Trails-P performance

Children were included if they completed at least one condition of the Trails-P task

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