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Dopamine Genetic Scores Modulate Positive Reinforcement Learning in Healthy Undergraduates

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Background: Dopamine has been implicated in modulating reinforcement learning from positive and negative feedback. Enhanced dopamine levels are linked to better learning from positive feedback, whereas decreased dopamine mediates learning from negative feedback. Naturally-occurring variations in dopamine genes contribute to individual differences in reinforcement learning. Dopamine exerts its actions via proteins located pre- (D2 receptors), within- (transporter), and post-synaptically (D1 and D2 receptors) to regulate dopaminergic function.

Objectives: In our study, we created a dopamine genetic score based on the effects of naturally-occurring functional polymorphisms in the aforementioned D1, D2, and dopamine transporter genes to highlight individual differences in dopamine functionality.

Methods: We recruited 423 healthy undergraduates from Al-Quds University. All participants completed a computer-based probabilistic reinforcement learning task that dissociates positive and negative feedback. We divided participants into low, medium, and high dopamine groups according to their dopamine genetic scores.

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Results: Dopamine scores exhibited a normal distribution in the recruited sample. For each participant, we analyzed learning accuracy and response time for positive and negative feedback, prior trial type (positive, negative), and prior trial feedback (positive, negative, no feedback). Consistently across all analyses, results indicate that participants with higher dopamine scores have the highest learning accuracy from positive feedback accompanied by the shortest response time for both positive and negative feedback. To rule out single gene effects we performed a leave-one-out analysis by removing one polymorphism at a time from the dopamine score; the results remained consistent. Thus, the observed effect of the dopamine score is not driven by a single polymorphism.

Conclusion: Our results highlight the importance of examining the collective variations in the dopamine circuitry as opposed to single nucleotide polymorphisms. Dopamine genetic scores can be significant in understanding the pathophysiology of psychiatric disorders that are related to dopamine, such as major depressive disorder and attention-deficit hyperactivity disorder.

Research Keywords: Dopamine, genetic score, naturally-occurring genetic polymorphisms, reinforcement learning, positive feedback, negative feedback.

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