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VISUAL MOTOR CONTROL IN PATIENTS WITH PARKINSON'S DISEASE

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Although previous studies have suggested deteriorated visual motor control in patients with Parkinson disease (PD) is likely due to deficits in both the motor and perceptual systems, no study has directly measured such deficits and how antiparkinsonian medication improves visual motor control in PD patients. Here we took a control-theoretic approach to address these issues. We tested 20 PD patients ON and OFF medication and 20 healthy controls with a typical manual control task. Specifically, in each 90-s trial, participants were instructed to use a joystick to control the movement of a red target to keep it centered on a CRT display (37°Hx21°V) as its horizontal position was perturbed by the sum of seven harmonically-unrelated sinusoids (0.1-2.19Hz). The time series of target position and joystick displacement were Fourier analyzed and averaged across six trials. The performance data were fit by an extensively validated Crossover Model (McRuer et al., 1965) to evaluate the deficits in PD patients' perceptual processing and motor control. We found that although antiparkinsonian medication improved visual motor control in PD patients, they still showed significantly decreased control precision (measured by RMS error) and response amplitude (gain) as well as increased response delay (phase) compared with the controls. Our model based analysis showed PD patients' deteriorated visual motor control was due to (1) impaired perceptual sensitivity to input visual information for online motor control, (2) impaired perceptual ability to anticipate the input error to generate control ahead of the error signal, and (3) decreases stability of the neuromuscular system. Surprisingly, antiparkinsonian medication improved the former two but did not help the latter, suggesting that the effect of the medication on visual motor control is primarily through improving perceptual processing. The findings have practical implications for developing assessment tools to evaluate the efficacy of different therapies for PD.

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