"Ocular Tremor" in Parkinson's Disease: A Technology-dependent Artifact of Universal Head Motion?

Gitchel and colleagues recently claimed to have detected a characteristic ocular tremor in Parkinson's disease.[1] Our reaction was skeptical. Having published many oculomotor studies in Parkinson's (including the only one to have a larger number of participants[2]), we are confident, as are others,[3] that we would have observed the phenomenon if it had the described characteristics (including on fundoscopy). We concur that the most parsimonious explanation is an artifact due to vestibulo-ocular reflex (VOR) compensation for head movement.[4,5] Gitchel et al used a magnetic tracker in a subset of patients to attempt to rule out such small-amplitude head tremor. We suspect that their trackSTAR system was not sufficiently sensitive for this task, as its adaptive filter is applied most aggressively in the presence of only small-amplitude rotations. Indeed, even if their hypothesis is true, at least *some* of their patients should have had detectable head motion (we not infrequently observe it in ours). With our older equipment (Skalar IRIS head-mounted limbus tracker; Skalar Medical BV, Delft, the Netherlands), such VOR artifacts in people with Parkinson's tremor could not readily be distinguished from actual gaze change, as such systems measure eye position relative to the head, rather than gaze position relative to the environment. This artifact would persist despite the use of a bite bar to stabilize the head. With modern video-oculography, however, such artifacts can often be eliminated entirely because, as well as tracking the pupil, these systems measure the position of the Purkinje reflection from the corneal surface (avoiding the difficulties of synchronizing and co-registering separate eye and head tracking systems[3]). This allows substantial head movement artifacts to be removed, even while permitting the head to be unrestrained (see Fig. 1).

The EyeLink-II system (SR Research Ltd., Kanata, Ontario, Canada) described by Gitchel et al provides corneal reflection compensation, but only when sampling at 250 Hz.[6] The manufacturer recommends using this mode to reduce "errors caused by headband slippage, muscle tremor, or environmental vibration."[6] However, Gitchel et al recorded at 500 Hz. We suggest that it is not wise, in a movement disorder population, to trade a form of head-motion correction for (an unnecessarily) higher sample rate. EyeLink provides another head-motion correction option, using external optical landmarks. The authors do not describe whether this was used and provide no evidence that their magnetic head tracking was as effective as the motion-correction mechanisms available within the eye tracker itself.

Although probably misinterpreted as "ocular tremor," the data nonetheless may be serendipitously interesting. These VOR recordings effectively may have been a very sensitive proxy measure of a universal subclinical somatomotor tremor in their patients (only two of 60 controls showed such an oscillation, one of whom subsequently developed parkinsonian features). Electromyography has revealed rhythmical muscle activity in people who have Parkinson's but no clinically apparent tremor.[7] If the demonstration of universal (or at least highly prevalent) tremor by Gitchel et al can be replicated, then they may have unintentionally re-vindicated James Parkinson's original conception of the disorder as the "shaking" palsy.

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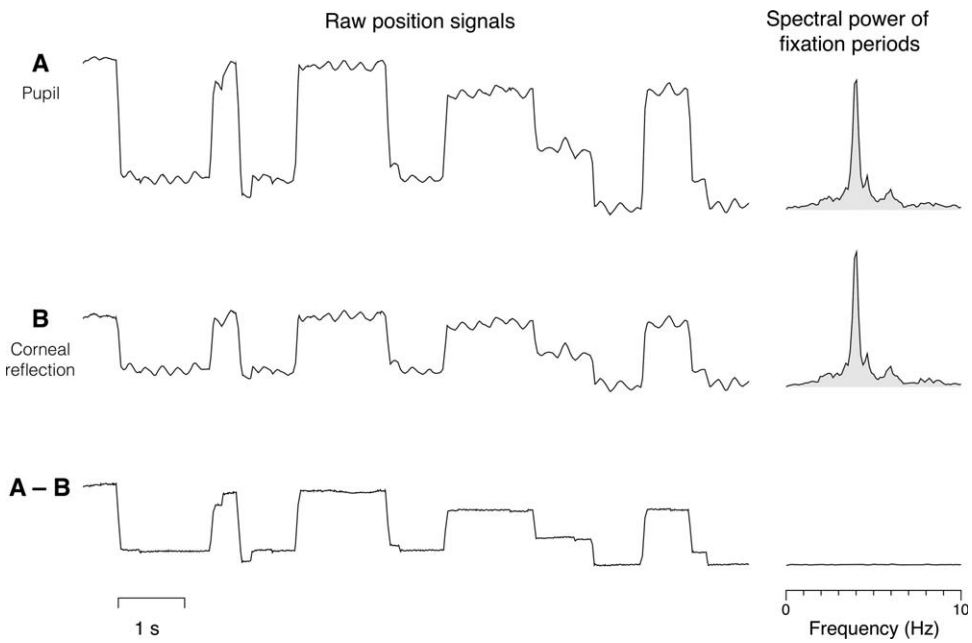

FIG. 1. Horizontal reflexive saccades and fixations made by a 70 year old woman with Parkinson's disease (data were recorded with an SMI iView X Hi Speed 1250 Hz eye tracker; SensoMotoric Instruments GmbH, Teltow, Germany). While seated at the eye tracker, the clinically evident tremor of her arm appeared to be mechanically transmitted to her head, which was placed unrestrained on a chin rest. **A:** Raw position of the center of the pupil, clearly showing a superimposed sinusoidal oscillation. Fast Fourier Transform (FFT) analysis revealed a clear peak of power at approximately 4.0 Hz, in the typical range of parkinsonian tremor. The FFT was restricted to the fixation periods to remove frequency components due to saccades. **B:** The position of the first Purkinje reflection from the cornea. The pupil center and corneal reflection move differentially in response to pure eye rotation but together in response to the translation due to head movement. This signal also shows a clear peak in power at 4.0 Hz. **A – B:** Simply subtracting B from A provides a signal related to the true direction of eye gaze in space and entirely abolishes the tremor-related component. Despite substantial head movement, the eyes are now seen to be very stable in space during the fixation periods due to effective stabilization by the vestibulo-ocular reflex. This corneal reflection correction was not used by Gitchel et al.