OCULAR TORSION: ROTATIONS AROUND THE "WHY" AXIS

To the Editor: In his Costenbader Lecture, Dr. Kushner depends on a literature review, analysis of his previous experiments, and inductive and deductive reasoning to present a theory on why torsional movements occur: the so-called "anticompensatory saccade" theory. According to this theory "anticompensatory saccades" are necessary to eliminate most of the counterrolling of the eye at the end of the head tilt to preserve convergence and stereopsis.

The eyes can move independently of the head, but when the head moves, the eyes always move in space or in the orbits or both. With the head held steady in any position in space, the eyes do not rotate around the visual line (Kushner's "WHY" axis) in any direction of gaze or in convergence. The orientation of the eyes is constant for any given gaze direction regardless of the route the eye takes to reach that direction. This is Donders' Law, which has been confirmed with numerous after-image tests and contemporary video tracking experiments.

How the eyes respond to head tilt is the controversy. Kushner, and practically every other investigator in ocular motor physiology, believes that when the head tilts there is a static compensatory ocular counterrolling. For example, when the head tilts 45°, the eye rotates around the visual line less than 45°. How much less the eye rotates than the head tilts differs from investigator to investigator.

A device was employed to investigate the response of the eyes to head tilt that maintained synchrony between the eyes and the head, while allowing the head to move freely. It was found that during head tilting in normal subjects there are intermittent torsional movements (rotations around an anterior–posterior axis), but when the head comes to rest in any position, there is no static counterrolling of the eyes. The retinas are in dynamic equilibrium with the brain and each other in all gaze directions and in all positions of the head in space. Kushner's theory of "anticompensatory saccades" is based on a phenomenon that does not exist.

Videos of some of my experiments demonstrating the absence of ocular counterrolling may be viewed on my web site: www.rsjampel.com.[1-4]

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REPLY

To the Editor: Dr. Jampel is to be commended for the important contributions he has made to our understanding of ocular torsional movements. All of us who are interested in this subject have benefited from his observations. Nevertheless, his conclusion that static compensatory ocular counterrolling does not occur after head tilt is inconsistent with numerous facts and observations.

The fact that it really does occur can be easily appreciated by any observer using a simple afterimage experiment.[1,2] The experiment requires access to an afterimage strobe as is typically used to test for anomalous retinal correspondence, a Maddox rod or Bagolini lens, and a trial frame. With one eye occluded, a vertical afterimage is created on the retina of the subject. This afterimage will then continue to mark the meridian between 12 o'clock and 6 o'clock retina regardless of the position of the eye or the amount the head is tilted. While the subject appreciates the afterimage, a Maddox rod or Bagolini lens is placed in a trial frame in front of the eye being tested and the subject looks at a fixation light. The Maddox rod or Bagolini lens is then rotated so that the line that it creates on the retina appears to the subject to be exactly superimposed on the afterimage. If the subject then tilts his or her head, both lines will be seen to move with the head. However, in the steady-state position at the end of head tilt, it will be evident that the line created by the afterimage will appear to have lagged behind the line created by the lens and the trial frame. This indicates the eye did not rotate as far as the head. By rotating the lens in the trial frame until the lines are again superimposed, one can quantify the amount of compensatory ocular countertorsion that occurred. It is typically 5 to 10 degrees, depending on the magnitude of the head tilt. I suggest all readers interested in this issue to try this simple experiment themselves. The results should be completely convincing, even to the most diehard skeptics. In a prior Letter to the Editor regarding Dr. Jampel's work, I described this experiment and suggested that readers (including Dr. Jampel) try it for themselves.[2] Regrettably, in that letter I only described performing the experiment using a Maddox rod and did not indicate that it is equally impressive when a Bagolini lens is used. In his reply to my letter, Dr. Jampel dismissed this observation with the contention that the use of a Maddox rod "disrupts the fusion reflex and uncovers a