Spatial computations in the perception of vertical visual motion and line verticality during whole-body tilt  
M. de Vrijer\textsuperscript{1,2}, W.P. Medendorp\textsuperscript{2}, J.A.M. Van Gisbergen\textsuperscript{1}  
\textsuperscript{1}Biophysics, \textsuperscript{2}Institute for Cognition and Information, Radboud University Nijmegen, The Netherlands

Introduction  
To compute the absolute direction of visual motion, the brain must combine retinal motion and head-tilt signals. Can it perform this spatial computation? Studies have shown systematic errors when tilted subjects estimate the orientation of a visual line in space. Here we asked whether the world-centered perception of visual motion direction in tilted subjects is subject to similar errors.

Adjustment tasks  
Subjects (n=8), roll-tilted at various angles (\([-120°, 120°]\)), adjusted the direction of a moving random-dot pattern (motion task) or the orientation of a line (line task), to the perceived direction of gravity. Stimuli were shown on a head-fixed screen (\([8°, 14°]\)). Left: polarized line Right: random dot pattern (30% coherence), moving at 6°/s.

Results adjustment tasks  
1. Undercompensation for tilt in both tasks  
2. Comparison of systematic errors  

In all subjects, systematic errors were virtually identical in the two tasks. This suggests identical computations for world-centered line and motion vision. Potential caveat: In the motion task, subjects could conceivably imagine single dots as moving along a virtual line, whose orientation in space was handled as in the line task.

Control experiment  
4. No line strategy in motion task  
Subjects (n=4) judged the direction of either a moving random-dot pattern (global motion task) or a single moving dot (local motion task), using a 2AFC-paradigm. Performance in local motion task was much worse than in global motion task; subjects must have used spatial integration.

Bayesian interpretation  
We tested whether a Bayesian observer model could account for the systematic and random errors in the adjustment tasks.

Modeling results  
The model is based on the following assumptions:  
- Visual noise is orientation and direction independent  
- Tilt noise increases with tilt angle  
- Prior on tilt angle  
- Response based on maximum of posterior distribution (MAP)  
- Eye torsion was ignored

Conclusions:  
- Systematic errors in line and motion subjective vertical are virtually identical.  
- Bayesian model explains size and task independence of systematic misjudgments.  
- This framework ascribes variations among subjects to differences in tilt noise.