A new stimulus for isolating optokinetic eye movement from smooth pursuit

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The traditional small-field optokinetic stimulation with an optokinetic drum or a striped tape would elicit regular eye movement pattern without apparent self-motion. However, this kind of stimulation activates both the pursuit and the optokinetic system for eye movement. We hypothesize that the use of limited lifetime dots moving coherently in one direction would only elicit optokinetic eye movement without the involvement of smooth pursuit eye movement.

Six healthy volunteers (±30 years old) participated in three fMRI experiments. For each experiment, T2*-weighted single shot gradient echo EPI functional scans were acquired (TR/TE 3750/50 ms, matrixsize 64x64, slice thickness 4 mm) on a 1.5 clinical MRI scanner. The image data was processed with SPM2 on both single-subject and group analysis level. In the first experiment, optokinetic eye movements were evoked by a moving random dot pattern with an infinite lifetime. In the second experiment, the optokinetic eye movements were evoked by a moving random pattern of dots that have a limited lifetime (i.e. each dot was repositioned within 50ms), which effectively excludes ocular tracking by smooth pursuit. As a control condition, smooth pursuit eye movements were evoked by a single moving dot in a third experiment. In each experiment a block design was used with three conditions of 30 seconds with five repetitions: the stimulus either moves to the right, the left or is static.

Substantial cerebellum activities at the culmen of vermis and the declive of vermis were observed with the experiment using the limited life time dots as the stimulus. This suggests that the cerebellum is more involved in optokinetic eye movement as commonly known. In addition, bilateral activation at the middle temporal (MT) area, the major visual-motion information centre that guides pursuit movement, was observed only with the experiment with the full life time dots and smooth pursuit as the stimuli. Since MT (and MST) is involved in pursuit initiation (and maintenance), this suggests that the pursuit eye movement was only present using the traditional stimulus for optokinetic stimulation and smooth pursuit stimulation, but not when limited lifetime dots are used as stimulus for optokinetic eye movement.

Our study has, therefore, revealed evidence that the use of moving limited lifetime dots as stimulus elicits only optokinetic eye movements without the involvement of smooth pursuit eye movements.