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A computational neural network model of perisaccadic mislocalization in total darkness

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Normally, visual space is perceived as stable across eye movements, but under certain conditions it becomes illusory. We are proposing a computational neural network model to explain a misperception called "perisaccadic shift" which occurs typically in complete darkness. In early visual areas, space is represented in retinotopic coordinates. Models for this misperception have to explain how stimulus position information is transformed into head-centered coordinates [1]. We are improving on existing models by integrating behavioral as well as numerous neurophysiological constraints and explain new empirical data [2].

Classically, the *subtraction theory* assumes a continuous *extraretinal eye position signal* (EEPS), which, if it is tuned perfectly to the eye movements, compensates any saccade-induced movements of stimuli on the retina. The perisaccadic shift illusion suggests that the stipulated EEPS does not follow the eye movements perfectly. Experimental findings indicate that the time course of the EEPS is much smoother than the actual eye movements [1,3]. A major problem of the continuous EEPS is that there has been no neurophysiological evidence for it so far.

Our model uses a much more realistic "*binary*"*eye position signal* which does not represent the continuous movement of the eye but only its start and end positions (thus it is *binary*) [4]. When the eye is at rest, there is an eye position signal representing its position. At a time t_1 before or during a saccade this signal goes off while at another time t_2 the signal for the eye position after the saccade goes on. This eye position signal is accompanied by a phasic corollary *discharge signal* that encodes the saccade target. Coordinate transformation is achieved by a basis function network [5] that is embedded in a fully dynamic model. We followed the experimental procedure in [2] and tuned the timing parameters of the binary eye position signal to fit the experimental data.

We show that our model is able to reproduce for the first time all experimental findings, while it is based on much more realistic assumptions than previous models. In particular, we show that a) a continuous EEPS is not necessary, b) both an EEPS *and* a corollary discharge signal are necessary and c) a basis function network can well explain the experimental data.

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