Supplementary Materials

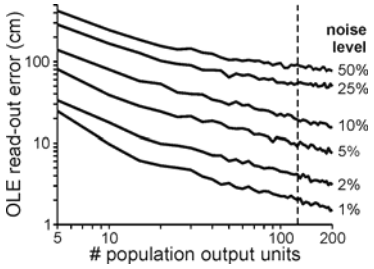
Performance of the optimal linear estimator

In this section we describe our analysis of the influence of white noise in the population output (3rd) layer units on the Optimal Linear Estimator (OLE) read-out (Salinas and Abbott, 1994). This analysis determined our choice of the number of population output (3rd) layer units in the neural network model. The goal was to find the best possible number of units for this layer, while keeping this number as small as possible to minimize computational cost and at the same time having a large enough number to obtain meaningfully accurate read-out results in the presence of white noise on the unit activity. We assumed that small fluctuations on a unit's activity level due to small variations in the afferent connections and signals could be considered as "noise".

We performed an analysis of absolute movement read-out error for different noise levels and also varied the number of population output units encoding a given motor plan. The result of this analysis is shown in Supplementary Figure 1. The read-out error for each noise level and for each population output layer size was the mean of 1,000 randomly chosen movement vectors that were encoded using the theoretical cosine tuning properties of the units.

While the read-out accuracy increased with increasing number of population output units, we believed that above 125 units, the increase in accuracy with the layer size was too small to provide a real benefit for the study. Indeed, the larger the layer, the more computational resources are required

during training. Since even noise levels of 5% provided theoretical read-out accuracy of less than 10 cm for networks with 125 population output units, we estimated that 125 units would be sufficient in terms of obtained network precision.



Supplementary Figure 1: OLE mean read-out error as a function of the population output layer size. Results for different noise levels are shown (noise amplitude was % of signal range).

It should be noted however, that the exact number of population output (3rd) layer units is not important and does not affect our main results. In other training sessions, we used 27 or 64 units instead of the 125 units in the networks described here and the results were qualitatively identical. A larger number of units simply improved performance to be closer to that of human subjects (Blohm and Crawford, 2007).

References

Blohm G, Crawford JD. 2007. Computations for geometrically accurate visually guided reaching in 3-D space. Journal of Vision 7: 1-22.

Salinas E, Abbott LF. 1994. Vector reconstruction from firing rates. J Comp Neurosci 1: 89-107.