Principal component analysis

While a number of source estimation techniques have been developed in the past, accurate estimation of VEP from human visual experiments remains a difficult challenge. In contrast, the principal component analysis provides a means for analyzing VEP signals with much greater operational simplicity and transparency. Unlike the conventional source estimation algorithms, PCA does not require the knowledge of the source location. This is important, as the researcher can bypass the resource intensive procedures such as f/MRI retinotopic experiments, 3D digitization and co-registration of sensors, as well as solving of the inversion problems that require delicate optimization of likelihoods and priors. Developing methods for utilizing the principal components from PCA to augment or otherwise replace the conventional procedures may have a far reaching impact.

V1/V2 area sensitivity

Our results show that the failure rate of PCA is highly correlated with the subject’s V1/V2 size composition. Under ideal conditions, failure to predict V1 occurs exclusively when V2 is similar in size or larger than V1. However, it should be noted that the V1 does not seem to require large amount of size advantage for successful PCA prediction to take place. In our subject pool, given high levels of SNR and low levels of external signal source, V1 needed to be approximately 10% larger than V2 to have 100% success rate. One possible remedy for improving success rate is to present stimulus that will preferentially activate V1 over other areas.

~~Things to do: Artificially enlarge V1/V2 area ratio (or signal strengths) of failed subjects~~

External Signal

A major problem with PCA seems to be its inability to cope with external signal contamination adequately. When presented with a relatively distant parietal source at less than half the signal amplitude, the PCA failed to predict V1 for all subjects while the conventional source estimation method could still resolve 16 of 20 subject’s V1 successfully. Fundamentally, PCA and SEA works differently in that PCA does not use priors to form spatial filters to emphasize the occipital areas. When time locked activation of non-visual areas are expected, such as in studies involving attention, PCA should be avoided.