On the operation of visual cortical gamma in the light of frequency variation

Appendix

Knowledge Valorization

The work presented in this thesis was aimed to deepen our understanding of the underlying principles of cortical gamma synchronization which is a basic element of neural dynamics and computation. The work should be categorized as being ‘fundamental research’ that is directed to generate new knowledge underlying a natural phenomena. Fundamental research establishes the knowledge on which ‘applied research’ can solve concrete problems arising from society. Both, fundamental and applied research, necessitate each other and need both to be pursued equally (Poyago-Theotoky, 2002).

Because it was fundamental research, no direct valorization for society (beside increase in knowledge) can be scientifically demonstrated here. Future application-directed research will need to evaluate how this knowledge can be used for concrete problems. However, we will shortly discuss which applications fields could potentially use the insights from the thesis in a fruitful manner.

In clinical neuroscience, gamma synchronization has been discussed in the context of various psychiatric illnesses (Herrmann and Demiralp, 2005), for example in the context of psychosis/schizophrenia (Lee et al., 2003; Symond et al., 2005). It was found that gamma oscillations are profoundly affected in patients with psychosis(Haig et al., 2000). The causes of gamma oscillation deterioration is not well established nor the role of these deterioration for explaining the cognitive disabilities (Lee et al., 2003). Previous work has concentrated on gamma power and gamma coherence for investigating the role of gamma oscillation in psychotic patients. Our work suggests that frequency variations and synchronization principles (sensitivity to coupling and detuning) are critical variables for understanding how gamma oscillations operate. Future research might gain further insights by taking these variables into account.

Another example is the understanding of epilepsy which arise when brain regions get over-synchronized (da Silva et al., 2003; Parra et al., 2003; van Drongelen et al., 2005). Our work suggests that input-dependent frequency variation is critical for controlling synchronization among locally coupled neurons. Understanding the (intrinsic) frequency variations in an epileptic brain region might reveal further insights. In addition, medication or devices that increase the intrinsic frequency variation might be developed to counteract acute epileptic attacks.

The gamma synchronization principles and its linkage to the theory of weakly coupled oscillators have interesting computational properties, as described in chapter 5. For example, oscillatory synchronization has been studied as image segmentation technique and shown to be very powerful (Kuntimad and Ranganath, 1999; Kuzmina et al., 2004; Wang and Terman, 1997). It is therefore likely that the thesis work might inspire development of new or more efficient algorithms for artificial intelligence problems. For example, image segmentation (or generally as clustering algorithm) is useful for example for recognition tasks (e.g. tumor image recognition software). Further, it might help to improve significantly devices developed for blind or half-blind people (Dowling, 2005).

In summary, despite this work represents fundamental research and the benefits for society will be concretized only in the next years, it is reasonable to expect the improved knowledge will have positive effects in various applications fields including psychiatry and artificial intelligence.

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