Imaging imagery

VALORISATION

The work presented in this thesis describes neuroscientific results on the fine-grained functional organisation of brain areas in the human visual system during perception and imagery. These results are quite hard to "valorise" but rather fundamental research findings with an inherent value.

Valorisation as BCIs

In the discussions of Chapter 3 and Chapter 4, as well as in the General Discussion in Chapter 5 the possibilities of building advanced brain-computer interfaces (BCIs) that would make use of the results at hand are mentioned. If one is very eager to valorise these studies one could, indeed, try to put a 7 Tesla functional magnetic resonance imaging (fMRI) scanner into the living room of a potential BCI user and enable her to steer a computer cursor using motion imagery (e. g., a centimetre in one of four directions every 20 seconds) or imagine a letter to spell (one letter out of 'H', 'T', 'S', or 'C' every 15 seconds). This would be an extremely costly way of steering a computer cursor or typing letters, considering the costs of such an fMRI scanner. These costs and the required environment for an ultra-high field fMRI scanner make a normal usage in one's the living room frankly impossible. Furthermore, the rather low decoding accuracies for some subjects described in Chapter 3 and Chapter 4 would require many trial repetitions increasing the confidence of the BCI system to acceptable levels. The rather uncomfortable BCI user experience and the need for highly qualified personnel to operate the fMRI scanner make this BCI even more impractical. Taking into account the costs (and practical is-

sues) of an ultra-high field fMRI scanner, the bitrates (with which the BCI can translate intentions into actions), and decoding accuracies, this does not offer a competitive solution when compared to readily available BCI system like an electroencephalography (EEG) P300 speller. The direct translation of the results presented in this thesis into an fMRI-based BCI is, thus, not a very promising valorisation.

Actual valorisation as BCIs

The results presented in this thesis are, however, potentially useful in a BCI context. Neuroimaging research on mental imagery can potentially enable a future BCI system, based on a new neuroimaging technique to locate and decode the neural correlates of mental imagery in a more guided and straightforward way. It is conceivable that, e. g., more invasive neuroimaging techniques like electrocorticography (ECoG) or multielectrode arrays (MEAs), or even not yet invented (potentially) non-invasive high-resolution neuroimaging techniques would make use of the feature representations described in the studies of this thesis. The information about the fine-grained cortical organisations of feature maps during imagery could guide the development of such BCIs. Moreover, insights into inter-individual differences in imagery strategies as well as brain activations during mental imagery – as discussed throughout this thesis – are important to successfully implement any BCI system and could, therefore, also improve the performance of other non-fMRI-based BCIs.

Finally, there are medical conditions in which high-field fMRI-based BCIs can become important. Some locked-in syndrome patients (e. g., some patients with amyotrophic lateral sclerosis (ALS)) cannot successfully use BCIs based on other neuroimaging methods (e. g., EEG or functional near-infrared spectroscopy (fNIRS)). In such extreme situations when all other means of communication are lost and the quality of life is severely affected, the above-

mentioned impracticalities loose their importance. The ability to communicate with one's environment cannot be matched with costs for technical equipment. The results presented in this thesis could be used in such rare cases not only to allow the patient to communicate again but could also outperform BCI results based on conventional fMRI data (e. g., 3 Tesla).

Actual valorisation

Besides the inherent value of basic research results presented in this thesis I see the main value of the work I did over the last few years not in potential (BCI) products. I see value in the methodological and practical scientific knowledge that I gained during my work and tried to share with fellow researchers. The photo on the cover of this thesis shows a lonely sculler on a (seemingly wide and) empty ocean. It depicts something that immediately evokes some form of imagery in the viewer ('Who is this person and where does she come from?' or 'How long is she already sculling?') and, therefore, fits the title of my thesis. However, the scene also resembled a feeling one can easily get when confronted with neuroscientific research projects. Especially, when new methods are involved (like ultra-high field fMRI) or largely uncharted scientific territory is entered (like neuroimaging of mental imagery) the problems that arise during research do not seem to end. From the beginning of my PhD studies I could rely on the knowledge and help of others and I continued to help others in turn as soon as I started solving new problems arising from my own work. While there are many talented bright scientists working in cognitive neuroscience the task at hand – that is, to unravel the functional working principles of the human brain – demands the sharing of knowledge, not only in the form of scientific publications, but also in very practical terms. Wherever I could, I tried to spare time for the dissemination of, e. g., source code (contributions to the experiment software PsychoPy, Import/Export rou-

tines for BrainVoyager file formats into Python), manuals (Eye-tracking on the 7 T system, 7 T segmentation guides, MNI space transformation guides to convert fMRI maps for data sharing platforms), or hands-on help. I am very happy to have worked in an environment where more people acted like I did, as the sharing of practical knowledge is crucial to the success of scientific projects. By making our work available in an accessible way (through open-access publications or by releasing source code and manuals under open source/libre licenses) and through collaborative efforts (like Wiki documentations or contributing to existing open source projects), we create immense value for the scientific process and, thereby, society in general.