BCI adaptation for end users
The Graz-BCI approach

Andreas Schwarz[1], D. Steyrl[1], M. K. Höller[1], K. Statthaler[1] and G.R. Müller-Putz[1]
andreas.schwarz@tugraz.at, ***gernot.mueller@tugraz.at***
[1]*Institute of Neural Engineering, Graz University of Technology, Austria*

Non-invasive Brain-Computer interfaces (BCI) enable its users to interact with their environment only by thought. A possible BCI application may be to control a computer game by e.g. imagery of motor tasks. However, this requires several control commands and individual BCI training. In the following, we describe our four stage approach for individualizing and adapting BCI technology for an end user **based on the performance of the pilot of the MIRAGE91 racing team** [1].
Our approach is based on [2] and the findings of Friedrich et al.[3](Figure 1).

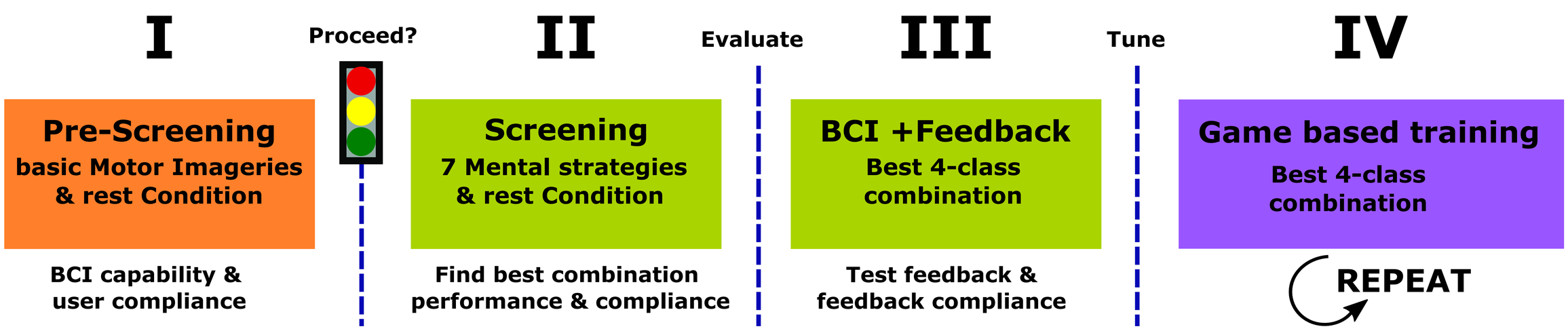

Figure 1: 4-Stage training procedure. Stage I to III investigate the best performing mental tasks for the user, which are applied in Stage IV for game based training.

In **Stage I** (Figure 2) we performed pre-screening to **test users' BCI capability and compliance**. Results of this stage indicated whether continued training with the user was reasonable. **Stage II** (Figure 3) incorporated a **screening of several mental tasks**, including a non-control state. In an offline cross-validation procedure, we determined the most effective (in terms of accuracy and user acceptance) combination of at least 4 different classes. In **stage III** (figure 4), the previously identified class combination was used to test **user compliance to feedback**. In the beginning of **Stage IV** (figure 5), a BCI was closely tailored to users based on the findings in the previous stages. Thereafter the **user started game based BCI** training.

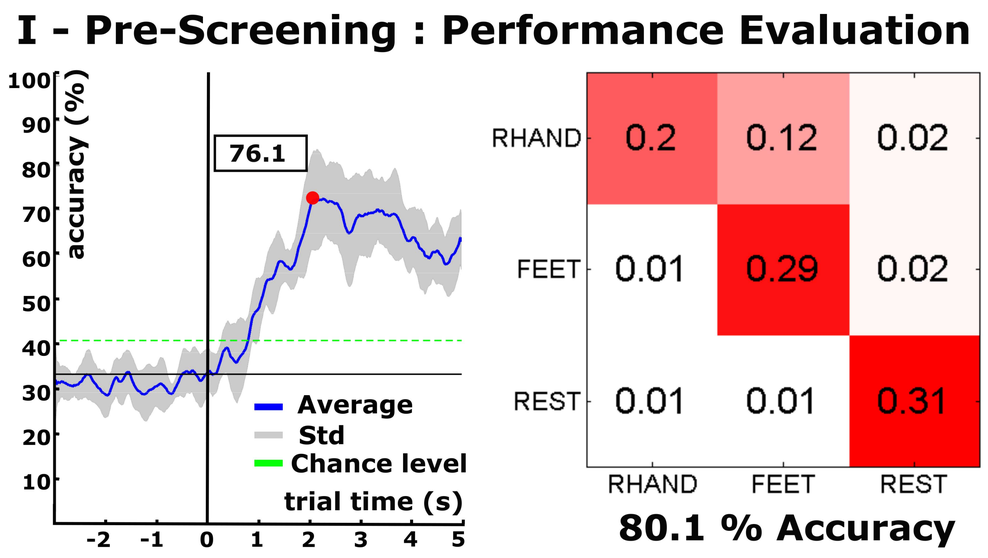

Figure 2: Cross-validation (10x5) results of Pre-Screening: Accuracy over all trials and trial based confusion matrix. Standard GRAZ-BCI paradigm was used to record 50 Trials per condition (TPC).

Figure 3: Cross-validation (10x5) results of Screening Accuracy over all trials and trial-based confusion matrix of the best performing mental task combination (out of 70).

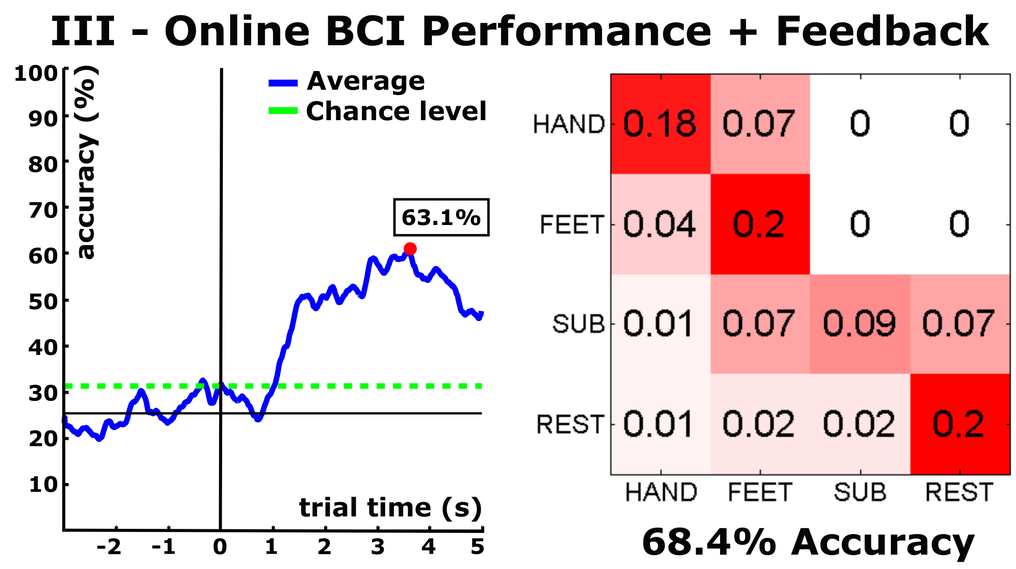

Figure 4: Stage III Online Performance: Accuracy over all trials and trial-based confusion matrix. 50 TPC were used for training the BCI model. Therafter 40 TPC were recorded where the user received feedback for evaluation.

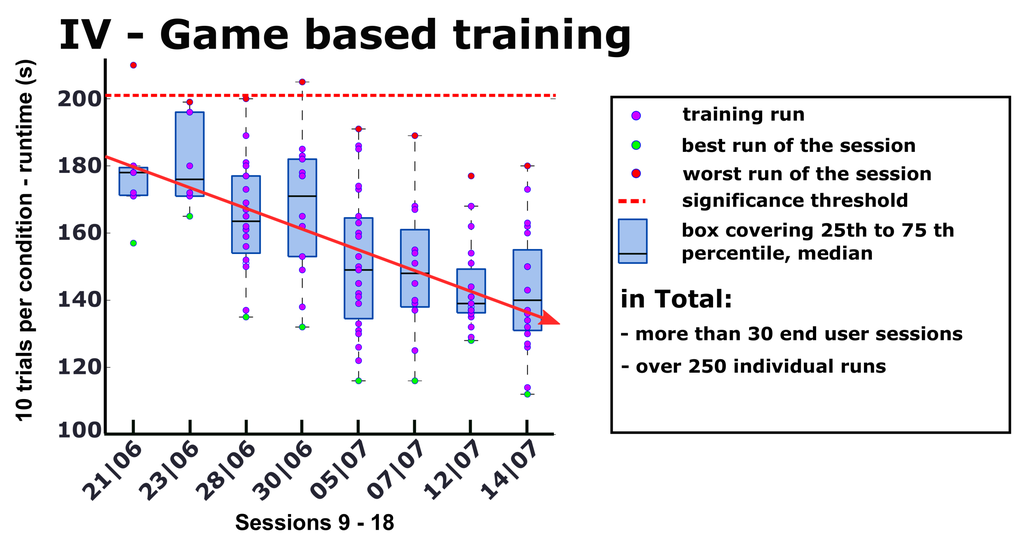

Figure 5: Stage IV game based training over several sessions. The median race time over sessions 9 to 18 shows a steady decrease.

References

1. A. Schwarz, D. Steyrl et al. "Brain-Computer Interface adaptation for an end user to compete in the Cybathlon", IEEE International Conference on Systems, Man, and Cybernetics (SMC 2016), At Budapest, Hungary, 2016, accepted
2. G. Müller-Putz, R. Scherer, et al., "Temporal coding of brain patterns for direct limb control in humans," Frontiers in Neuroscience, vol. 4, no. 34, 2010.
3. E. Friedrich, C. Neuper, et al., "Whatever works: A systematic user-centered training protocol to optimize brain-computer interfacing individually," PLOS ONE, vol. 8, no. 9, 2013.

Acknowledgments

VAMED health.care.vitality. SWIETELSKY JUFA HOTELS