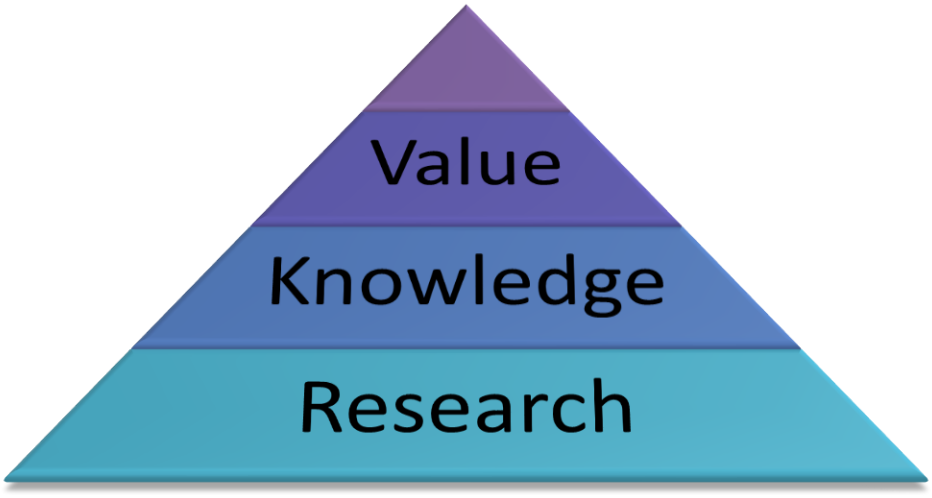
New avenues towards mobile brain computer interfaces

Knowledge valorization

In this chapter, the worth of the gained knowledge from this thesis is evaluated concerning a new possible value that can be created based on the presented findings. Examples for these possible values are very diverse and range from patents, licenses, open source tools, algorithms and software to many more. We will point out the direct and indirect merit of this thesis concerning the developed methods and software, starting with the potential benefits for a more widespread application of neurofeedback treatments. The different chapters will be targeted individually, and the relevant points, target groups, activities/products, innovation, and implementation will be discussed.



Potential knowledge valorization from chapter 2

As already described in the introduction of this thesis, the increasing amount of publications in the field of BCI and especially neurofeedback research shows the increasing interest and the potential of these approaches (Mihara & Miyai, 2016; Naseer & Hong, 2015; Thibault, MacPherson, Lifshitz, Roth, & Raz, 2018). Since the findings of this research are continuously becoming more sophisticated and accepted in the field, the next step should be striving to make NF therapy available to patients. To be able to provide these rather complicated methods as a therapy option, pipelines that allow a streamlined and patient-centered approach needs to be developed.

The presented findings in this chapter are of interest for clinical use in the near future (Marzbani, Marateb, & Mansourian, 2016). With the newly developed algorithm to automatically select brain areas based on an individual localizer of the participant, we not only provide a tool that could be a part of these pipelines (Lührs, Sorger, Goebel, & Esposito, 2017), but we also aim at reducing the need for highly trained personnel to carry out the NF therapy, and thus, making the approach simpler and easier to implement.

The products or processes, into which the research can be translated to, were already described in the chapter We based our research on the analyzed fMRI data from Turbo-BrainVoyager. The developed procedures were implemented entirely or partially as plugins for this product, giving a direct value to researchers using this product. The research showed that combining different routines and procedures creates a new method with a wide application range. Since it has already been implemented in a commercial product, part of this research is directly available.

Potential knowledge valorization from chapter 3

Improving and developing new methods has always been a significant research outcome, which translates into social and economic value (Fine, Denzin, & Lincoln, 1995). The increasing developments in MR-sequences could provide benefits for fMRI neurofeedback, as described in chapter three of this thesis (Assländer et al., 2013; Zahneisen et al., 2011). Investigating them does not hold a direct social or economic value, but it can translate into it, as it will bring us closer to developing efficient fMRI-based NF therapies in the near future. These do benefit not only the academic community but also the same target groups, as described in the previous section.

Concerning innovation, this chapter focused primarily on the verification of available methods suitable for the used MR-sequence. Therefore, the leading innovation was the sequence itself, and to a lesser extent, the proof of principle to use established fMRI analysis methods for these data. Next steps will be focused on implementing real-time workflows and will eventually become the most important outcome of this chapter because it will make this technique available to a broader range of applications.

Potential knowledge valorization from chapter 4

The knowledge we gained was directly transferred into the developed software for rt-fNIRS analysis, Turbo-Satori (Lührs & Goebel, 2017). Combining the knowledge into software that gives access to very advanced procedures and algorithms in a natural way is one of the most valuable outcomes of this thesis.

Future research and developments can now be directly translated into the software package, which will further gain value over time. So, in addition to the research interest in the academic community, the software is also of interest as a tool in this community. Bringing in value from research findings to develop tools to be used for research directly. At the same time, it is essential that the tools, such as fNIRS, become available to a broader audience. fNIRS is a mobile application, which gained more interest in the recent years, as described in the introduction of this thesis. The points raised for the fMRI methods apply to fNIRS as well, with the addition that the Turbo-Satori software is more likely to be used in therapeutic applications, due to its lower complexity and costs, compared to fMRI. Since the software itself is the product, there is no

translation. Since the field of rt-fNIRS applications is entirely new, the software itself is innovative and can be seen as a contribution towards a more full spread of the fNIRS method. The last point, the implementation, is also already accomplished with the first release of the software.

In summary, the focus of this thesis relied on the development and improvement of automatic procedures for fMRI and fNIRS neurofeedback applications. Developing automatic routines is a strong valorization of the gained knowledge in itself since the newly developed procedures can help to pave the way to use automatic procedures for patient treatment. Even though it will still take some time to be established, every step towards this goal is helpful and will be beneficial in the upcoming years.

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