Neuro Information Systems: A Literature Review and an Analysis of Common Tools

Bachelorarbeit

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1. Introduction

Information systems (IS) play an important role in peoples everyday life and the scientific importance is reflected in many conducted studies dealing with IS in the last decades. In the past, IS studies were often based on self-reported data, such as surveys, interviews, questionnaires and field experiments [Dimoka et al. 2007]. Although, these techniques brought advanced insights in several kinds of IS research, IS theories as well as many IS phenomena and their impact on the individual user are not totally investigated and explained by the current state of research [Wang et al. 2011]. Furthermore, self-reported data can be afflicted with common method, social desirability and subjectivity biases. On top of that technology users are usually not aware of all feelings and thoughts, or they feel uncomfortable or unwilling to report everything. Subsequently, an interview or questionnaire based study would not show all relevant feelings and thoughts [Dimoka et al. 2011]. Therefore several IS investigators searched for approaches and innovative measurement possibilities adapted from other social sciences, which have not been used in IS research yet and which are able to overcome the concerns with self-reported data studies [Dimoka et al. 2007, Riedl et al 2010b]. Due to an increased availability of neuroscientific methods and theories in the recent years, IS researchers realized the potential of neuroscience approaches for their field of study. The first paper, which tried to describe a possible complementing method to the traditional self-reported approaches via neuroscience, was Dimoka et al. (2007). The authors had "*the idea of applying cognitive neuroscience theories, models, and tools in information systems research*" and termed this idea NeuroIS [Dimoka et al. 2007, p.1]. Riedl et al. (2010b, p. 245) defines NeuroIS as "*a subfield in the IS literature that relies on neuroscience and neurophysiological theories and tools to better understand the development, use, and impact of information technologies (IT). NeuroIS seeks to contribute to (i) the development of new theories that make possible accurate predictions of IT-related behaviors, and (ii) the design of IT artifacts that positively affect economic and non-economic variables (e.g., productivity, satisfaction, adoption, well-being)*." which is used as the common definition of NeuroIS.

After Dimoka et al. (2007) was published, the number of publications in the field of NeuroIS have increased. Especially in IS security [e.g. Anderson et al. 2014, Hu et al. 2015], technology acceptance (TAM) [e.g., Ortiz de Guinea 2014], and E-Commerce [e.g. Adam et al. 2011, Di Stasi et al. 2010]. In addition, many researchers investigated frameworks, guidelines and methodologies either for a special field in IS research or for the possible use of NeuroIS tools [e.g. Liang and Vom Brocke 2014]. These tools can be split into two categories: psychophysiological tools and brain imaging tools [compared to Dimoka et al. 2012].

Concerning NeuroIS, psychophysiological tools, such as eye tracking, facial electromyography (fEMG), electrocardiography (ECG) and electro dermal activity (EDA) methods, measure the real-time physiological state of an individual, while interacting with information technology (IT) [Lux et al. 2015]. Whereas, brain imaging tools, such as functional magnetic resonance imaging (fMRI), positron emission tomography (PET), electroencephalography (EEG), magnetoencephalography (MEG), and functional near infrared (fNRI), allow the visualisation of brain activity of an individual in an information technological context [Dimoka et al. 2012, Riedl 2010b]. Both group tools are able to convey new insights in the field of IS. This thesis aims at analysing trends in the use of NeuroIS tools in research and discuss advantages and disadvantages of any of the tools and give suggestions for future research on the basis of the findings. Due to the fact that NeuroIS research is a young subfield of IS research, the implemented literature review is the first comprehensive literature review in this study field and can be used for further research.

This thesis will proceed as follows: Chapter two gives a short overview of the human brain anatomy, to facilitate the understanding of the following explanations and discussions of common NeuroIS tools. In chapter three a comprehensive literature review following Webster and Watson is conducted. Afterwards an analysis and a discussion of commonly used NeuroIS tools, identified by the results of the literature review, take place in the thesis. In addition, suggestions as well as research questions are elaborated for future NeuroIS research. Finally, a summary and an outlook will be presented.

2. Anatomy of the Human Brain

This chapter is designed to provide a short overview of interacting brain areas which form the basis of IS research relevant processes (IS constructs) such as decision-making, cognitive, emotional, and social processes.
The brain consists of the cerebrum, the cerebellum and the brainstem (figure 1). The cerebellum is located directly under the cerebrum at the posterior part of the head. It processes and coordinates muscle movement, balance and fine motor skills like writing or catching a ball. Furthermore, the brainstem consists of the midbrain, pons and medulla. Its' mainly task is to control reflexes and automatic responses like heart rate and blood pressure. The cerebrum makes up two-thirds of the brain mass and can be split up into the right and left hemisphere. Each hemisphere controls the opposite side of the body. The surface of the cerebrum has a folded appearance called the cerebral cortex (also just called cortex) which contains about 70 percent of the 100 billion nerve cells of the brain. Each hemisphere can be divided into four lobes: the frontal, parietal, temporal and occipital lobe [Freudenrich and Boyd 2001, NIH 2015].

6. Conclusion and Outlook

In conclusion, the NeuroIS field is a very important complement to the traditional measurement techniques in the field of IS research. However, it is a difficult decision to choose NeuroIS measurement tools fitting to the IT stimulus which should be investigated. As shown in the literature review the use of NeuroIS tools varies among the aim and subject of the publications. Due to several characteristics of each analyzed tool it is not possible to advise one tool fitting all measurement purposes. The strength of the problem to choose the right tool can be mitigated by multi-method approaches. This thesis give a basic overview about the differences of NeuroIS tools and is the first academic work conducting a comprehensive literature review in the field of NeuroIS. In the following years the sub-field NeuroIS will continue to grow. IS researchers have noticed the potential of neurophysiological and neuropsychological approaches for testing old and developing new IS theories. Therefore the focus of previous NeuroIS publications was on the one hand to acquire guidelines [e.g. Vom Brocke & Liang 2014] and on the other hand to test whether NeuroIS approaches are practicable to test old IS theory. In the following years, NeuroIS research will unfold and focus on more different IS research areas. For instance human-mobile system interaction can get in the focus of future NeuroIS research, due to the fact that mobility becomes more important every year for society and economy and due to the fact that the number of people using mobile devices is increasing as well. Which kind of development NeuroIS will take in the next years should be expected with high interest.