Chapter 7
Chances for and Limitations of Brain–Computer Interface use in Elderly People

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ABSTRACT

Recent demographic prognoses show tendencies toward a significant increase in the number of elderly people, especially in developed countries. This makes geriatric therapy, rehabilitation, and care difficult, especially with maintaining as long as possible the highest quality of life and independence in activities of daily living. Lack of specialized personnel and financial shortages may cause increased application of Assistive Technology (AT) and associated control devices. The most advanced current devices for diagnosis, communication, and control purposes are perceived Brain-Computer Interfaces (BCIs). BCIs use brain-derived bioelectrical signals as an input to enable diagnosis, communication, and/or control (e.g. neuroprostheses, medical robots, wheelchairs, whole integrated environments) without any movement. BCIs are regarded as novel solutions offering another breakthrough in everyday life, care, therapy, and rehabilitation in patients with severe sensory and neuropsychological deficits. However, particular issues in the area of BCIs use in elderly people should be emphasized, including influence of neurodegenerative disorders accompanied with secondary changes resulting from other medical problems (e.g. heart diseases, hypertension, diabetes mellitus, and osteoporosis), co-occurence of various drug therapies, etc. This chapter investigates the extent to which the available opportunities are being exploited, including both chances and limitations, medical, technical, psychological, societal, ethical, and legal issues.

INTRODUCTION

Due to demographic changes, especially in developed countries, we are faced with a potential increase in the number of elderly people (i.e. older than 65 years) – in ten to twenty years they may comprise approximately 25-30% of the population. Moreover, there is a predicted increase in life expectancy while maintaining the highest possible quality of life (QoL) and independence in activities of daily living (ADLs) as long as possible. Doubtlessly, neurodegenerative changes, frequently associated with moderate and severe secondary changes in patients' health status and illnesses (diseases of the circulatory system, hypertension, diabetes mellitus, osteoporosis, etc.) may make this task very difficult. Shortages in specialized medical staff and financial issues may cause an increased application of medical robotics, assistive technology (AT), integrated environments of elderly and disabled persons, and associated control devices. The most advanced current devices for diagnosis, communication and control purposes are considered to be brain-computer interfaces (BCIs). This article aims at investigating the extent to which the available opportunities are being utilized, including chances and limitations, as well as medical, psychological, societal, ethical and legal issues.

Technical Background

Despite the known basic rules of BCIs' selection and adjustment, it is still unclear why some BCI paradigms or features are effective with some patients, and some not. Research on so called "BCI demographic assessment", i. e. how many people and which people may use a particular kind of BCI, was partly (in the area of steady-state visual evoked potentials – SSVEP-based BCI) provided by Allison et al. (Allison et al., 2010) and Volosyak et al. (Volosyak et al., 2011). They provided data sets concerning correlations among BCI-associated tasks' performance, patients' fac-

tors, and their personal preferences. In the case of SSVEP-based BCIs, young and female users achieved better results, and the preferred BCI was considered the Bremen SSVEP BCI system. This may confirm that older users may achieve worse results than younger ones; moreover, older users may require more training or more sophisticated learning methods. Handedness, tiredness, flickering stimuli, alcohol, or caffeine did not influence BCI effectivity. The reported accuracy was 89-92% (Allison et al., 2010; Volosyak et al., 2011). But research on accuracy in BCI use frequently reported variations in performance between users. Results of two research studies by Guger et al. (Guger et al., 2012a; Guger et al., 2012b) showed that worse results in accuracy were usually accompanied by longer reaction to cue. Despite high average accuracy (95.5%), even the poorest accuracy was not below 60% (and 96.2% reached an accuracy above 80%) for SSVEP-based systems (Guger et al., 2012a; Guger et al., 2012b). This may suggest that BCI-based communication systems for elderly should provide proper functioning even with an accuracy of 60%.

Importance of the Problems

These devices may rapidly become basic equipment for elderly people. Unfortunately associated problems may be regarded as underestimated. Limited amount of evidence influences medical and organizational issues. Published literature may be regarded as insufficient to assess it objectively.

USE OF BRAIN-COMPUTER INTERFACES AS A PART OF ASSISTIVE TECHNOLOGY DEVICES

Elderly patients need assistive technology (AT) solutions providing independence and increasing life quality. The main AT solutions concern communication, computer adaptation for learning or work purposes, control (smart home, i-wear,

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