Chapter 2
Nascent Access Technologies for Individuals with Severe Motor Impairments

Sarah Power
University of Toronto, Canada

Saba Moghimi
University of Toronto, Canada

Brian Nhan
University of Toronto, Canada

Tom Chau
University of Toronto, Canada

ABSTRACT

As the number of individuals without physical access to communication or environmental interaction escalates, there are increasing efforts to uncover novel and unconventional access pathways. In this chapter, we introduce three emerging access technologies for individuals with severe disabilities: near-infrared spectroscopy, electroencephalographic measurement of visually-evoked potentials and infrared thermographic imaging of the face. The first two technologies harness activity directly from the brain while the third exploits spontaneous temperature changes in the face. For each technology, we discuss the physiological underpinnings, the requisite instrumentation, the scientific evidence to date and the future outlook.

INTRODUCTION

Personal autonomy in the context of physical chronic illness can be conceptualized as the correspondence between the desired and actual life of an individual (Mars et al., 2008). To achieve this correspondence, Mars et al. (2008) asserts that individuals need to "develop principles expressing what their lives to be like" (p. 345) through daily interactions, choice-making and experiences.

DOI: 10.4018/978-1-60566-206-0.ch002

However, many individuals do not have physical access, due for example to an environment that does not support the functional capability of the individual. A lack of access severely limits one's daily interactions, choice-making and social experiences and thus impinges upon personal autonomy. To restore a level of correspondence, a common approach in rehabilitation is to augment the opportunities for interpersonal connection through an access solution.

An access solution provides a means of interacting meaningfully with one's milieu (people and objects within the environment) when functional speech or movements are not available, due for example to severe motor impairments. Often times access solutions are technology-mediated. In such case, the technical components of an access solution include an access technology and a user interface technology (Tai et al., 2008) as depicted in Figure 1. The access technology comprises of (a) an access pathway, that is, the input devices by which an expression of functional intent (e.g., a movement or physiological change) is translated into an electrical signal, and (b) a signal-processing unit that analyzes (e.g., filtering and pattern classification) the input signal and generates a corresponding control signal. The control signal in turn operates a user interface, which may be an iconic display for an electronic communication aid, a front panel for an environmental control unit, or an on-screen keyboard running on a computer.

The objective of this chapter is to introduce the reader to three nascent access technologies for individuals with severe disabilities, namely, near-infrared spectroscopy, electroencephalographic measurement of visually-evoked potentials and facial infrared thermography. While these pathways are in the pre-clinical research stages, existing scientific evidence supports their continued development into viable body-machine interfaces.

BACKGROUND

A Growing Population without Access

The incidence of severe and multiple disabilities (concomitant profound sensory, physical and speech impairments) among children has been increasing globally (Tudehope et al., 1995). This upward trend is expected to continue into the foreseeable future due to improved early identification of disabilities (Rumeau-Rouquette et al., 1997), increased life expectancy of medically fragile

Figure 1. Components of a technology-mediated access solution