

Chapter 36

Nascent Access Technologies for Individuals with Severe Motor Impairments

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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. 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.

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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 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 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

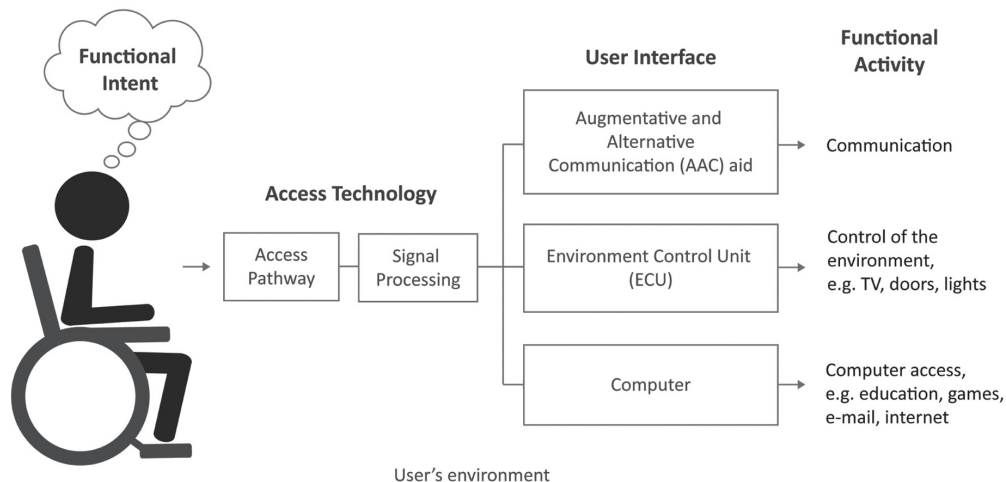
facial infrared thermography. While these pathways are in the pre-clinical research stages, existing scientific evidence supports their continued development into viable body-machine interfaces.

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 children with multiple disabilities (Jeppesen et al., 2003; Eagle et al., 2002) and higher survival rates of very low birth-weight, premature infants, the majority of whom develop disabilities (Goldson, 1996). According to United Cerebral Palsy (www.ucp.org), there are annually 5,000 new cases of children born in Canada and the USA with severe physical involvement.

Figure 1. Components of a technology-mediated access solution



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