Preferences of Individuals with Severe and Multiple Disabilities: Can They Be Reliably Detected?

Bloorview KIDS REHAB

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Introduction

Individuals with severe disabilities are often unable to access augmentative and alternative communication (AAC) or environmental control system (ECS) technologies as a result of pathological changes of their somatic nervous system. As illustrated in Figure 1, an alternate access pathway to these technologies may be the autonomic nervous system (ANS).

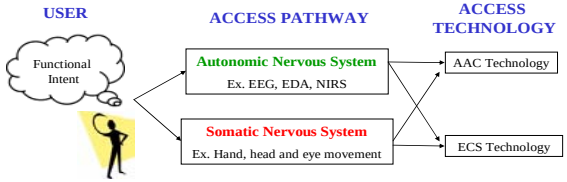

Figure 1: Both the autonomic and somatic nervous systems can be used to express functional intent and access conventional technologies.

Studies with able-bodied individuals indicate that performing mental exercises results in ANS signal changes that can be distinguished by an individually-trained computer algorithm to an accuracy of over 80% [1].

Objectives

To determine whether an individual without an existing access pathway can create distinguishable patterns in his or her ANS via mental exercises (Figure 2). Specifically:

1)To determine whether the preferences of an individual with severe disabilities can be reliably detected through changes in their ANS signals.

2)To determine whether this individual can be trained to consciously control these changes via mental exercises.

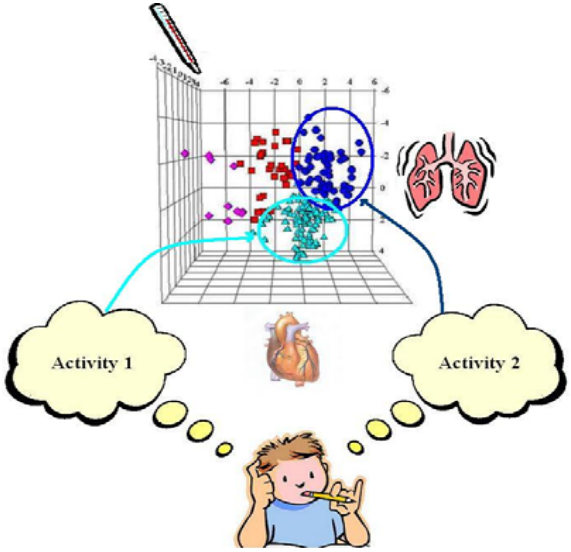

Figure 2: An individual thinking of two activities could potentially generate two distinct clusters in a features space of their ANS signals, enabling them to use a binary switch and access their environment.

Methods

The ProComp Infinti data acquisition system was used to record 4 ANS signals (Figure 3).

During recording, the participant's mother showed her son 10 stimuli, each for a duration of 1 minute, 7 of which he enjoyed, 3 of which he disliked.

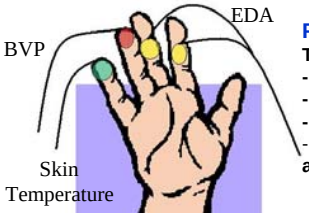

Figure 3:
The recorded ANS signals:
- **Electrodermal activity (EDA)**
- **Skin temperature**
- **Blood pulse volume (BVP)**
- **Respiration rate (recorded around thoracic cavity)**

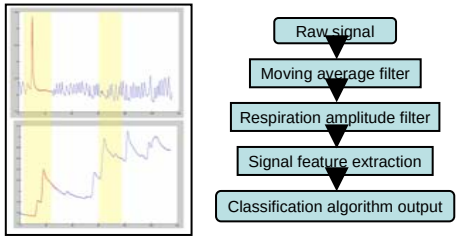

Figure 4: Left – EDRs due to large inspirations are filtered out of the analysis. Right – signal analysis algorithm.

Analysis

Four salient features were extracted:
- **Number of electrodermal reactions (EDRs)**
- **Skin temperature first derivative**
- **Respiration length line (RLL)**
- **EDA first derivative**

Pattern classification was used to correlate the resultant signals with participant's preference for each stimuli using the algorithm in Figure 4.

Results

Over 90% of the trials could be identified according the algorithm presented in Figure 5a. The user interface that was developed to track preferences in real-time based on this algorithm is presented in Figure 5b.

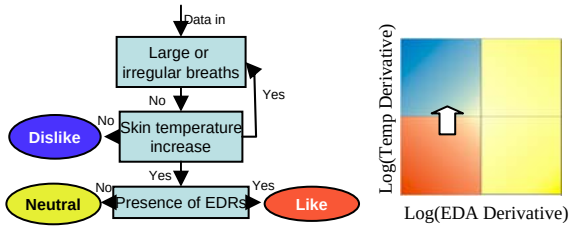

Figure 5. a) Classification algorithm, b) real-time preference detector interface

[1] Blain, S., Mihailidis, A., Chau, T. *Assessing the potential of electrodermal activity as an alternative access pathway.* Medical Engineering & Physics. (In press)