Psychophysiological Markers of Emotion in Healthy Persons and in Persons with Amyotrophic Lateral Sclerosis

Femke Nijboer
fnijboer@fatronik.com
Private Research Centre, with market orientation and a distinct aim: to achieve the major impact in economic terms, through the innovation and the technological development.

Under this premise, it contributes to the management and social development, transferring new technologies to companies, or promoting the creation of new management activities.
Active versus Passive “BCI”

Information about users state from physiological signals (emotional, cognitive, physical)

Voluntary control of physiological signals

User

BCI / Adaptive system

Bio/neurofeedback

Adaptation to user state

(see also Zander, 2008)
Applications of active and reactive BCIs

- Therapeutic effect of neurofeedback

- Control of environment / communication
BCI for communication and control in severely paralyzed patients – lessons after 6 years of working in the daily life of people:

• Severely paralyzed patients and locked-in patients can use BCIs based on slow cortical potentials, sensorimotor rhythms and event-related potentials (ERP) for communication (Birbaumer et al, 1999; Kübler et al, 2005; Nijboer et al, 2008)

• ERP-based BCIs yield quickest and most accurate communication after least implementation time (Nijboer, PhD thesis; Guger et al, 2003, 2009)

• However, severely paralyzed patients and locked in patients can communicate better and cheaper and easier with muscle-dependent “conventional” aids

• Those who really need a BCI, complete locked-in patients, seem unable to use a BCI (Kübler and Birbaumer, 2008; Hill et al, 2005; Hill et al, in preparation)
Passive “BCI”: lessons from the past

Information about users state from physiological signals (emotional, cognitive, physical)

User

BCI / Adaptive system

Adaptation to user state

(see also Zander, 2008)

“Our newest brainchild... the Atari Mindlink system

An entirely new and exciting way to use Atari game systems and computers:
- Placed around forehead, you “think” the movement of objects on screen
- Works on EMG technology—measures muscle activity
- Transmits to game console via infrared remote control—no wires attached
- Exciting, versatile, expandable
- Opens up entirely new areas to video gaming
- Rewards relaxation and concentration
- Increases computer and game system intent to purchase
- Includes infra-red transmitter, receiver, head band and one software cartridge

“The state of the art for the state of your mind!”

“... controllers did not perform well and gave people headaches from over concentration and constantly moving their eyebrows around to control the onscreen activities.”
Bio Tetris
Input signal: blood pressure at earlobe

“Truth to be told, the bio sensor is a neat little gimmick for health freaks, but it doesn't really add much to the whole gameplay experience. It's a cool extra, but we wouldn't want to pay extra to get it. www.ign.com”
Emotiv Epoc
Input signal: EMG and EEG

“Why plunk down hundreds of dollars for a device that does badly what can already be done well—by a finger on a joystick?” IEEE Spectrum
If you’re going to develop a affective BCI to assess how a user feels.....

- make ‘em work
- choose sensors that are comfortable and easy to put on
- make ‘em cheap
- find good use for them $$$$$€€€$$$

Affective BCIs might have very useful applications in human-computer interaction.

Affect: emotions, feelings and moods

Start with the least difficult to measure
"bioregulatory reactions aimed at the promotion, directly or indirectly, of the sort of physiological states that secure not just survival, but... [also] well-being”

(Damasio, 2004)
Emotions as a multi-element phenomenon:

A) Appraisal of events
B) Psychophysiological changes
C) Motor expressions
D) Action tendency
E) Subjective experiences
F) Emotion regulation

(Fontaine et al, the world of emotions is not two-dimensional, Psych Science, 2007)
Short-term emotion assessment in a recall paradigm (Chanel et al, 2009) \( N = 11 \)

The **objective** of this study was to investigate the use of EEG modality, peripheral modality and fusion of these two for emotion assessment on short time periods.

**Elicitation method:** recall of past experiences
- negatively-excited
- positively excited
- neutral-calm

**Dependent variables:** EEG, GSR, respiration, blood pressure
Results from Chanel et al, 2009

- Using EEG time-frequency features 3 classes can be classified with 63 % accuracy.

- Using a fusion of peripheral and central signals increases classification accuracy to 70 %.
Lessons from BCI in day to day life at the home of people

- Person-to-person transfer may be low
  - Need: aBCI needs individual set-up of parameters

- Day-to-night-to-day transfer
  - Need: aBCI needs regular calibrations

- Aging
  - Need: aBCI needs protocol how to adapt parameters to aging users

- External confounding factors: day light, temperature, substance intake, caffeine, shampoo, facial cream)
  - Need: aBCI should “sense” environment

- Sensitivity of aBCI: change represents phasic or tonic change?
  - Need: aBCI should have memory of events

- Wet electrodes? No thanks!
  - Where are the cheap dry electrodes that measure good quality signals?
Affect in severely paralyzed patients
aBCI as reinforcer for communication
Altered emotional processing in ALS patients

Altered signals in ALS/locked-in patients

- Medication
- GSR differences
- artificial respiration
- diabetes
- slowing of EEG
- ERP changes
- Attention and fatigue
• Fusion of peripheral and central signals from the nervous system for aBCI

• Should we use the EEG at all foreseeing the sensor problem and the cost problem?

• Is the term **Brain-Computer Interface** really appropriate?

• aBCI for paralyzed people: **content** + **affect** reinforces communication and promotes social life
Eskerrik asko!

- Ulrich Hoffmann
- Enrique Leon
- Randal Koene
- Stefan Carmien
- Cristina Rodriguez
- Fabrice Morin
Information about users state from physiological signals (emotional, cognitive, physical)

Voluntary control of physiological signals

User

Bio/neurofeedback

Adaptation to user state

BCI / Adaptive system

Active BCI

Passive BCI