Lessons Learned from using Physiological Sensing in Learning Environments

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MIT Media Lab
Fluid Interfaces Group
My Projects

Robotic control

Priming/Neuromarketing: video game DOOM

Smart home control - ALS

AR/VR+EEG: sports/pilots training

AttentivU - attention+, fatigue

Mindset, self-esteem
AttentivU 1.0: Test Setup

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AttentivU 1.0: Feedback Component

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AttentivU – XP1

1) Neurofeedback (accurate feedback), meaning the scarf was vibrating each time a drop in attention was detected by the EEG headband

2) Random feedback, where the vibrations did not correlate or depend on the attention level detected by the system

3) No feedback, no vibrations were administrated.
AttentivU – XP1

Same feedback type for all three lectures with no changes;

Data collected: Participants’ responses to the questions about the content of the lectures, their self-reported scores regarding whether they aid attention for different slides as well as their perception of the system in the subjective questionnaires.
Progression of user’s answers on content questions after each session, Avg LECQ: Users answers to the content questions

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Session 1. Average objective attention scores of participants during the first lecture. The X-axis represents slide number (cluster of slides), Y-axis – attention score based on EEG data.

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AttentivU – XP2

36 subjects, 3 lectures/per subject:

12 subjects got self-regulation feedback on the Neural Networks (NN) lecture, 12 other subjects got a random feedback on the NN lecture and 12 different subjects got no feedback on the NN lecture, and so on.

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AttentivU – 2\textsuperscript{nd} XP

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AttentivU – XP2

Average user response on accuracy for different feedback types across different lectures

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AttentivU – XP2

Average attention scores computed from the EEG across different lectures.

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AttentivU – XP1 and XP2

48 unique subjects for TWO experiments
56 hours of EEG recordings
17 full days of experiments
Lesson 1

It might work but it does not mean you can actually use it…
Challenges

Hey et al., 2017

Kosmyna et al., 2018

Offline/sticky electrodes/socially unacceptable form-factor

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Sensing

EmotiGO

Optalert

Google Glass

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Smith Focus

JINS MEME

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Picture taken from JINS MEME website

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EEG sensors
(electroencephalography)

EOG sensors
(electrooculography)
Feedback alerts when attention is low

Bone conduction sound feedback

EEG sensors (electroencephalography)

Bluetooh transmission to device

EOG sensors (electrooculography)

Sensors monitor attention level
Reported Tasks

<table>
<thead>
<tr>
<th>Activity</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Programming</td>
<td>16</td>
</tr>
<tr>
<td>Testing the code</td>
<td>16</td>
</tr>
<tr>
<td>Installing new environment</td>
<td>12</td>
</tr>
<tr>
<td>Reading</td>
<td>11</td>
</tr>
<tr>
<td>Watching tutorials</td>
<td>9</td>
</tr>
</tbody>
</table>

Group 1 (online)
Group 2 (offline)
Group 3 (online/ offline)
TOP 5
What can be measured with AttentivU:

- Attention
- Fatigue
- Cognitive Performance
- Creativity
- Perception vs recognition
Intensive Tests

- Drivers
- Lectures in real classroom
- Video and other learning materials
- Workspace
- Safety
- Other
Lesson 2

You might face challenges in the areas you did not expect
AttentivU: Limitations and Future Work

Disclaimer: AttentivU - not a system to be used around-the-clock

1. Our study is preliminary and exploratory; we envision conducting longer-term studies with more participants;
2. Use of a simple EEG band;
3. Testing additional sensors (such as an eye-tracker) to possibly combine two inputs;
4. Improve the algorithms to removing further motion artifacts so as to increase the signal quality; social acceptability of the device’s form factor;
5. New algorithms to detect the engagement (attention) level;
6. Ultimately, it remains to be tested whether the system could increase the total time a person can be attentive throughout a day;
7. Privacy issues and data protection
Lesson 3

It should be fun...especially for the learning environments
Lesson 3

It should be fun...especially for the learning environments
The Thinking Cap
The Thinking Cap:
Improving self-esteem, motivation and performance in children

speaker

EEG

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Thinking Cap: Results on Mindset
Thinking Cap: Results on Task Persistence

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Thinking Cap: Results on Task Engagement
Thinking Cap 2.0
Thinking Cap: edTech

- STEM
- Adding magic to science
- Fostering self esteem
- Empowerment

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The Force is in You

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This Talk =

2 years of work + 369 papers read + 105 hours of EEG recordings + 125 children + 125 adults + 12 live demos + 8 papers written + 3 papers submitted + 3 papers in preparation
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“I built this for you. And some day you'll realize that it represents a whole lot more than just people's inventions. It represents my life's work. This is the key to the future. I'm limited by the technology of my time, but one day you'll figure this out. And when you do, you will change the world”

Iron Man
Thank you Team!

Pattie Maes
Yujie Wang
Nha Nguyen
Caitlin Morris
Jin Dou
Eileen Wu
Klare Hu
Katie Bacher
Thank YOU!

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ATTENTIVU