Lessons Learned from using Physiological Sensing in Learning Environments

Nataliya Kosmyna, Ph.D
nkosmyna@media.mit.edu

MIT Media Lab
Fluid Interfaces Group




mit media lab
fluid interfaces
ATTENTIVU
Integrated Learning Initiative
Massachusetts Institute of Technology

My Projects

Robotic control

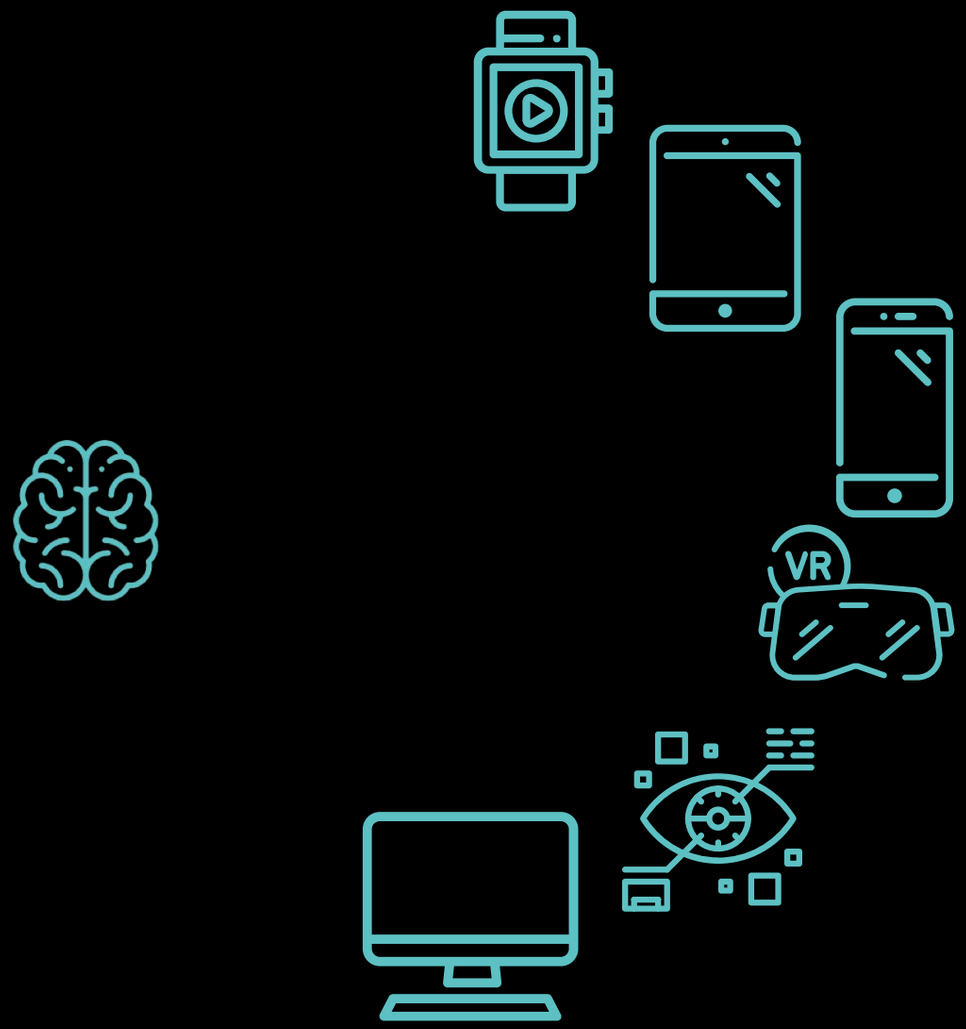
AR/VR+EEG:
sports/pilots training

Priming/Neuromarketing:
video game DOOM

AttentivU - attention+, fatigue

Smart home control - ALS

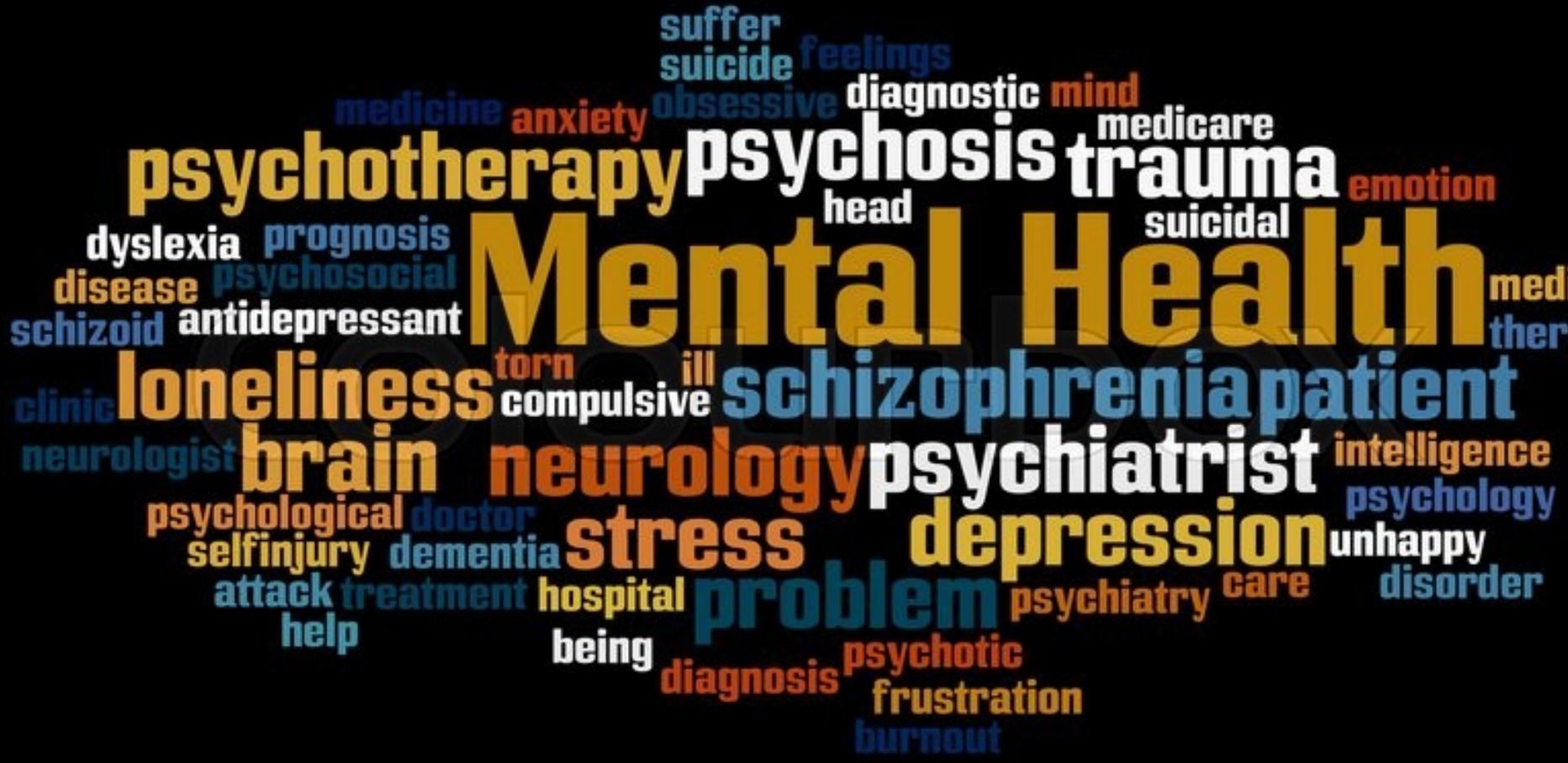
Mindset, self-esteem



mit media lab

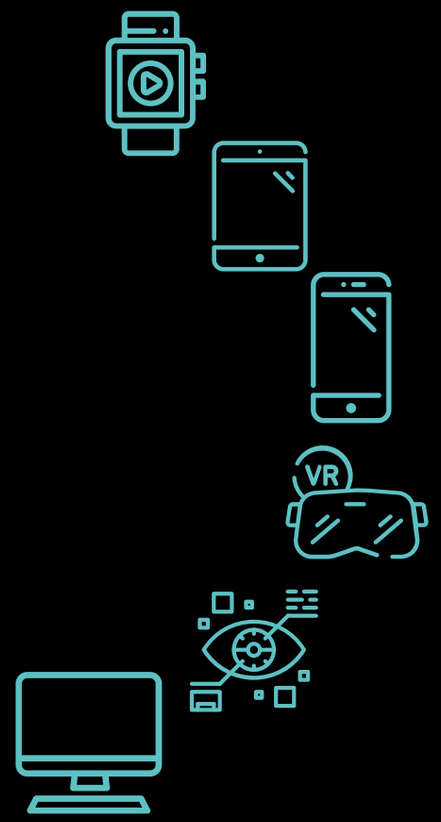
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna



mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

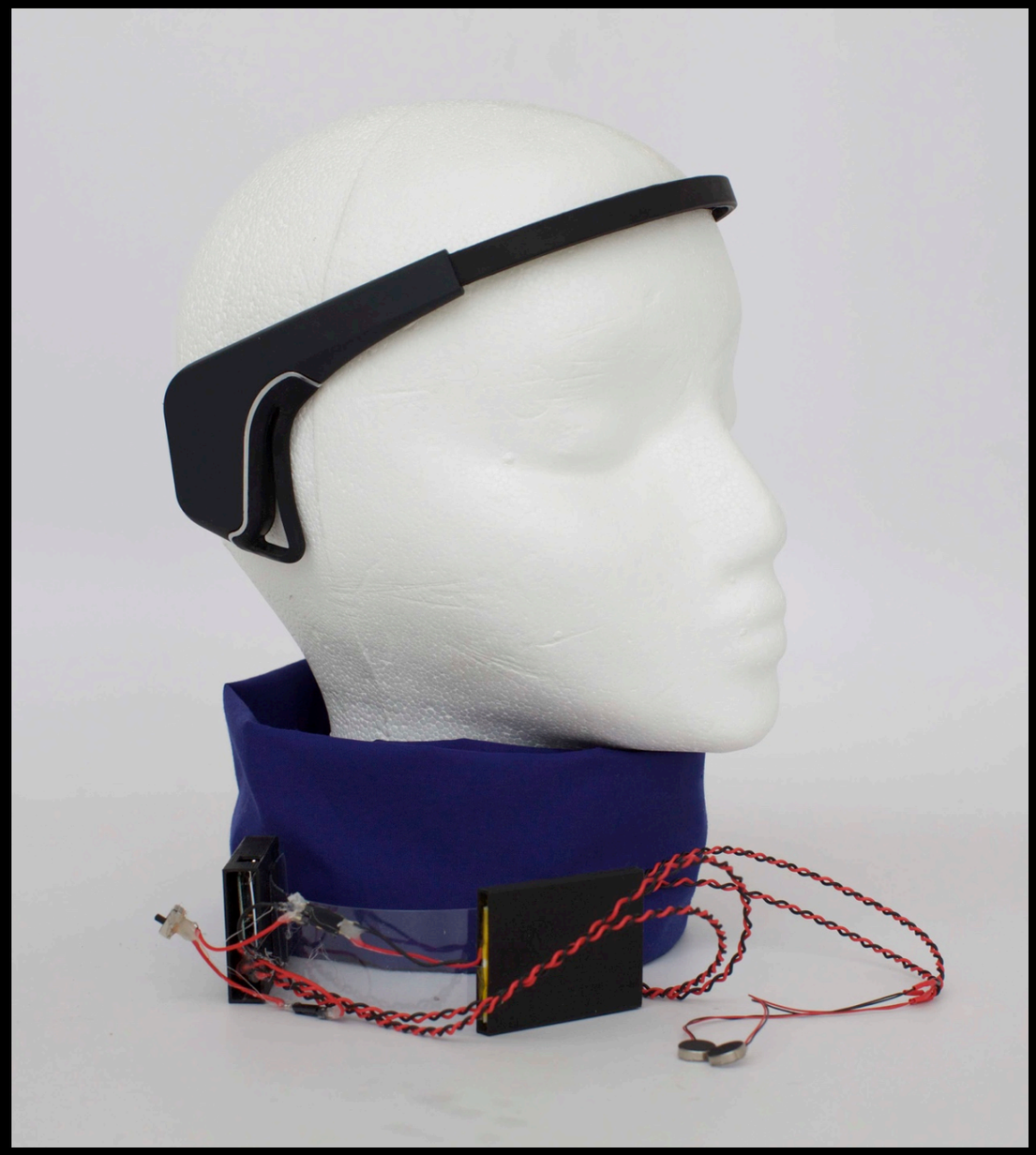


mit media lab

fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU 1.0: Test Setup



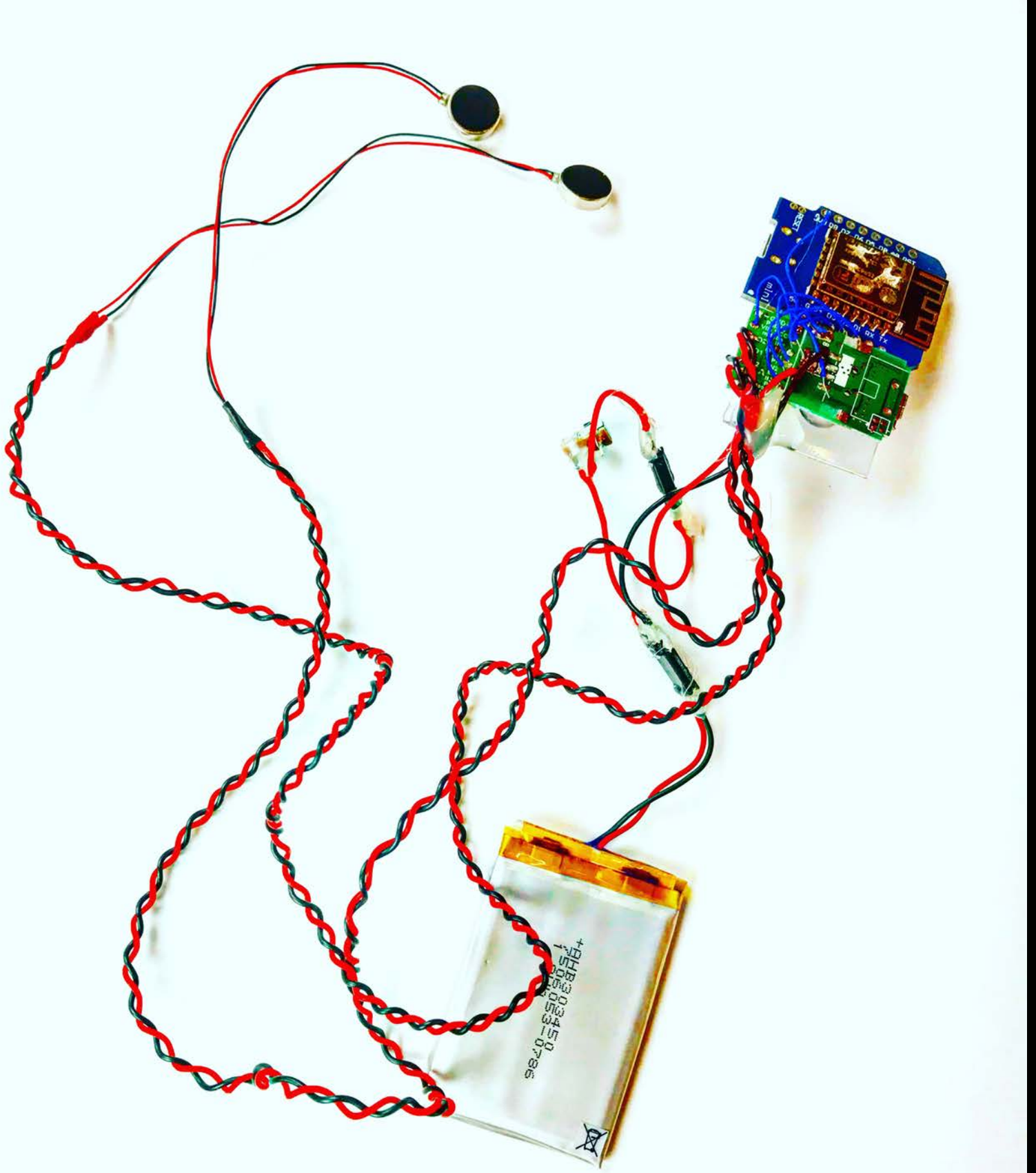
mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU 1.0: Feedback Component

fluid interfaces
mit media lab

nkosmyna@media.mit.edu @nataliyakosmyna



mit media lab

fluid interfaces

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

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.

mit media lab fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU – XP1

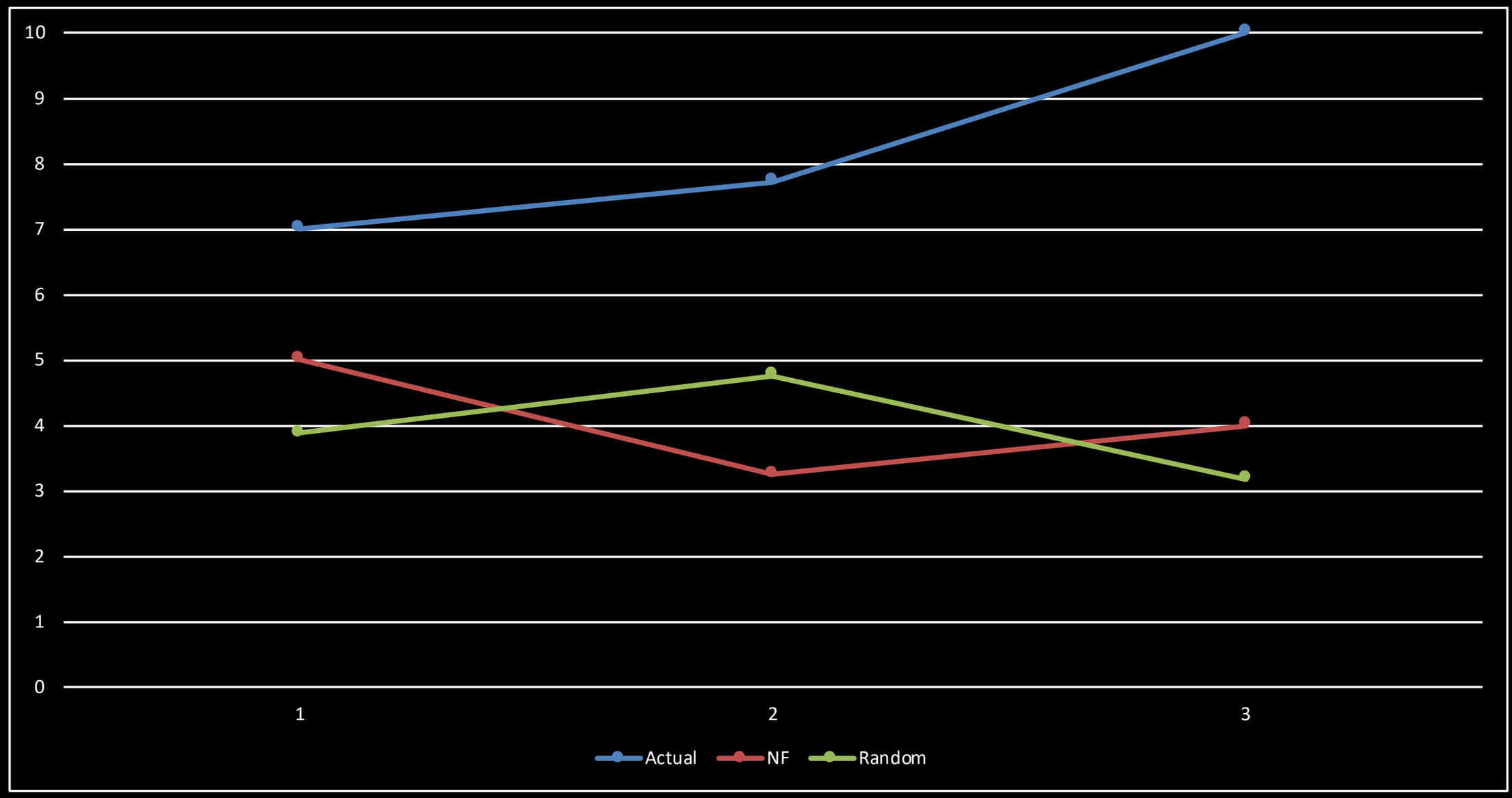
Same feedback type for all three lectures with no changes;

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.

mit media lab fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU – XP1

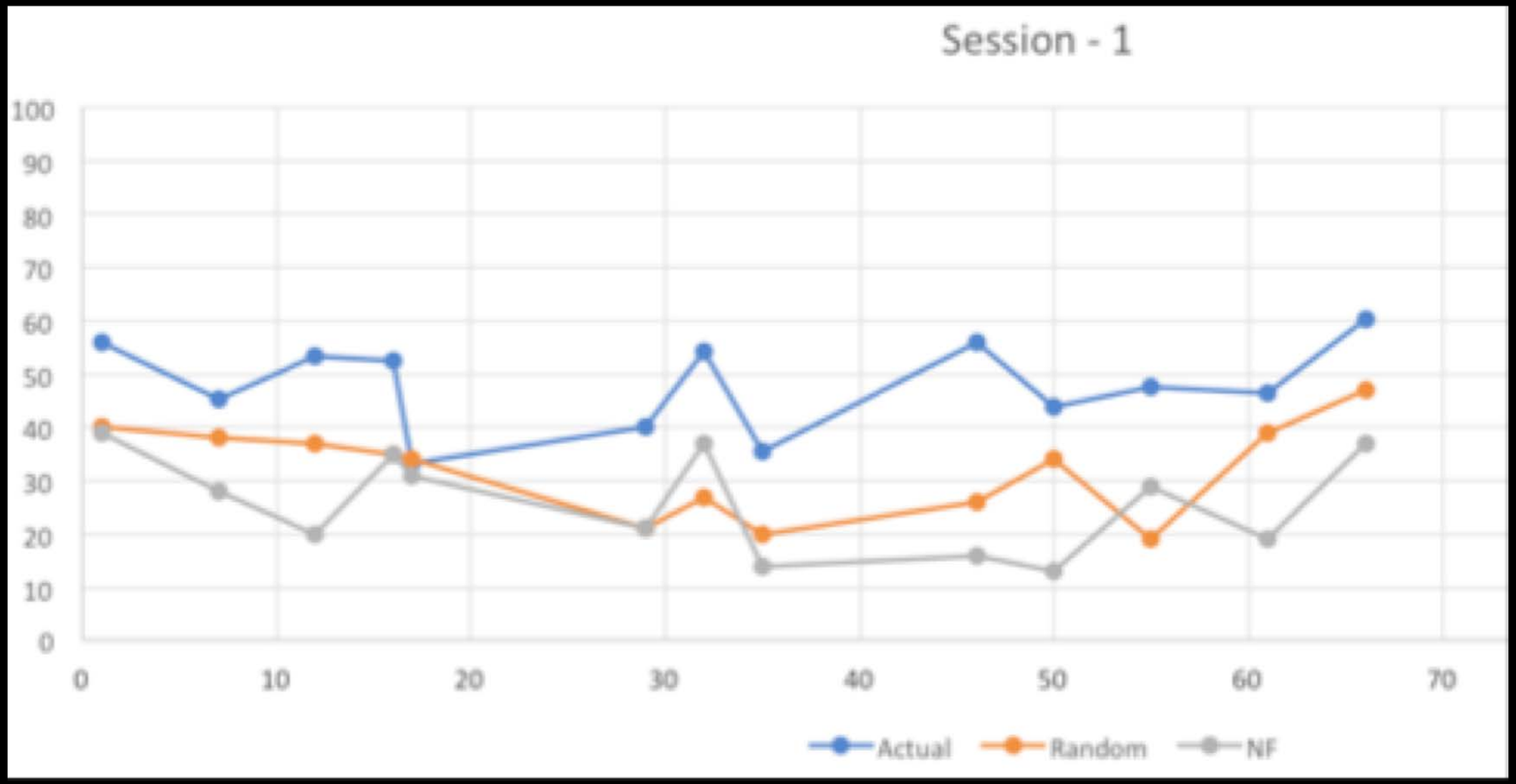


Progression of user's answers on content questions after each session, Avg LECQ: Users answers to the content questions

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU – XP1



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.

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

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.

mit media lab fluid interfaces

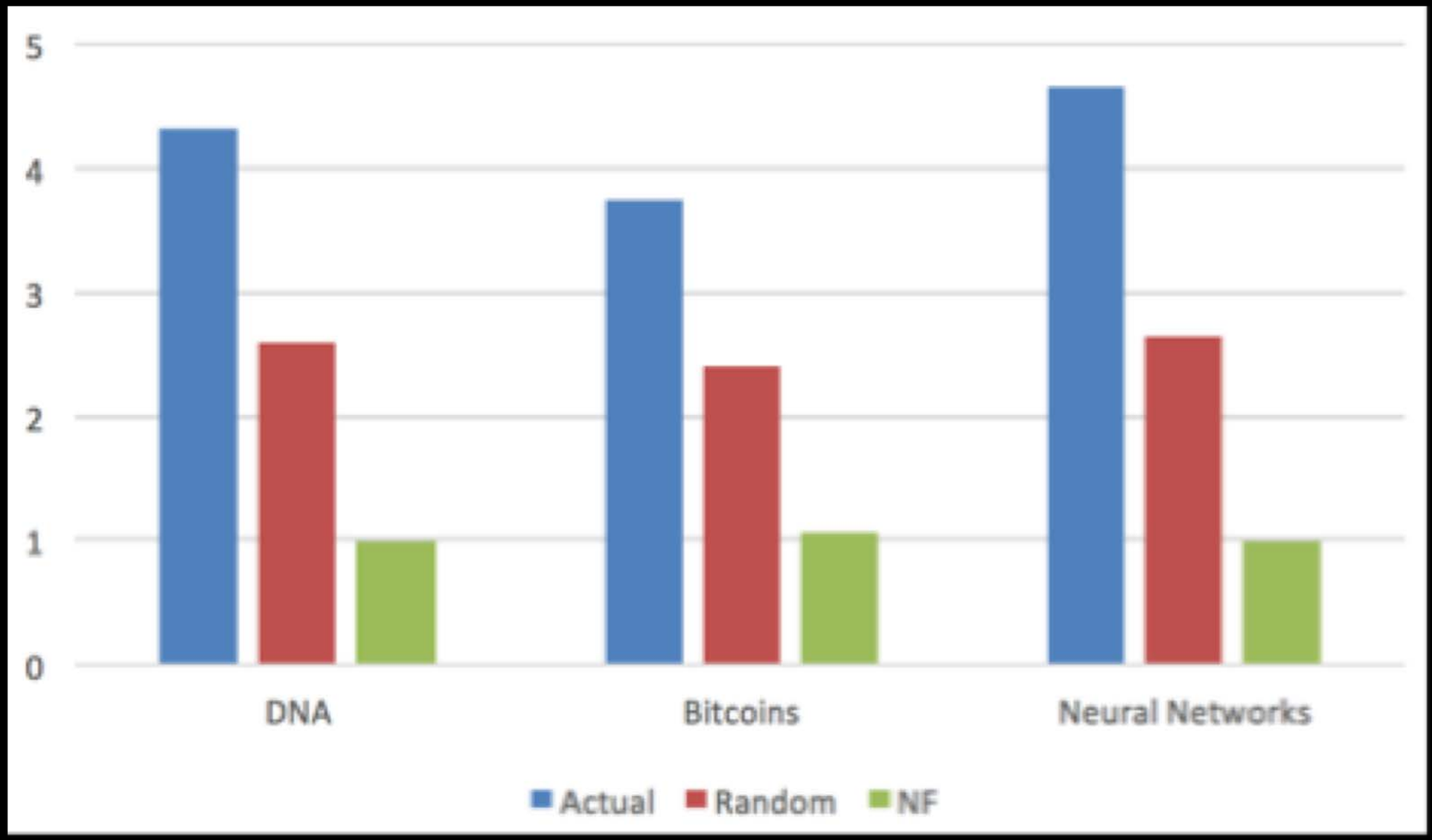
nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU – 2nd XP

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU – XP2

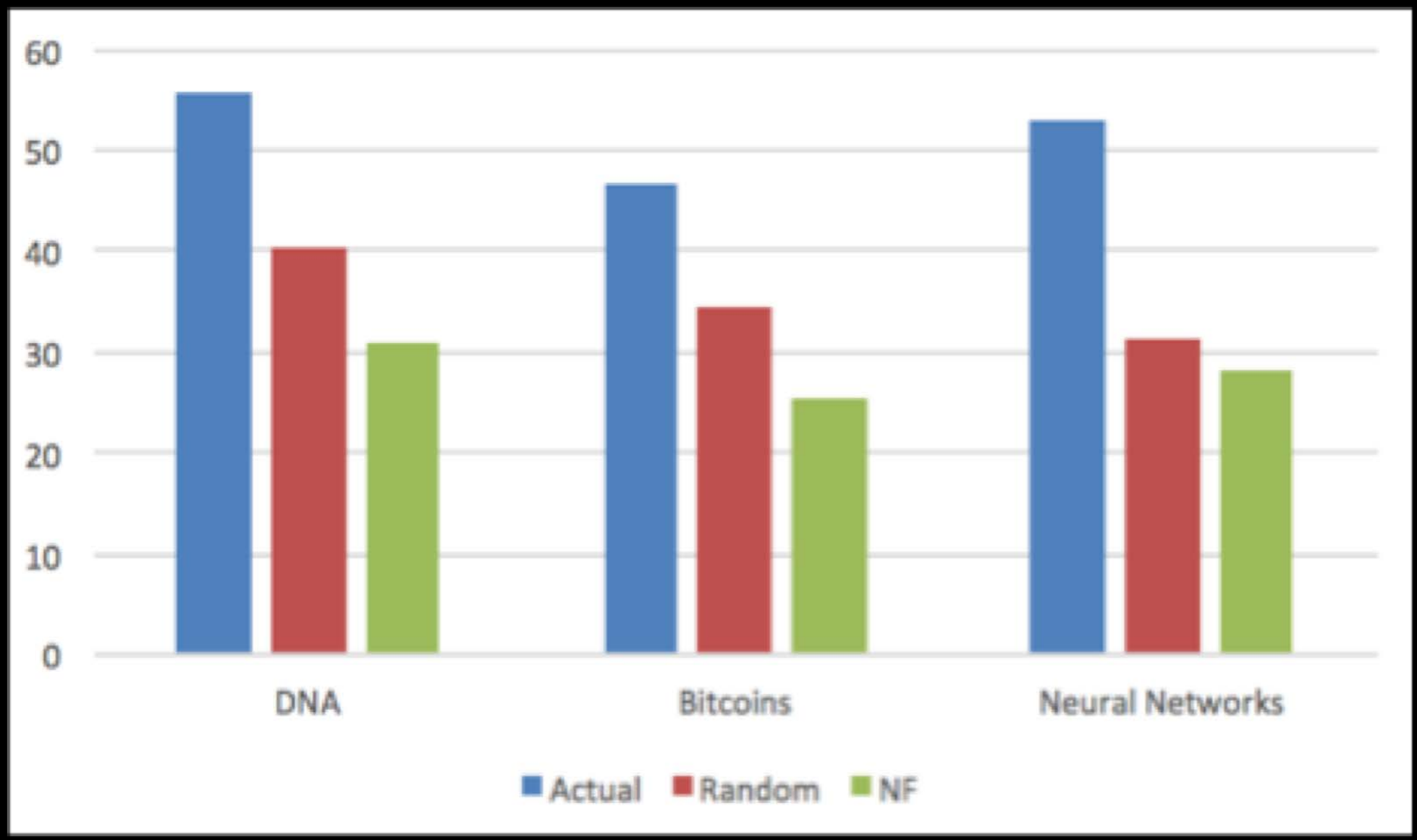


Average user response on accuracy for different feedback types across different lectures

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU – XP2



Average attention scores computed from the EEG across different lectures.

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

AttentivU – XP1 and XP2

48 unique subjects for TWO experiments

56 hours of EEG recordings

17 full days of experiments

mit media lab

fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

Lesson 1

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

nkosmyna@media.mit.edu @nataliyakosmyna

Challenges

Hey et al., 2017

Kosmyna et al., 2018

Offline/sticky electrodes/socially unacceptable form-factor

mit media lab fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

Information Delivery

Bose AR Frames

Focals by North

1D eyewear

nkosmyna@media.mit.edu @nataliyakosmyna

Sensing

EmotiGO

Optalert

nkosmyna@media.mit.edu @nataliyakosmyna

Smith Focus

JINS MEME

mit media lab
fluid interfaces

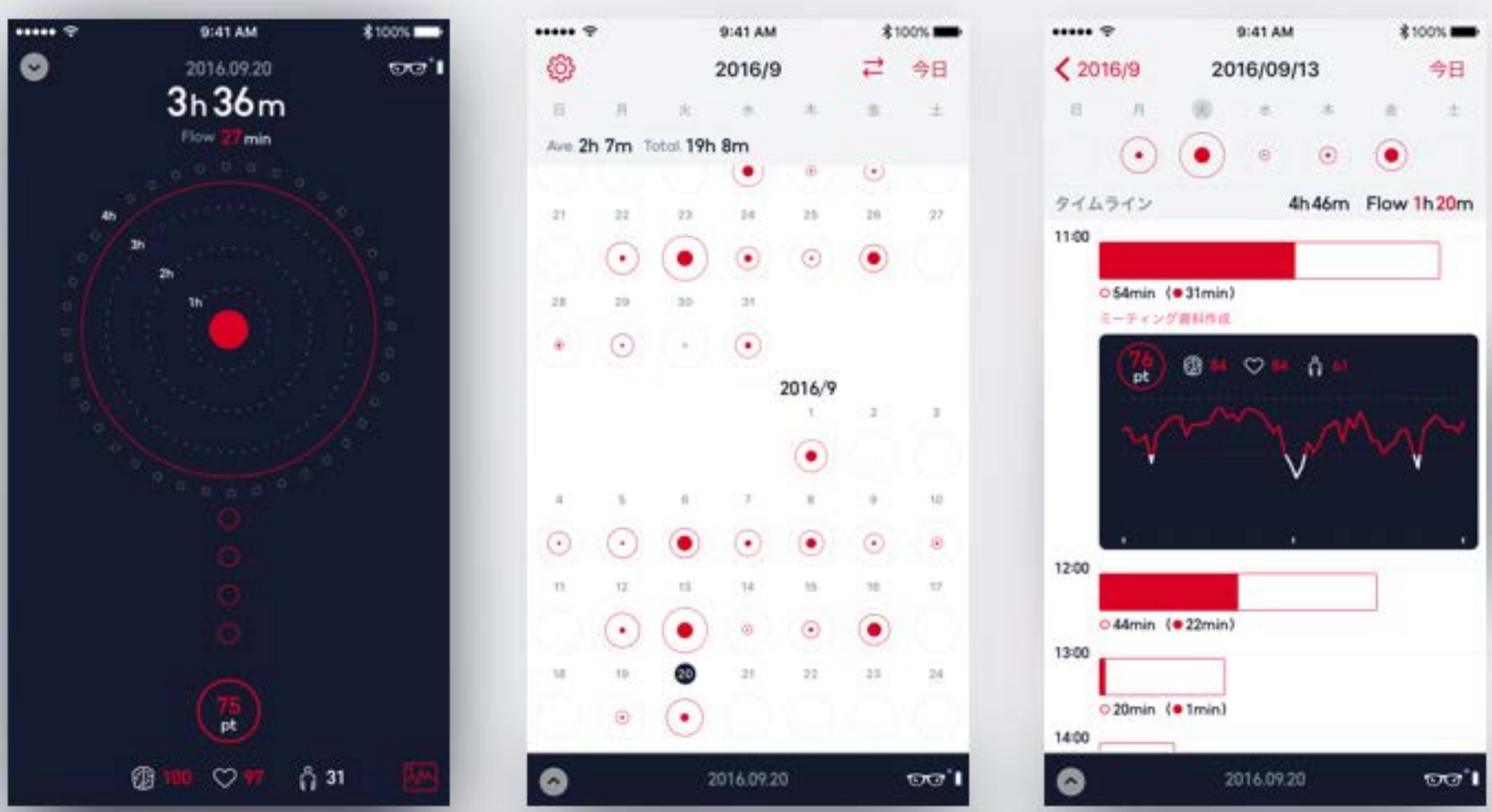
nkosmyna@media.mit.edu @nataliyakosmyna

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna



Picture taken from JINS MEME website

fluid interfaces

mit media lab

nkosmyna@media.mit.edu @nataliyakosmyna

Feedback

Sensors

mit media lab
fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

Feedback

Sensors

mit media lab
fluid interfaces

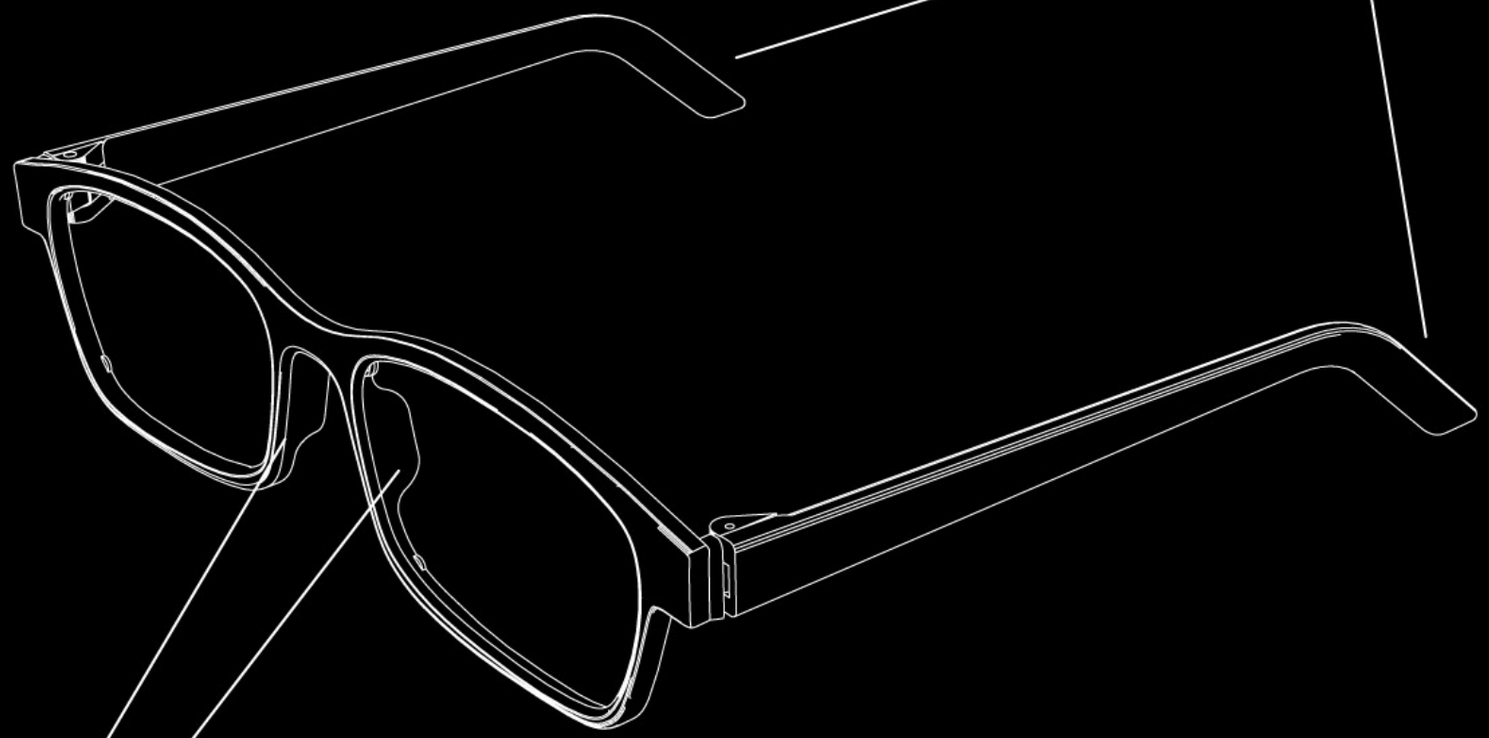
nkosmyna@media.mit.edu @nataliyakosmyna

fluid interfaces

mit media lab

Nataliya Kosmyna, Ph.D
nkosmyna@media.mit.edu

EEG sensors
(electroencephalography)



EOG sensors
(electrooculography)

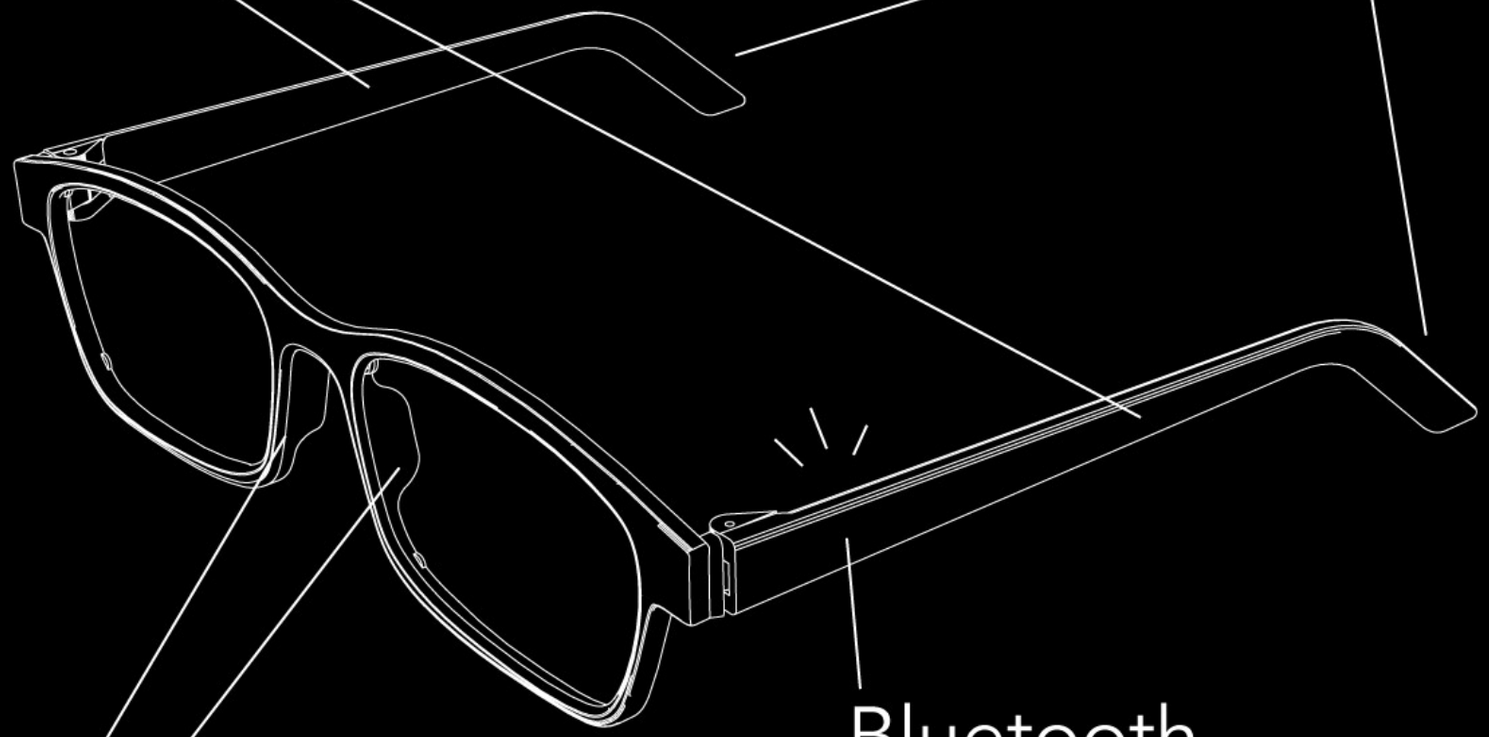
mit media lab

fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

Bone conduction
sound feedback

EEG sensors
(electroencephalography)



EOG sensors
(electrooculography)

Bluetooth
transmission to device

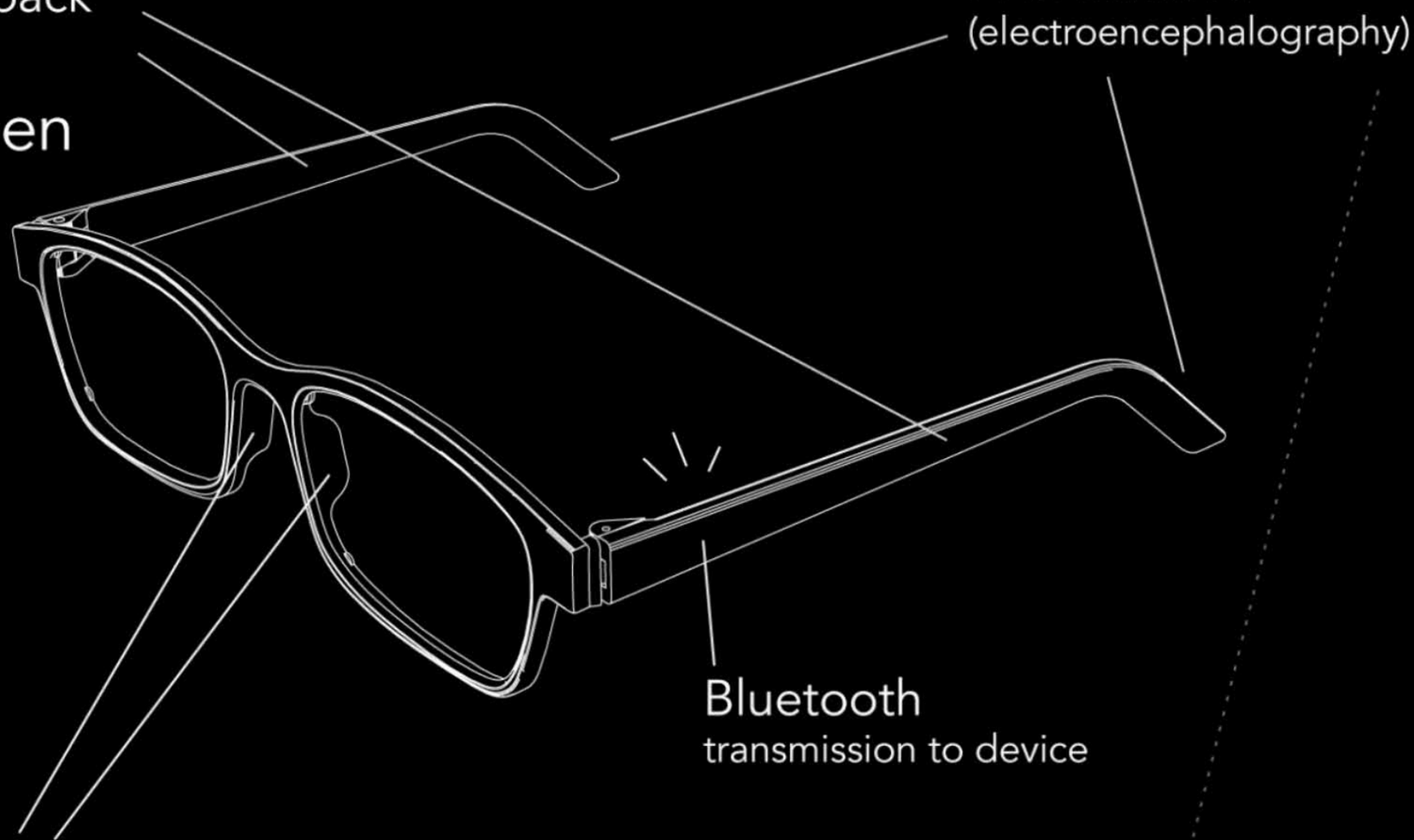
mit media lab

fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

Bone conduction
sound feedback

Feedback alerts when
attention is low



EEG sensors
(electroencephalography)

Bluetooth
transmission to device

EOG sensors
(electrooculography)

Sensors monitor
attention level

mit media lab

fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

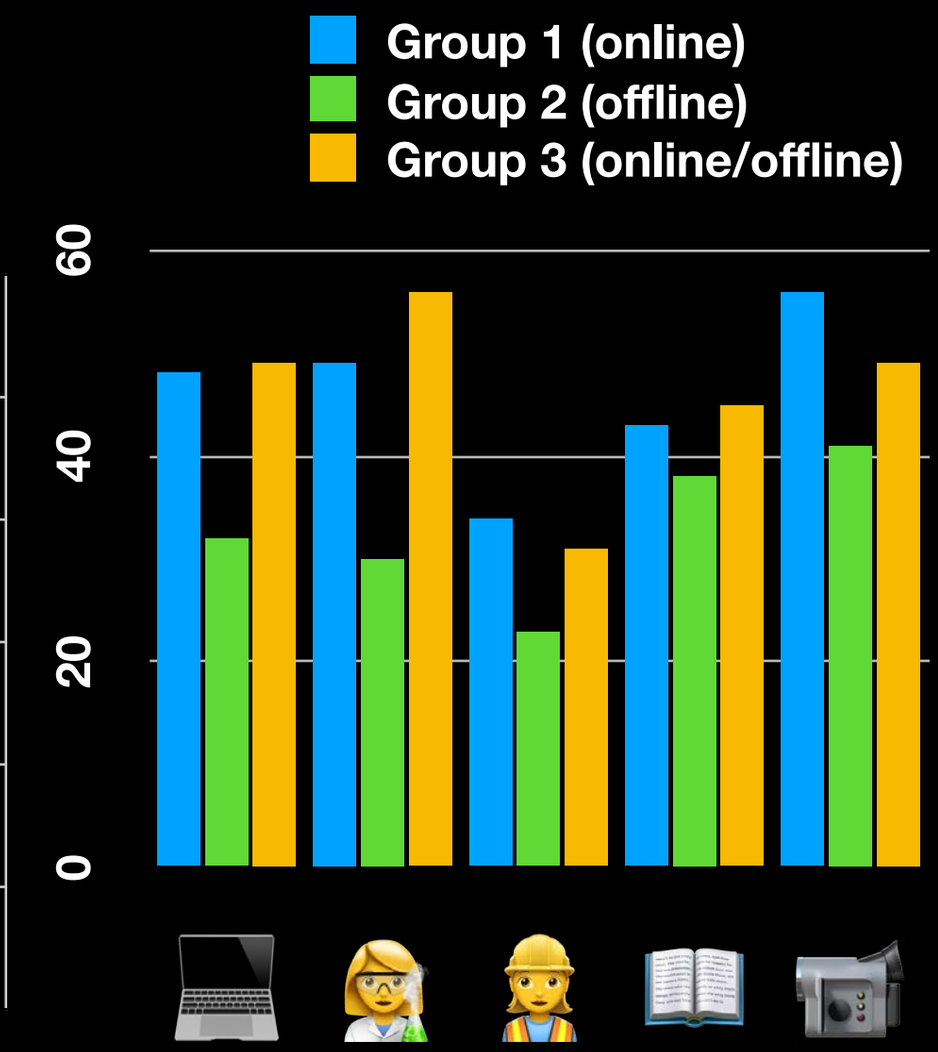
AttentivU

Nataliya Kosmyna
Caitlin Morris
Utkarsh Sarawgi
Pattie Maes

fluid interfaces
mit media lab

AttentivU 2.0

	Reported Tasks
Programming	16
Testing the code	16
Installing new environment	12
Reading	11
Watching tutorials	9



mit media lab
fluid interfaces
ATTENTIVU
nkosmyna@media.mit.edu @nataliyakosmyna

TOP 5
What can be measured with AttentivU:

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

ATTENTIVU

nkosmyna@media.mit.edu @nataliyakosmyna

Intensive Tests

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

mit media lab | fluid interfaces | ATTENTIVU

nkosmyna@media.mit.edu @nataliyakosmyna

Lesson 2

You might face challenges in the areas you did not expect

nkosmyna@media.mit.edu @nataliyakosmyna

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

mit media lab fluid interfaces

nkosmyna@media.mit.edu @nataliyakosmyna

Lesson 3

It should be fun…especially for the learning environments

nkosmyna@media.mit.edu @nataliyakosmyna

Lesson 3

It should be fun…especially for the learning environments

ATTENTIVU

nkosmyna@media.mit.edu @nataliyakosmyna

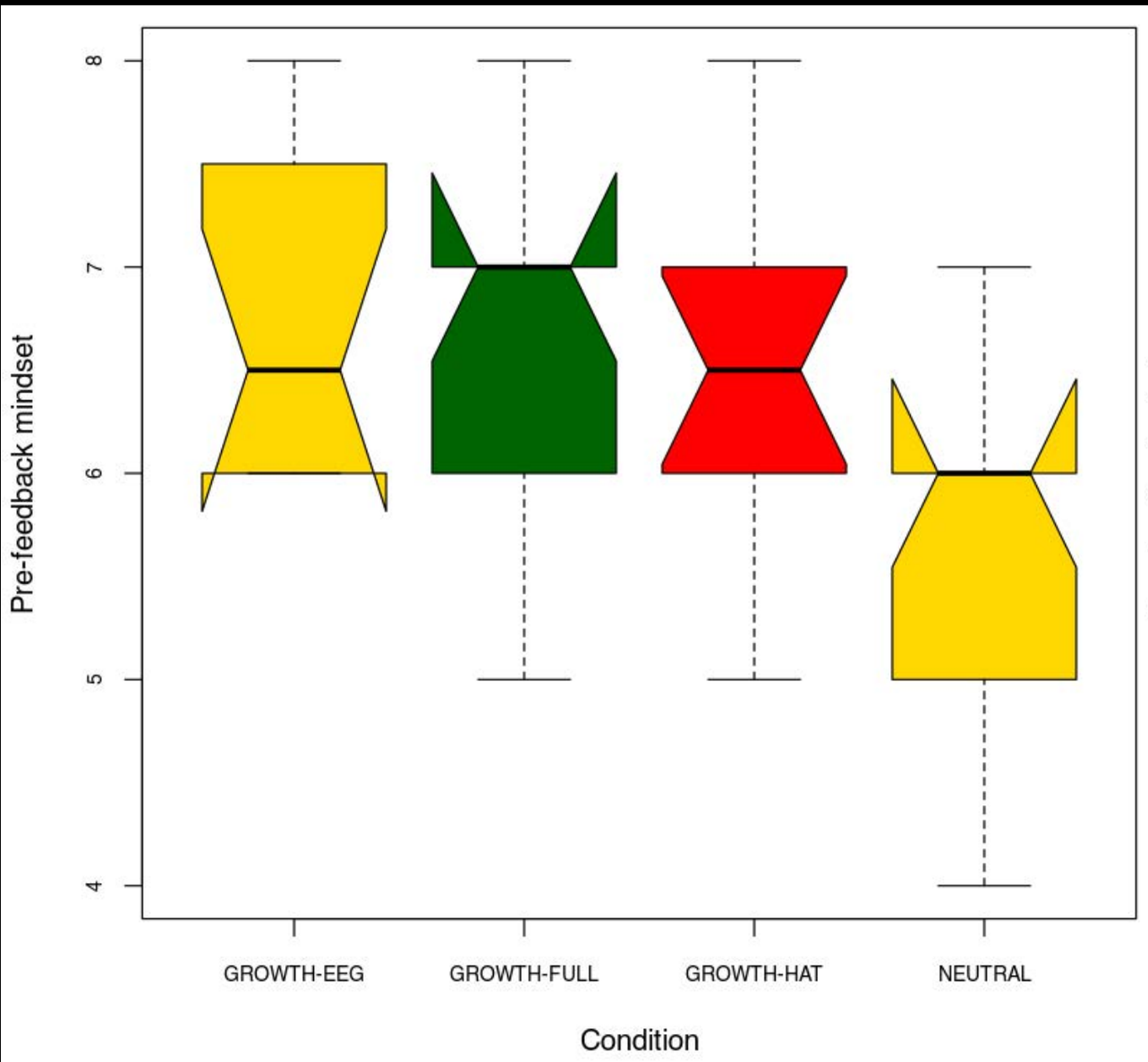
Harry Potter

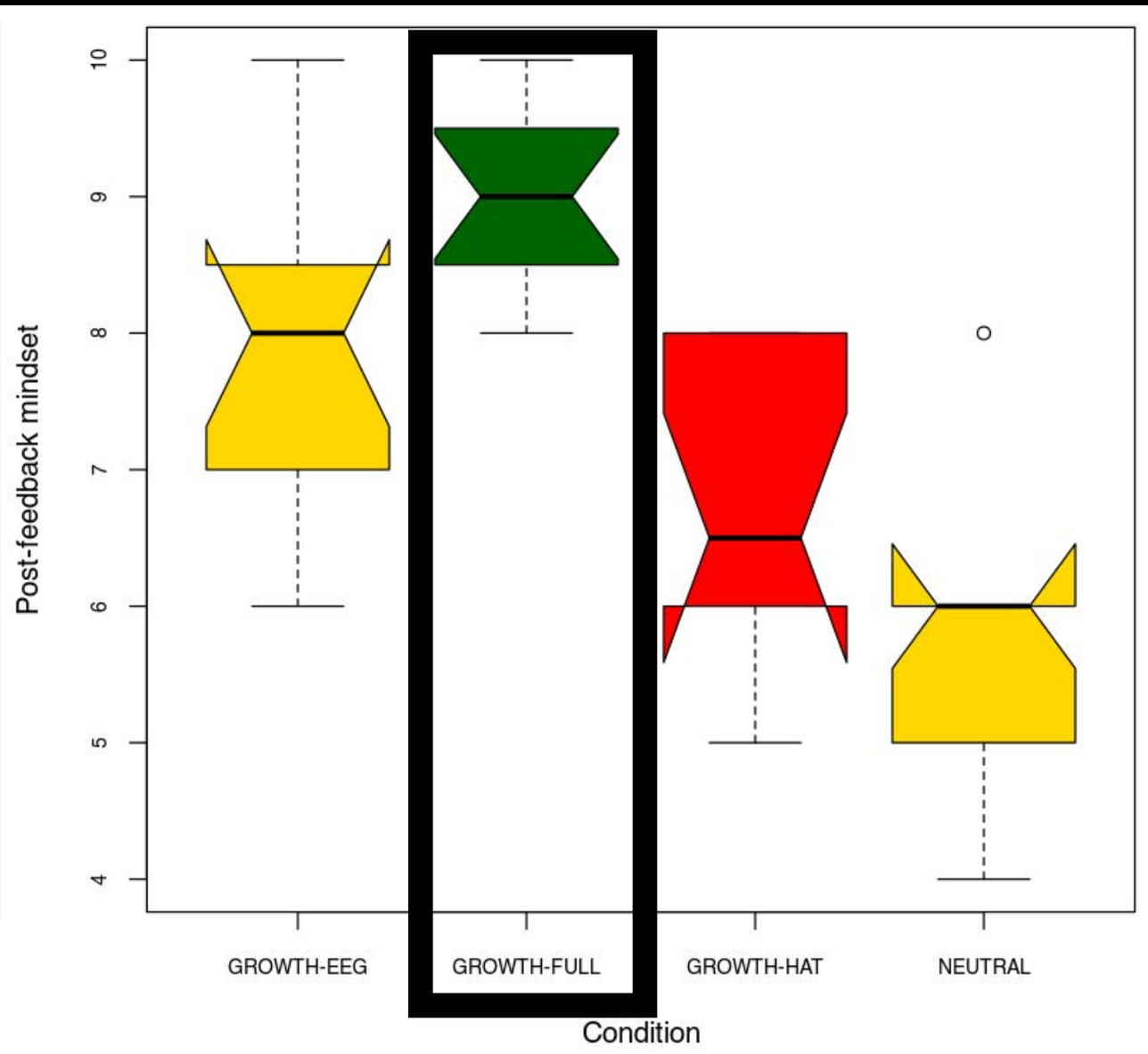
The Thinking Cap

The Thinking Cap:
Improving self-esteem, motivation and performance in children

nkosmyna@media.mit.edu @nataliyakosmyna

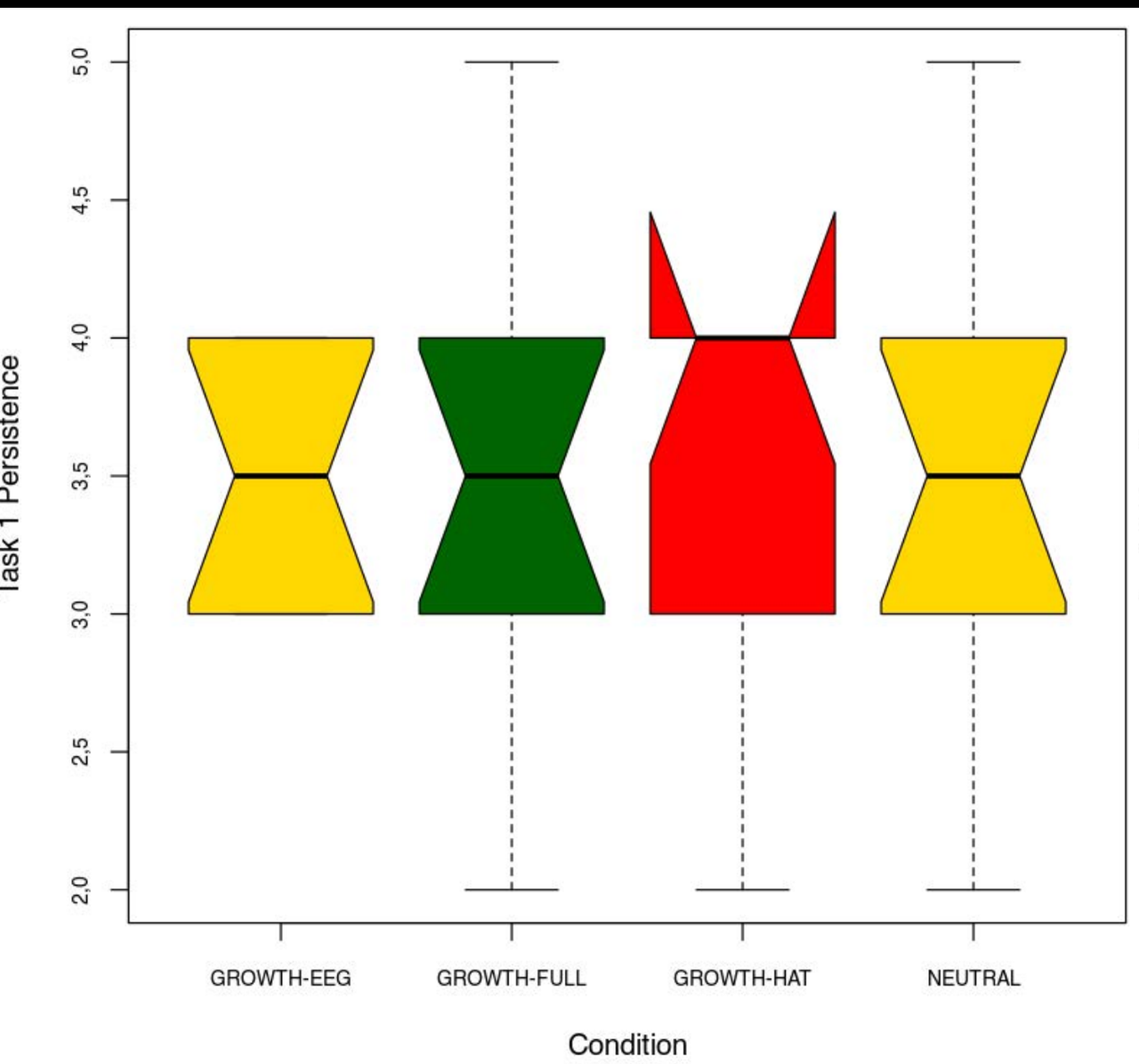
Thinking Cap: Results on Mindset

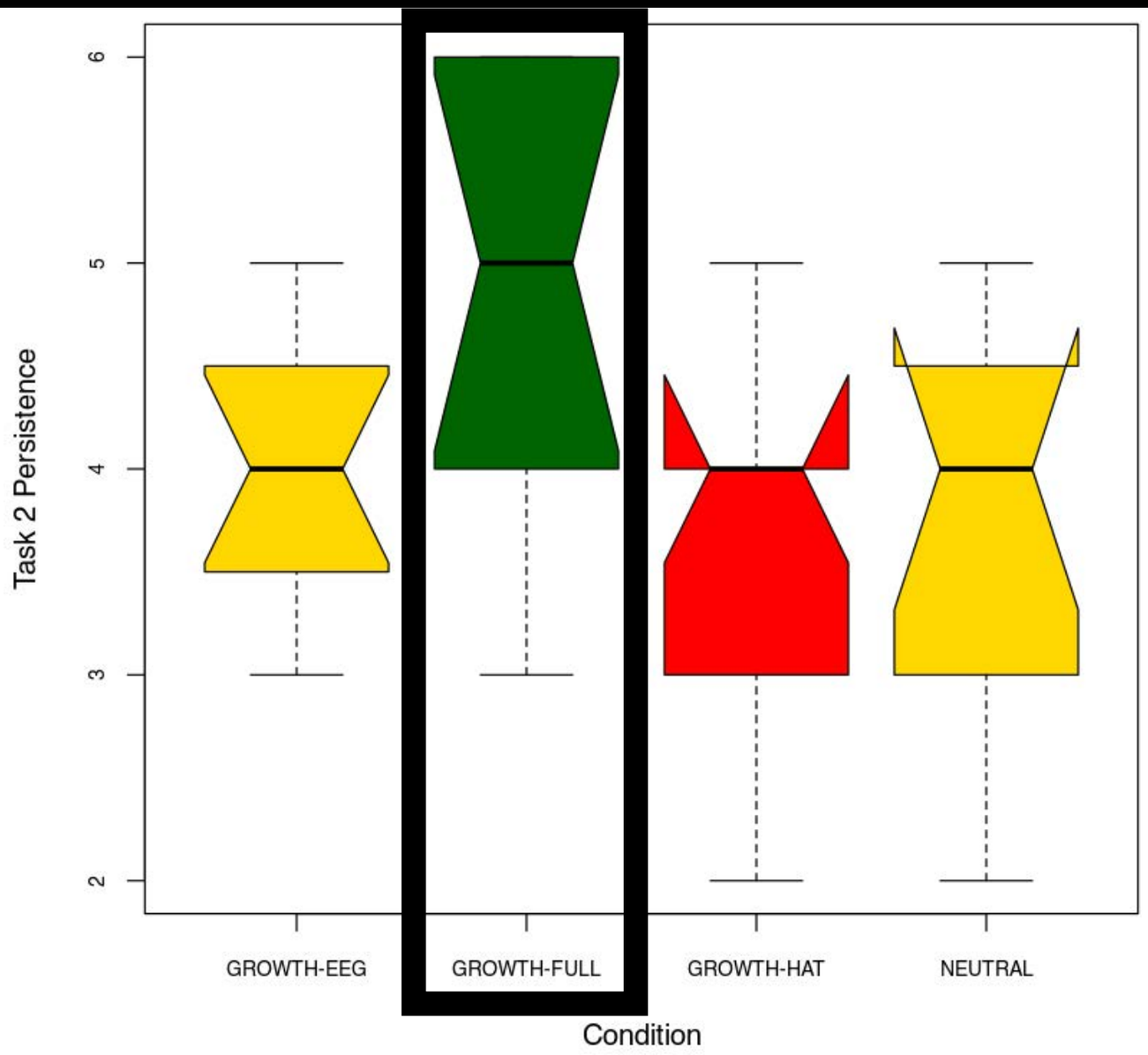




nkosmyna@media.mit.edu @nataliyakosmyna

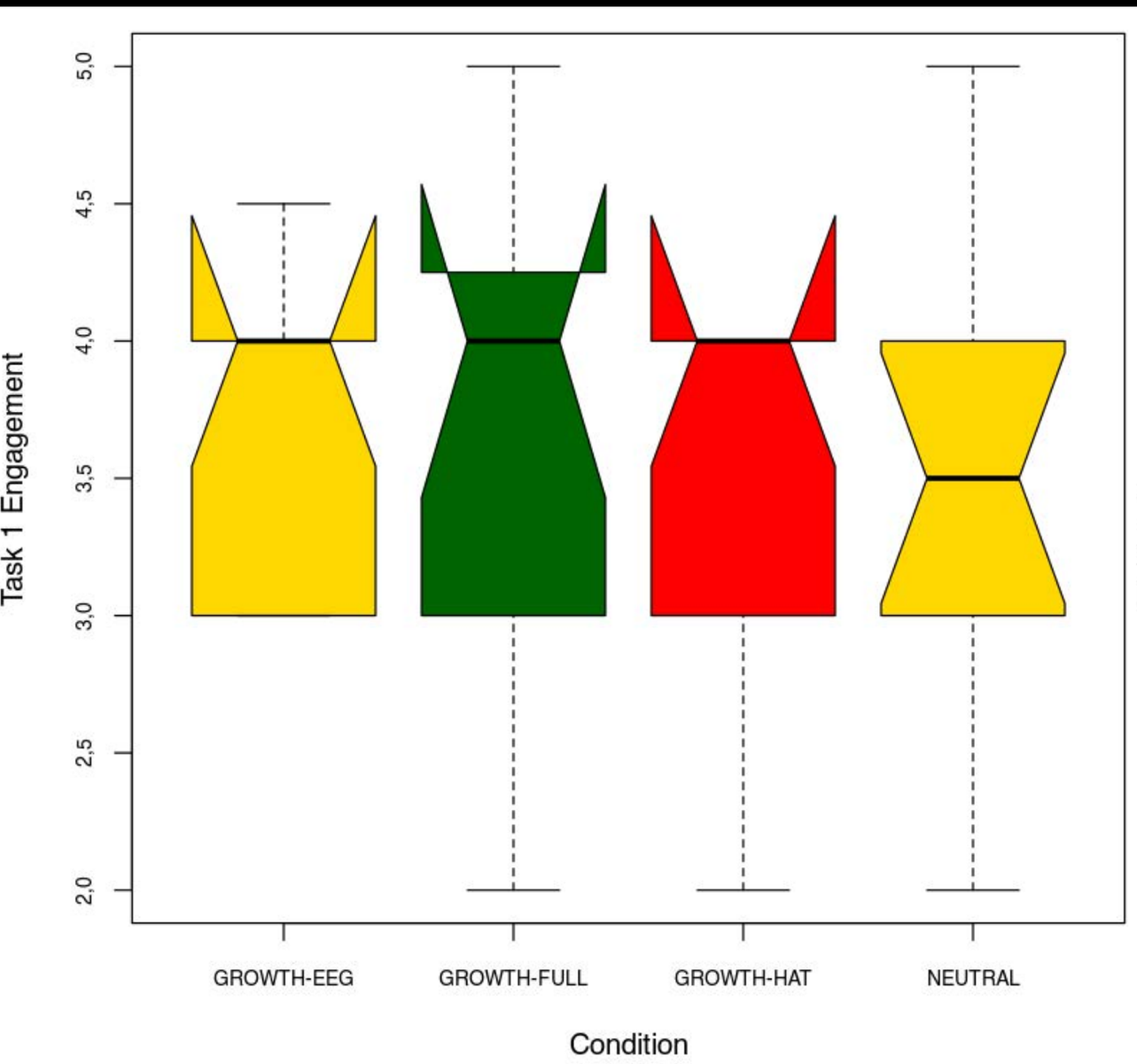
Thinking Cap: Results on Task Persistence

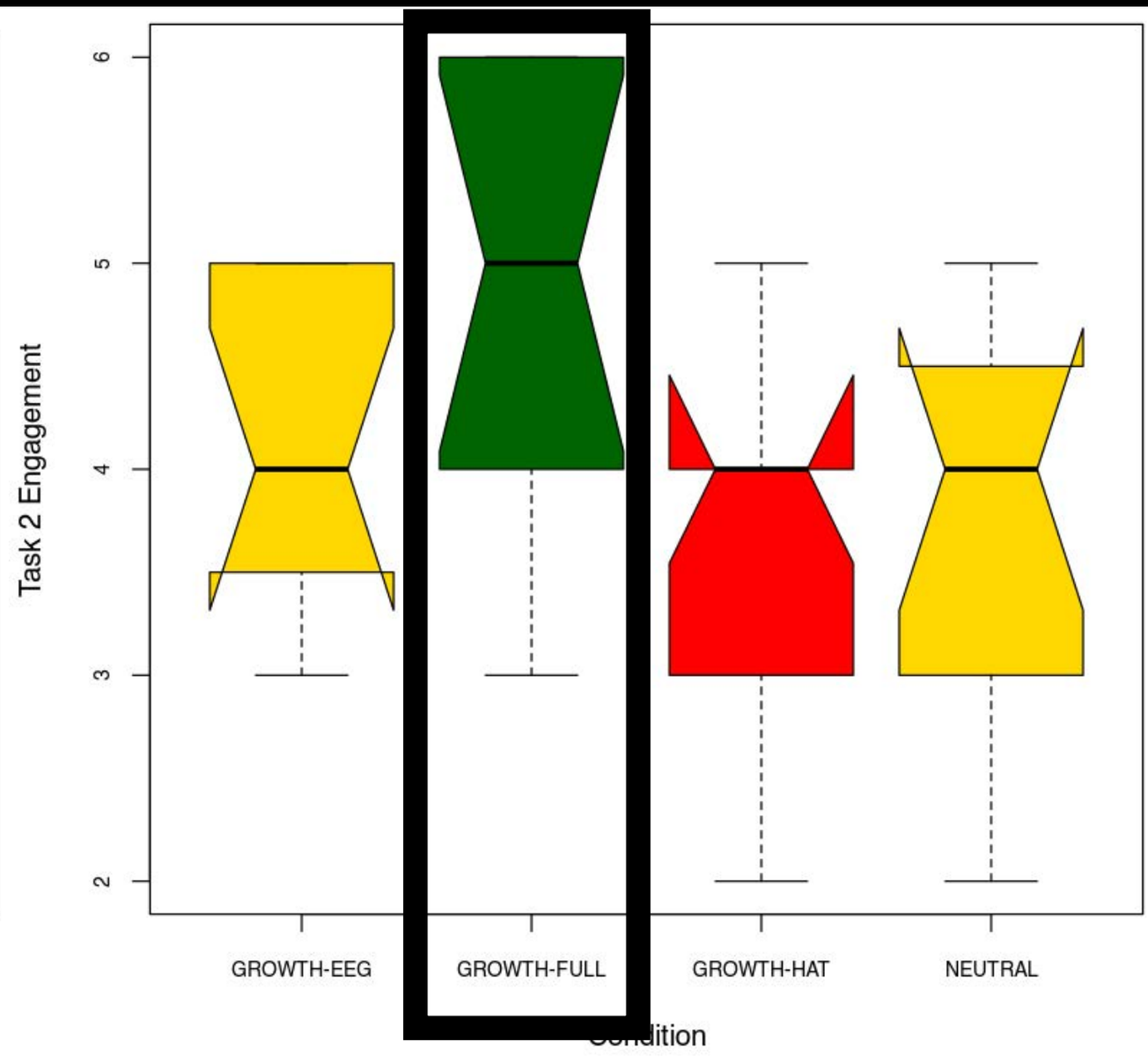




nkosmyna@media.mit.edu @nataliyakosmyna

Thinking Cap:
Results on Task Engagement





nkosmyna@media.mit.edu @nataliyakosmyna

Thinking Cap 2.0

Thinking Cap: edTech

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

BOSTON CHILDREN'S MUSEUM

nkosmyna@media.mit.edu @nataliyakosmyna

The Force is in You

nkosmyna@media.mit.edu
@nataliyakosmyna

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

ATTENTIVU

nataliya@attentivu.com @nataliyakosmyna

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

ATTENTIVU

nataliya@attentivu.com @nataliyakosmyna

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

ATTENTIVU

nataliya@attentivu.com @nataliyakosmyna

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

ATTENTIVU

nataliya@attentivu.com @nataliyakosmyna

“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

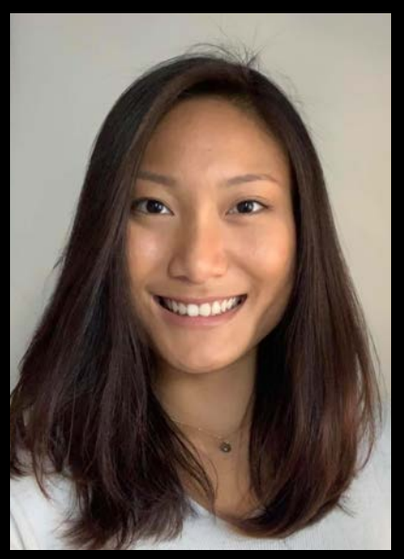
Yujie Wang

Nha Nguyen

Caitlin Morris

Jin Dou

Eileen Wu



Klare Hu

Katie Bacher

Thank YOU!

Nataliya Kosmyna, Ph.D

nkosmyna@media.mit.edu
@nataliyakosmyna

ATTENTIVU