During the study tasks, we used three sensors to record psycho-physiological data: eyetracking, EDA, and EEG.

The following devices were used for recording the data:

Eye tracker: Tobii TX300 eye tracker with 300 Hz tracking frequency

EDA sensor: Affectiva Q Sensor 2.0 with 8Hz sampling rate

EEG sensor: Neurosky MindBand with 512 Hz sampling rate

DATA PROCESSING AND ANALYSIS

To extract the features from the recorded data, we did the following data cleaning, transformation and feature extraction step in Matlab.

Eye tracking data:

1) Remove all data points that are not valid according to the eye tracking device

2) Remove the first data point in each fixation after a blink (since the pupil gets a tiny bit larger before opening the eyes)

3) Standardize pupil size measurements per subject and per subject and task combination

4) Use a peak finder algorithm to count the number of times the pupil size rises 1, 2, and 3 standard deviations above the mean

5) Calculate the fixation count and the duration of each fixation, as well as the saccades count and the duration of each saccade

6) Standardize all values either by time or by comparing to the same measurements during the preceding fishtank movie

EDA data:

1) Correct DC Shift so that the EDA signal starts at 0 micro Siemens

2) Remove noise from the signal in the range of 2 to 4 Hertz with an exponential smoothing filter

3) Apply a 5th order low-pass Butterworth filter set to 0.05 Hz to extract the tonic signal

4) Apply a high-pass Butterworth filter to extract the phasic signal

5) Use a peak finder algorithm to find peaks with a minimum amplitude of 0.02 micro Siemens in the phasic part of the signal

6) Normalize all phasic peak measurements by comparing them to the peak measurements during the preceding fishtank movie

7) Calculate the mean of the tonic SCL signal and compare it to the preceding fishtank movie

8) For both, the phasic and the tonic part of the signal, calculate the area under the curve (AUC) and normalize them by task completion time

EEG data:

1) Split data into well-known brainwave frequency bands using Fast Fourier Transformation (FFT)

2) Compute min, median, max, mean and standard deviation of each signal

3) Compute all ratios between two brainwave frequency bands

4) Compute additional well-known ratios:

Beta / (Alpha + Theta)

Theta / (Alpha + Beta)

5) To detect eye blinks, use a band-pass Butterworth filter from 0.5Hz to 3Hz and apply a peak finder algorithm to find peaks in the signal that are 100 or more times stronger than the waveform's average amplitude

6) Normalize eye blinks by comparing to the number of eye blinks during the preceding fishtank movie

LIBRARIES AND TOOLS USED FOR DATA ANALYSIS

Peak finder algorithm: http://www.mathworks.ch/matlabcentral/fileexchange/25500-peakfinder/content/peakfinder.m

EDA Toolbox: https://github.com/mateusjoffily/EDA/wiki

WEKA: weka.sourceforge.net