

Subjective well-being and frontal alpha asymmetry: is the AF4 location special?



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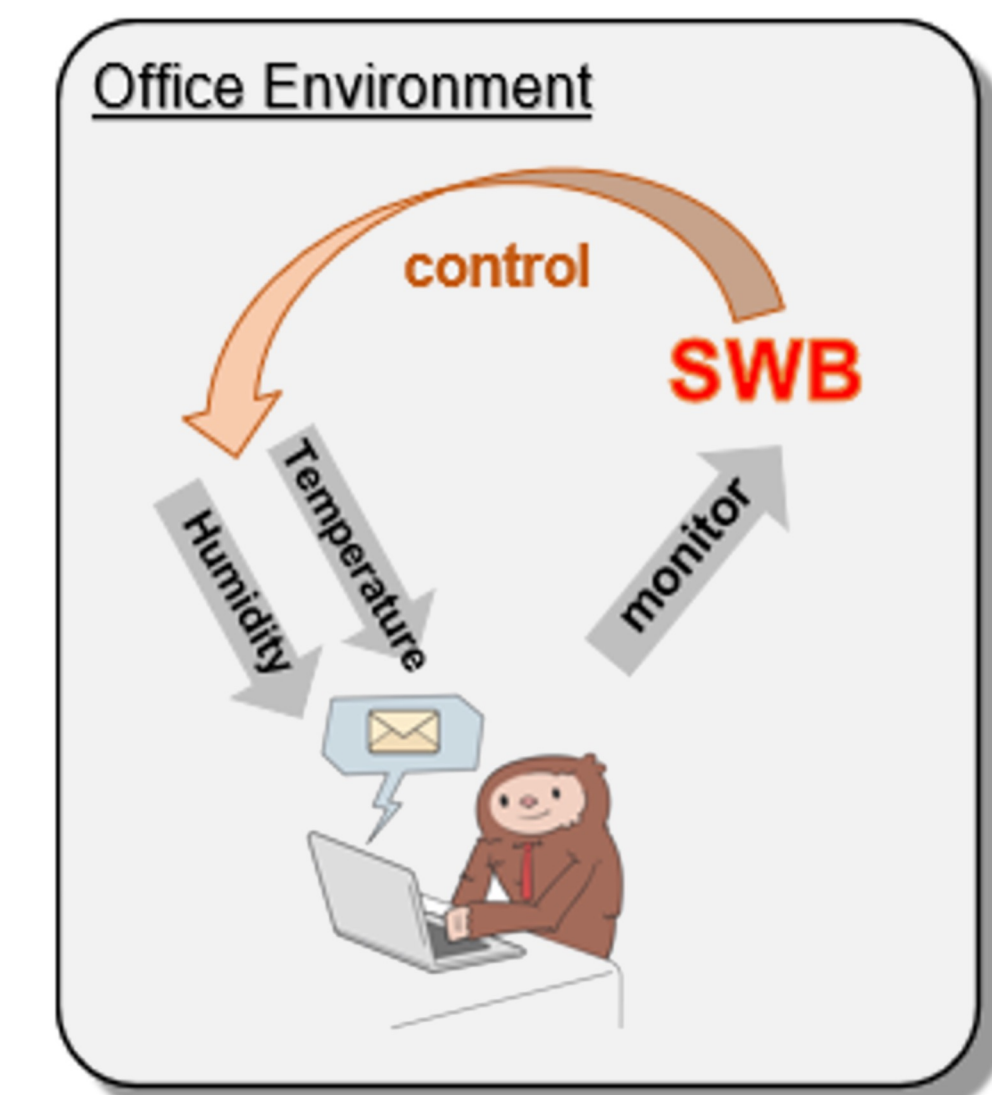
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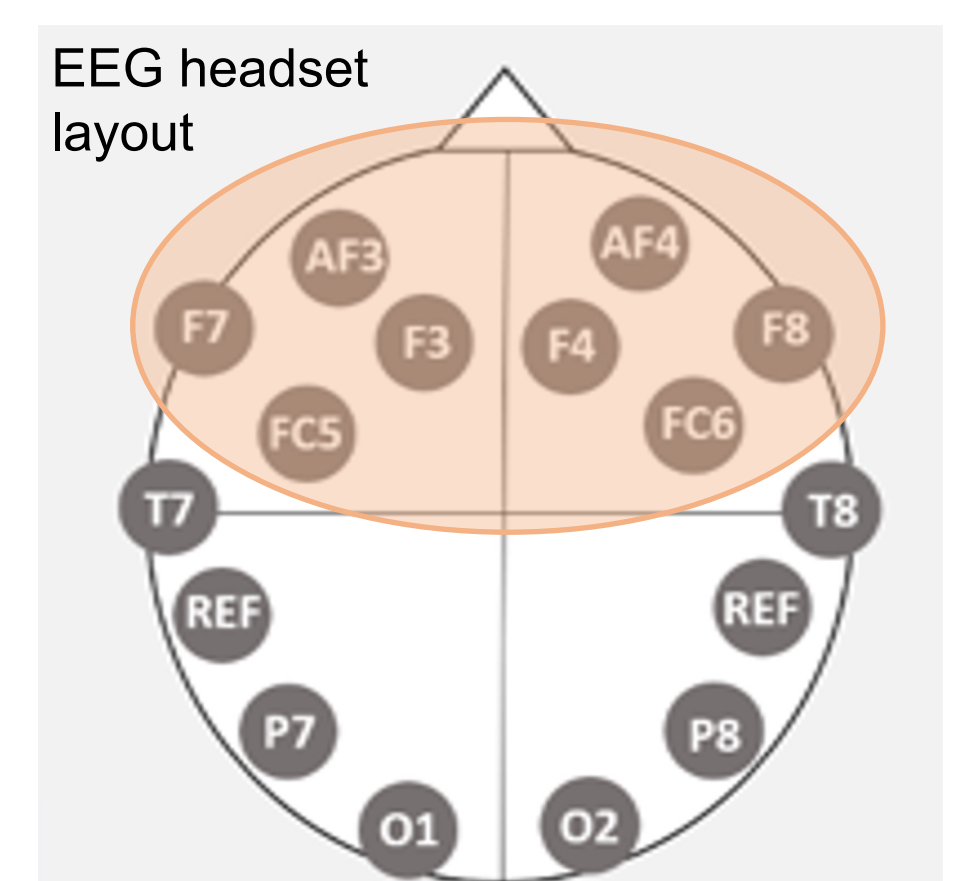
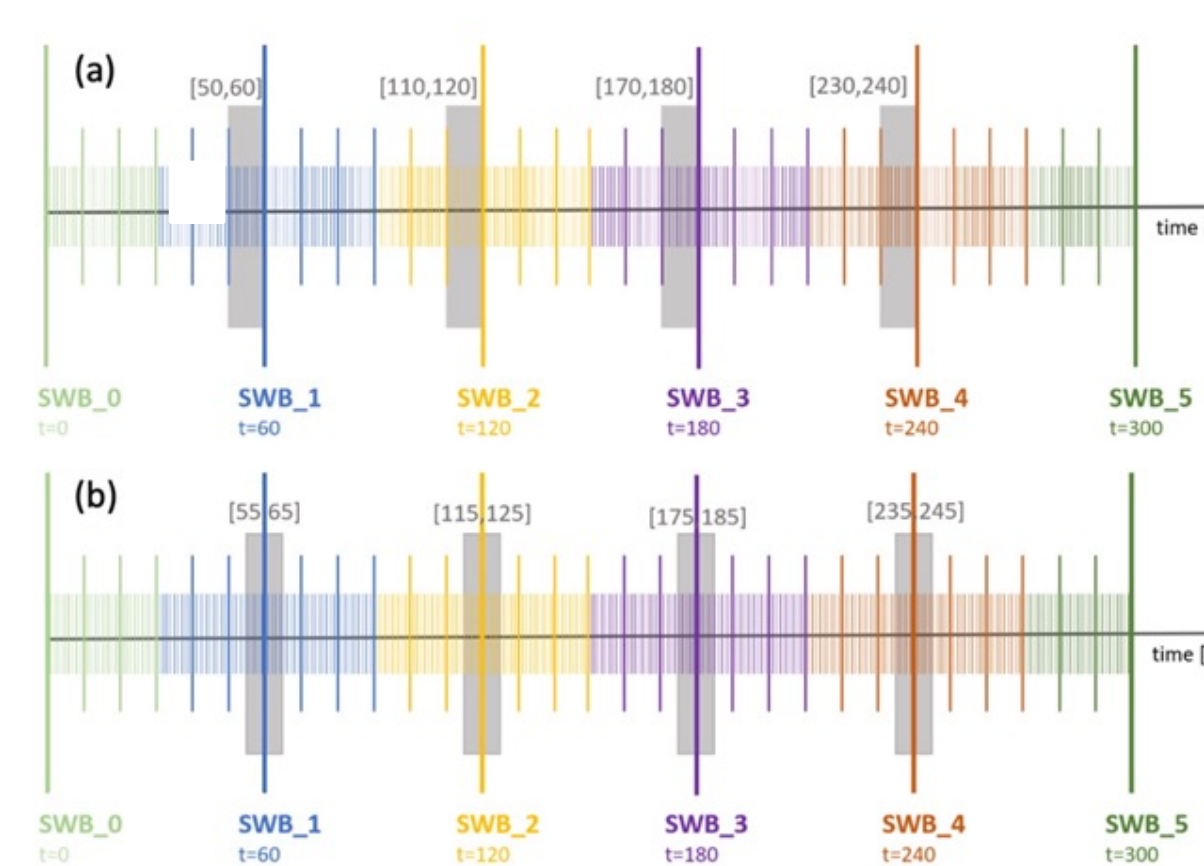
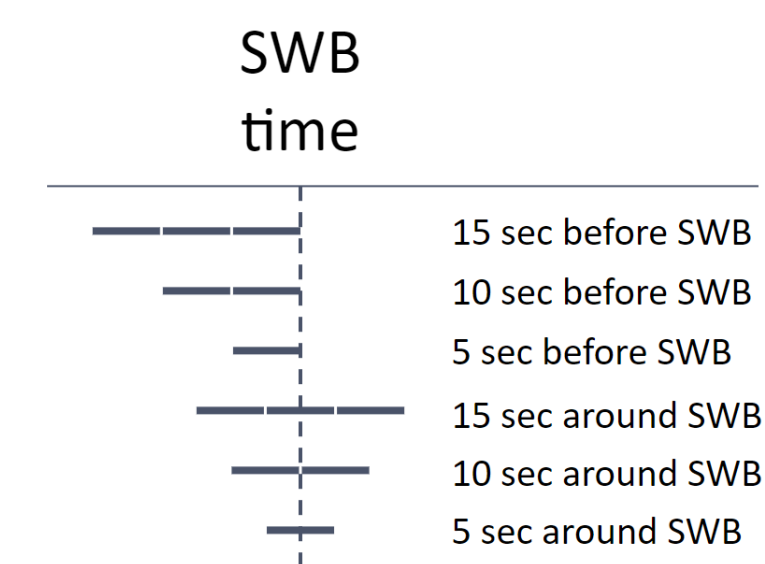
Subjective Well-Being (SWB)

- What is SWB?
 - “A broad category of phenomena that includes people’s emotional responses, domain satisfactions, and global judgements of life satisfaction” (Diener et al. 1999), p. 277
 - Also known as “psychological well-being” (Ryff 1989), “quality of life” (Frisch et al. 1992), or “subjective happiness” (Lyubomirsky and Lepper 1999), and similar to “comfort” (Pinto et al. 2017)
 - SWB can be influenced by environmental conditions (e.g., too hot or too cold causes discomfort)
- Electroencephalography (EEG) and SWB
 - Correlation between SWB and Frontal Alpha Asymmetry (FAA) using EEG, e.g., (Urry et al. 2004; Xu et al. 2018)
 - SWB usually measured as a static metric or with psychological or psychiatric interventions over weeks, months, or longer
- Our assumptions
 - Participants’ depression scores or other psychological measures remain the same over experiment
 - Focus on short-term (60 or 30 second) scale and try to influence SWB by environmental changes
 - Consider different frontal EEG sensors to measure FAA



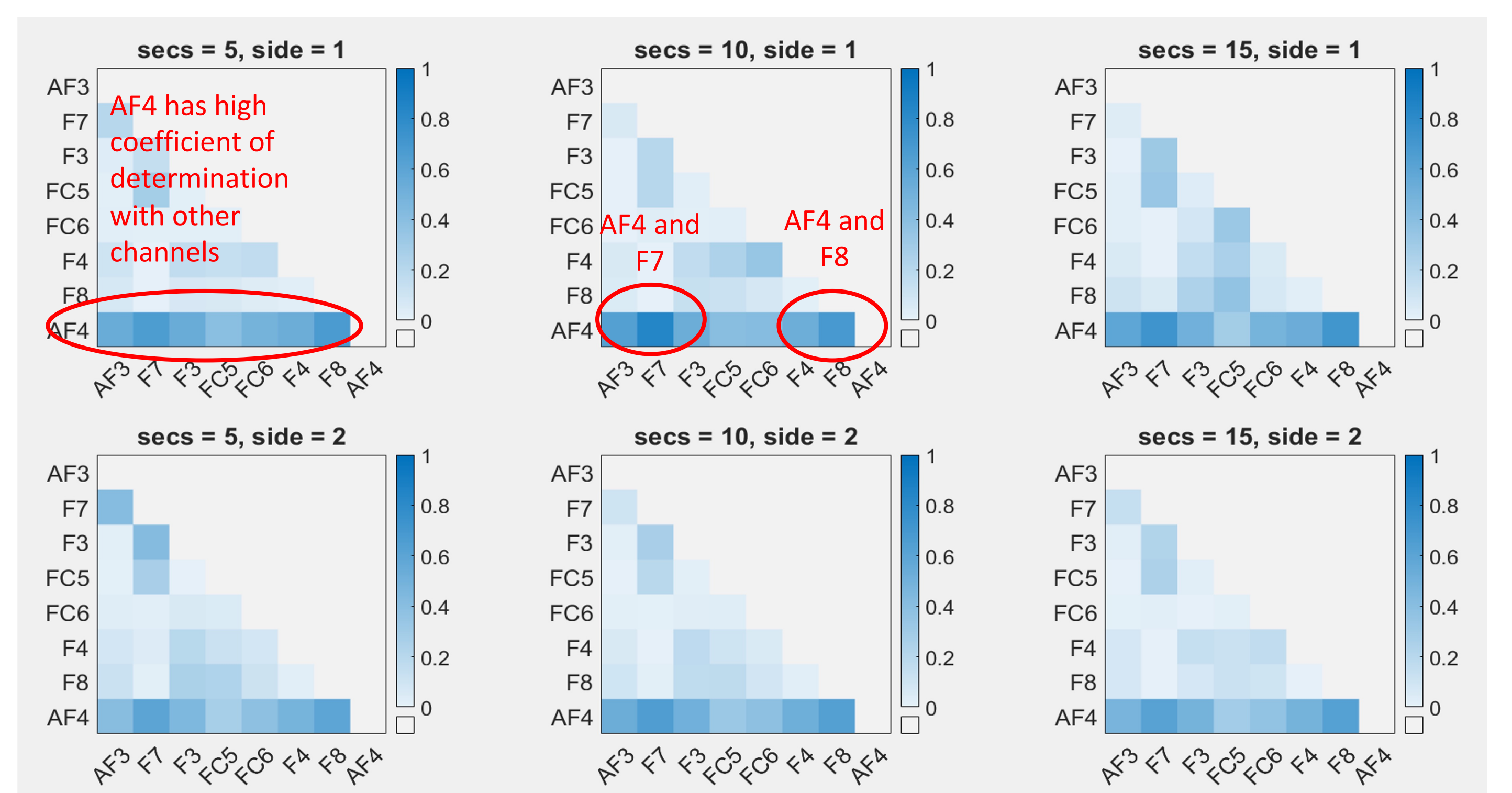
Methods

- We tried to change the SWB via varying temperature and humidity in a medium-sized office room (different sessions having different temperature and humidity settings)
- SWB was given verbally by the participant on a scale from 1 (worst) to 10 (best) at given intervals
- Two experiments:
 - Experiment 1 (2020): Emotiv EPOC+ headset (EMOTIV, San Francisco, USA), SWB every 60 seconds
 - Experiment 2 (2022): Emotiv EPOC X headset (EMOTIV, San Francisco, USA), SWB every 30 seconds
- EEG preprocessing (each subject and session individually): EEGLAB (Delorme and Makeig 2004), HAPPE (Gabard-Durnam et al. 2018), MARA (Winkler et al. 2011, 2014)
- Filtered EEG data into the alpha band (8 – 13 Hz) and chose a specific time window, either 5, 10, or 15 seconds before the SWB was recorded or 5, 10, or 15 seconds with the SWB being recorded in the middle of the interval
- All combinations of 8 frontal channels: AF3, F7, F3, FC5, FC6, F4, F8, and AF4
- Calculate FAA from power spectrum $FAA = mean(\log pow_R - \log pow_L)$
- Several (FAA, SWB) pair for each channel combination
- Many (FAA, SWB) for SWB value 6, 7, or 8 and only a few for SWB value of 1, 2, 3, or 10 \Rightarrow mean over all FAA with the same SWB resulting in 10 mean (FAA, SWB) pairs
- Linear fit of these 10 mean (FAA, SWB) pairs
- Coefficient of determination and p-value were determined by performing a permutation test with $n = 1000$ permutations



Results

- Experiment 1: 30 students (29 right-handed, 1 left-handed, 16 males, 14 females, ages 23.4 ± 3.3 years)
- Experiment 2: 30 students (28 right-handed, 2 left-handed, 16 males, 14 females, ages 22.3 ± 4.2 years)
- Excluded 6 subjects for various reasons (left-handed, too short recordings, too much movement, etc.)
- The figures on the right show heatmaps of the coefficient of determination of the different parameter settings and different channel combinations
- **AF4 seems to be of special interest:** Combinations of AF4 and any other channel give relatively high coefficient of determination
- When we compare all 6 different analysis methods (AF4, F7) and (AF4, F8) are always statistically significant ($p=0.05$) with (AF4, F7) for the analysis of 10 s before the SWB giving the best result



Heatmaps for the coefficient of determination of the linear fitting for all different time windows, i.e., length of either 5, 10, or, 15 seconds and side = 1 denotes that the time interval was taken before the SWB was recorded and side = 2 stands for an interval with SWB in the middle.

Conclusion

- Tendency toward positive linear correlation between FAA (calculated over different positions of time intervals) and short-term SWB present but not always statistically significant
- Alpha asymmetry of various combinations of frontal sensors correlates to SWB, as long as AF4 is among them, especially the combination with F7
- AF4 is the sensor above the superior frontal gyrus or Brodman area 9 (Koessler et al. 2009) which plays a role in attention to positive emotions (Kerestes et al. 2012)