Final Report
Effects of the Device Qi-Shield

A neurophysiological and psychological study to evaluate the effects of the Device Qi-Shield

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Motivation and Objectives

Motivation and Objective

Qi-Shield

Device: Qi-Shield contains conductive liquids in particular geometric configurations designed to interact with radiofrequency and environmental electromagnetic fields.

Already explored: Evaluation on a subjective level based on customer interviews and within an experiment exploring immediate effects of the technology during a rest period without any stressors.

Objective of the Project: Can we observe effects of the device on the physiological level (EEG, ECG, EDA) and subjective well-being (questionnaires) of consumers after a time exposure of seven days within a systematic study?

Theoretical Background

Literature review

Electromagnetic fields (EMF) and Electromagnetic hypersensitivity (EHS)

- **Electromagnetic fields and public health – according to World Health Organization**
  - Electromagnetic hypersensitivity (EHS) – EHS is characterized by a variety of non-specific symptoms, which afflicted individuals attribute to exposure to EMF (electromagnetic field). The symptoms most commonly experienced include dermatological symptoms as well as neurasthenic and vegetative symptoms. EHS resembles multiple chemical sensitivities (MCS), another disorder associated with low-level environmental exposures to chemicals. Both EHS and MCS are characterized by a range of non-specific symptoms that lack apparent toxicological or physiological basis or independent verification.
  - **Studies on EHS individuals -** The majority of studies indicate that EHS individuals cannot detect EMF exposure any more accurately than non-EHS individuals. Well controlled and conducted double-blind studies have shown that symptoms were not correlated with EMF exposure.
  - **Conclusion -** EHS is characterized by a variety of non-specific symptoms that differ from individual to individual. The symptoms are certainly real and can vary widely in their severity. Whatever its cause, EHS can be a disabling problem for the affected individual. EHS has no clear diagnostic criteria and there is no scientific basis to link EHS symptoms to EMF exposure. Further, EHS is not a medical diagnosis, nor is it clear that it represents a single medical problem.
  - **Research** - Some studies suggest that certain physiological responses of EHS individuals tend to be outside the normal range. In particular, **hyper-reactivity in the central nervous system** and **imbalance in the autonomic nervous system** need to be followed up in clinical investigations and the results for the individuals taken as input for possible treatment.

Source: https://www.who.int/peh-emf/publications/facts/fs296/en/

Literature review

Electromagnetic fields (EMF) and Electromagnetic hypersensitivity (EHS) (2)

- **Current studies on the influence of EMF and cause of EHS are not conclusive**
  - There is no conclusive evidence for an association between impaired well-being and exposure to mobile phone radiation. However, the limited quantity and quality of research in this area **do not allow to exclude long-term health effects definitely.**
  - A meta-analysis provides evidence that **short term exposure of RF-EMF emitted by mobile phones do not affect well-being and related parameters**. They found no impact on headaches, nausea, fatigue, dizziness, skin irritation, blood pressure, heart rate, heart rate variability and skin resistance, or respiration. Future research should **focus on the possible effects of long-term exposure.**
  - It is suggested that EHS is related to **(idiopathic) environmental intolerance (IEI).** There seems to be an **association of psychological symptoms in idiopathic environmental intolerance attributed to electromagnetic fields**. Such psychological symptoms were found e.g. on obsessive/compulsive behavior, interpersonal hypersensitivity, hostility, phobic anxiety, paranoid thoughts in the IEI-EMF group compared to referents.
  - High exposure activities of EMF involve high people density or percentage urban ground use. The main contributors to total exposure are cordless and cellular phones. Exposure in the evening is four times higher than at night, so it can be diminished.
  - Better exposure characterization, in particular with respect to sources of extremely low frequency magnetic fields (ELF-MF) is needed to draw more solid conclusions.

Seitz et al.2005. Electromagnetic Hypersensitivity (EHS) and Subjective Health Complaints Associated With Electromagnetic Fields of Mobile Phone Communication--A Literature Review Published Between 2000 and 2004

Augner et al. 2012. Acute effects of electromagnetic fields emitted by GSM mobile phones on subjective well-being and physiological reactions – A meta-analysis.

Bolte et al. 2012. Personal radiofrequency electromagnetic field measurements in the Netherlands: Exposure level and variability for everyday activities, times of day and types of area.

Baliastsas et al.2015. Actual and perceived exposure to electromagnetic fields and non-specific physical symptoms: An epidemiological study based on self-reported data and electronic medical records.

Kjellqvist et al.2016. Psychological symptoms and health-related quality of life in idiopathic environmental intolerance attributed to electromagnetic fields.

Special issue in Journal of chemical Neuroanatomy: Controversies on Electromagnetic Fields in Neurobiology of Organisms https://www.sciencedirect.com/journal/journal-of-chemical-neuroanatomy/vol/75/part/PB

Literature review

some general background on possible effects in brain networks

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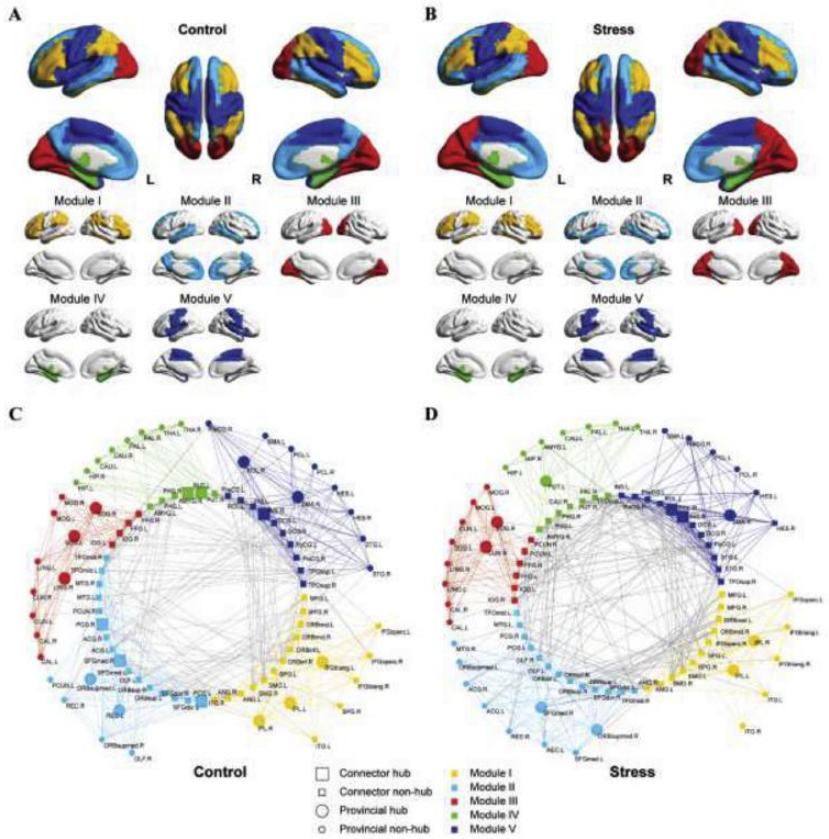
journal homepage: www.elsevier.com/locate/ynstr

Stress-induced changes in modular organizations of human brain functional networks

Yuan Zhang[a,b], Zhongxiang Dai[c], Jianping Hu[d], Shaozheng Qin[e], Rongjun Yu[f,*], Yu Sun[a,g,**]



- This study gives an overview how stress induced changes are manifested in resting-state brain functional networks.
- Five-module architecture of the brain functional network under stress are affected, which corresponded to functional systems underpinning cognitive control, self-referential mental processing, visual, salience processing, sensory and motor functions.
- More specifically, acute stress weakened the frontoparietal module connectivity and strengthened the default-mode module connectivity.
- Hence, stress alters the information flow in networks important for salience processing and self-referential metal processing.

Literature review

Suitable correlates in ECG, GSR and EEG

- **Possible measures from electrocardiography (ECG) – defining heart rate (variability)**
  - A meta-analysis shows that HRV is impacted by (chronic) stress and the most commonly found parameter was **low parasympathetic activity**, which is **characterized by a decrease in the high-frequency (reflects vagal activity)** band and an **increase in the low-frequency band (reflects sympathetic modulations).** Furthermore, **increases in heart rate** (decrease in RR-Interval) and **decrease in heart rate variability** (standard deviation of RR-Interval, SDNN).
    - maxima, minima and average of the heart rate (interval of the R-peaks);
    - heart rate variability can be characterized with different approaches in the time and frequency domain such as:
      - skewness, kurtosis and standard deviation
      - RMSSD (square root of the mean of the sum of successive differences between adjacent RR intervals); SDNN (standard deviation of the RR intervals); MeanNN (mean of the RR intervals); SDSD (standard deviation of the successive differences between RR intervals)
      - ratio of low (0.04-0.15Hz) to high (0.15-0.4Hz)) frequency power (LF-HF)
- **Possible measures from galvanic skin response (GSR)**
  - GSR signal can be decomposed into smaller phasic responses (individual rapid spontaneous responses – usually related to certain stimuli) and tonic components (longer lasting basic skin resistance level). (Chronic) stress impacts **more spontaneous** EDA responses which is associated to a general **higher arousal state**
    - from these two components several indices can be derived: number of individual phasic responses, summed amplitude of phasic responses; minimum, maximum and average of phasic responses; integral of phasic responses; tonic state of electrical conductivity

Malik, M. 1996. Heart rate variability standards of measurement, physiological interpretation, and clinical use. Eur. Heart J. 17, 354–381

Augner et al. 2012. Acute effects of electromagnetic fields emitted by GSM mobile phones on subjective well-being and physiological reactions – A meta-analysis.

Dishman et al. 2000. Heart rate variability, trait anxiety, and perceived stress among physically fit men and women – A meta-analysis

Kim et al. 2017. Stress and Heart Rate Variability: A Meta-Analysis and Review of the Literature

Zhong et al. 2005 . Incresed sympathetic and decreased parasympathetic cardiovascular modulation in normal humans with acute sleep deprivation.

Papousek, I. et al. (2001). Associations between EEG asymmetries and electrodermal lability in low versus high depressive and anxious normal individuals.

Literature review

Suitable correlates in ECG, GSR and EEG (2)

- **Possible measures from electroencephalography (EEG) – effects of RF-EMF**
  - Exposure of acute RF-EMF affects **spectral power alpha band in resting activity** - decrease in alpha band power (eyes closed: lower alpha 8–10 Hz and upper alpha 10–12 Hz) during exposure to RF-EMF, which persisted in the post-exposure period.
  - Exposure of RF-EMF reduces the **resting spectral power** and the **interhemispheric coherence** in the **alpha- and beta-bands** in **frontal and temporal** EEG-channels
  - **In summary:** Data in the literature have shown that exposure to radiofrequency signals modifies the resting EEG-activity with the main effect on the **alpha frequencies** (8–13 Hz). However, **some studies** have reported an **increase in alpha band power, while others have shown a decrease**, and other studies showed **no effect on EEG power.** These discrepancies are explained by different study protocols – mainly attributed to exposure time, eyes open versus eyes closed and reference channel in the EEG set-up. In general, the EEG power spectra are highly heritable, with highest heritability around the alpha peak frequency and lower heritability in the other frequencies like theta and delta bands. **Inter-individual differences are much more marked than intra-individual variations**. **Since effects—if present—are expected to be small, a crossover design is more appropriate than a parallel-group design.**
- **Possible measures from electroencephalography (EEG) – quantative markers of resting state activity (power and coherence) and its relation to mental process and mental stress**
  - frontal resting **EEG theta/beta ratio** is as an electrophysiological marker for **executive control functions** or more specifically attentional control
  - changes of resting state **frontal (power and connectivity) alpha asymmetry** (fight-or-flight response system which is generally associated with valence and arousal level) is related to **emotion regulation difficulties** – like deficits in impulsive control - and has been suggested to **vary under conditions of chronic stress.** It was reported that chronic stress primarily affects a **shift in frontal alpha asymmetry towards the right side.**
  - a general **decrease in alpha band power** and **increase in beta band power** on the frontal regions under stress conditions was reported.
    - A persistent exposure of this short-term stress for a longer duration can cause long lasting effects on the neurology of an individual and may give rise to chronic stress symptoms or depression.

Ghosn et al. 2015 . Radiofrequency signal affects alpha band in resting electroencephalogram

Yang et al. 2017. Long-Term Evolution Electromagnetic Fields Exposure Modulates the Resting State EEG on Alpha and Beta Bands.

Wallace et al. 2019. Effect of mobile phone radiofrequency signal on the alpha rhythm of human waking EEG: A review.

Danker-Hopfe et al. 2019. Effects of RF-EMF on the Human Resting-State EEG—the Inconsistencies in the Consistency. Part 1: Non-Exposure-Related Limitations of Comparability Between Studies.

Lewis, K.S. et al (2007). The effect of a naturalistic stressor on frontal EEG asymmetry,stress, and health.

Al-Shargie et al. (2016). Mental stress assessment using simultaneous measurement of EEG and fNIRS.

Angelidis et al. 2016 . Frontal EEG Theta/Beta Ratio as an Electrophysiological Marker for Attentional Control and Its Test-Retest Reliability

Son et al. 2019. Electroencephalography theta/beta ratio covaries with mind wandering and functional connectivity in the executive control network

Imperatori et al. 2019. Is resting state frontal alpha connectivity asymmetry a useful index to assess depressive symptoms? A preliminary investigation in a sample of university students.

Zhang et al. 2020. Resting state frontal alpha asymmetry predicts emotion regulation difficulties in impulse control

Papousek, I. et al. (2002). Covariations of EEG asymmetries and emotional states indicate that activity at frontopolar locations is particularly affected by state factors.

Methods
Sample requirement and recruitment

Methods

Sample requirement and recruitment

- Age: 18 – 50
- Sex: 50:50
- No neurological diseases such as e.g. epilepsy or psychiatric disorders (asked for by self-disclosure) or the intake of centrally effective drugs, as these factors can influence electrophysiological signals such as EEG ECG and EDA.
- No persons with COVID risk factors (https://www.rki.de/DE/Content/InfAZ/N/Neuartiges_Coronavirus/Steckbrief.html;jsessionid=26ED201254272C667A65E5C73C18A839.internet062#doc13776792bodyText2)
- sufficient language skills

Online Screening questionnaire: send before invitation with demografic question and screening criteria

Methods
Experimental design, Subjective Methods, and Data recording

Methods

Experimental Design and Manipulation

Between subject study design

A sham device Qi-Shield - placebo

B real device

C control group no device

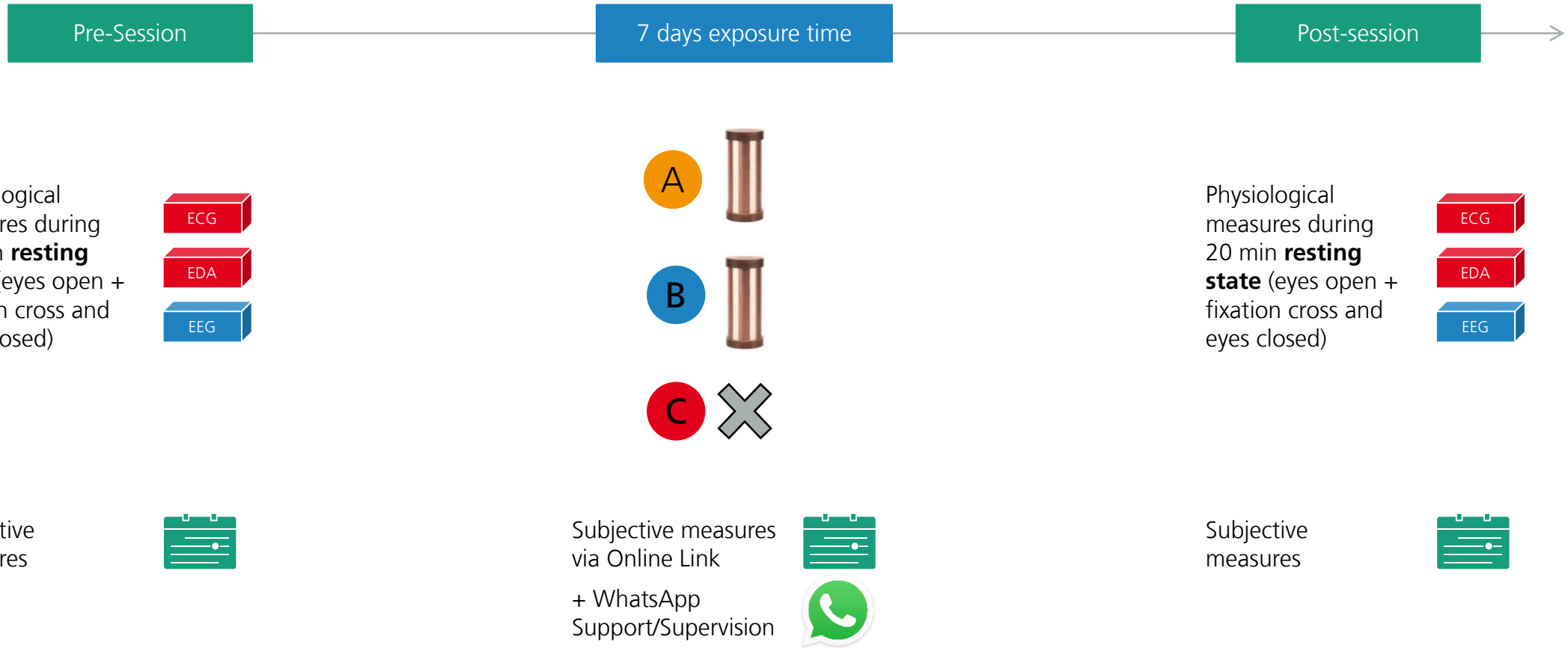
→ Latin-squared counter-balanced semi-randomized assignment to the groups

Double-blind study design

- The Experimenter does not know which device belongs to which group (treatment vs no treatment vs placebo).
- All the devices from Waveguard need to be identical in their appearance regarding their form, style, and weight.
- The devices need to be clearly labelled with e.g., a sign (star, triangle) or number (0/1).
- The information which label refer to the real device and which to the placebo/sham device group should be send in a sealed envelope together with the devices.
- The envelope will be opened after the experiment and analysis together with the client (e.g. in a skype meeting).
- No information concerning Waveguard should be visible on the device (no engraving of the company logo/name).

Methods

Experimental study design



Methods

Subjective measures – Pre-session

Screening Questionnaire: Exclusion criteria and demographic data

Control: Ist Ihnen das Gerät bekannt?
Engl.: Are you familiar with the device?

Sleep (before RS): adapted Pittsburgh Sleepindex, Karolina Sleepiness Scale

RESTING STATE (EEG, ECG, EDA - 20 min)

Personality: Big 5 21 Item Short Version

Intelligence: WMT

Belief scales Paranomal Beliefs Scale, Short Version of the Paranormal Experience Scale, Complementary and Alternative Medicine (CAM) Health Belief Questionnaire (CHBQ)

Subjective Well-being: WHO-5, Satisfaction with Life Scale, PANAS, STAI, Perceived Stress Scale, Brief Resilience Scale

Methods
Subjective measures - Daily

Subjective Well-being: WHO – 5, PANAS

Self-constructed subjective well-being: Wie fühlen Sie sich heute auf einer Skala von 0 (überhaupt nicht gut) – 10 (sehr gut)?
Engl.: How do you feel today on a scale of 0 (not well at all) – 10 (very well)?

Self-constructed stress (1): Wie stressig war Ihr Tag heute auf einer Skala von 0 (überhaupt nicht) – 10 (sehr)? Falls Sie den Tag als stressig wahrgenommen haben, beschreiben Sie bitte die Auslöser des Stresses:
Engl.:How stressful was your day today on a scale of 0 (not stressful at all) to 10 (very stressful)? If you have experienced the day as stressful, please describe the triggers of the stress:

Self-constructed stress (2): Wie gut konnten Sie mit dem Stress umgehen auf einer Skala von 0 (überhaupt nicht) – 10 (sehr)?
Engl.: How well did you cope with the stress on a scale of 0 (not at all) to 10 (very well)?

Self-constructed special experience: Ist Ihnen heute etwas Besonderes widerfahren? Falls ja, beschreiben Sie bitte Ihre Erfahrung:
Engl.: Did anything special happen to you today? If yes, please describe your experience:

Self-constructed special experience: Falls ja, wie würden Sie das Erlebnis bewerten (sehr negativ – negative – neutral – positiv – sehr positiv)
Engl.: If yes, how would you rate the experience (very negative - negative - neutral - positive - very positive)

Self-constructed Qi-Shield: Wie viele Stunden hatten Sie das Gerät mit einem max. Abstand von 2 Metern bei sich?
Engl.: How many hours did you carry the device with you at a maximum distance of 2 meters?

Self-constructed Qi-Shield: Wie viele Meter war das Gerät im Schnitt von Ihnen entfernt?
Engl.: On average, how many meters was the device away from you?

Methods
Subjective measures – Post-Session

Sleep (before RS): Pittsburgh Sleepindex, Karolina Sleepiness Scale

RESTING STATE

Belief scales Paranomal Beliefs Scale

Subjective Well-being: WHO-5, Satisfaction with Life Scale, PANAS, STADI, Perceived Stress Scale, Brief Resilience Scale

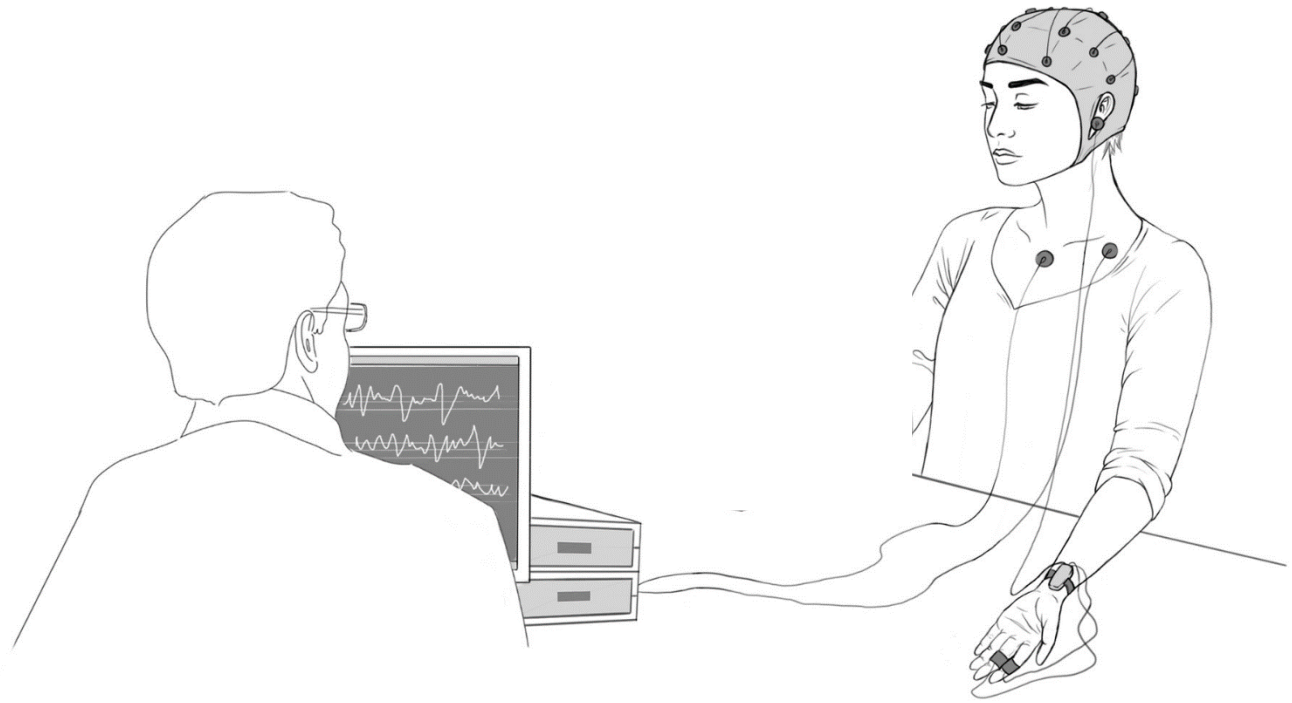
Self-constructed anxiety radiation: Bewerten Sie Ihre Angst vor Strahlungen im Alltag auf einer Skala von 0 (überhaupt nicht) – 10 (sehr)?
Engl.: Please rate your fear of radiation in everyday life on a scale of 0 (not at all) – 10 (very much)?

Self-constructed electromagnetic hypersensitivity (EHS): Reagieren Sie sensibler auf elektromagnetische Strahlung (z.B., Wlan) als andere Personen in Ihrem Umfeld? (10-p-likert)
Bitte beschreiben Sie wie sich dies bei Ihnen auswirkt:
Engl.:Would you consider yourself as more sensitive to electromagnetic radiation (e.g., Wlan) than other people (10-p-Likert)? Please describe how it affects you:

Self-constructed control Qi-Shield:
Haben Sie irgendwelche Informationen zu dem Produkt in den letzten sieben Tagen außerhalb der Studie erfahren? (Ja – Nein)
Wenn ja, welche:
Wie haben Sie das Gerät wahrgenommen? (sehr negativ – negative – neutral – positiv – sehr positiv)
Wie würden Sie das Gerät einer dritten Person beschreiben? (Open question)
Würden Sie das Gerät einer dritten Person empfehlen? (Ja und Nein) Wenn ja, warum:
Was glauben Sie bewirkt das Gerät? (Open question)
Have you learned any information about the product in the last seven days outside of the study? (Yes - No) If so, please tell us what information?
How did you perceive the device? (very negative - negative - neutral - positive - very positive)
How would you describe the device to a third person? (Open question)
Would you recommend the device to a third person? (yes - no) If yes, why:
What do you think the device does? (Open question)

Methods

Neurophysiological recordings



Electroencephalography (EEG – reflecting brain activity)

- Scalp EEG potentials are recorded (BrainAmp, Brainproducts GmbH, Germany) from 32 positions, with Ag/AgCl electrodes (actiCAP, Brainproducts GmbH, Germany)
- EEG data was digitized at 1000 Hz, using the Brain Vision Recorder Software (Brain Products, Munich, Germany)

Electrocardiography (ECG – to obtain heart rate activity)

- ECG was recorded (BrainAmp, Brainproducts GmbH, Germany) according to Einthoven technique, electrodes were placed on the left clavicle and at the sternum, while the GND was placed at left elbow
- ECG data was digitized at 1000 Hz, using the Brain Vision Recorder Software (Brain Products, Munich, Germany)

Electrodermal activity (EDA – to obtain psychophysical activation)

- EDA was recorded (Shimmer GmbH) with electrodes placed on the fingertips of the index finger and the middle finger of the left hand
- EDA was digitized at 43 Hz

Methods
Statistical Analysis and Hypotheses

Methods

Statistical analysis with *N* = 90 (30 : 30 : 30)

- Descriptive analysis of the demographic characteristics
- Statistical analysis of the comparability of the groups concerning
  a) demographic parameters, b) personality, c) beliefs, d) subjective well-being at t= 0
- Check for manipulation and control items
- Check assumptions for parametric vs. non-parametric testing for the subjective measures
- Subjective measures: Inferential statistic of differences between the groups (between-subject factor) for the delta (Pre – Post)
  - Sleep
  - Subjective Well-being
  - Stress
  - Resilience
- Physiological measures: Inferential statistic of differences between the groups (between-subject factor) for the delta (Pre – Post) for the relevant neurophysiological parameters
  - EEG, ECG (HRV), EDA

Methods

Hypotheses for the subjective measures

Groups

A Placebo Device

B Real Device

C No Device

- Pre Session (t=0) Baseline: No statistical differences between the groups in the variables
  - **Demographics**
  - **Sleep Quality and Sleepiness**
  - **Personality**
  - **Belief Scales**
  - **Subjective Well-being**
  - **STAI**
  - **PANAS**
  - **Stress**
  - **Coping**

  A = B = C

  - **Exclusion/Control**

- Daily - Exploratory Hypotheses: At a sufficient amount of exposure time, there should be significant differences between the real vs. placebo and no device/control group

Subjective Well-being WHO-5	B > R and C
PANAS	B +> R and C
Stress (single item)	B < R and C
Coping (single item)	B > R and C

- No significant difference between the real and placebo device would suggest an early placebo effect.

- Post Session - Explanatory Hypotheses: A statistically significant difference in the delta (t1 – t0) between the real vs. placebo and no device/control group.

Sleep Quality	B > A and C
Subjective Well-being WHO-5	B > A and C
STAI	B < A and C
PANAS	B +> A and C
Stress	B < A and C
Coping	B > A and C

- No significant difference between the real and placebo device would suggest a placebo effect. The control/no device group should reveal no difference in the within-subject factor t1 vs t=0.

Methods

Hypotheses for the neurophysiological signals

Groups

A Placebo Device

B Real Device

C No Device

- Pre Session (t=0) Baseline: No statistical differences between the groups in the variables
  - **ECG: HRV and Power of HRV**
    - SDNN, heart rate, LF and HF
  - **Spontaneous EDA responses**
    - number of individual phasic responses, summed amplitude of phasic responses;
  - **EEG**
    - Alpha band, beta band, frontal alpha asymmetry, frontal theta/beta ratio

  A = B = C

  - **Exclusion/Control**

- Post Session - Explanatory Hypotheses: A statistical significant differences in the delta (t1 – t0) between the real vs. placebo and control/no device group.
  - **EEG**: Alpha band power and connectivity — B > A and C
  - **EEG**: Beta band power and connectivity — B < A and C
  - **EEG**: Frontal alpha band asymmetry (right side activity) — B < A and C
  - **EEG**: Frontal theta/beta band ratio — B > A and C
  - **EDA**: number of individual phasic responses, summed amplitude of phasic responses — B < A and C
  - **ECG**: LF of HRV — B < A and C
  - **ECG**: HF of HRV — B > A and C
  - **ECG**: SDNN and heart rate — B > A and C
- No significant difference between the real and placebo device would suggest a placebo effect. The control/no device group should reveal no difference in the within-subject factor t1 vs t=0.

Final Report

Methods
Sample description

Methods

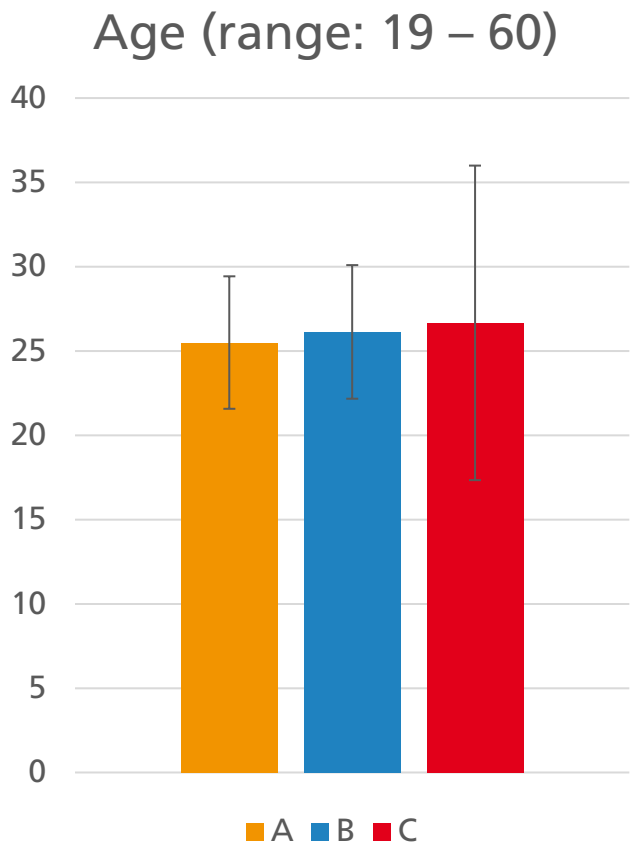
Demographic parameters

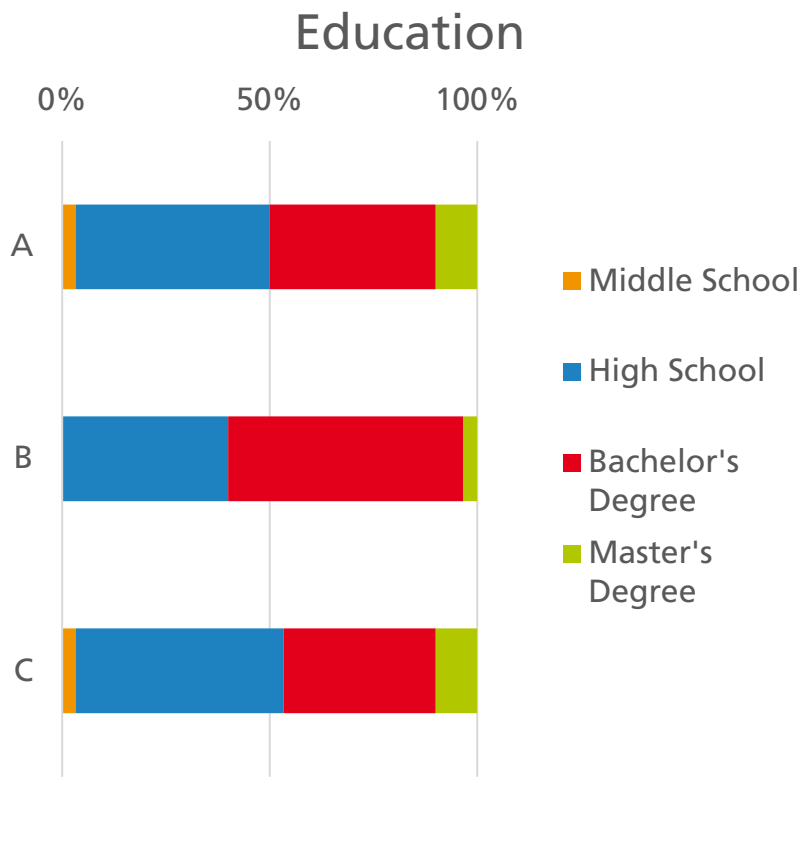
Groups

A Placebo Device

B Real Device

C No Device





Methods

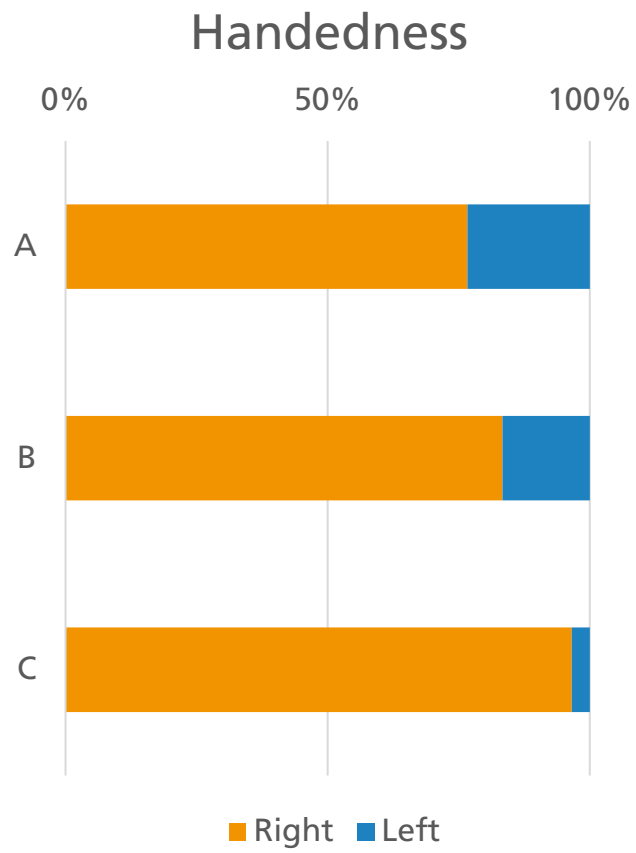
Demographic parameters

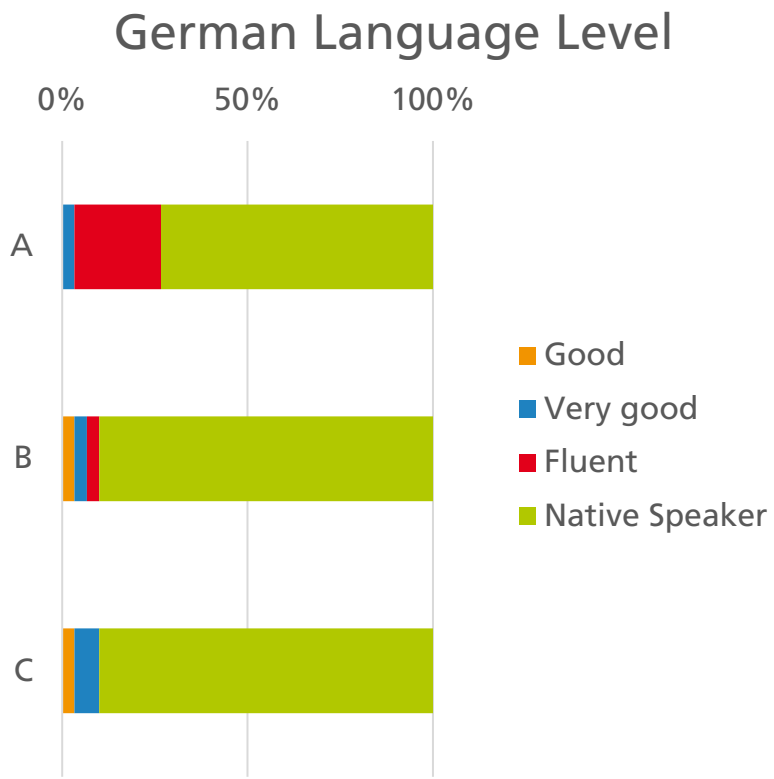
Groups

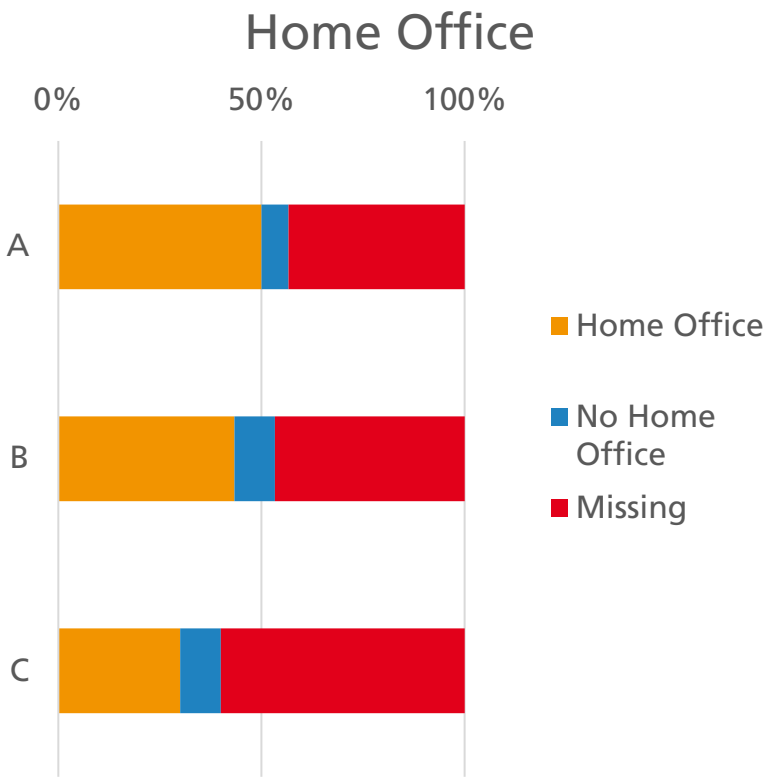
A Placebo Device

B Real Device

C No Device







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Methods
Neurophysiological Data Analysis

Methods
Assumption checks

- Check for **Outliers**: Values beyond 3 standard deviations from the group mean were excluded from the respective analysis
- Check for **Normal Distribution**: Shapiro-Wilk test ($p > .05$) and visual inspection of the respective boxplots
- ANOVAS: analysis of differences between groups (pre-existing or over time)
  - Check for **Equality of Variances**: Levene's test ($p > .05$)
  - Check for **Sphericity**: Mauchly test of sphericity ($p > .05$)
- MANOVAS: multivariate analysis of differences between groups
  - Check for **Homogeneity of Covariance Matrices**: Box's M-test ($p > .05$)
  - Check for **Multivariate Normality**: Shapiro-Wilk test ($p > .05$)

Methods
Correlations and Effects

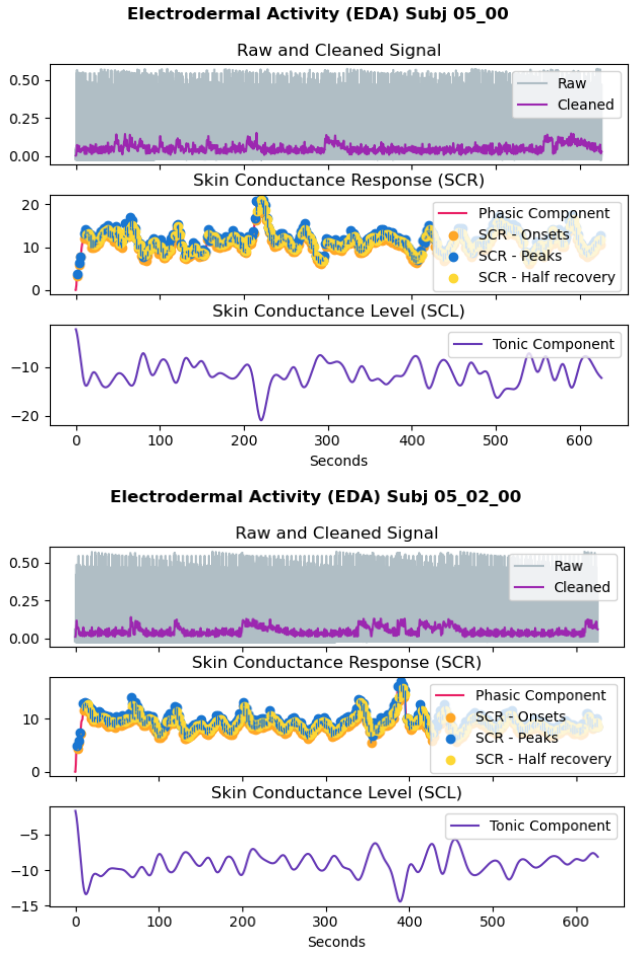
- **Pearson correlation coefficient** (Pearsons' ***r***) for linear correlations: $r = \frac{\sum(x-\bar{x})(y-\bar{y})}{\sqrt{\sum(x-\bar{x})^2 \sum(y-\bar{y})^2}}$, where $\bar{x}$ and $\bar{y}$ are the respective sample means
  - **| *r* | = .10:** Small relationship
  - **| *r* | = .30:** Medium relationship
  - **| *r* | = .50:** Large relationship
- Significance level of ***p* < .01** to counteract the problem of multiple comparisons
- **Effect Size: Partial Eta Squared $\eta_p^2 = SS_{effect} / (SS_{effect} + SS_{error})$**
  - Where **SS_{effect}:** The sum of squares of an effect for one variable and **SS_{error}:** The sum of squares error in the ANOVA model. Range: from 0 to 1, where values closer to 1 indicate a higher proportion of variance that can be explained by a given variable in the model after accounting for variance explained by other variables in the model.
  - **.01:** Small effect size
  - **.06:** Medium effect size
  - **.14 or higher:** Large effect size

Methods

Electrodermal Activity (EDA) – Pre versus Post Resting State

EDA
A – 29
B – 29
C – 29

- All analyses are performed via custom written or adapted scripts in python (3.7) and the neurokit2 toolbox.
- The EDA signal was low-pass filtered using a 5th order Butterworth infinite impulse response (IIR) filter with a cut-off frequency at 1 Hz followed by a moving average smoothing using a linear convolution with a filter kernel size of 0.75 * sampling rate and a boxzen window (Gamboa et al., 2008).
- Next, the signal was cut into non-overlapping epochs of 60 s and z-score baseline corrected using the mean and standard deviation of a time window of 500 ms before each epoch. The epoched EDA signal was decomposed in phasic and tonic components via the cvxEDA algorithm using a convex optimization (Greco et al., 2016 a,b).
- For each condition, we extracted statistical measures (**min, max, mean, sd, kurtosis, skewness**) from the tonic and phasic components as well as additional peak-related measures from the phasic response (**sum of peaks of skin conductance response (SCR), mean amplitude of SCR, sum of SCR recovery, average time of SCR recovery;** Taylor et al., 2014; Braithwaite et al., 2013**)**.



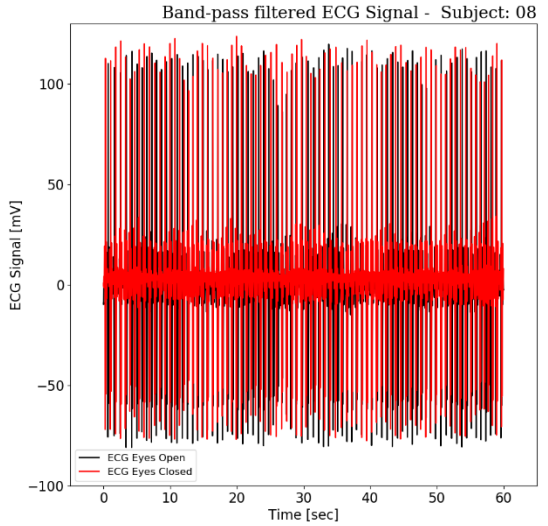
Methods

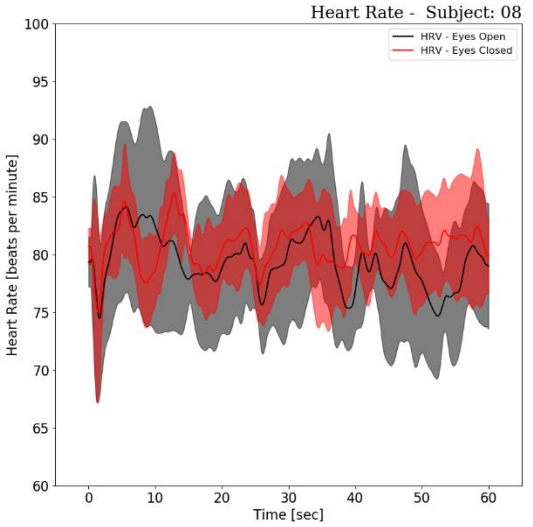
Electrocardiography (ECG) – Pre versus Post Resting State

ECG
A – 28
B – 25
C – 27

- All analyses are performed via custom written or adapted scripts in python (3.7) and the neurokit2 toolbox.
  - ECG measurements were used to calculate heart rate variability (HRV) measures. First, the data was downsampled to 500Hz. Next, the data was transformed to acquire the inter-beat interval (IBI – the inverse of heart rate). For this purpose, ECG was band-pass filtered between 5 and 15 Hz using a 3rd order Butterworth filter. We defined non-overlapping epochs of 60 sec eyes open (EO) and eyes closed (EC) - including baseline correction using the mean of a time window of 500 ms before each epoch
  - R-Peaks were detected following Pan and Tompkins method (including artefact correction method). This was done since HRV measurements can contain artefacts such as extra, missed or misaligned beat detections. The algorithm is based is based on time-varying thresholds estimated from a distribution of successive RR-interval differences combined with a novel beat classification scheme.
  - Next, the IBI semi-time series was transformed into a time series. This was done by interpolating (quadratic spline interpolation) consecutive IBIs and then resampling at 500 Hz. IBI was then transformed to heart rate and further used in the analysis. The heart rate is a measure that indicates the heart beats per min.
  - Welch's method, was carried out for the transformed heart rate time series up to a maximum frequency of 0.5 Hz. From the power spectrum we used the low frequency (LF; 0.04 - 0.15 Hz) related to the sympathetic activity, high frequency (HF, 0.15-0.4 Hz) related to the parasympathetic activity, and the LF/HF ratio.

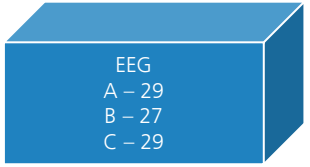
- **HRV Measures:** For the quantitative comparisons among the three conditions, we defined the following measures from the segments per participant:
  - **Heart Rate**: **max, min, mean and std** and **LF, HF**, and **LF/HF ratio** from the 60 sec following of EC and EO.
  - **From the interpolated R-R peak time series :**
    - **RMSSD:** square root of the mean of the sum of successive differences between adjacent R-R intervals. This is a measure of the **short-term variability of the heartbeat**.
    - **SDNN:** standard deviation of the R-R intervals This measure gives an impression of the **total variability of the heartbeat**.
    - **SDSD**: standard deviation of the successive differences between R-R intervals This is a measure of the **short-term variability of the heartbeat.**





Methods

Electroencephalography (EEG) – Pre versus Post Resting State



- All analyses are performed via custom written or adapted scripts in python (3.7) and the mne toolbox
- The EEG data were grouped into the two experimental conditions (eyes open, EO and eyes closed, EC) and evaluated among the three different conditions (A, B and C). For this purpose, the oscillatory activity - power spectrum analysis and functional connectivity of the EEG - was quantitatively evaluated. In order to statistically evaluate these measures, a so-called "pre-processing" procedure was previously carried out. This was done to remove artefact in the EEG signals, e.g., technical and other physiological disturbances, such as superimposed muscular activity, eye movement and cardiac activity.
  - **Pre-Processing:** We first marked bad EEG channels and interpolated them with spherical spline interpolation (as implemented in mne). Next, we band-pass filtered the EEG signals between 1 to 35 Hz (zero-phase lag FIR filter) and re-referenced the data to mathematically linked mastoids. For the analysis of the power spectrum and functional connectivity, we defined non-overlapping segments of length 2 sec. Segments were rejected when they contained a maximum deviation above 200 µV in any of the frontal EEG channels (Fp1, Fp2). The method of "Independent Component Analysis (ICA)" was used for additional artifact correction. ICA is a standardized procedure in EEG analysis to eliminate unwanted noise components and thus leave only those parts of the EEG signal that are related to brain activity. Here, for each un-rejected segments we performed ICA using the extended-infomax ICA algorithm, and removed further cardiac, ocular movement and muscular artefacts. The selection of components indicating artefacts was done by careful visual inspection of the topography, times course and power spectral intensity of each component.
- **Oscillatory Activity**
  - **Power Spectrum Analysis**: For the quantitative calculation of the power spectrum of the EEG signals, a modified version of the "Fast Fourier Transformation" (FFT) - analysis, the so-called Welch's method, was carried out for the individual electrodes in the frequency range 1 – 35Hz. We averaged the power among Frequency **(Theta, Alpha, Beta)** and Regions of Interest **(Frontal, Central, Parietal, Temporal, Occipital)**. We further calculated three EEG-Indices which represent mental workload (Workload-Index, WL), affective valence (Frontal Alpha Asymmetry, FAA) and cognitive control (Frontal theta-to-beta ratio, FTB). All power measures were log-transformed.
    - **WL** $= \frac{Frontal-Theta}{Parietal-Alpha}$ average theta power over Fz (frontal electrode) and average alpha power Pz (parietal electrode). WL represents the fronto-parietal network, which correlates with attention and mental workload.
    - **FAA** = *Right alpha-band power – Left alpha-band power* average alpha power of F3 (left hemisphere) and F4 (right hemisphere) electrodes. Increased right frontal activity is an indicator of a mental state characterized by negative affective valence, and vice versa for positive valence (increased left hemispheric activity).
    - **FTB** $= \frac{Frontal-Theta}{Frontal-Beta}$ ratio of *average theta power over frontal electrodes and average beta power* over frontal electrodes as an electrophysiological marker for executive control functions or more specifically attentional control.
- **Functional Connectivity (FC) Analysis**: For the quantitative analysis of the FC, we used a debiased version of the weighted phase lag index (WPLI). The WPLI is an improved measure to identify true phase-synchronization while being in-sensitive from volume-conduction problems at the sensor level. The cross-spectral densities were calculated using a FFT of the EEG time series and spectrally smoothing the data according to a multi-tapering approach. We systematically evaluated the FC networks between the frontal, motor, sensorimotor, parietal and occipital cortex and the whole brain (all other EEG channels), for each frequency band of interest (FOI), by defining F3, Fz and F4 (**frontal**), C3, Cz, C4 (**motor**), CP5, CP1, CP2, CP4 (**sensorimotor**), P3, Pz, P4 (**parietal**) and O1, Oz, O2 (**occipital**) as the seed electrodes. FOI were defined as **theta** [4, 7]Hz, **alpha** [8, 14]Hz and **beta** [15, 25]Hz.
  The WPLI was fisher z-transformed (arctanh) to fit a Gaussian distribution

Results – Subjective Measures
Comparablity Check of the Groups – Time Point One

Results – Subjective Measures

Group Difference - Demographic Parameters

- There was **no statistically significant difference between groups** regarding
  - age, $F(2, 87) = 0.26$, $p = .772$,
  - gender, $\chi^2(2) = 1.16$, $p = .561$,
  - educational level, $\chi^2(6) = 4.03$, $p = .672$,
  - handedness, $\chi^2(2) = 4.83$, $p = .089$,
  - German language level, $\chi^2(6) = 12.91$, $p = .045$, and
  - home office ratio, $\chi^2(2) = 0.86$, $p = .651$

  with a significance level of $\alpha = .01$ to counteract the problem of multiple comparisons.

Results – Subjective Measures

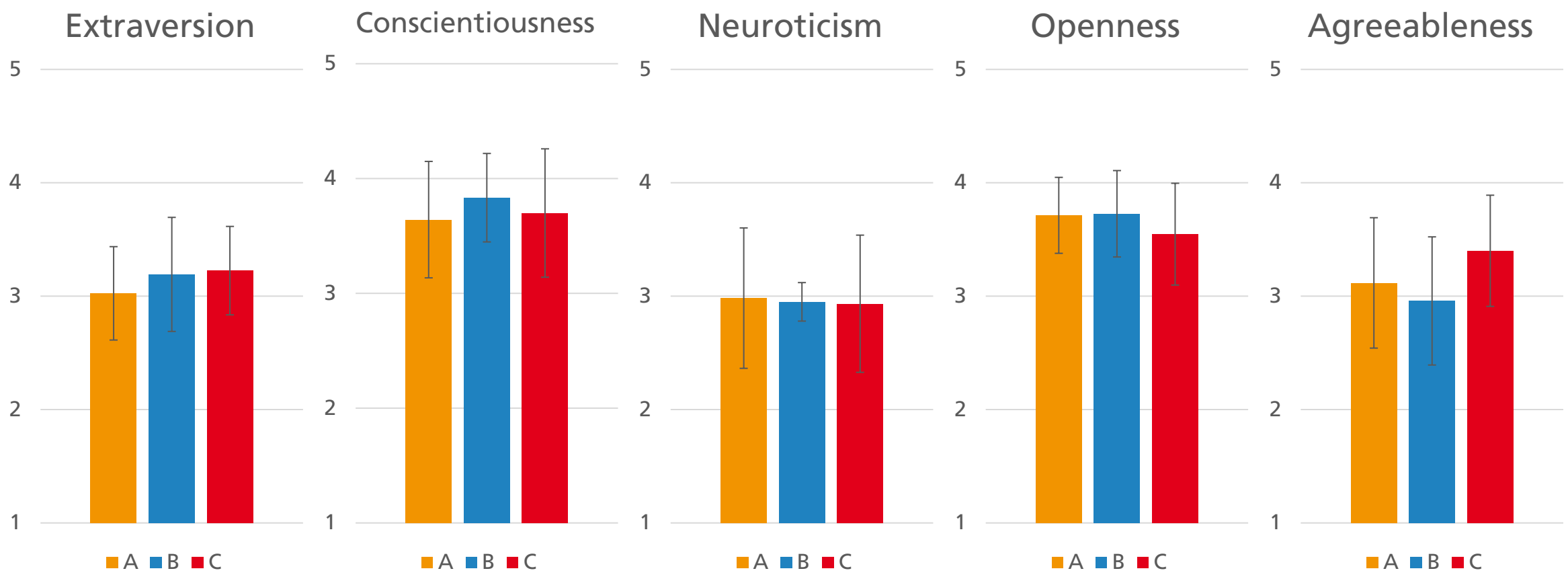
Personality

Groups

A Placebo Device

B Real Device

C No Device



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Results – Subjective Measures

Personality

Groups
A Placebo Device
B Real Device
C No Device

- There was a **statistically significant difference between groups** regarding the personality, $F(10, 166) = 2.125$, $p = .025$, Wilk's $\Lambda = .786$.
- Box's M-test for Homogeneity of Covariance Matrices $\chi^2(30) = 30.587$, $p = .436$.
- Shapiro-Wilk Test for Multivariate Normality: 0.960, $p = .007$ → one-way multivariate ANOVA using Wilk's Lambda because of the lack of multivariate normality.
- The single ANOVAs revealed a significant group difference in the facet Agreeableness, $F(2, 87) = 5.065$, $p = .008$, $p\eta^2 = .104$.
- Bonferroni-corrected Post-hoc tests revealed a significant difference between the group B and C, $t = -3.141$, $p = .007$, $MD = -0.442$ with *95%CI* [-0.777, -0.106] with lower values in the group B.
- We compared the groups' values with the young (18-35 years) and well-educated subgroup of a representative reference sample ($N = 459 + 391$) used to test the questionnaire (Rammstedt & John, 2005). All groups showed similar values on personality scales compared to the reference sample.

Results – Subjective Measures

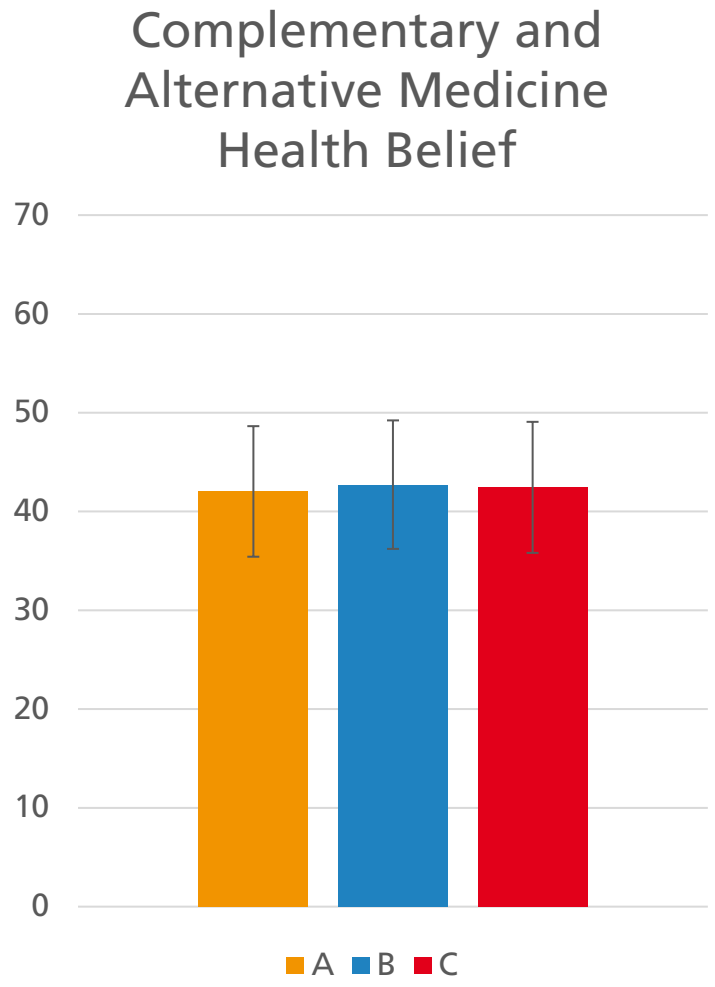
Beliefs

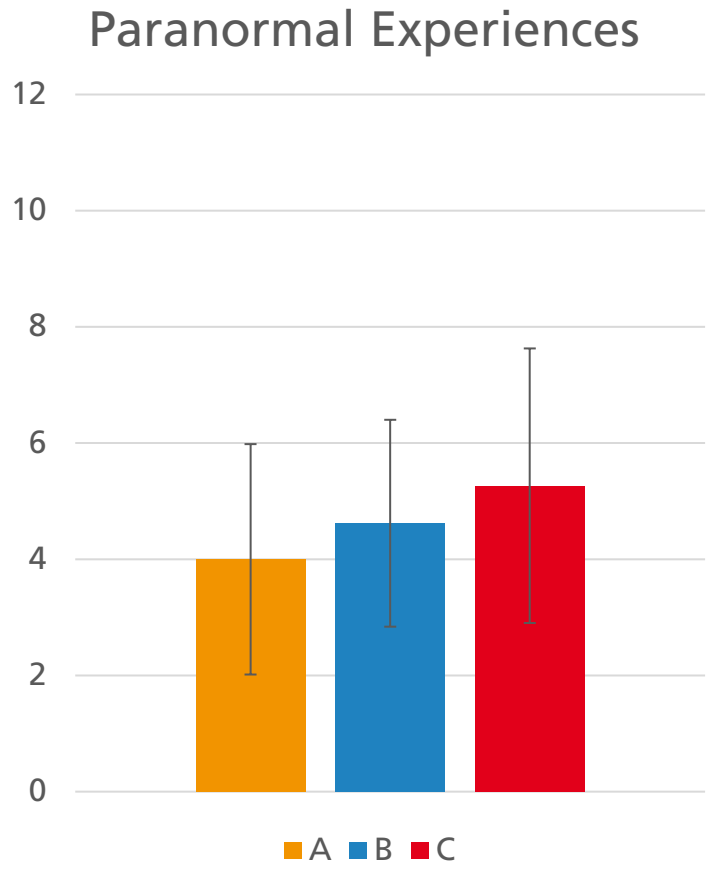
Groups

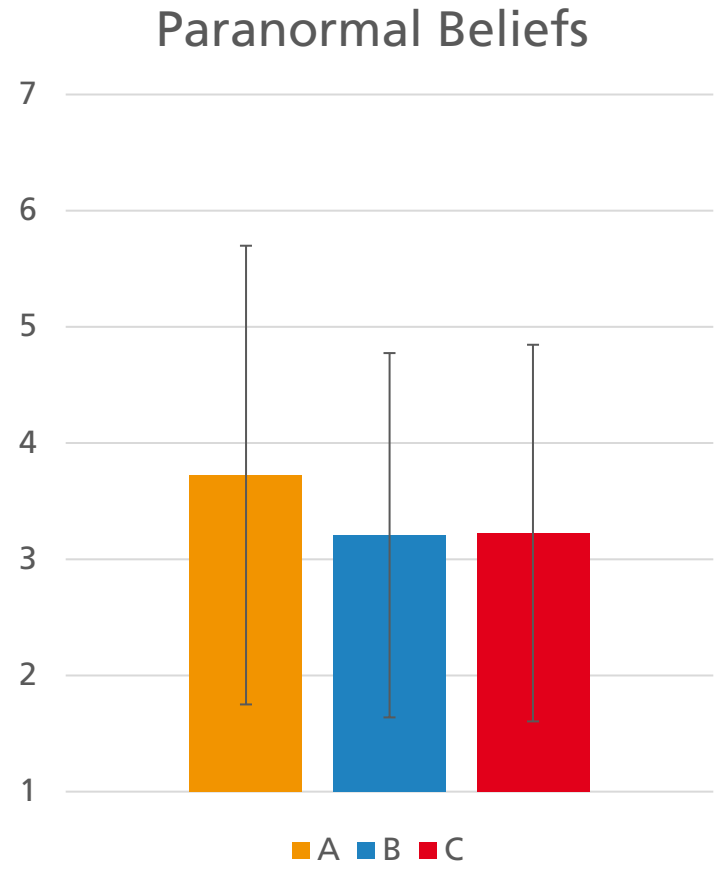
A Placebo Device

B Real Device

C No Device







Results – Subjective Measures
Beliefs

Groups
A Placebo Device
B Real Device
C No Device

- There was **no statistically significant difference between groups** regarding the paranormal beliefs, experiences, or belief in complementary/alternative medicine, $F(6, 168) = 1.95$, $p = .076$, Wilk's $\Lambda = .874$.
- Box's M-test for Homogeneity of Covariance Matrices $\chi^2(12) = 11.85$, $p = .458$.
- Shapiro-Wilk Test for Multivariate Normality: 0.926, $p < .001$ → one-way multivariate ANOVA using Wilk's Lambda because of the lack of multivariate normality.

- Our sample showed a slightly **lower average belief in complementary and alternative medicine** compared to a reference sample of medical students at entry to medical school used to develop the questionnaire ($N = 85$, $M = 48.4$, $SD = 8.9$).
- All experimental groups showed a **comparable average belief paranormal activities** to the reference sample of the questionnaire development ($N = 217$, $M = 3.4$). However, in our study the answers varied highly.

Results – Subjective Measures

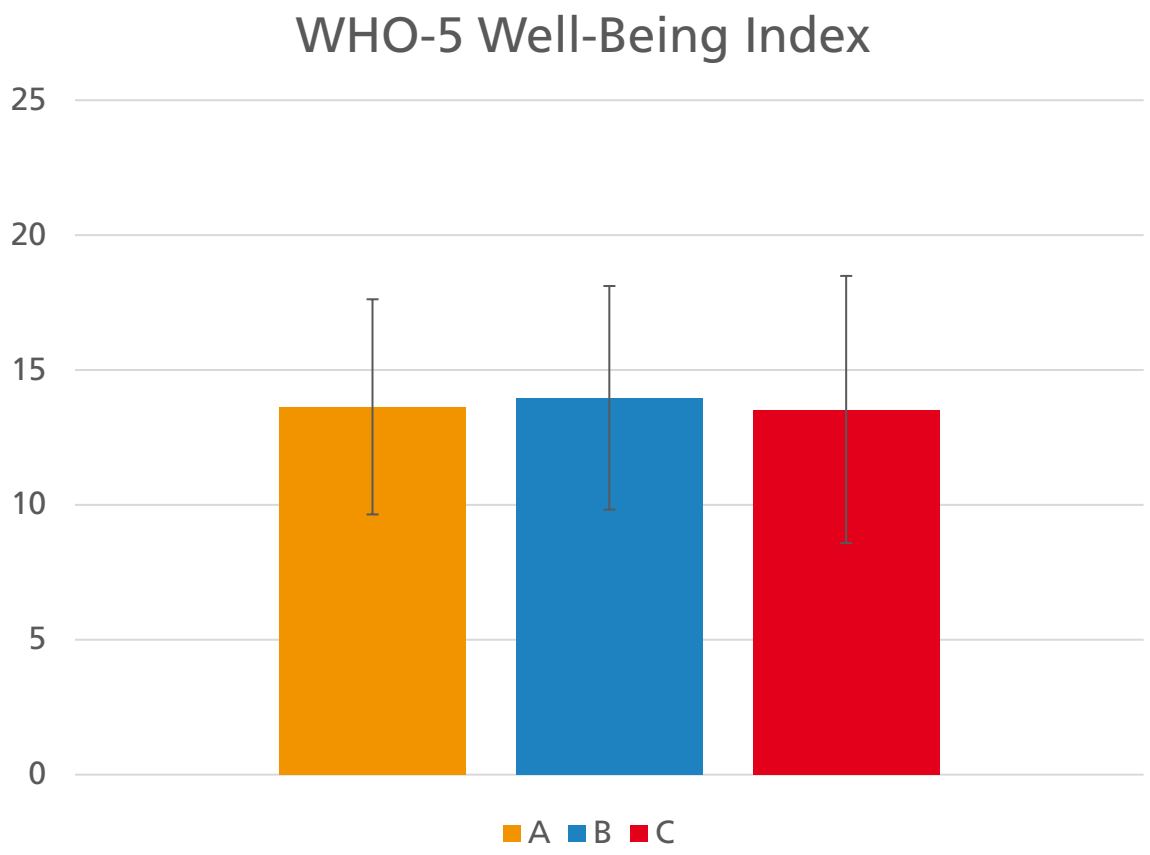
Initial Subjective Well-Being

Groups

A Placebo Device

B Real Device

C No Device



- A one-way ANOVA revealed that there was **no statistically significant difference between groups regarding subjective well-being**, $F(2, 86) = 0.08$, $p = .925$
- All groups showed a **lower average well-being** than a representative young (< 40 years) subsample ($N = 929$, $M = 18.4$, $SD = 4.8$) which used to test and standardize the German WHO-5 questionnaire.

Summary – Subjective Measures
Comparability Check

Groups
A Placebo Device
B Real Device
C No Device

- There were no significant pre-existing differences between the groups A, B, and C regarding
  - Demographic variables,
  - Personality facets (Openness to experience, conscientiousness, extraversion, and neuroticism)
  - Beliefs about complementary and alternative medicine and paranormal events, and
  - Well-being.

- There was a **significant difference between the groups B and C** regarding the personality facet **agreeableness**. However, this difference could rather be neglected for the study based on former literature suggesting the facet Extraversion and Neuroticism as main influencing factors (Williams, Francis, & Robbins, 2007; Thalbourne, Dunbar, & Delin, 1995; Thalbourne & Haraldsson, 1980).
- Respondents indicated considerably **lower well-being** as assessed by the WHO-5 questionnaire compared to the norm values of a representative sample - probably due the stressful circumstances of the Covid-19 pandemic.

Results - Subjective Measures: Primary Outcome Measures

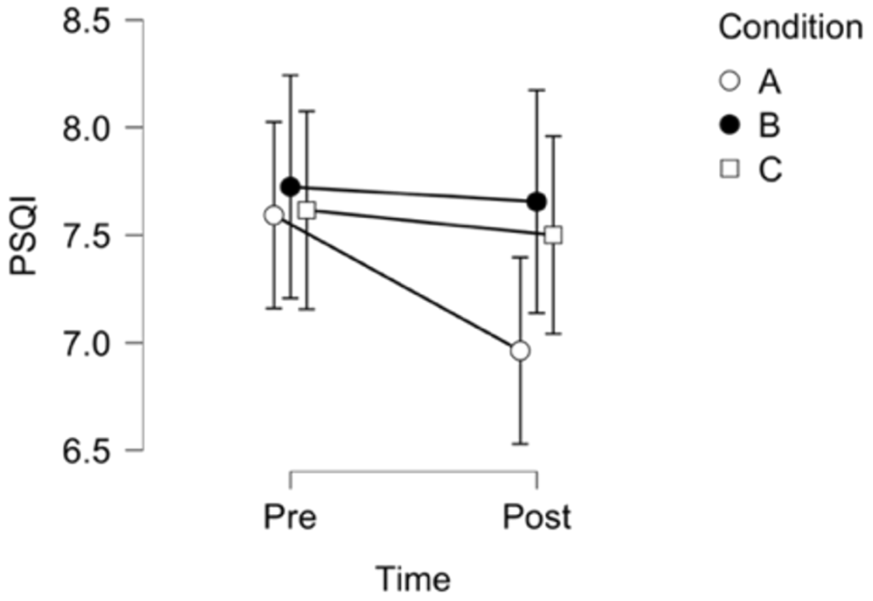
Sleep Quality, Well-Being, Anxiety, Affect, Stress, Resilience, Life Satisfaction

Results – Subjective Measures

Sleep quality – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: Adapted Pittsburgh Sleep Quality Index (PSQI), Buysse et al. (1989)
- Two participants were excluded from this analysis due to extreme values (beyond 3 standard deviations from the mean).
- Small values indicate good sleeping quality, consequently, sleep quality seemed to be rather bad within participants.
- Most of the groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of almost 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
(Pre: $F(2, 79) = 1.97$, $p = .146$; Post: $F(2, 79) = 1.89$, $p = .159$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding sleep quality over time, $F(2, 79) = 0.91$, $p = .409$. The visible trend towards better sleeping quality in group A was not significant.

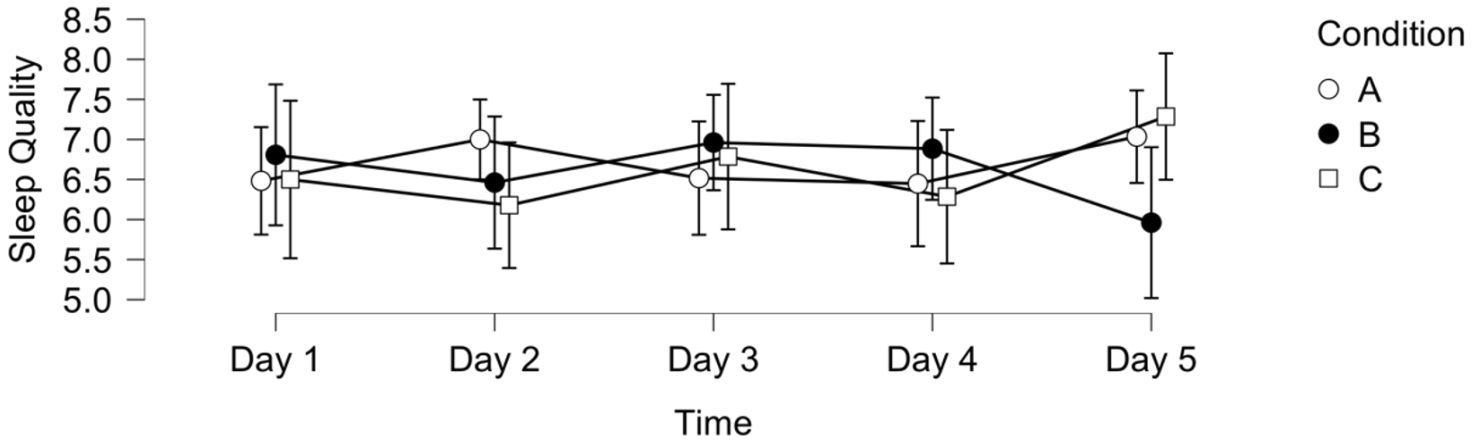


Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Sleep quality – Question (daily)

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device



Question: *How would you rate the quality of your sleep last night on a scale from 0 (not good at all) to 10 (very good)?*

Note. Error bars = 95%-Confidence Interval.

- Many groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust. Equality of Variances between subgroups can be assumed for all analyses, as assessed by the Levene's test ($p > .05$). No violations of sphericity were detected, as assessed by the Mauchly test of sphericity ($p > .05$).
- A repeated measures ANOVA determined no statistically significant difference between groups regarding sleep quality over time, $F(8, 320) = 1.46$, $p = .173$.

Results – Subjective Measures

Sleep quality – Reasons for bad sleep

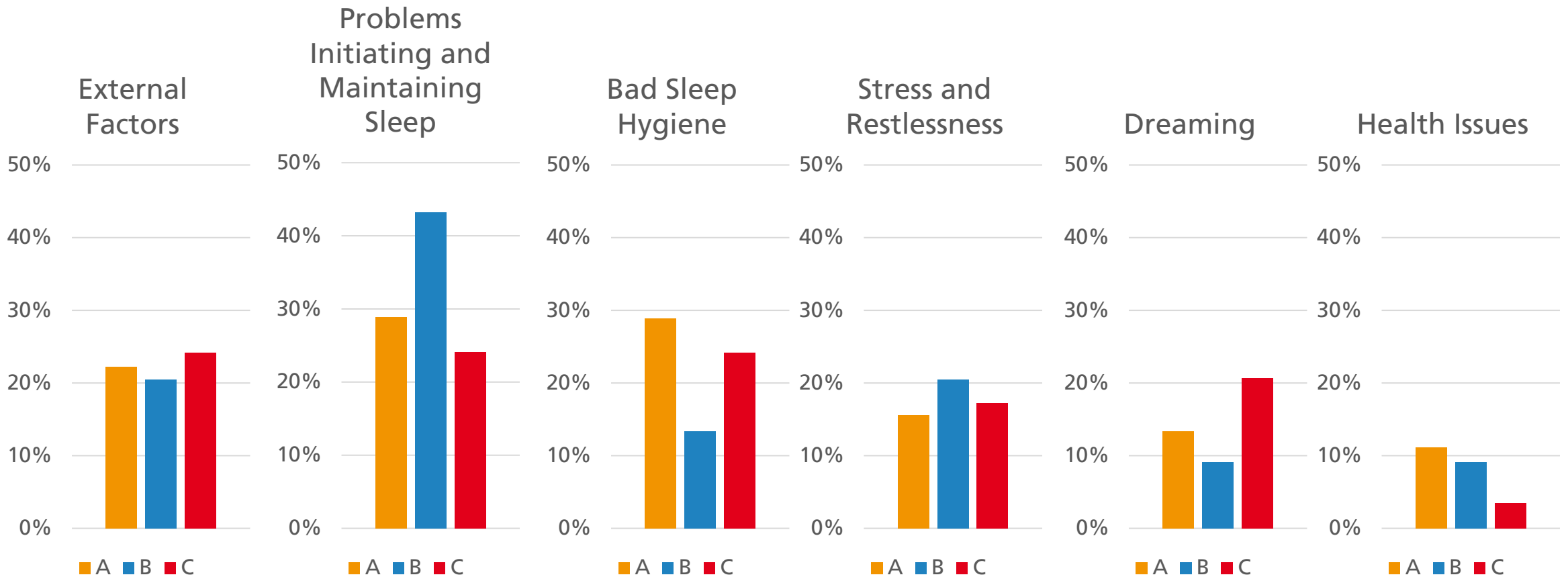
Groups

A Placebo Device

B Real Device

C No Device

Percentage of people of this group who gave reasons for bad sleep that named this reason. Multiple responses were allowed. Responses are summed up over all daily questionnaires.



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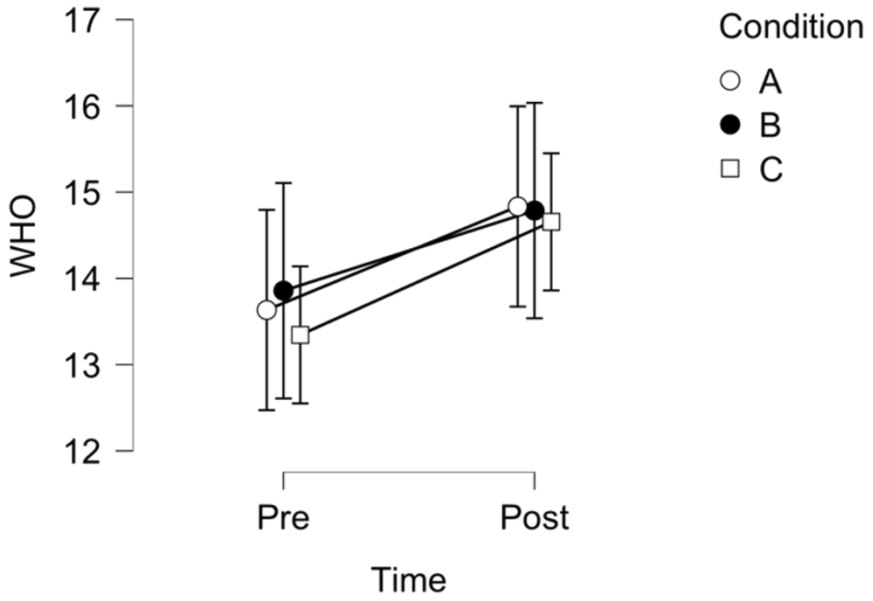
Results – Subjective Measures

Well-being – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: WHO-5 Well-being index, WHO, Psychiatric Research Unit
- High values indicate better subjective well-being. The maximum value is 25. A value lower than 13 indicates a possible depression.
- Most of the groups were normally distributed. Only the post values in group B and C were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
  (Pre: $F(2, 84) = 1.10$, $p = .337$; Post: $F(2, 84) = 0.78$, $p = .460$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding well-being over time, $F(2, 84) = 0.07$, $p = .935$.
- The overall average well-being increased in all groups.



Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

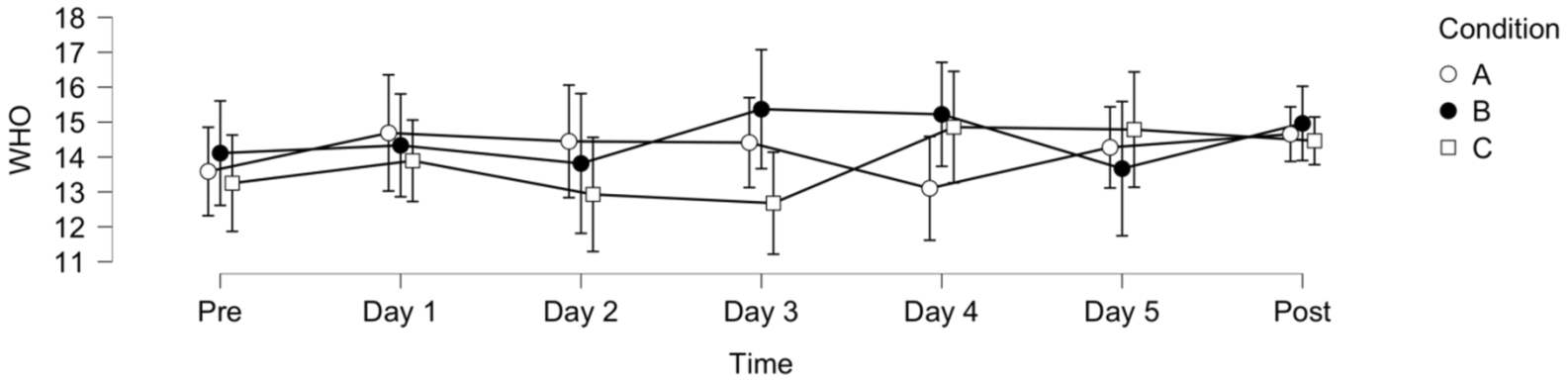
Well-being – Questionnaire (pre/post and daily)

Groups

A Placebo Device

B Real Device

C No Device



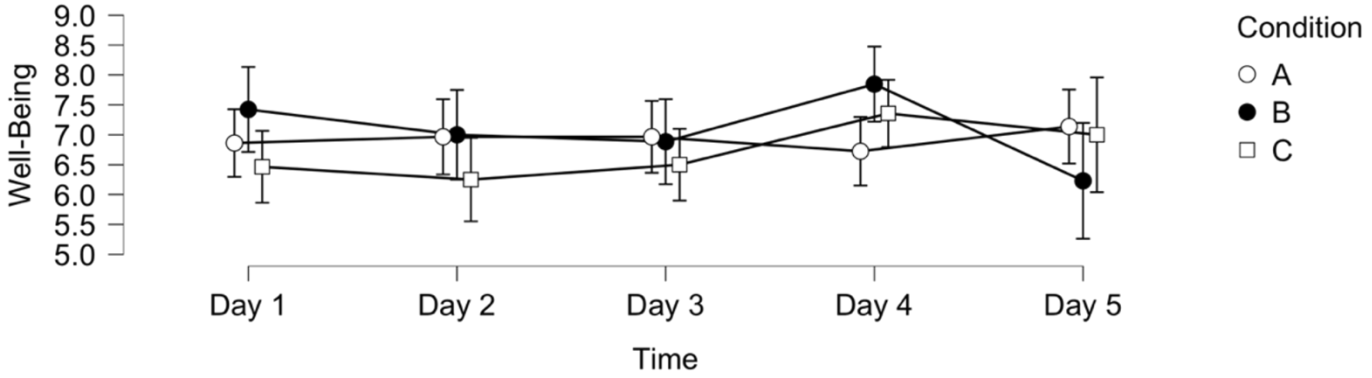
Note. Error bars = 95%-Confidence Interval.

- Most groups were normally distributed (except for day 2 and day 4 values in group A), as assessed by the Shapiro-Wilk test ($p > .05$). Equality of Variances between subgroups can be assumed for most analyses (except for Day 1 and Day 5), as assessed by the Levene's test ($p > .05$). The Greenhouse-Geisser adjustment was used to correct for violations of sphericity, as assessed by the Mauchly test of sphericity ($p > .05$).
- A repeated measures ANOVA with a Greenhouse-Geisser correction determined no statistically significant difference between groups regarding well-being over time, $F(10.48, 424.24) = 1.22$, $p = .273$.

Results – Subjective Measures

Well-being – Question (daily)

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device



Question: *On a scale of 0 (not good at all) to 10 (very good), how do you feel today?*

Note. Error bars = 95%-Confidence Interval.

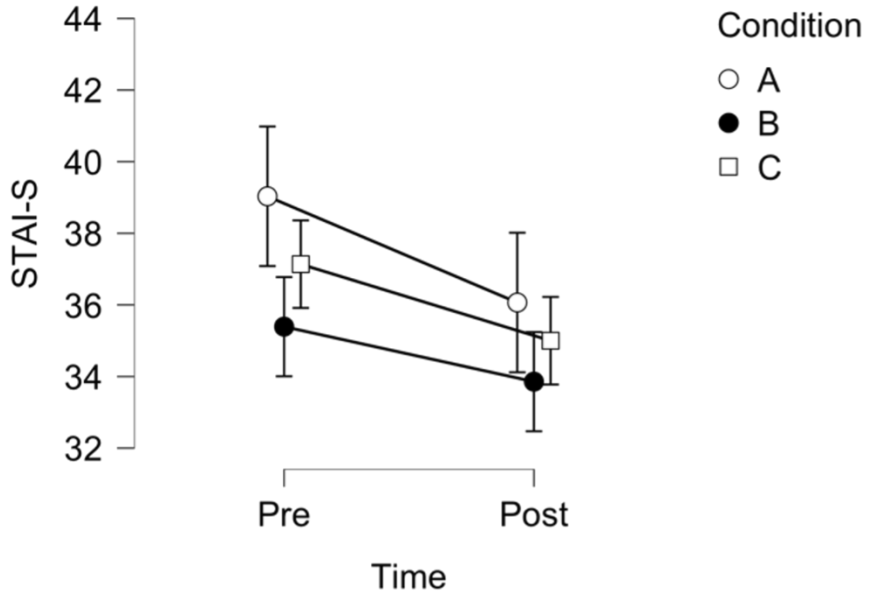
- Many groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust. Equality of Variances between subgroups can be assumed for most analyses (except for Day 5), as assessed by the Levene's test ($p > .05$). The Greenhouse-Geisser adjustment was used to correct for violations of sphericity, as assessed by the Mauchly test of sphericity ($p > .05$).
- A repeated measures ANOVA with a Greenhouse-Geisser correction determined no statistically significant difference between groups regarding well-being (over time, $F(7.10, 283.82) = 1.92$, $p = .066$.

Results – Subjective Measures

State Anxiety – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: State Trait Anxiety Inventory (Laux, Glanzmann, Schaffner & Spielberger (1981)
- High values indicate higher state anxiety .
- Some of the groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
(Pre: $F(2, 84) = 0.85$, $p = .432$; Post: $F(2, 84) = 2.93$, $p = .059$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding state anxiety over time, $F(2, 84) = 0.44$, $p = .644$. The apparent pre-existing difference between groups was not significant, $F(2, 84) = 1.47$, $p = .235$.



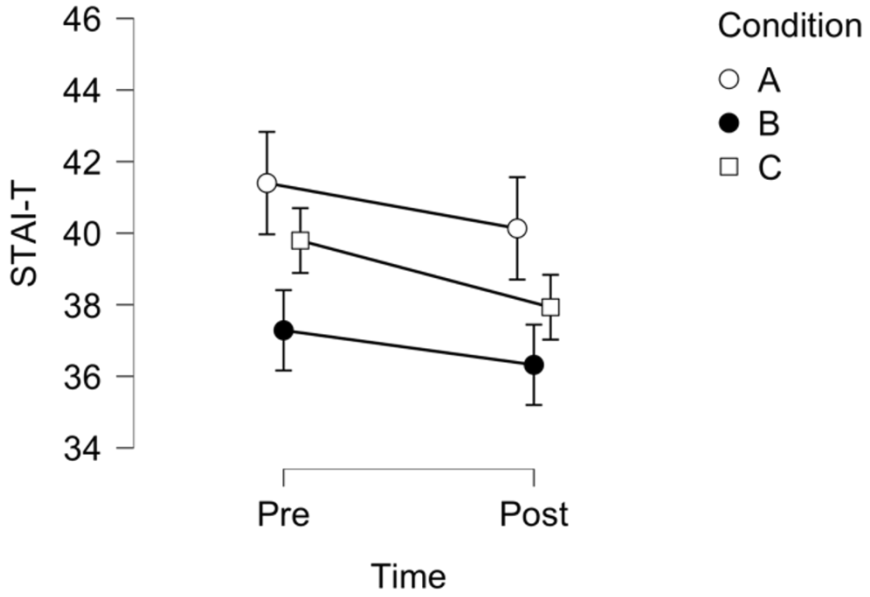
Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Trate Anxiety – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: State Trait Anxiety Inventory (Laux, Glanzmann, Schaffner & Spielberger (1981)
- High values indicate higher trait anxiety .
- Some of the groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
  (Pre: $F(2, 84) = 0.20$, $p = .817$; Post: $F(2, 84) = 2.19$, $p = .119$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding trait anxiety over time, $F(2, 84) = 0.31$, $p = .735$. The apparent pre-existing difference between groups was not significant, $F(2, 84) = 1.75$, $p = .179$.



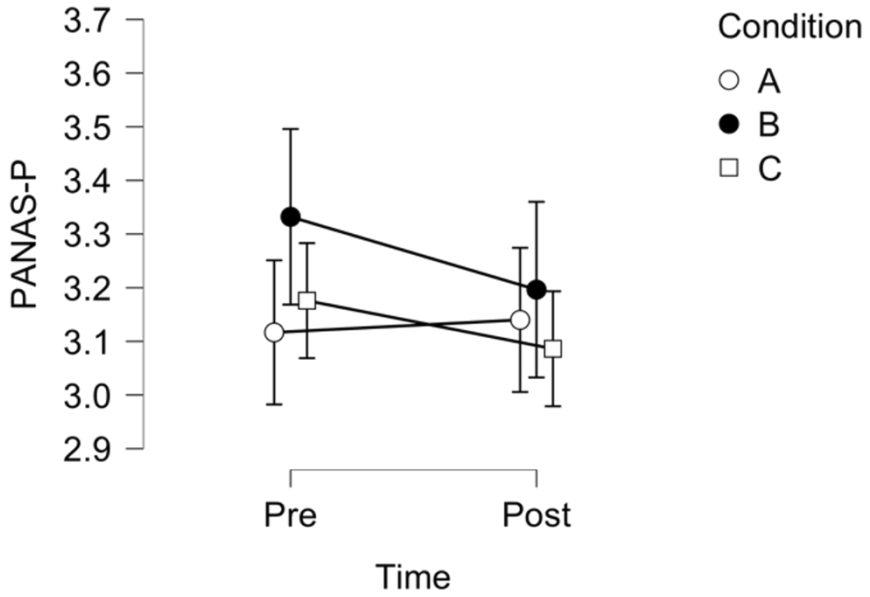
Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Positive Affect – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: Positive and Negative Affect Schedule, PANAS, Breyer & Bluemke (2016)
- High values indicate higher positive affect.
- Almost all groups were normally distributed (except pre values in group B), as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
  (Pre: $F(2, 84) = 0.66$, $p = .520$; Post: $F(2, 84) = 1.10$, $p = .338$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding positive affect over time, $F(2, 84) = 0.76$, $p = .470$.



Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

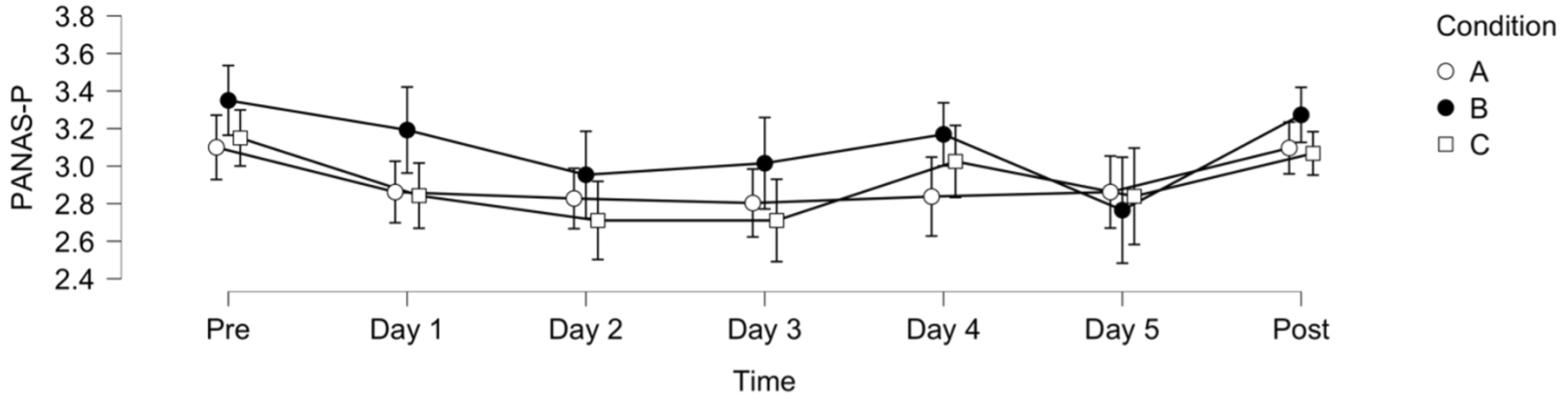
Positive Affect – Questionnaire (pre/post and daily)

Groups

A Placebo Device

B Real Device

C No Device



Note. Error bars = 95%-Confidence Interval.

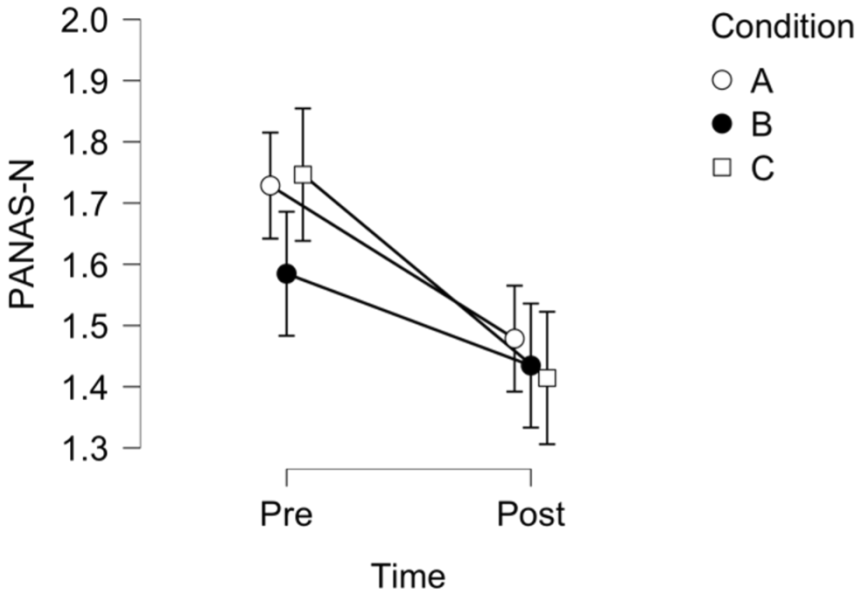
- Most groups were normally distributed (except for pre values in group B), as assessed by the Shapiro-Wilk test ($p > .05$). Equality of Variances between subgroups can be assumed for most analyses (except for Day 1), as assessed by the Levene's test ($p > .05$). The Greenhouse-Geisser adjustment was used to correct for violations of sphericity, as assessed by the Mauchly test of sphericity ($p > .05$).
- A repeated measures ANOVA with a Greenhouse-Geisser correction determined no statistically significant difference between groups regarding positive affect over time, $F(9.94, 118.91) = 0.93$, $p = .502$.

Results – Subjective Measures

Negative Affect – Questionnaire (pre/post)

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device

- Questionnaire: Positive and Negative Affect Schedule, PANAS, Breyer & Bluemke (2016)
- High values indicate higher negative affect.
- Five participants were excluded from this analysis due to extreme values (3 standard deviations from the mean) and impairment of normal distribution.
- Most of the groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
  (Pre: $F(2, 79) = 0.04$, $p = .962$; Post: $F(2, 79) = 2.48$, $p = .090$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding negative affect over time, $F(2, 79) = 0.54$, $p = .586$.
- The overall average negative affect decreased in all groups.

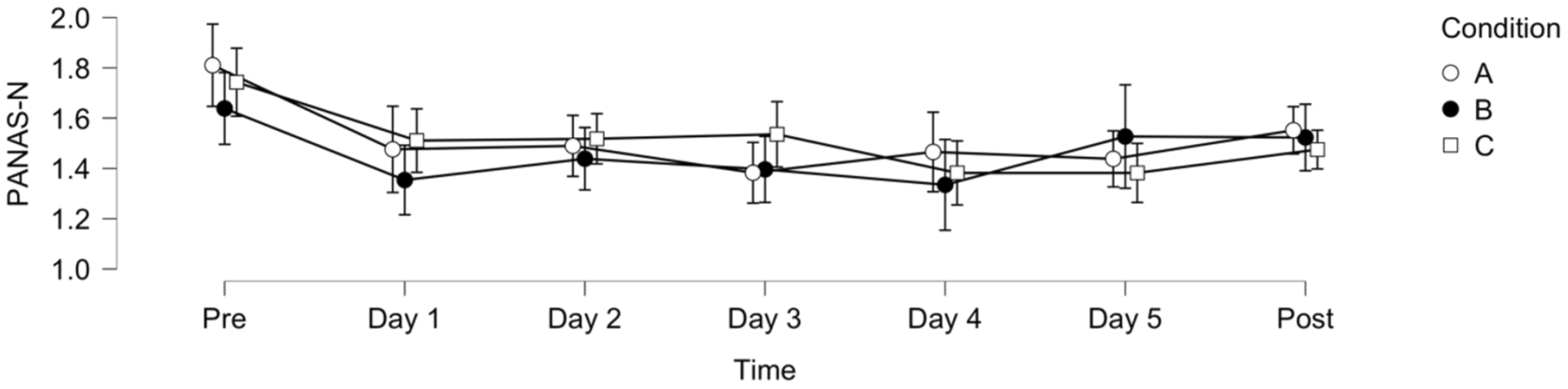


Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Negative Affect – Questionnaire (pre/post and daily)

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device



Note. Error bars = 95%-Confidence Interval.

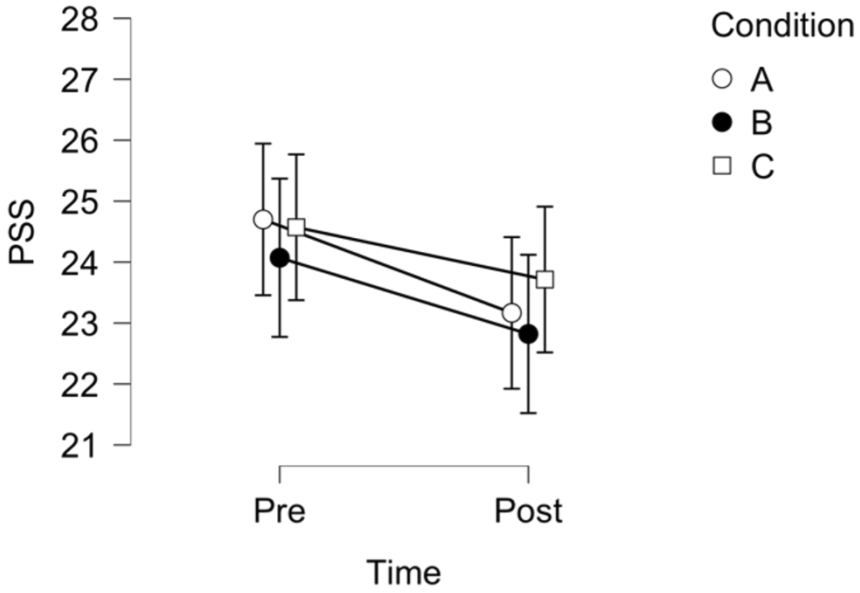
- Almost all groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust. Equality of Variances between subgroups can be assumed for most analyses (except for Day 5), as assessed by the Levene's test ($p > .05$). The Greenhouse-Geisser adjustment was used to correct for violations of sphericity, as assessed by the Mauchly test of sphericity ($p > .05$).
- A repeated measures ANOVA with a Greenhouse-Geisser correction determined no statistically significant difference between groups regarding negative affect over time, $F(10.03, 401.37) = 2.04$, $p = .409$.

Results – Subjective Measures

Stress – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: Adapted Perceived Stress Scale, Schneider, Schönfelder, Domke-Wolf & Wessa (2020)
- Higher scores reflect greater levels of perceived stress.
- Two participants were excluded from this analysis due to extreme values (3 standard deviations from the mean) and impairment of normal distribution.
- Most groups were normally distributed (except post values in group B), as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
(Pre: $F(2, 83) = 1.37$, $p = .260$; Post: $F(2, 83) = 1.21$, $p = .304$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding perceived stress over time, $F(2, 83) = 0.16$, $p = .855$.

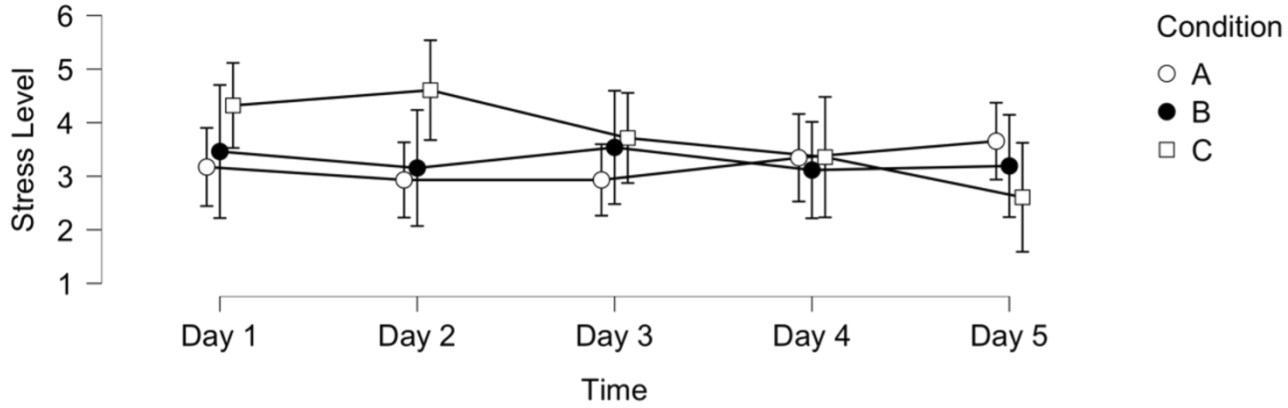


Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Stress perception – Question (daily)

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device



Question: *On a scale of 0 (not at all) to 10 (very much), how stressful was your day today?*

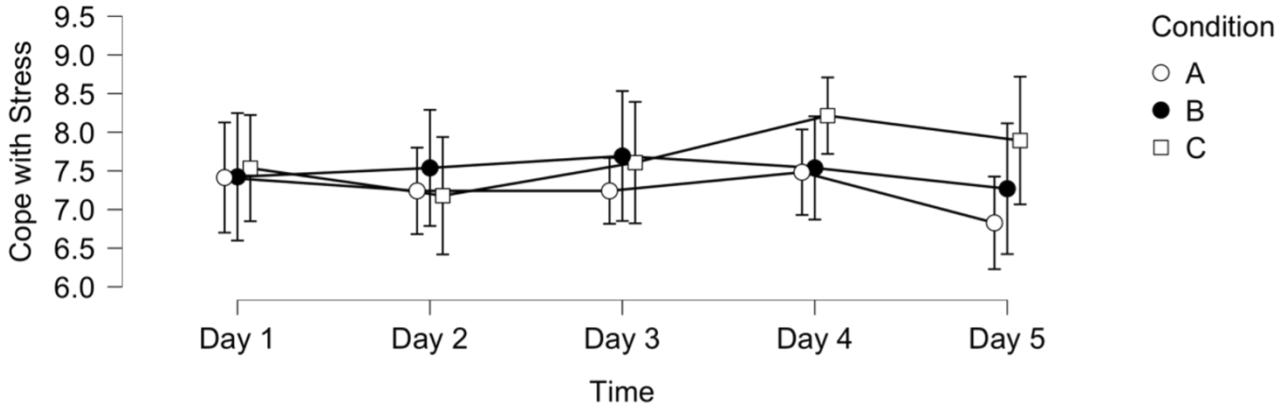
Note. Error bars = 95%-Confidence Interval.

- Many groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust. Equality of Variances between subgroups can be assumed for most analyses (except for Day 5), as assessed by the Levene's test ($p > .05$). The Greenhouse-Geisser adjustment was used to correct for violations of sphericity, as assessed by the Mauchly test of sphericity ($p > .05$).
- A repeated measures ANOVA with a Greenhouse-Geisser correction determined no statistically significant difference between groups regarding stress level over time, $F(6.52, 260.94) = 1.65$, $p = .128$.

Results – Subjective Measures

Stress coping – Question (daily)

Groups
A Placebo Device
B Real Device
C No Device



Question: *On a scale of 0 (not at all) to 10 (very much), how well were you able to handle stress?*

Note. Error bars = 95%-Confidence Interval.

- Many groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust. Equality of Variances between subgroups can be assumed for all analyses, as assessed by the Levene's test ($p > .05$). The Greenhouse-Geisser adjustment was used to correct for violations of sphericity, as assessed by the Mauchly test of sphericity ($p > .05$).
- A repeated measures ANOVA with a Greenhouse-Geisser correction determined no statistically significant difference between groups regarding coping abilities with stress over time, $F(6.87, 274.90) = 0.67$, $p = .698$.

Results – Subjective Measures

Stress – Reasons for stress

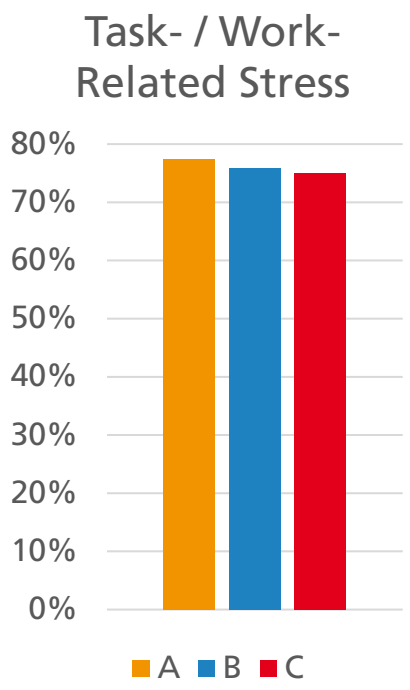
Groups

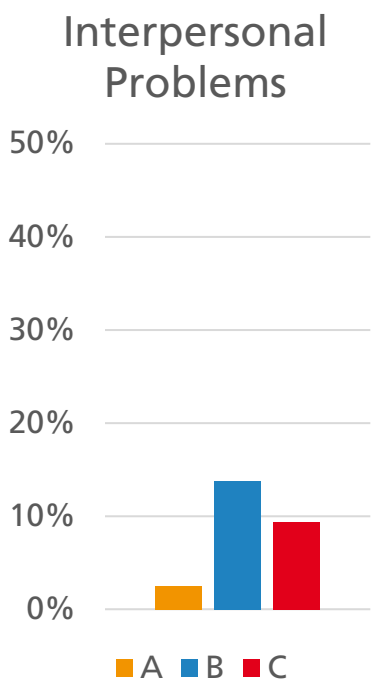
A Placebo Device

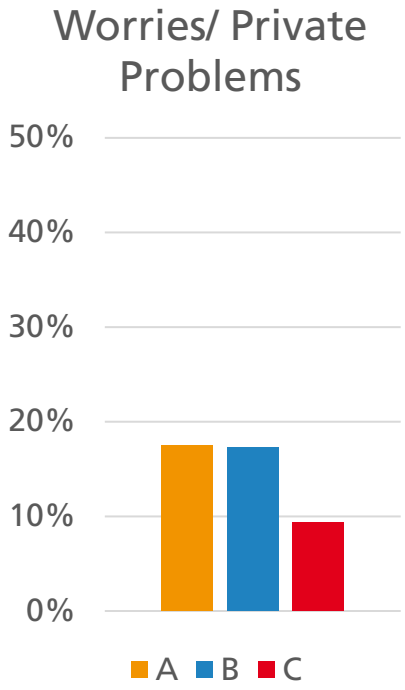
B Real Device

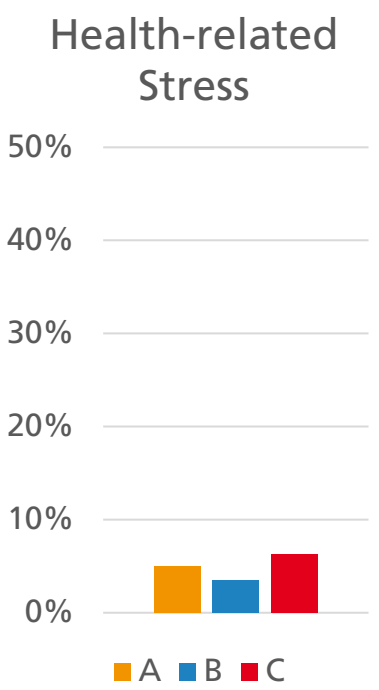
C No Device

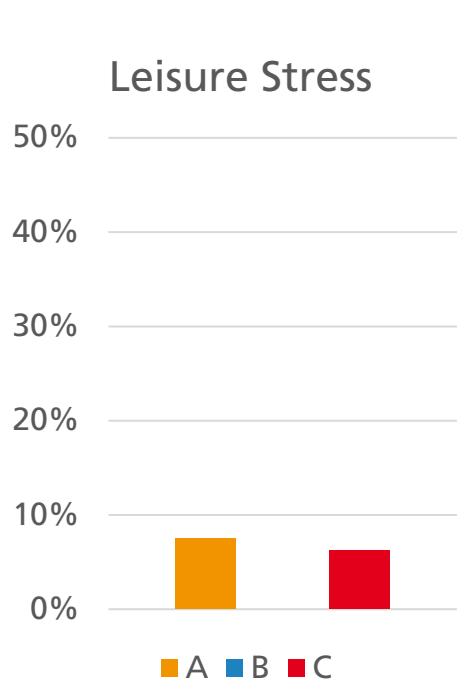
Percentage of people of this group who gave reasons for stress that named this reason. Multiple responses were allowed. Responses are summed up over all daily questionnaires.











Universität Stuttgart
Institut für Arbeitswissenschaft und Technologiemanagement IAT

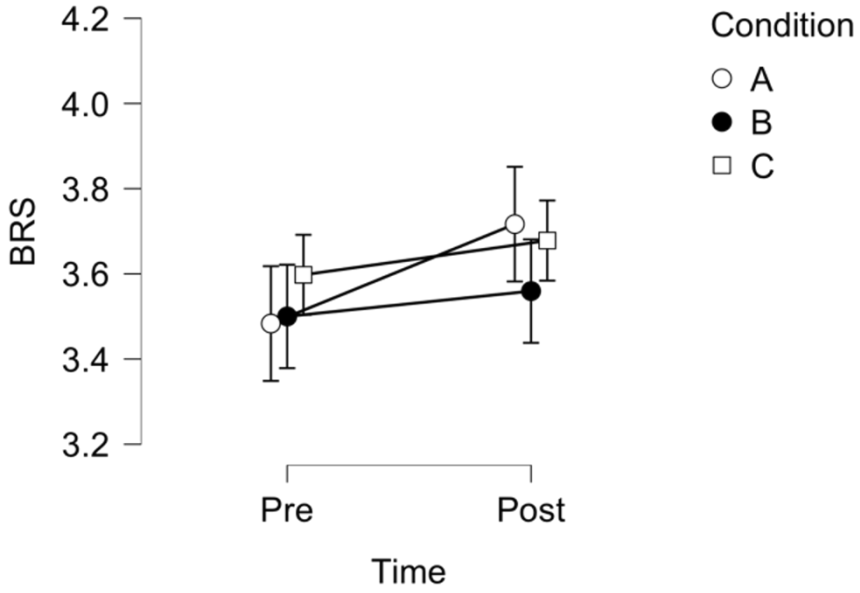
Fraunhofer IAO

Results – Subjective Measures

Resilience – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: Brief Resilience Scale, Chmitorz et al. (2018)
- Higher scores reflect better resilience.
- Most groups were normally distributed (except pre values in group C and post values in group B), as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
  (Pre: $F(2, 84) = 2.51$, $p = .088$; Post: $F(2, 84) = 0.57$, $p = .569$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding resilience over time, $F(2, 84) = 1.37$, $p = .260$.



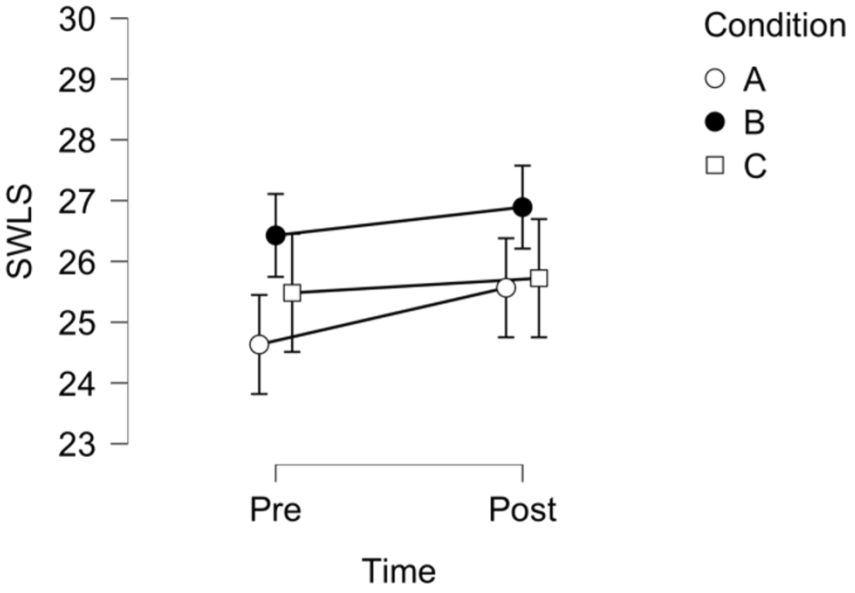
Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Life Satisfaction – Questionnaire (pre/post)

Groups
A Placebo Device
B Real Device
C No Device

- Questionnaire: Satisfaction with Life Scale, Janke & Glöckner-Rist (2012)
- Higher values reflect better higher satisfaction with life.
- Most groups were normally distributed (except post values in group A), as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
(Pre: $F(2, 84) = 0.12$, $p = .889$; Post: $F(2, 84) = 0.21$, $p = .808$).
- A repeated measures ANOVA revealed that there was no statistically significant difference between groups regarding life satisfaction over time, $F(2, 84) = 0.38$, $p = .683$.



Note. Error bars = 95%-Confidence Interval.

Summary – Subjective Measures
Primary Outcome

Groups
A Placebo Device
B Real Device
C No Device

- There was **no significant difference between the groups** regarding changes in any of the reported subjective measures, neither regarding pre- and post-differences, nor regarding changes in variables reported on a daily basis.
- Only in the BIG 5 questionnaire examining personality, we observed a significant difference between the group with lower agreeableness values in the group B compared to C.
- There was a **trend** towards: better well-being, lower anxiety, lower negative affect, lower stress, higher resilience, and higher life satisfaction in the post-values in **all** experimental groups.
- Respondents reported **higher perceived stress** than a representative reference sample. Most said, that this stress was work- or task-related stress.
- Furthermore, they reported quite **bad sleep quality**, mainly because of problems initiating and maintaining sleep, bad sleep hygiene and external reasons such as noise or temperatures.

Results - Subjective Measures: Secondary Outcome Measures

Belief in Complementary and Alternative Medicine, Paranormal Beliefs, Paranormal Experiences and Intelligence

Results – Subjective Measures

Intelligence – Questionnaire

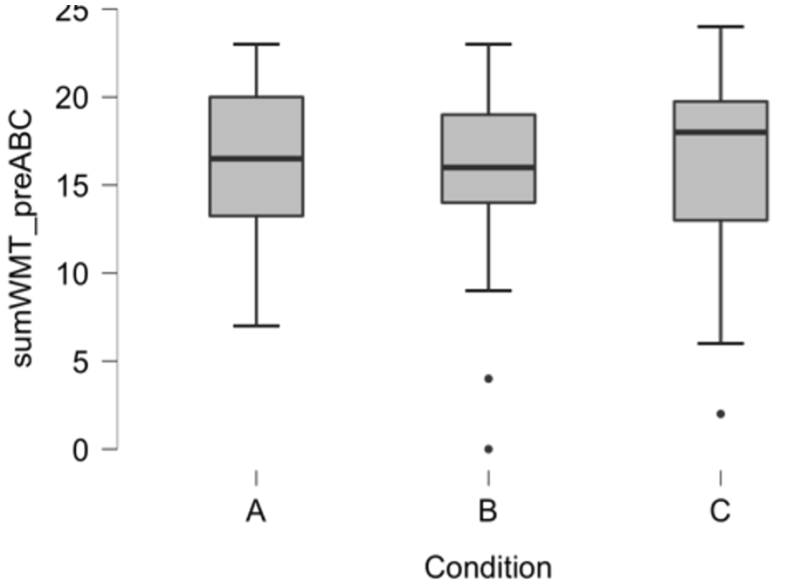
Groups

A Placebo Device

B Real Device

C No Device

- Questionnaire: Vienna Matrix Test (WMT), Formann, Waldherr & Piswanger, 2011
- Some groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed. (Pre: $F(2, 87) = 0.85$, $p = .431$).
- A one-way ANOVA revealed that there was no statistically significant difference between groups regarding intelligence, $F(2, 87) = 0.22$, $p = .806$.
- Compared to other studies using the WMT to measure intelligence (with $M \simeq 12\text{-}15$), respondents in our study performed slightly better.



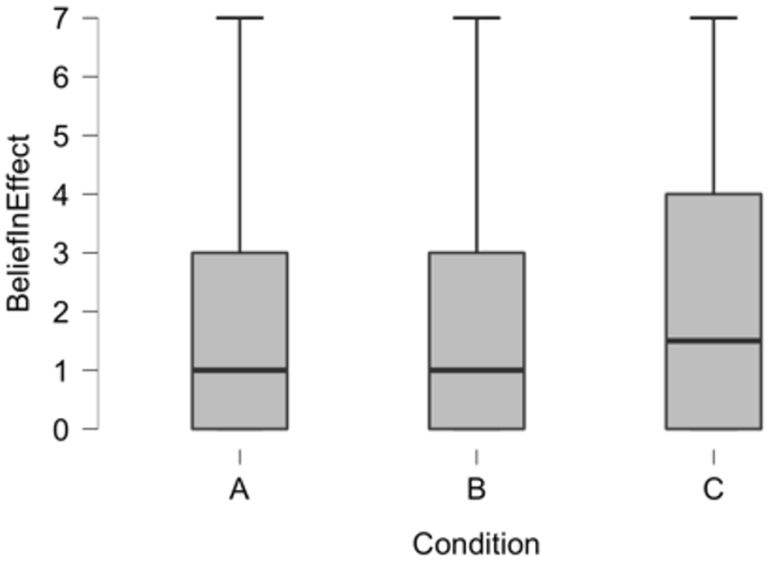
Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Belief in Effect – Post-Hoc question

Groups
A Placebo Device
B Real Device
C No Device

- A few weeks after the study, we asked participants how they would you rate the effectiveness of the product on a scale from 0 (not at all effective) to 10 (very effective). If they did not yet know the product because they were part of the control group, they were asked to answer the question based on an informational text.
- All groups were not normally distributed, as assessed by the Shapiro-Wilk test ($p > .05$). However, the visual inspection of the boxplots and a subsample size of about 30 allows for parametrical testing because the rmANOVA is rather robust.
- Equality of Variances between subgroups can be assumed.
(Follow-Up: $F(2, 42) = 0.12$, $p = .892$).
- A one-way ANOVA revealed that there was no statistically significant difference between groups regarding belief in effect, $F(2, 42) = 0.12$, $p = .892$.



Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

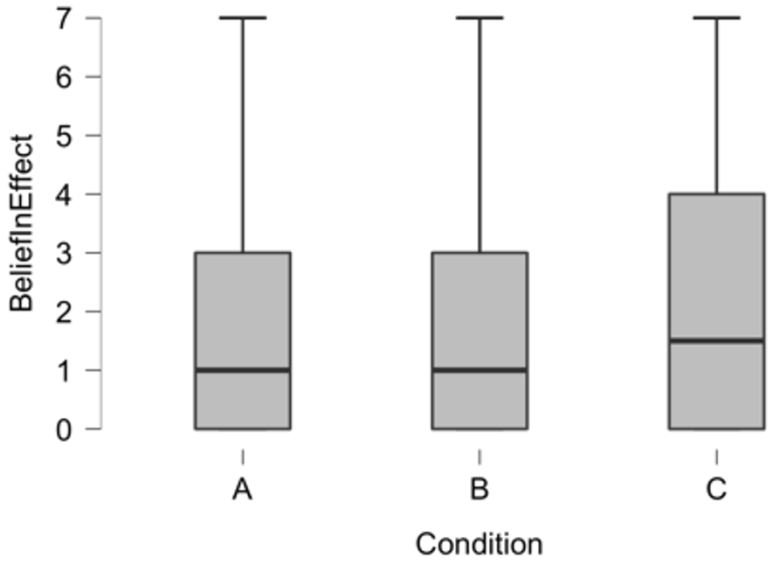
Belief in Effect – Directly after the study and Post-Hoc question

Groups
A Placebo Device
B Real Device
C No Device

- Directly after the study we asked participants which effect they presume:

Suspected Effects	A	B
Effect on Stress and Well-Being	9	12
Effect on Sleep	5	8
Effect with Radiation	14	6
No / Placebo Effect	8	17
Missing	1	2

Post Hoc Question



Note. Error bars = 95%-Confidence Interval.

Results – Subjective Measures

Correlation Analysis

Groups

A Placebo Device

B Real Device

C No Device

	Openness	CAM	PES	RPBS	WMT	Belief
Personality Facet Openness						
Belief in Complementary and Alternative Medicine (CAM)	.164					
Paranormal Experience (PES)	–.12	.42***				
Paranormal Belief (RPBS)	–.215*	.28**	.27*			
Intelligence (WMT)	.191	–.24*	–.23*	–.28**		
Follow-Up: Belief in Effect	.254	.29	.11	.43**	–.17	
Fear of Radiation	.144	.14	–.07	.02	–.08	.56***

*** $p < .001$, ** $p < .01$, * $p < .05$.

There was a statistically significant positive correlation between the belief in complementary and alternative medicine with paranormal beliefs and the experience of paranormal events. There was also a positive correlation between paranormal beliefs and the experience of paranormal events. However, this correlation was not statistically significant with respect to our corrected alpha-level.

Intelligence was negatively correlated with the belief in complementary and alternative medicine, paranormal beliefs, and the experience of paranormal events. Due to the corrected alpha-level only the negative correlation with the paranormal belief scale was statistically significant.

Perceived effectiveness of the device was correlated with paranormal beliefs and the subjective fear of radiation.

There was a negative correlation between the personality facet openness to experience and paranormal belief scale. However, this correlation was not statistically significant with respect to our corrected alpha-level.

Summary – Subjective Measures

Secondary Outcome

Groups

A Placebo Device

B Real Device

C No Device

- In our study unsurprisingly belief in complementary and alternative medicine and belief in paranormal phenomenon or events were significantly correlated.
- Participants with higher values in the Vienna matrices test had lower on belief in complementary and alternative medicine and paranormal activities.
- Participants who scored high on the paranormal belief scale were more likely to assume an effect of the device.
- Additionally, participants who indicated having of fear of radiation also were more likely to assume an effect of the device.

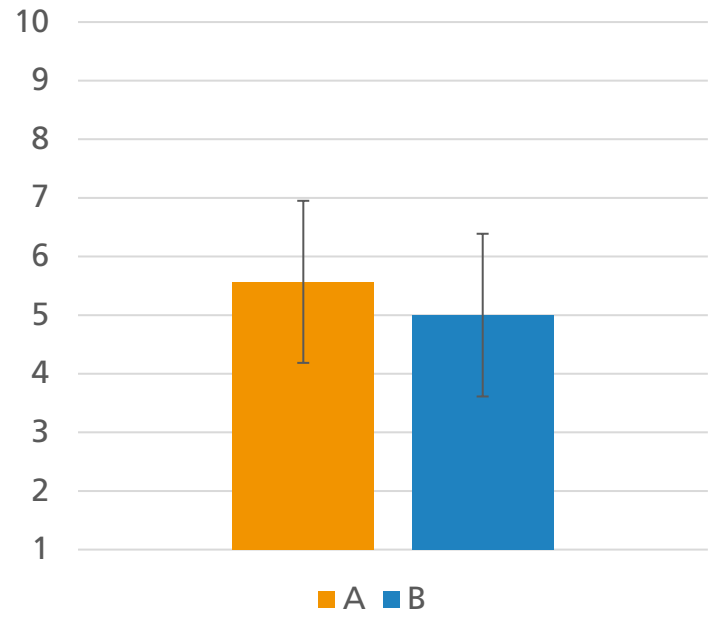
Results - Subjective Measures
Product Perception

Results – Subjective Measures

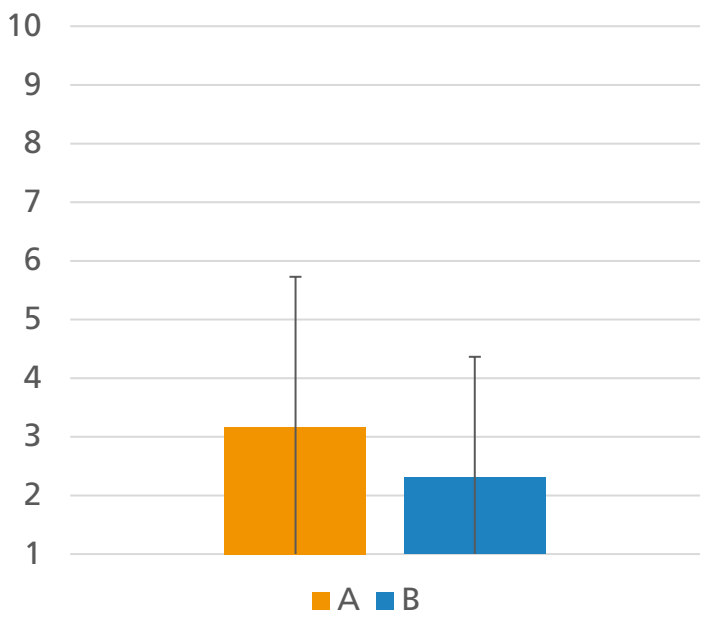
Product Perception

	Perception		Private Use		Recommendation	
	A	B	A	B	A	B
Mean	5,567	5	3	2,448	3,167	2,310
SD	1,359	1,363	2,251	1,868	2,518	2,019
Max	2	3	1	1	1	1
Min	9	8	9	7	10	8

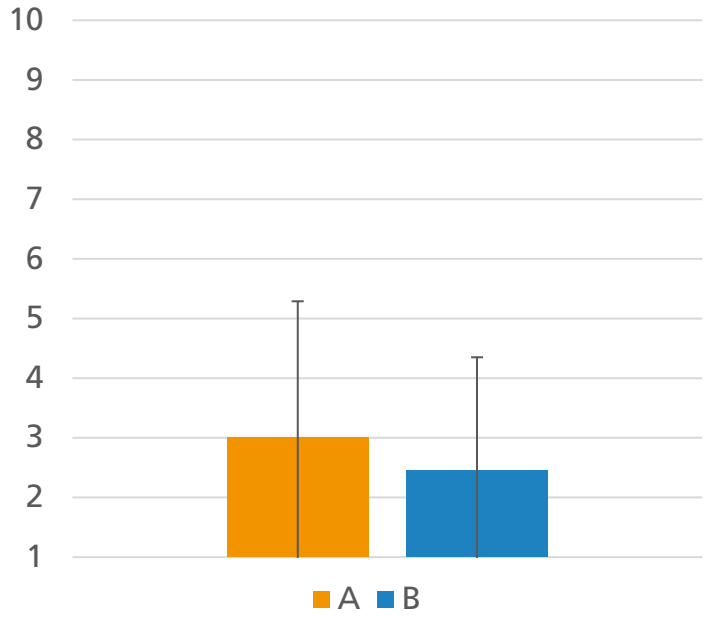
How did you perceive the product in general (1 very negative - 10 very positive)?



Would you be willing to continue using the product privately after the study (1 very unlikely - 10 very likely)?



Would you recommend the product to a third person (e.g., family or friends) (1 very unlikely - 10 very likely)?



Results – Subjective Measures

Product Perception

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device

What did people like most about the product?

Look, Design, Material	Handiness	Function, Effect
42 participants liked the design	11 participants liked the handling	5 participants liked the effect
Quotes: “chic look”, “modest, decent design”, “natural materials”, “valuable design”, “fine processing and finishing”, “beautiful shine”	Quotes: “handy”, “portable”, “nice bag”, “ease of use”	Quotes: “soothing effect” (A), “relaxing effect” (A), “sleep-promoting effect” (B)

Results – Subjective Measures

Product Perception

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device

What did people like least about the product?

Look, Design, Material	Handiness	Function, Effect
4 participants did not like the design	45 participants did not like the handling	7 participants did not like the effect
Quotes: “color”, “bag”, “wooden look”	Quotes: “too heavy”, “too big”, “bulky”, “inconvenient”, “laborious”, “you must always have it with you”, “you always have to explain yourself”	Quotes: “lack of effect” (A and B), “pseudoscience” (A)

Results – Subjective Measures
Product Perception

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device

How did people describe the product?

Look / Appearance	Function / Effect	Use
33 participants described the look and appearance of the product	39 participants described the (missing) function	10 participants described the use
Quotes: “looks interesting”, ”valuable appearance, heavy and noble”, “pretty copper cylinder with wooden lid”, “bulky and heavy copper cylinder”, “decorative item”	Quotes: “calming effect”, “generation of positive energy”, “improvement of the quality of life and sleep”, “mysterious, unknown function”, “no observable function”, “esoteric object”, “Talisman”, “decoration”	Quotes: “exhausting to wear and think about in the long run”, “bulky”, “annoying”, “arduous”

Results – Subjective Measures

Product Perception

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device

What effect did people suspect?

Stress, (Mental) Well-Being	Quality of Sleep	Radiation	No / Placebo Effect
21 participants suspected an effect on their mental well-being	13 participants suspected an effect on their quality of sleep	20 participants suspected a relation with radiation	25 participants suspected only a placebo effect or no effect at all
Quotes: "relaxing effect", "stress reduction", "pain relief", "increased balance", "improved well-being"	Quotes: "improvement of sleep quality", "optimization of the sleep behavior", "more dreams"	Quotes: "shielding/protection from electromagnetic radiation", "device generates radiation to make sleep deeper", "conversion of dangerous radiation into good radiation"	Quotes: "you have to believe in it to have a (placebo) effect", "better feeling through esoteric influence", "I think you have to believe it has a function and that's how it helps you."

Results - Subjective Measures
Explorative Analysis

Results – Subjective Measures

Explorative Analysis

Groups
A Placebo Device
B Real Device
C No Device

A

What influence has the time the participants spent with the product and the distance of the device to their body on sleep, well-being and stress?

	Stress Level	Cope with Stress	Sleep Quality	Well-Being
Cope with Stress	–0.02			
Sleep Quality	–0.11	0.22*		
Well-Being	–0.31***	0.41***	0.45***	
Rating Special Event	–0.30***	–0.11	0.08	0.09
Hours	0.07	0.09	0.10	0.08
Distance	0.21**	0.12	0.07	0.07

- A linear regression with a R^2 for the overall model of .016 (adjusted R^2 = .005) revealed that the hours the device was near to the person as well as the distance of the device to the person had **no predictive value to the responded sleep quality**, $F(2, 166) = 1.38$, $p = .254$.
- A linear regression with a R^2 for the overall model of .011 (adjusted R^2 = –.001) revealed that the hours the device was near to the person as well as the distance of the device to the person had **no predictive value to the responded well-being**, $F(2, 166) = 0.93$, $p = .397$.
- A linear regression with a R^2 for the overall model of .051 (adjusted R^2 = .040) revealed that the hours the device was near to the person as well as the distance of the device to the person had **a small predictive value to the responded stress level**, $F(2, 166) = 4.56$, $p = .013$. Both regression coefficients were positive, but only distance was significant, $\beta = .22$, $SE = .001$, $p = .005$. → **The nearer the device, the higher the reported stress level.**

Results – Subjective Measures

Explorative Analysis

Groups
A Placebo Device
B Real Device
C No Device

B

What influence has the time the participants spent with the product and the distance of the device to their body on sleep, well-being and stress?

	Stress Level	Cope with Stress	Sleep Quality	Well-Being
Cope with Stress	–0.21**			
Sleep Quality	–0.18*	0.01		
Well-Being	–0.37***	0.24***	0.35***	
Rating Special Event	–0.19*	0.22**	0.06	0.29***
Hours	0.01	–0.14	0.22**	–0.00
Distance	–0.14	0.08	–0.25**	–0.01

- A linear regression with a R^2 for the overall model of .096 (adjusted R^2 = .085) revealed that the hours the device was near to the person as well as the distance of the device to the person had a **small predictive value to the responded sleep quality**, $F(2, 157) = 8.38$, $p < .001$. Hours was positively related, $\beta = .19$, $SE = .038$, $p = .014$, and distance was negatively related, $\beta = -.22$, $SE = .004$, $p = .004$. → **The nearer the device and the longer the time spent next to the device, the better the reported sleep quality in Group B.**
- A linear regression with a R^2 for the overall model of .000 (adjusted R^2 = –.013) revealed that the hours the device was near to the person as well as the distance of the device to the person had **no predictive value to the responded well-being**, $F(2, 157) = 0.01$, $p = .988$.
- A linear regression with a R^2 for the overall model of .018 (adjusted R^2 = .006) revealed that the hours the device was near to the person as well as the distance of the device to the person had **no predictive value to the responded stress level**, $F(2, 157) = 1.46$, $p = .235$.

Results – Subjective Measures

Explorative Analysis

Groups
A Placebo Device
B Real Device
C No Device

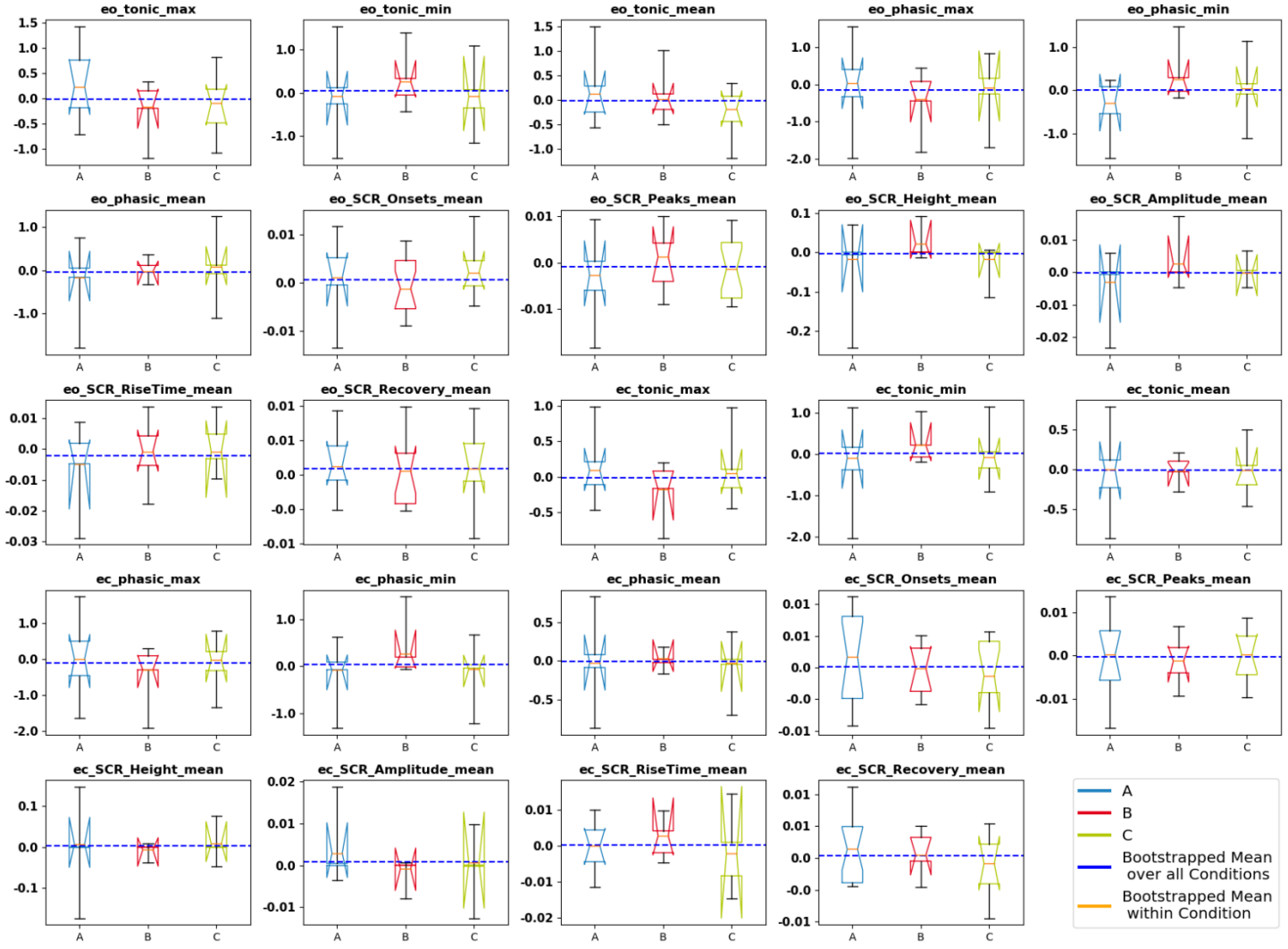
C

	Stress Level	Cope with Stress	Sleep Quality	Well-Being
Cope with Stress	–0.42**			
Sleep Quality	–0.25**	0.19*		
Well-Being	–0.20**	0.45***	0.30***	
Rating Special Event	0.01	0.24*	0.03	0.27*

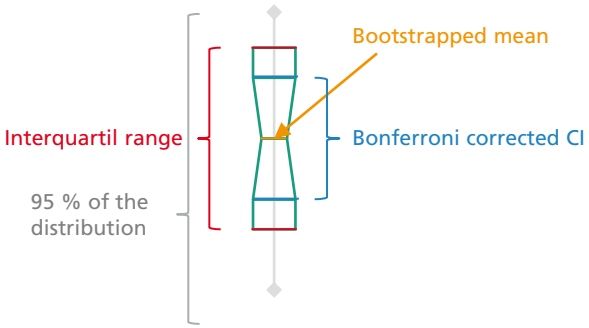
Results - Neurophysiological Measures
Electrodermal Activity (EDA)

Results – Neurophysiological Measures

Electrodermal Activity (EDA)



Boxplot Explanation



Groups

A Placebo Device

B Real Device

C No Device

EO Eyes open

EC Eyes closed

Assumptions

- Partly violated ND → robust
- ec_tonic_mean, ec_SCR_Onsets_mean, ec_SCR_Peaks_mean, ec_SCR_Height_mean: Equality of Variances violated → non-parametric

No significant difference between the conditions in EDA related measures ($p < .01$).

Results - Neurophysiological Measures
Electrocardiography (ECG)

Results - Neurophysiological Measures

Electrocardiography (ECG)

Groups

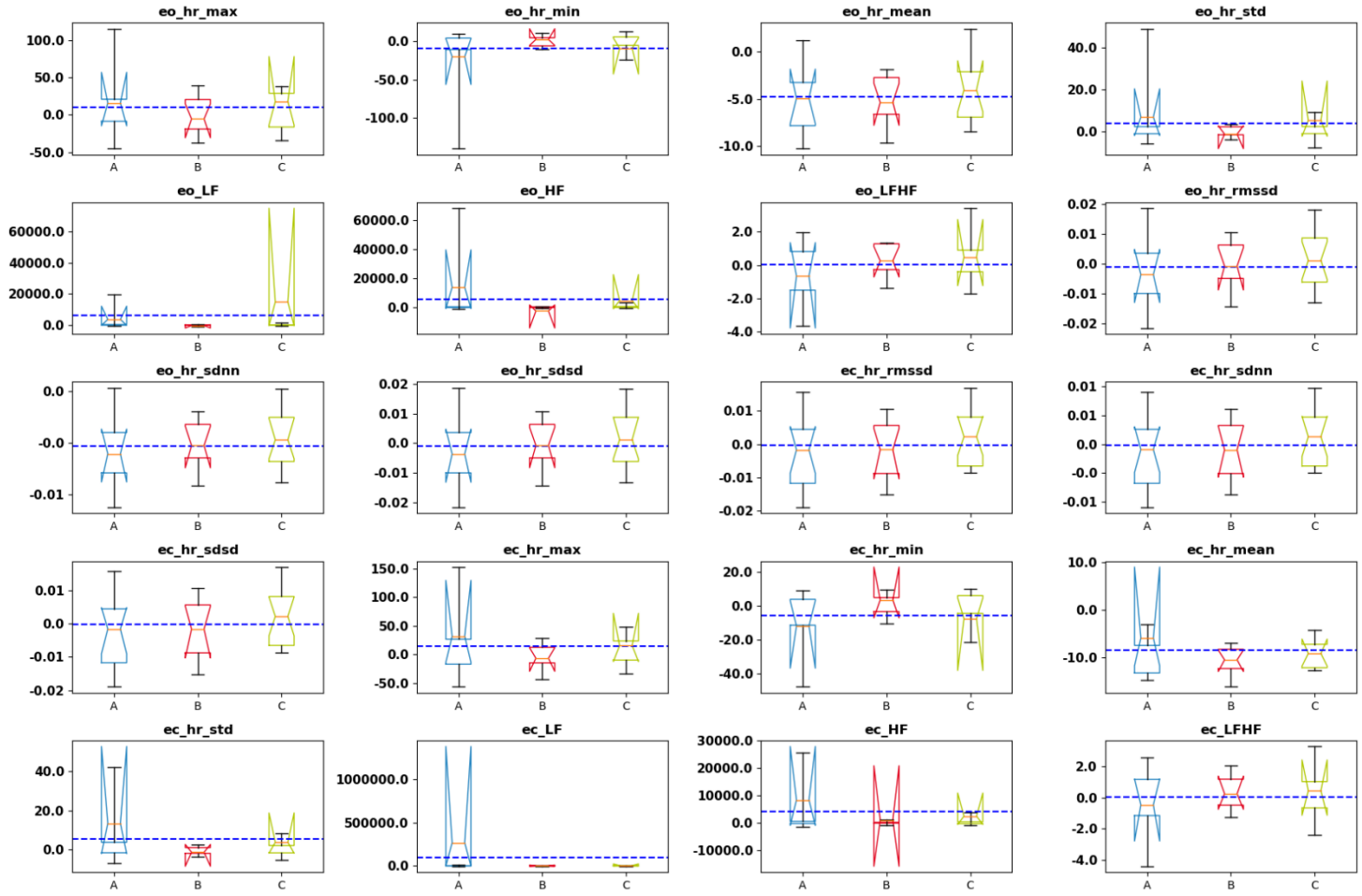
A Placebo Device

B Real Device

C No Device

EO Eyes open

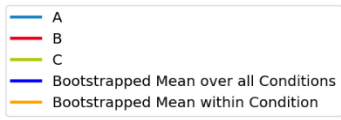
EC Eyes closed

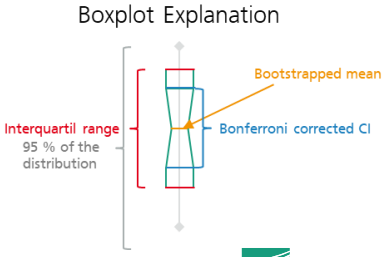


Assumptions

- Partly violated ND → robust
- EO_HF and EC_HF: Equality of Variances violated → non-parametric

No significant difference between the conditions in ECG related measures ($p < .01$).





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Results - Neurophysiological Measures
Electroencephalography (EEG)

Results - Neurophysiological Measures

Electroencephalography (EEG) – Power Spectrum Analysis - Eyes Open

Groups

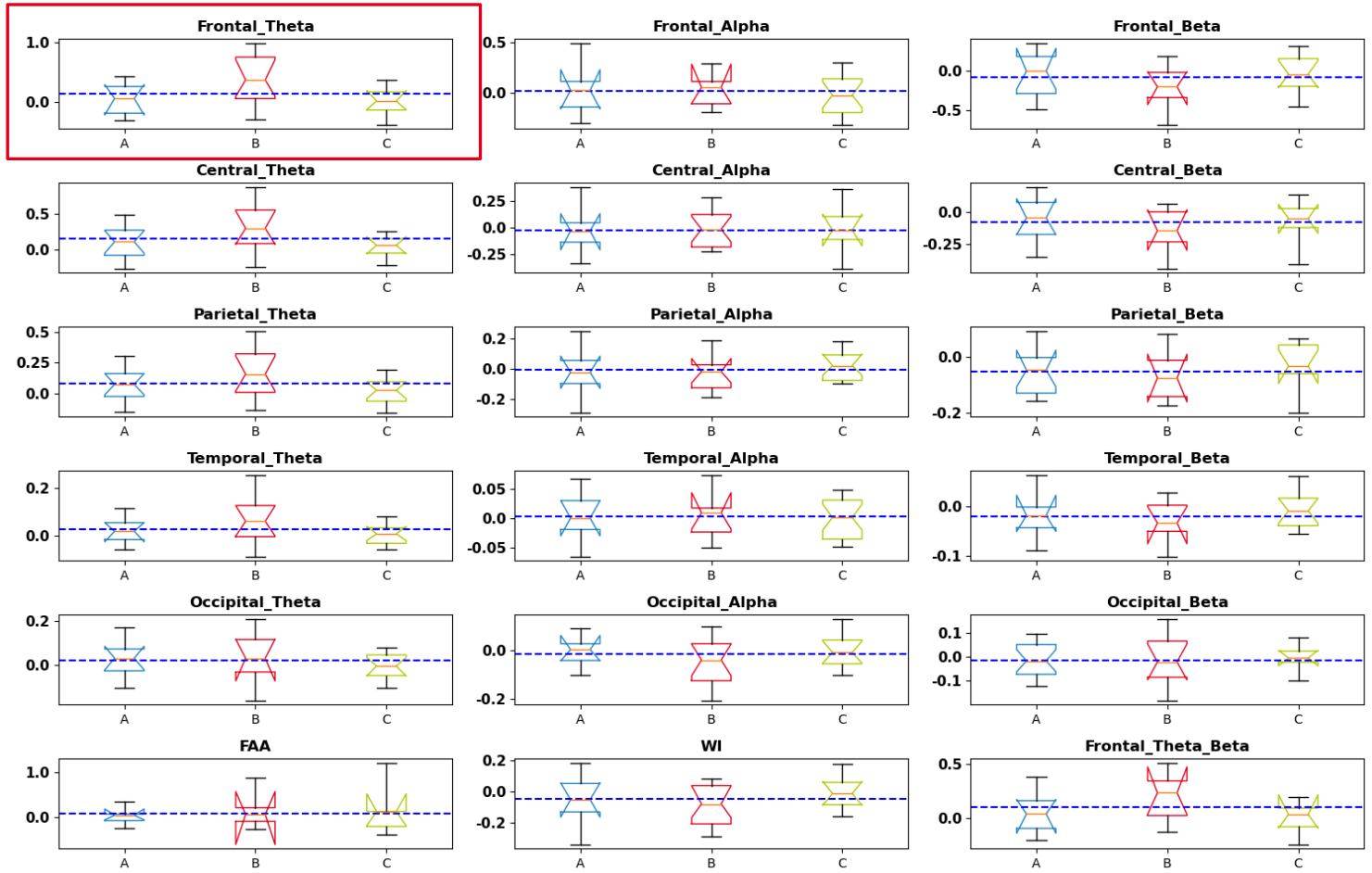
A Placebo Device

B Real Device

C No Device

Regions of Interests

Frequency band of Interests

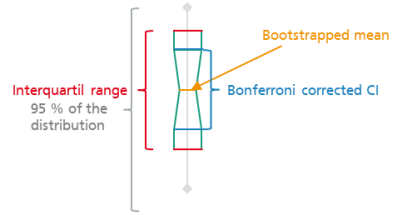


Assumptions

- Partly violated ND → robust
- FAA, Frontal_Theta, Central_Theta, Parietal_Theta, Temporal_Theta, Occipital_Alpha, Occipital_Beta: Equality of Variances violated → non-parametric
- Frontal theta-band power $\chi^2(81,2) = 10.599$, $p = .005$.

There is a significant difference between the conditions regarding the frontal theta-band power ($p < .01$).

Boxplot Explanation



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Fraunhofer IAO

Results - Neurophysiological Measures

Electroencephalography (EEG) – Power Spectrum Analysis - Eyes Closed

Groups

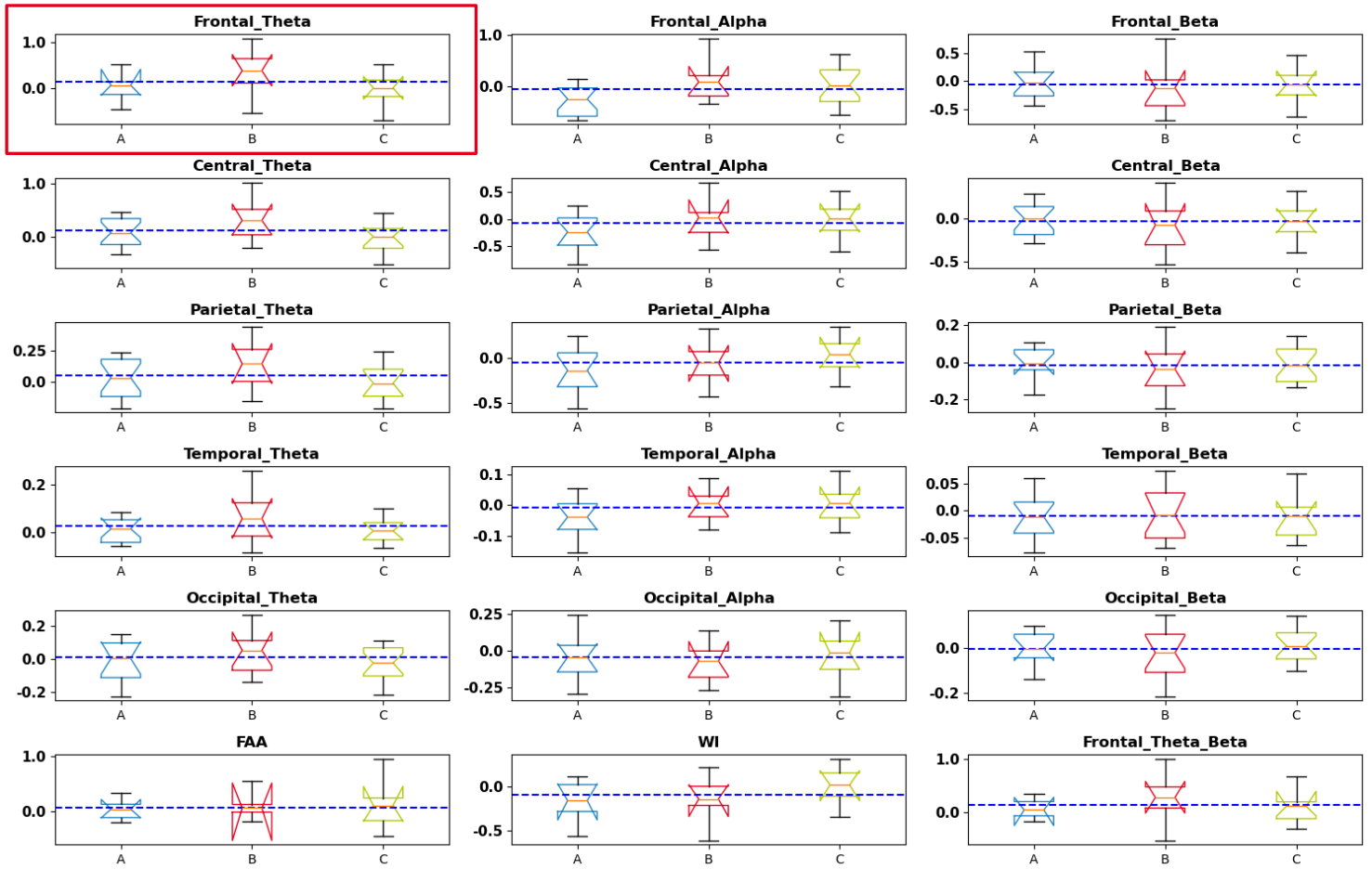
A Placebo Device

B Real Device

C No Device

Regions of Interests

Frequency band of Interests



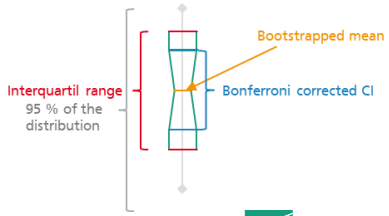
Assumptions

- Partly violated ND → robust
- FAA: Equality of Variances violated → non-parametric
- Frontal theta-band power

Source	SS	DF	MS	F	p-unc	np2
Condition	1,83	2	0,91	5,37	0,007	0,119
Within	13,65	80	0,17			

There is a significant difference between the conditions regarding the frontal theta-band power ($p < .01$).

Boxplot Explanation



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Fraunhofer IAO

Results - Neurophysiological Measures

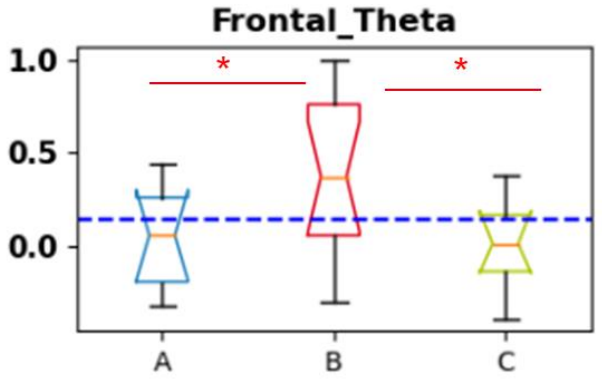
Electroencephalography (EEG) – Power Spectrum Analysis – Theta-band

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device

Bootstrapped Confidence Intervals

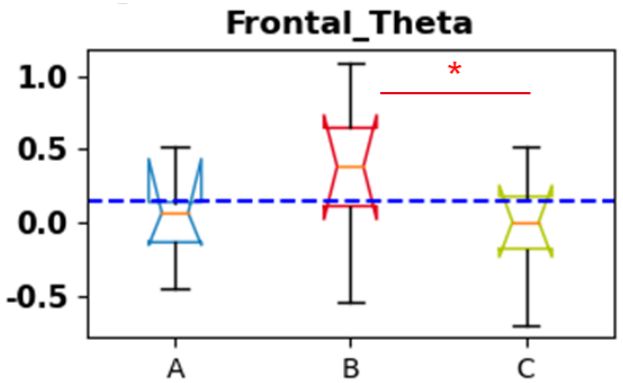
Frontal Theta Eyes Open

	lower	mean	upper
A	-0,181	0,060	**0,302**
B	0,078	**0,374**	0,667
C	-0,143	0,015	**0,192**



Frontal Theta Eyes Closed

	lower	mean	upper
A	-0,150	0,069	0,435
B	0,026	**0,383**	0,732
C	-0,230	0,007	**0,254**



*There is **significant higher theta-band** in the **post-session** for the **condition B***

Possible explanations

- Theta is a candidate of a biophysical mechanism for (need) ***cognitive control*** (Cavanagh & Frank, 2014). However, a transcranial alternating current stimulation only on the frontal lobe seems to negatively influence working memory performance (Chander et al., 2016).
- Increased theta power has been found in resting state EEG in individuals with Attention-Deficit/Hyperactivity Disorder (ADHD; Woltering et al., 2012) and ***increased mental fatigue*** during a demanding mental task (Wascher et al., 2014).
- A further study reported a *negative correlation between frontal theta and the default mode network activity* (Scheeringa et al., 2008).
  - *"The DMN is an intrinsically correlated network of brain regions that is regularly observed to deactivate during attention demanding cognitive tasks. Activation of this network has recently been linked to stimulus-independent thought, or in other words, mind-wandering (Mason et al., 2007). A negative correlation of frontal theta power with the DMN therefore suggests that **frontal theta activity can be used as an index of DMN activity**, at least in the **resting state condition**."* (Scheeringa et al., 2008).

Default Mode Network and Subjective Wellbeing

- A recent study found that psychological resilience was negatively correlated with cross-network connectivity between the Default Mode (DMN) and the Salience Network (SN; Brunetti et al., 2017).

- Enhanced DMN-SN connectivity, which is involved in sustained hypervigilance and hyperarousal, seems to be harmful to well-being (Shi et al., 2018).

- A negative correlation may account for the fact that people with low levels of subjective wellbeing are sensitive to negative emotional events, while people with high levels of subjective wellbeing are associated with good mental adaptability and resilience (Shi et al., 2018).

- **Summary**: There seems to be a **negative correlation between subjective wellbeing und static functional connectivity between the salience network (SN) and the anterior default mode network (DMN). Frontal theta power** is suggested to be an **index of DMN activity** in the resting state condition with a **negative correlation between frontal theta and the DMN activity** (Scheeringa et al., 2008).

Results - Neurophysiological Measures

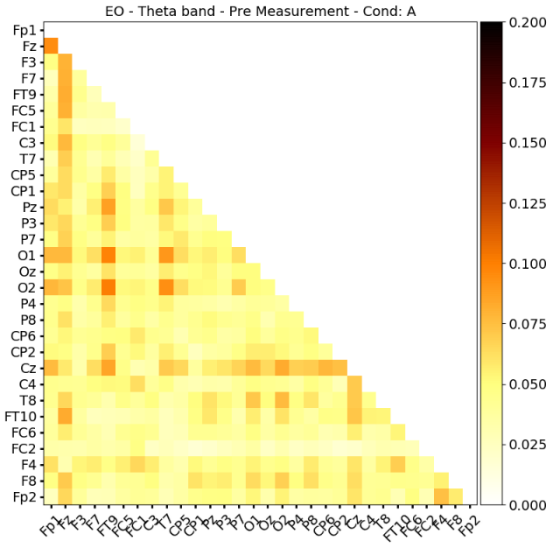
Electroencephalography (EEG) – Functional Connectivity – Theta Band (EO)

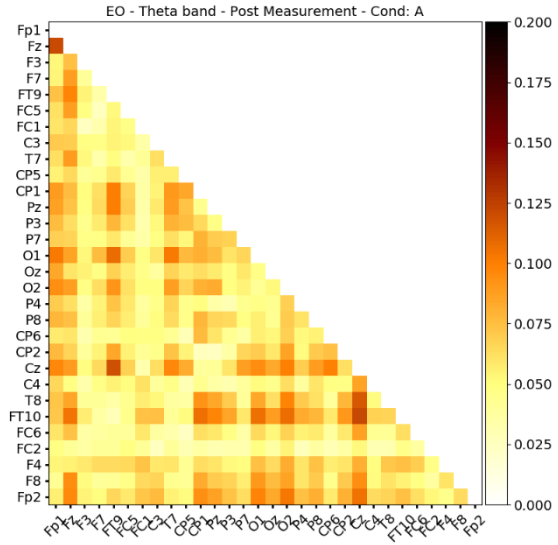
Groups

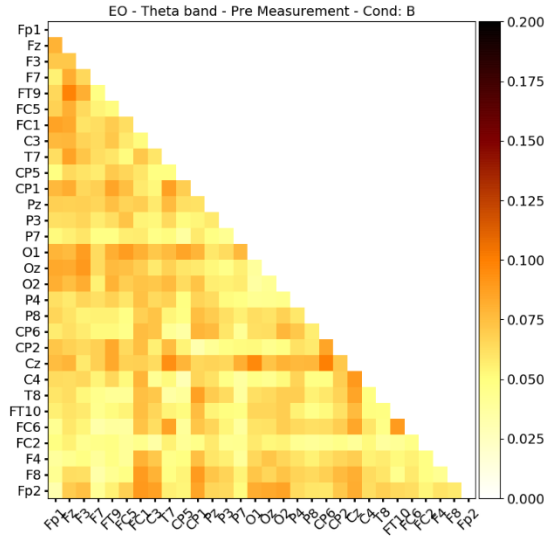
A Placebo Device

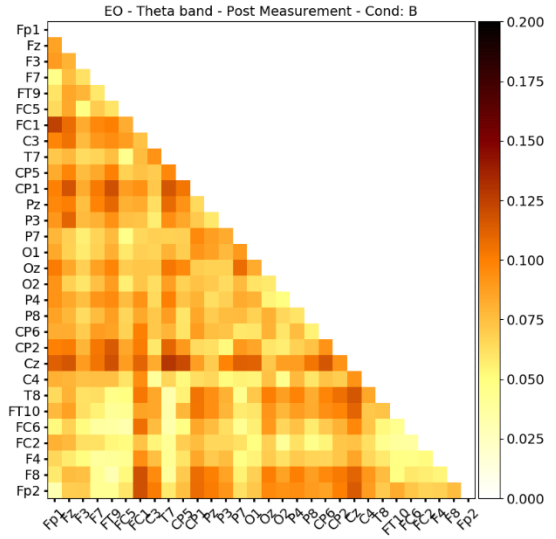
B Real Device

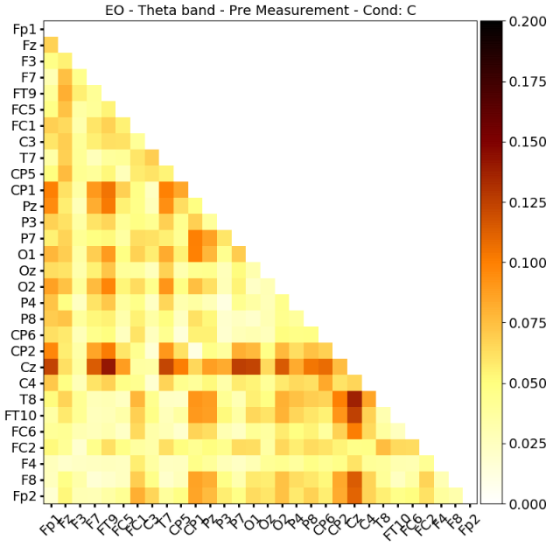
C No Device

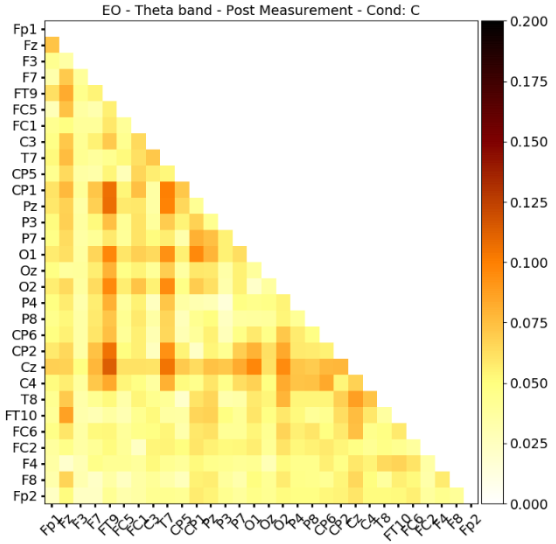












Results - Neurophysiological Measures

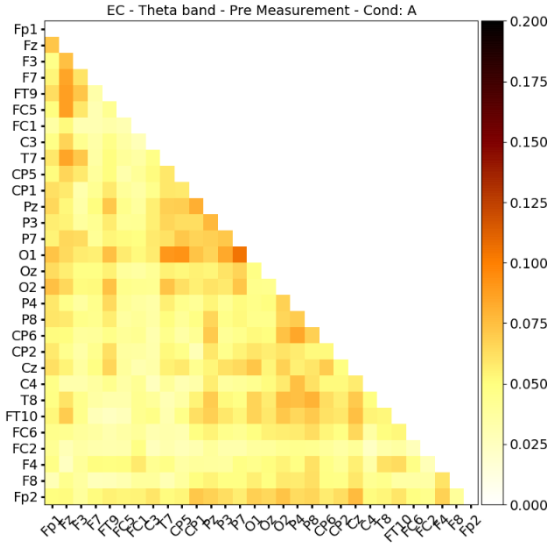
Electroencephalography (EEG) – Functional Connectivity – Theta Band (EC)

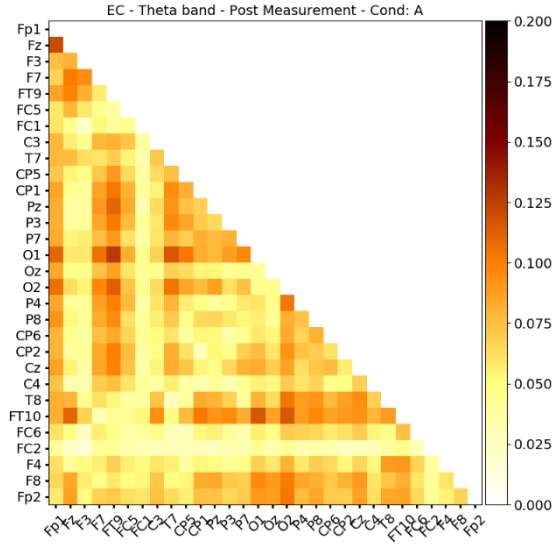
Groups

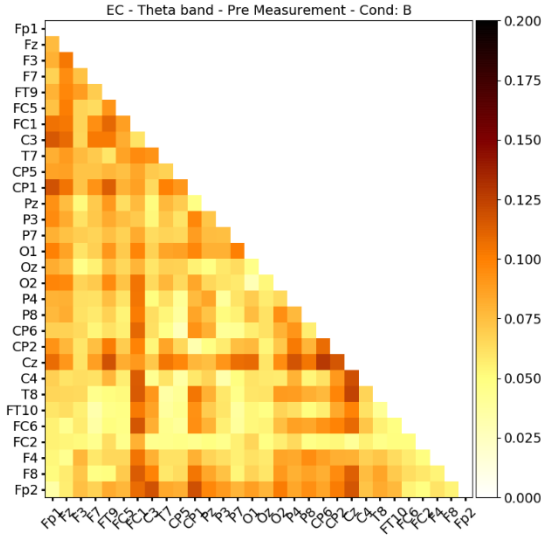
A Placebo Device

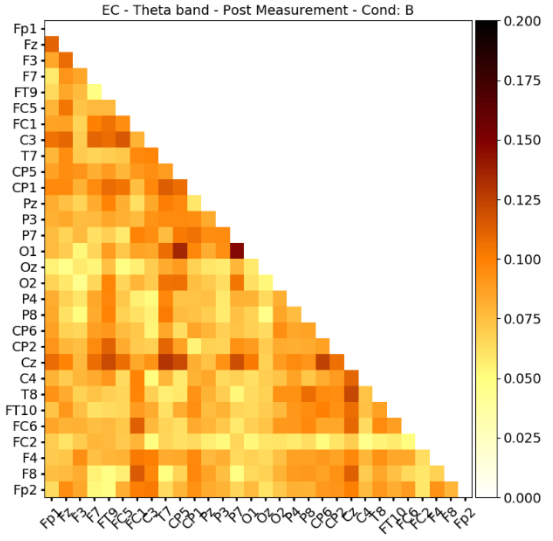
B Real Device

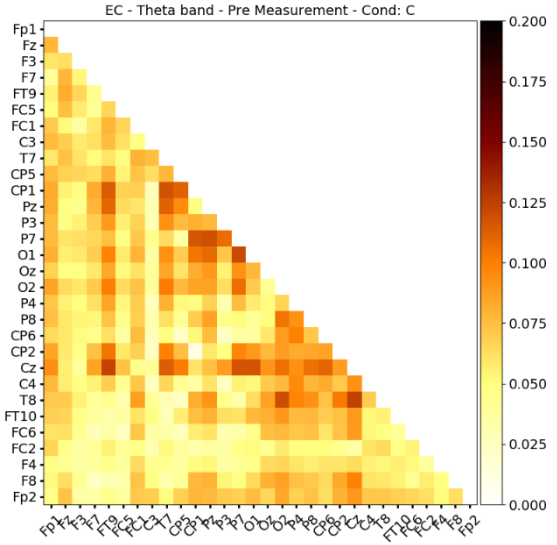
C No Device

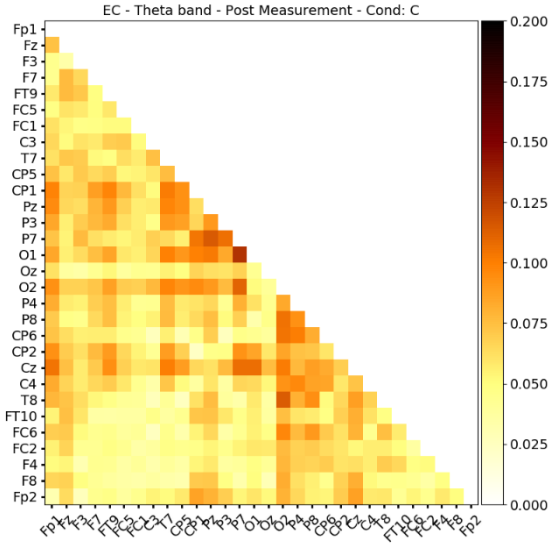












Results - Neurophysiological Measures

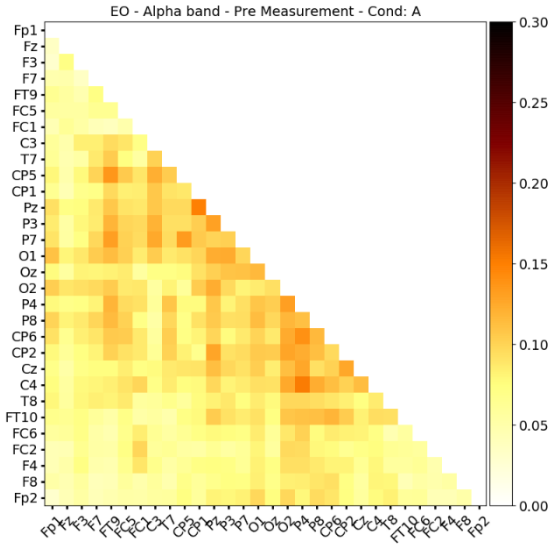
Electroencephalography (EEG) – Functional Connectivity – Alpha Band (EO)

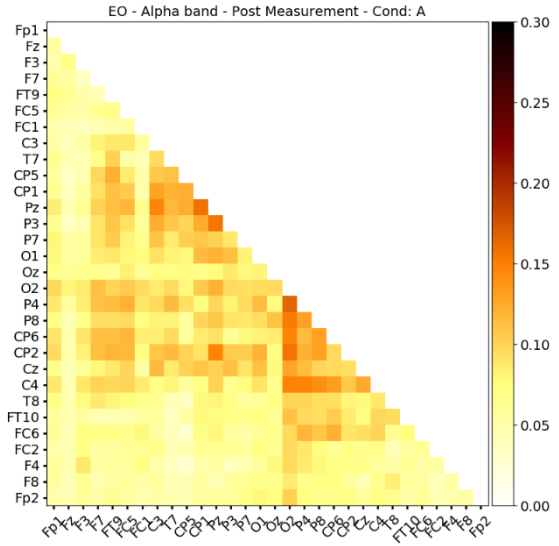
Groups

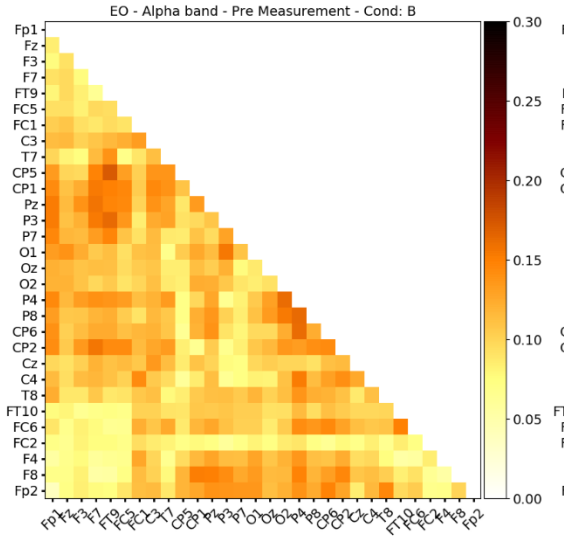
A Placebo Device

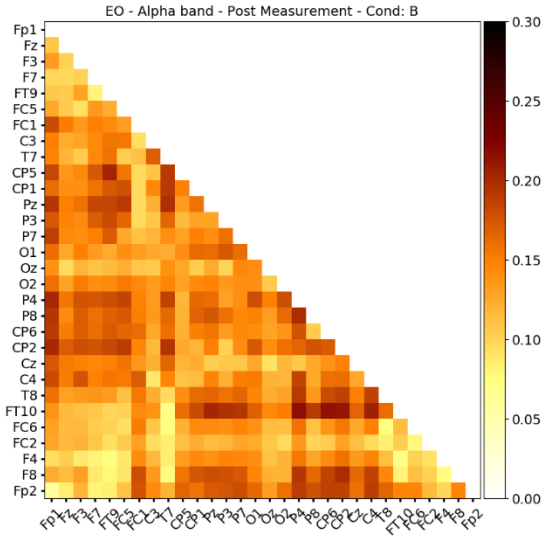
B Real Device

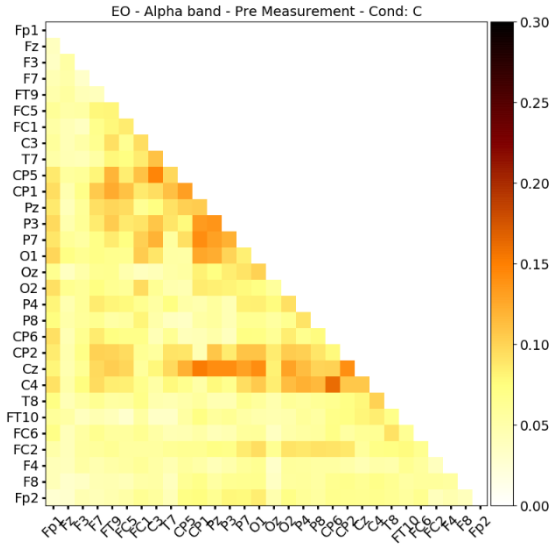
C No Device

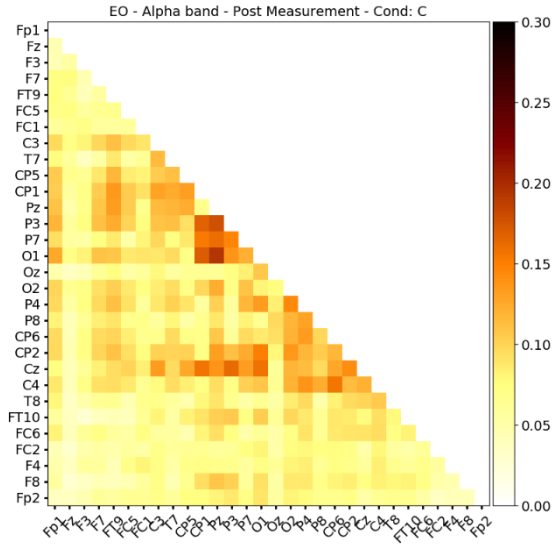












Results - Neurophysiological Measures

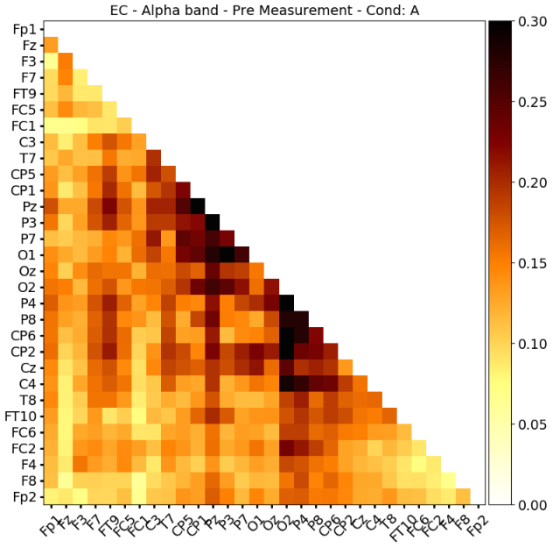
Electroencephalography (EEG) – Functional Connectivity – Alpha Band (EC)

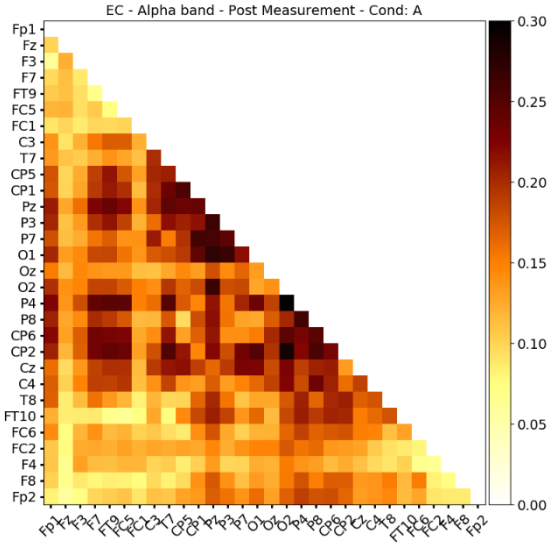
Groups

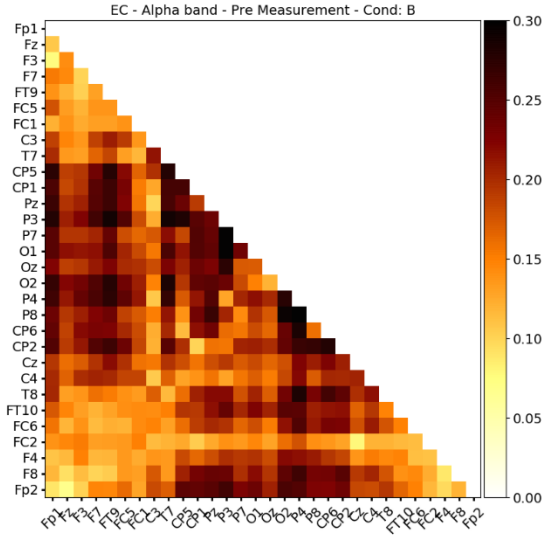
A Placebo Device

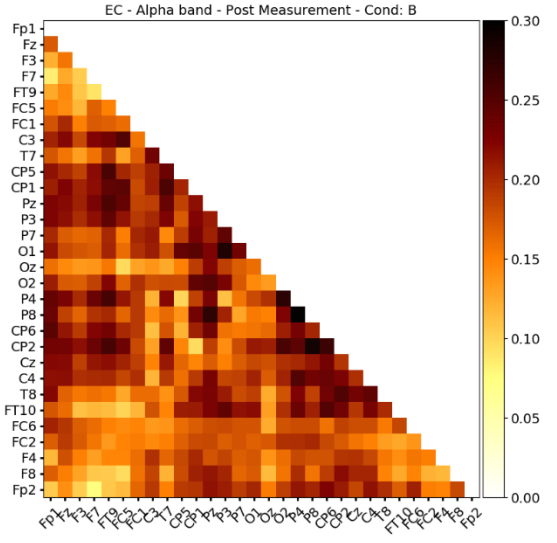
B Real Device

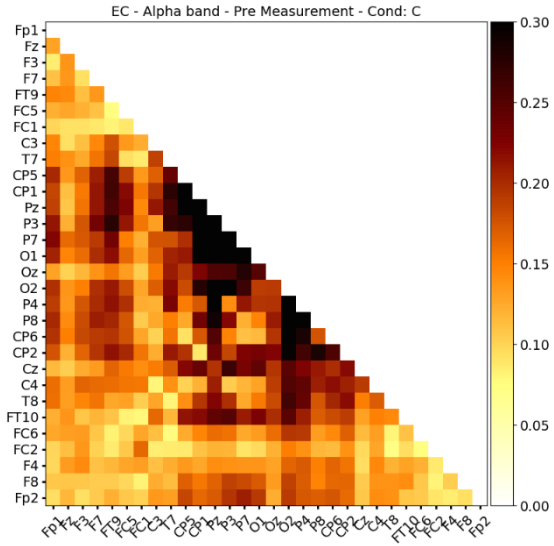
C No Device

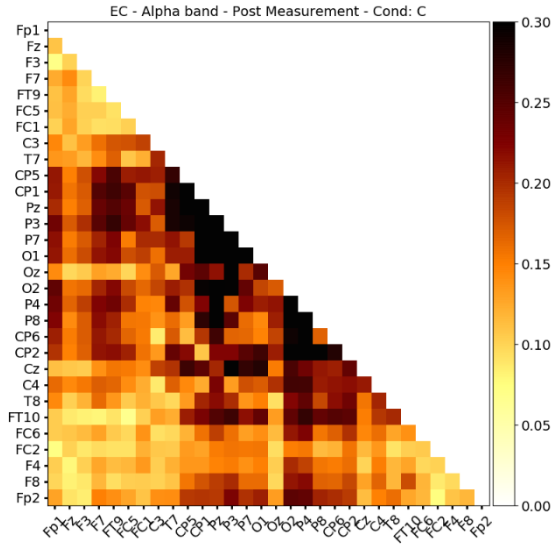












Results - Neurophysiological Measures

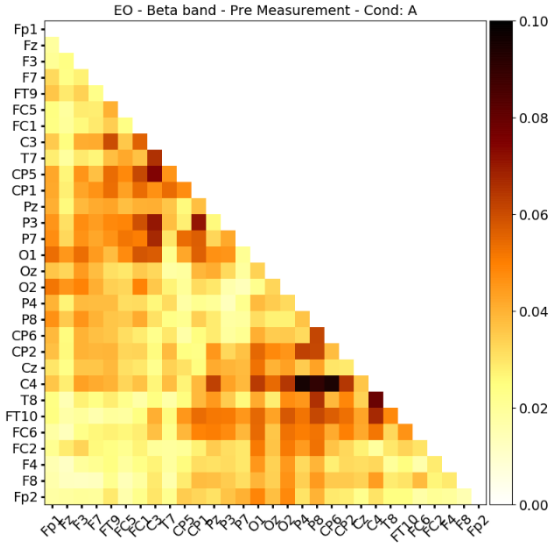
Electroencephalography (EEG) – Functional Connectivity – Beta Band (EO)

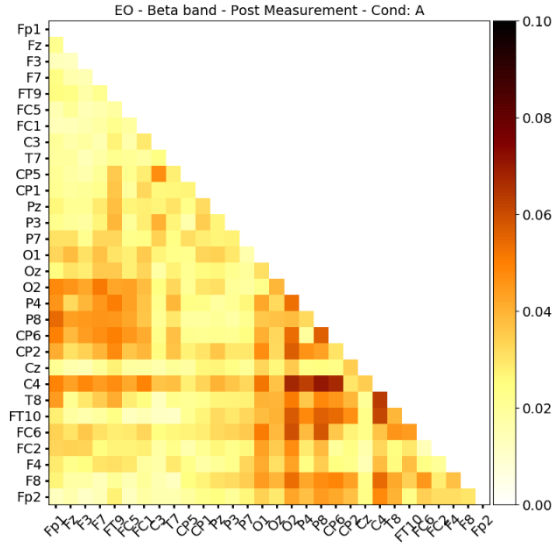
Groups

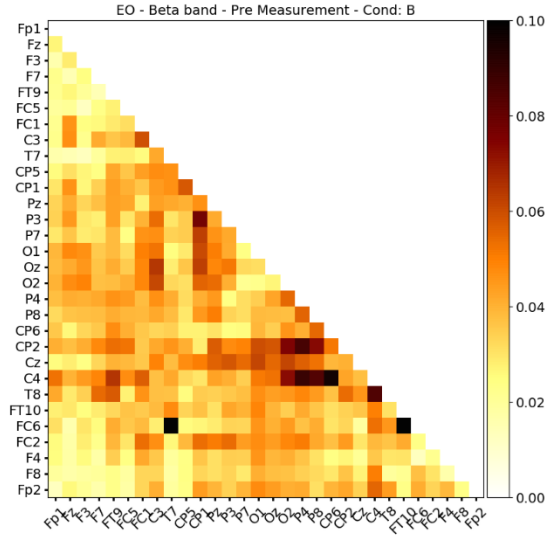
A Placebo Device

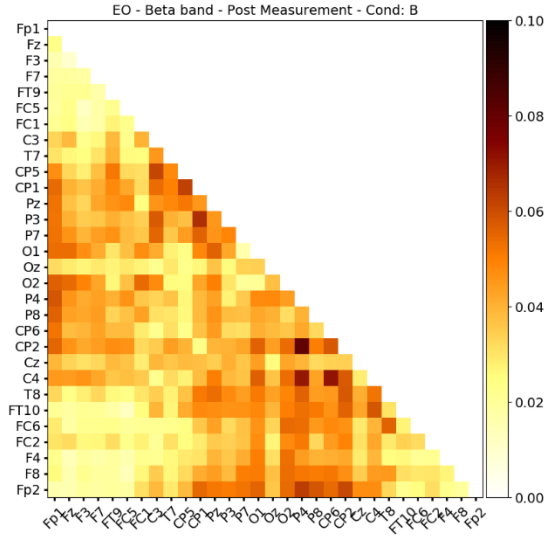
B Real Device

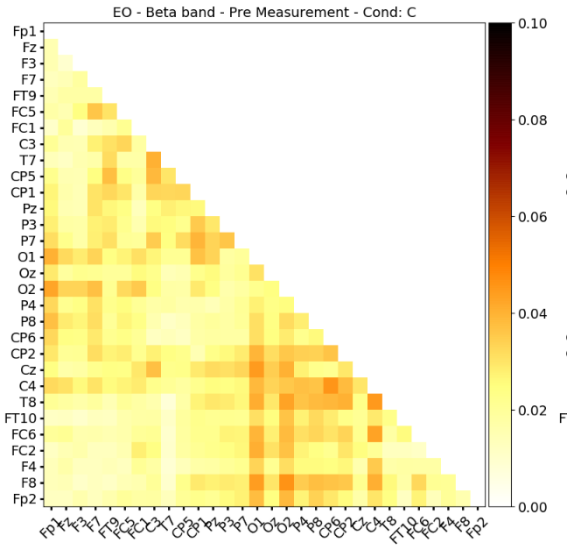
C No Device

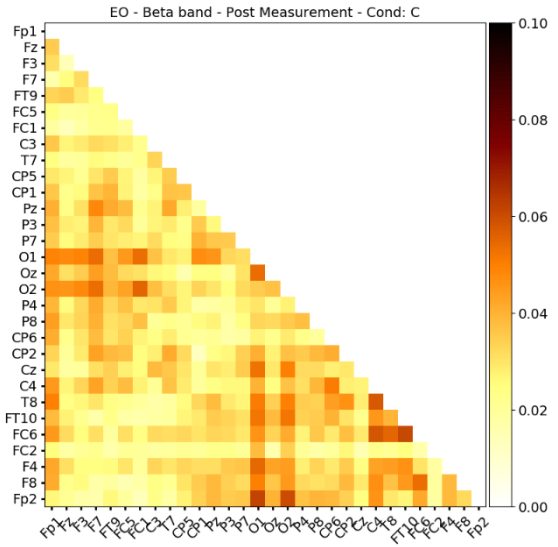












Results - Neurophysiological Measures

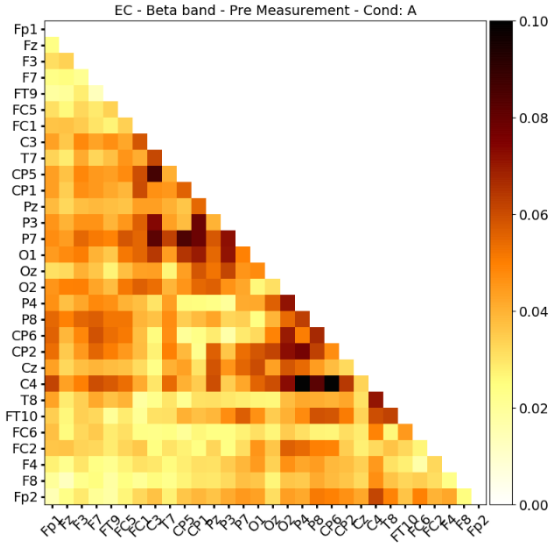
Electroencephalography (EEG) – Functional Connectivity – Beta Band (EC)

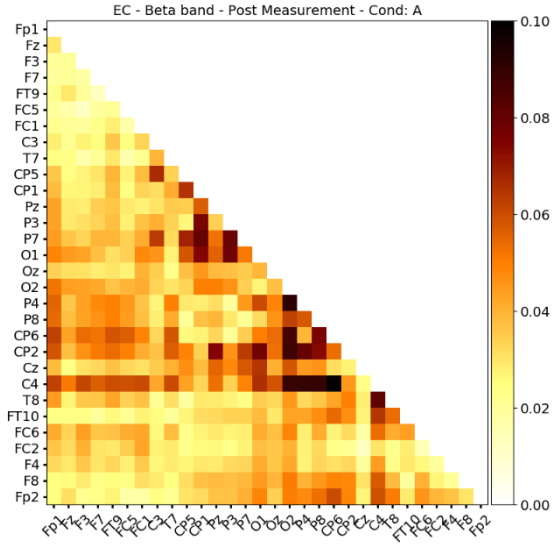
Groups

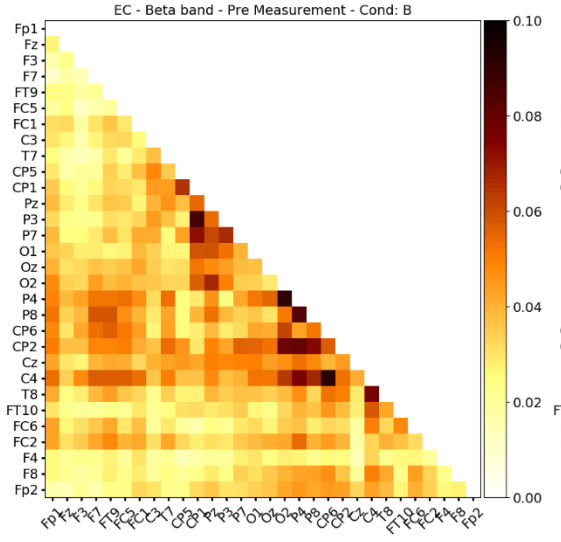
A Placebo Device

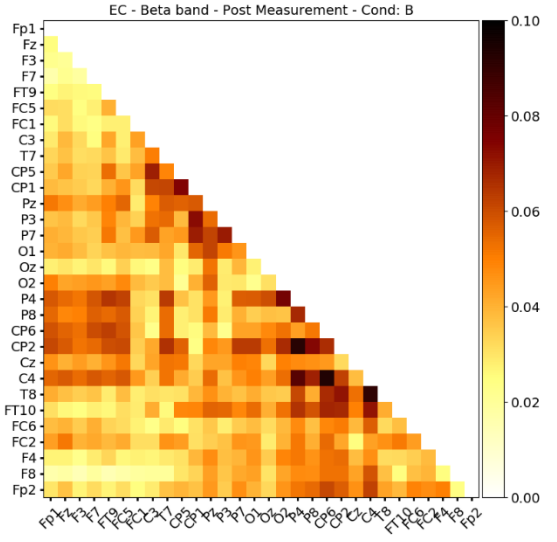
B Real Device

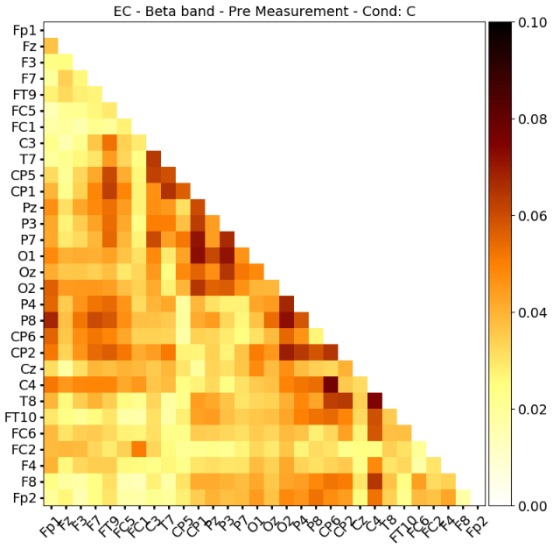
C No Device

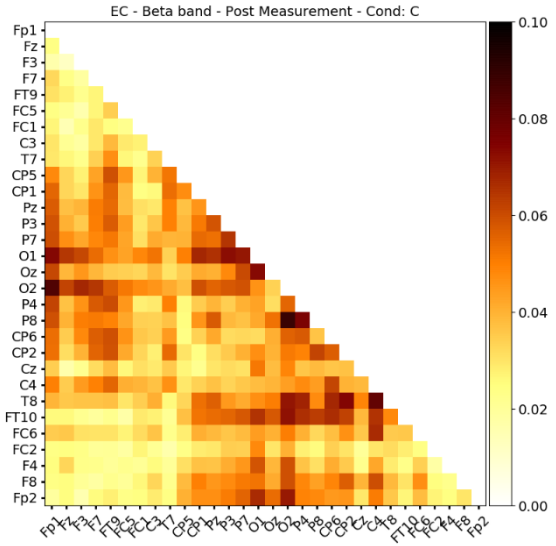












Results - Neurophysiological Measures

Electroencephalography (EEG) – Functional Connectivity - Eyes Open

Groups

A Placebo Device

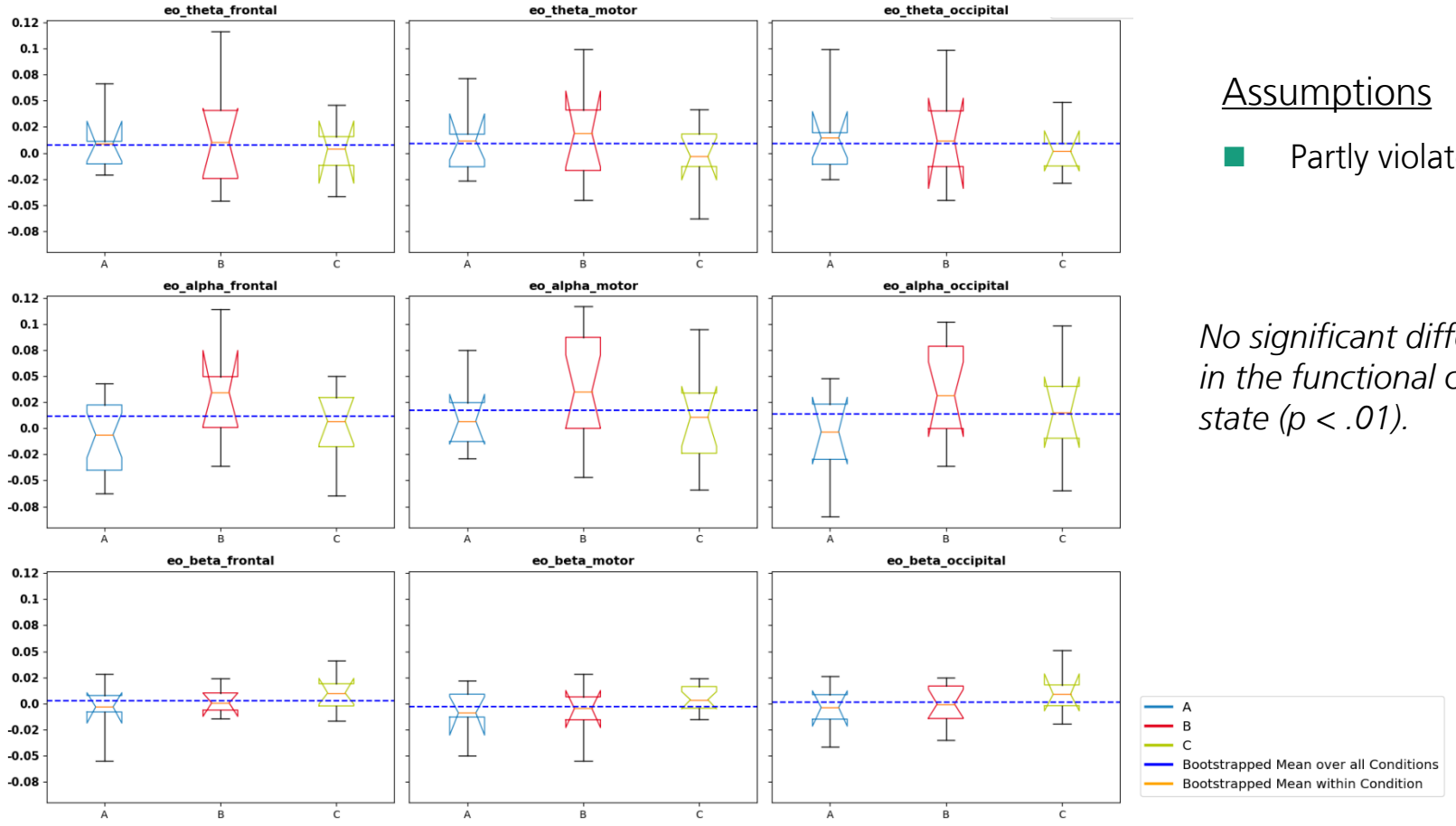
B Real Device

C No Device

EO Eyes open

EC Eyes closed

Seed electrodes in the frontal, motor and occipital regions

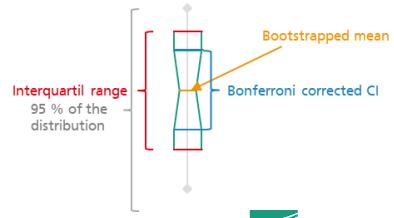


Assumptions

- Partly violated ND → robust

No significant difference between the conditions in the functional connectivity for eyes open resting state ($p < .01$).

Boxplot Explanation



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Results - Neurophysiological Measures

Electroencephalography (EEG) – Functional Connectivity - Eyes Closed

Groups

A Placebo Device

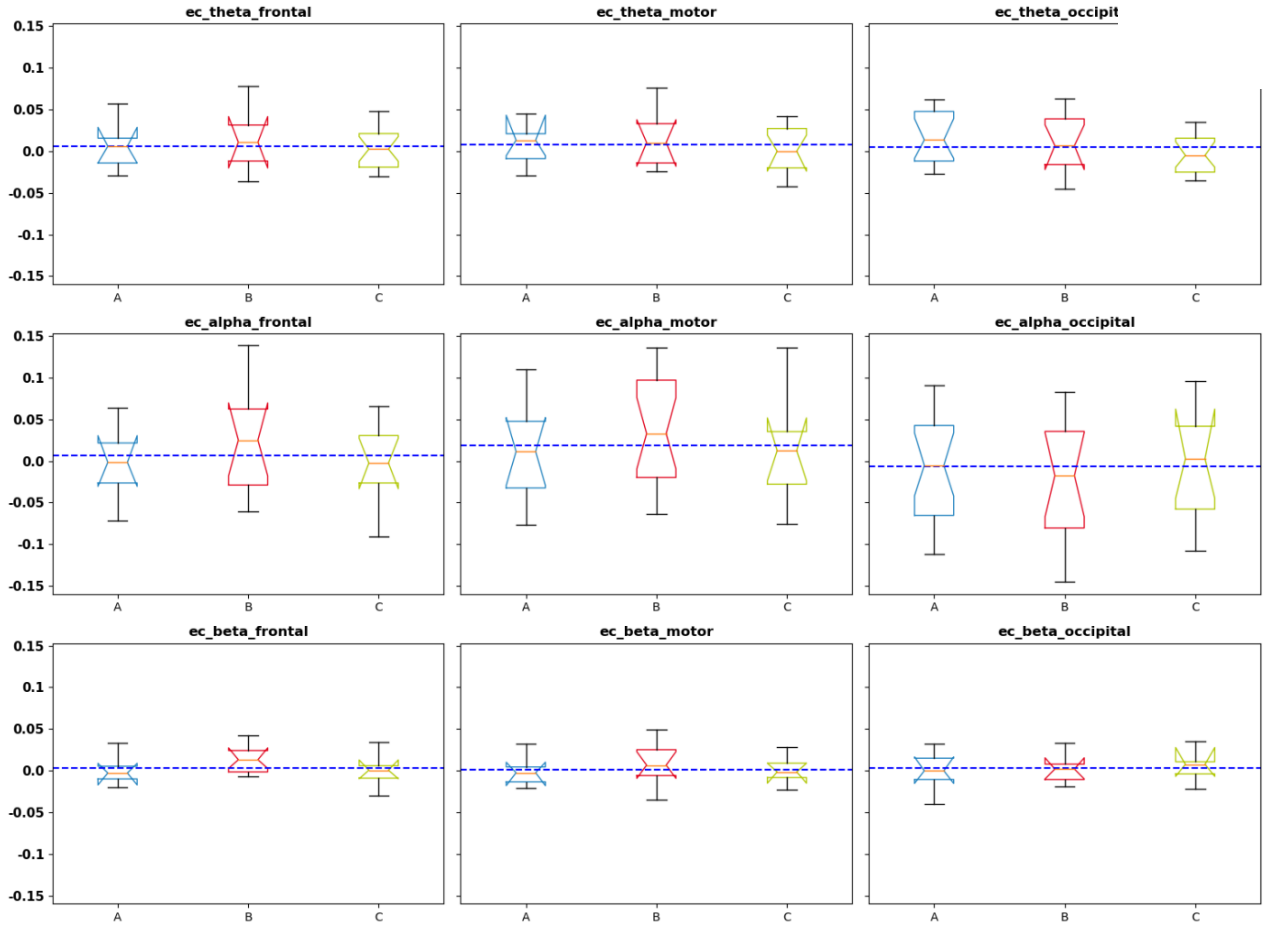
B Real Device

C No Device

EO Eyes open

EC Eyes closed

Seed electrodes in the frontal, motor and occipital regions

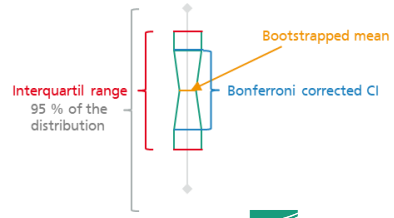


Assumptions

- Partly violated ND → robust

No significant difference between the conditions in the functional connectivity for eyes closed resting state ($p < .01$).

Boxplot Explanation



Universität Stuttgart
Institut für Arbeitswissenschaft und Technologiemanagement IAT

Fraunhofer IAO

Results - Neurophysiological Measures

Electroencephalography (EEG) – Functional Connectivity – Eyes Open

Groups

A Placebo Device

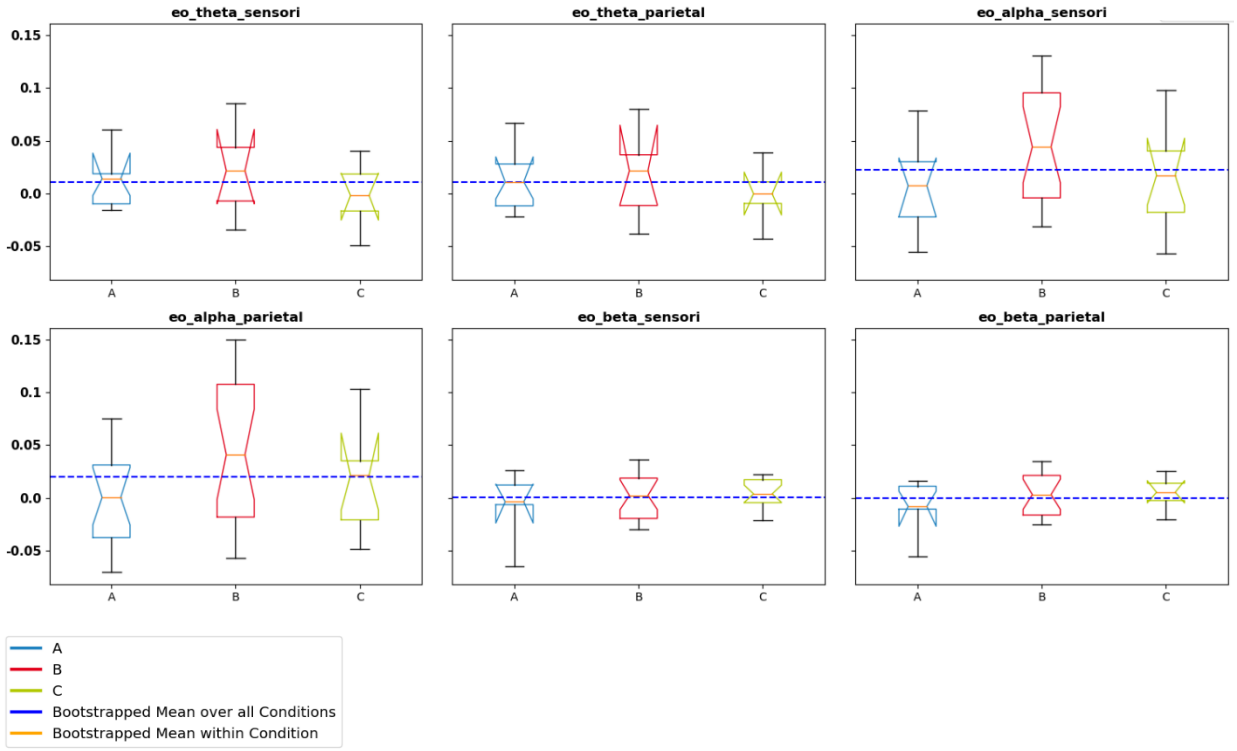
B Real Device

C No Device

EO Eyes open

EC Eyes closed

Seed electrodes in the sensorimotor and parietal regions

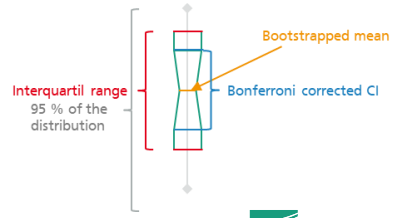


Assumptions

- eo_theta_sensori, eo_alpha_parietal: Equality of Variances violated → non parametric

No significant difference between the conditions in the functional connectivity for eyes open resting state ($p < .01$).

Boxplot Explanation



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Fraunhofer IAO

Results - Neurophysiological Measures

Electroencephalography (EEG) – Functional Connectivity – Eyes Closed

Groups

A Placebo Device

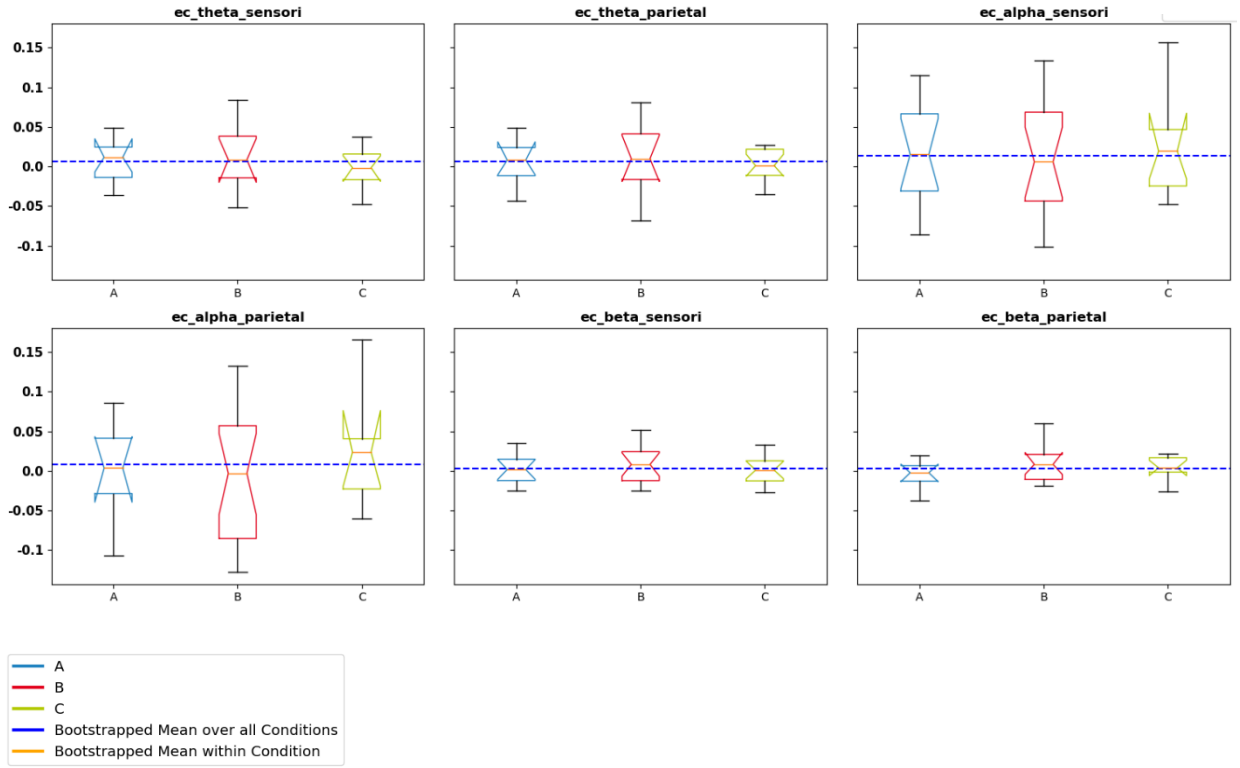
B Real Device

C No Device

EO Eyes open

EC Eyes closed

Seed electrodes in the sensorimotor and parietal regions

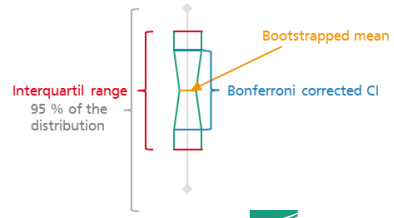


Assumptions

- ec_theta_sensori, ec_alpha_parietal: Equality of Variances violated → non parametric

No significant difference between the conditions in the functional connectivity for eyes closed resting state ($p < .01$).

Boxplot Explanation



Summary of Main Findings

Groups
- **A** Placebo Device
- **B** Real Device
- **C** No Device

Subjective Measures

- We calculated **16 ANOVAs** to reveal effects regarding subjective measures. All group comparisons were non-significant.
- We observed **no significant difference between the groups** regarding changes in any of the reported subjective measures, neither regarding pre- and post-differences, nor regarding changes in variables reported on a daily basis.
- Participants who scored high on the paranormal belief scale and who indicated having of fear of radiation were more likely to assume an effect of the device.
- We calculated **six regression models** of which one was significant: Participants of Condition B (real device) reported significantly better subjectively perceived sleep quality the nearer the device and the longer the time they spent next to the device compared to other participants in the Condition B with the real device that placed the device farer away and spent less time next to it.

Objective Measures

- We calculated **110 ANOVAs** to investigate effects regarding objective (psycho- and neurophysiological) measures (24 ANOVAs for the EDA, 20 for the ECG, and 66 for the EEG correlates).
- Two ANOVAs were significant: The EEG frontal theta-band power in the eyes open (EO) and eyes closed (EC) resting state recordings was higher in the post-session for the condition B with the real device.
  - Possible biophysical mechanism for cognitive control (Cavanagh & Frank, 2014).
  - Frontal theta-band power is an index of DMN activity in the resting state condition (Scheeringa et al., 2008). An increased frontal theta-band power indicated a deactivation of the DMN associated with higher subjective well-being and resilience.

The observed effects need to be replicated within a new study and sample to ensure no bias of multiple testing (here corrected via Bonferroni within ANOVAs and with a *significance threshold* of $p < 0.01$ among ANOVAs). Since we did not investigate possible physical and chemical effects of the product Qi-Shield, we cannot explain the observed effects, nor can we guarantee the absence of possible confounding effects in the experiment. Therefore, we emphasize the need to replicate the results within a new study and sample

Zusammenfassung der Hauptergebnisse

Gruppen
A Placebo Gerät
B echtes Gerät
C kein Gerät

Subjektive Messmethoden

- Wir haben **16 ANOVAs** gerechnet, um **subjektive Effekte** in Fragebögen und Skalen zu untersuchen. **Alle Gruppenvergleiche waren nicht signifikant**. Wir beobachteten keinen signifikanten Unterschied zwischen den Gruppen in Bezug auf Veränderungen in einem der berichteten subjektiven Maße, weder in Bezug auf Prä- und Post-Differenzen noch in Bezug auf Veränderungen in den täglich berichteten Variablen.
- Teilnehmende, die in einem Fragebogen eine hohe Ausprägung zu paranormale Überzeugungen aufwiesen und die angaben, Angst vor Strahlung zu haben, gingen eher von einem Effekt des Gerätes aus.
- Wir berechneten **sechs Regressionsmodelle**, von denen ein Modell signifikant war: Teilnehmende der Bedingung B (echtes Gerät) berichteten über eine signifikant bessere subjektiv wahrgenommene Schlafqualität, je näher das Gerät stand und je länger sie sich neben dem Gerät aufhielten, im Vergleich zu anderen Teilnehmenden der gleichen Bedingung B (echtes Gerät), die das Gerät weiter entfernt aufgestellt und weniger Zeit in der Nähe des Gerätes verbracht hatten.

Objektive (Neuro-)Physiologische Messmethoden

- Wir berechneten **110 ANOVAs**, um Effekte hinsichtlich objektiver (psycho- und neurophysiologischer) Maße zu untersuchen (**24 ANOVAs für EDA Analysen, 20 für EKG und 66 für EEG Analysen**).
- Zwei Modelle waren signifikant und wiesen somit auf einen Unterschied zwischen den Gruppen in diesem Maß hin:
  - Die EEG-Power des frontalen Theta-Bandes in der Ruhezustandsmessung mit offenen Augen (EO) und geschlossenen Augen (EC) war in der Post-Session in der Gruppe B mit dem realen Gerät höher als in der Gruppe A und B.
  - Die frontale Theta-Band-Leistung ist ein Index der DMN-Aktivität im Ruhezustand (Scheeringa et al., 2008). Eine erhöhte frontale Theta-Band-Leistung deutet auf eine Deaktivierung des DMN hin, die mit höherem subjektiven Wohlbefinden und Resilienz verbunden ist.

Die beobachteten Effekte müssen in einer neuen Studie und Stichprobe repliziert werden, um sicherzustellen, dass keine Verzerrung durch Mehrfachtests vorliegt (hier korrigiert mittels Bonferroni-Methode innerhalb der Modelle und mit einer Signifikanzschwelle von $p < 0,01$ auf Modell-Ebene).
Da wir mögliche physikalische und chemische Wirkungen des Produkts Qi-Shield nicht untersucht haben, können wir die beobachteten Effekte nicht erklären, noch können wir die Abwesenheit möglicher störender Effekte im Experiment garantieren. Daher betonen wir die Notwendigkeit, die Ergebnisse innerhalb einer neuen Studie und Stichprobe zu replizieren.

Implications for Further Studies

Groups
A Placebo Device
B Real Device
C No Device

- Condition A (Placebo Device; *n* = 30): The nearer the device, the higher the reported stress level.
- Condition B (Real Device; *n* = 30): Although there was no significant effect on the sleep quality and no differences between the conditions (real and placebo device) in their reported sleep quality, we observed a significant correlation only in the Condition B with the real device: the nearer the device and the longer the time they spent next to the device, the better their subjectively perceived sleep quality. Distance to the device and time spent close to the device are based on self-reports of the participants.
- Two ANOVAs were significant: The EEG frontal theta-band power in the eyes open (EO) and eyes closed (EC) resting state recordings was higher in the post-session for the condition B with the real device.

Since we did not investigate possible physical and chemical effects of the product Qi-Shield, we cannot explain the observed effects, nor can we guarantee the absence of possible confounding effects in the experiment. Therefore, we emphasize the need to replicate the results within a new study and sample.

Methodological Limitations of the Study

Groups
A Placebo Device
B Real Device
C No Device

- The exposure time necessary to reveal effects of the device is unknown
  - → In this study, we decided for an exposure time of seven days
- A crossover experiment would account for individual differences
  - → In this study we used a between-subject design due to financial limitations
- We can not control all possible confounding effects, since participants spent 5 days of the experiment at home.
- We cannot make any statements regarding possible physical and chemical effects of the product Qi-Shield
- Sample:
  - Limited range in age because of restrictions due to the COVID-19 pandemic (possible risk factors for elderly people)
  - Rather academic sample

Project Results and Data availability

Project Results

- The results of the project in form of the presentation deck and summary will be made available on the Fraunhofer IAO homepage after internal review.
- Waveguard GmbH can refer to the project via the reference text and URL of the project homepage.

Data availability

- After internal review, the data will be made publicly available on the Open Science Framework platform. We call on the research community to replicate and review the results. Analysis steps and code will be provided on request.

Reference

From September 2020 to April 2021, the Fraunhofer Institute IAO scientifically examined the effects of the product *Qi-Shield* produced by the Waveguard GmbH on a psychological, psychophysiological and neurophysiological level in a study commissioned by Waveguard GmbH.

Possible physical and chemical effects of the product *Qi-Shield* as well as statements of the producer on product effects were not analysed and were not considered in the assessment.

a) Under defined experimental conditions the study indicates no significant effect of the product *Qi-Shield* on the subjective psychological level including sleep quality, stress, life-satisfaction, anxiety, affect, subjective well-being and resilience compared to a placebo and control condition. A correlation in the experimental group with the real device revealed better subjectively perceived sleep quality for participants who reported to keep the device nearer and spent more time close to the device compared to participants in the same group who keep the device farer away and spent less time close to it.

b) The product *Qi-Shield* had no significant effect on a psychophysiological level compared to a placebo and control condition as investigated in 24 ANOVAs for the EDA and 20 ANOVAs for the ECG analysis.

c) Under defined experimental conditions the study indicates a significant effect of the product *Qi-Shield* on the neurophysiological level represented by a significant increase in EEG frontal theta-band power during a resting state recording compared with a non-functional placebo/sham device and a control group. The remaining 64 ANOVA models investigating EEG correlated revealed no significant effects of the product *Qi-Shield* compared to a placebo and control condition.

The results of the study can be viewed here:

Link to Fraunhofer homepage for

1) A short summary of the study results

2) The full report of the study results in form of a presentation deck

Reference
German Significant Results

Das Fraunhofer Institut IAO hat zwischen September 2020 und April 2021 im Rahmen einer von Waveguard GmbH beauftragten Studie die Wirkungen des von Waveguard GmbH hergestellten Produkts *Qi-Shield* auf den Menschen auf psychologischer, psychophysiologischer und neurophysiologischer Ebene wissenschaftlich untersucht.

Mögliche physikalische und chemische Effekte des Produkts *Qi-Shield* sowie Aussagen des Herstellers zu Produktwirkweisen, wurden dabei nicht analysiert und blieben bei der Betrachtung insgesamt unberücksichtigt.

a) Das Ergebnis der Studie ist, dass unter festgelegten experimentellen Bedingungen keine nachweisbare Auswirkungen des Produkts *Qi-Shield* auf einer subjektiven psychologischen Ebene bezüglich Schlafqualität, Stress, Lebenszufriedenheit, Angst, Affekt, subjektives Wohlbefinden und Resilienz im Vergleich zu einer Placebo- und Kontrollbedingung nachzuweisen sind. Eine Korrelation in der Versuchsgruppe mit dem echten Gerät ergab eine bessere subjektiv wahrgenommene Schlafqualität für Teilnehmende, die angaben, das Gerät mit geringerem Abstand zum Körper positioniert zu haben und mehr Zeit in der Nähe des Geräts verbracht zu haben im Vergleich zu Teilnehmern derselben Gruppe, die das Gerät weiter entfernt positionierten und weniger Zeit in der Nähe des Geräts verbrachten.

b) Das Produkt *Qi-Shield* hatte keinen signifikanten Effekt auf psychophysiologischer Ebene im Vergleich zu einer Placebo- und Kontrollbedingung. Dies wurde in 24 Analysemodellen für die Hautleitfähigkeit und 20 Modellen für die Herzaktivität gezeigt.

c) Unter festgelegten experimentellen Bedingungen zeigt die Studie einen signifikanten Effekt des Produktes *Qi-Shield* auf der neurophysiologischen Ebene, dargestellt durch einen signifikanten Anstieg im Powerspektrum des frontalen Theta-Band in der Elektroenzephalographie während einer Ruhezustandsaufzeichnung im Vergleich zu einem nicht funktionierenden Placebo/Scheingerät und einer Kontrollgruppe. Die restlichen 64 ANOVA-Modelle, die Maße im EEG untersuchten, zeigten keine signifikanten Effekte des Produkts *Qi-Shield* im Vergleich zu einem nicht funktionierenden Placebo/Scheingerät und einer Kontrollgruppe.

Die Ergebnisse der Studie sind hier einzusehen:

Link zur Fraunhofer-Homepage für

1) eine kurze Zusammenfassung der Studienergebnisse

2) den vollständigeren Bericht über die Studienergebnisse in Form eines Präsentationsdecks

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