# UNIVERSITY OF TWENTE

## A Confirmatory Study about the Gender Differences in Psychological and Physiological Processes

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**Abstract**

**Background and Purpose:** Currently there is a lack of studies based in real life settings, regarding gender differences in psychological and physiological processes. The novelty of the current study lies in its continuous measurements, of seven days in a row, of physiological as well as psychological response in real life settings. The aim of this study is to shed light on whether there are statistically significant differences in those processes of men and women.

**Methods:** 38 participants were examined in an observational study. The wearable device E4 was used to measure the physiological process Electrodermal Activity (EDA). Psychological processes were measured with the application mQuest by which a survey about self-reported stress (SR-Stress) was conducted. For the analyses, the Mann-Whitney U test as well as the independent sample t-test were chosen.

**Results:** The current study found no statistically significant effect of gender on EDA or Stress.

**Discussion and Conclusion:** The current findings indicate that there are no differences in males and females regarding the examined physiological and psychological processes. Future research should focus on integrating a report of participants' activities, to relate findings to real life events; moreover follow-up measurements should be done to give more balanced results by correcting for temporary life stressors e.g. exam week vs. vacation time.

**Table of Contents**

## 1. Introduction

'Men are from Mars, Women are from Venus' (Grey, 1999) is one of the many books on the literature market stressing the difference between men and women. The author of the book goes to such an extent that he claims gender-specific characteristics must stem from two different planets of origin. Since the late 19th century however, there is an ongoing trend towards gender equality and less focus on the differences between the two sexes (Hausmann, 2009). Despite this movement, currently there is a lack of real life setting research regarding physiological and psychological gender differences, which results in uncertainty to what extend men and women differ in those process.

In order to shed light on the question of gender differences the current study aims to examine whether there are statistically significant differences in the physiological processes and psychological processes of men and women.

### 1.1. Physiological Processes

As an indicator for physiological processes, the Electrodermal Activity (EDA) can be monitored which refers to all electrical phenomena in skin. EDA is part of the autonomic nervous system which regulates physiological functions e.g. heart rate, blood pressure and ectodermal activity. When stimuli evoke arousal or the need for thermoregulation, this can for instance be regulated by the activity of the sweat glands which produce sweat e.g. EDA (Boucsein, 2012; Buijs, & Swaab, 2013). In the current study three variables of EDA are measured, namely skin conductance level (SCL), skin conductance response (SCR) and amplitude (AMP), to give answer weather to accept or reject the stated hypotheses (see Figure 1).[1]

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[1] Due to a lack of research specifically regarding gender differences in EDA, the following references on EDA were retrieved from the Classic-Book 'Electrodermal Activity' (Boucsein, 2012).
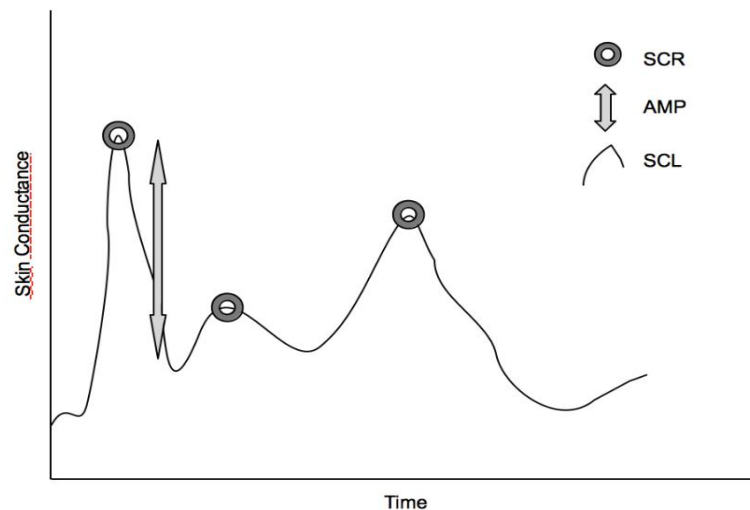
*Figure* 1. Example for Electrodermal Activity

**1.1.1. Skin conductance level**. SCL refers to the overall skin conductance level which changes more slowly over time in comparison with other variables like skin conductance response (Christie, 1981). In general the activity of the sweat gland is proportional to the skin conductance value, the higher the activity of the sweat glands, the higher the value or level of skin conductance (Garbarino, Lai, Bender, Picard, & Tognetti, 2005). Earlier research regarding gender differences and SCL found that males show a significantly higher SCL (Morimoto, 1978; Edelberg, 1971; Hare, Wood, Britain, & Frazelle, 1971). In general, this means that men have a greater bodily response to arousal than females concerning skin conductance.

**1.1.2. Skin conductance response.** SCR indicates that the skin shortly becomes a better conductor of electricity when aroused, represented by the peaks of EDA measurements (Boucsein, 2012). SCR therefore represents the more rapid change of electrodermal activity (Christie, 1981). Previous research found, that males display more SCR than females, which means that males show a reaction to presented stimuli easier than women, thus facing physiological stress more easily (Fowles, 1986).

**1.1.3. Amplitude.** Amplitude refers to the difference between a peak and a trough, the greater the difference, the greater the amplitude. Fowles (1986) stated that he observed a higher amplitude in females, which means that women tend to shift more extremely from peaks to troughs than men.

Taking these findings together, it can be said that previous research on gender differences on SCL and SCR showed a notion towards men scoring higher on both measures. Additionally men seem to have a general lower amplitude, which means that males in general show a greater arousal to presented stimuli but have less difference between the peaks and troughs than females.

## 1.2. Psychological Process

Arousal does not only lead to physiological but also to psychological reactions. If arousal is perceived in a specific situation, demands or challenges that accompany the situation might exceed personal capacities; if so, the individual perceives i.e. experiences stress (Cohen, Kamarck, & Mermelstein, 1983).  A measurement of a psychological process is therefore 'perceived stress' which can be measured through self-report (SR-Stress).

In previous research, it was found that women and men differ in reporting emotions with women being more comfortable of expressing those (Anderson, & Manuel, 1994). One study about gender differences focused on the relationship between having a balanced focus view regarding job, family and gender. A balanced-focus view is defined as preserving a balance between work and family obligations. It was found that having balanced-focused view led to less stress in general and that more men were using this view type than females (Li, Wu, & Johnson, 2018). Furthermore, it was found that self-efficacy was negatively correlated with the reported stress-level and that females in general show less self-efficacy and therefore more stress (Ye, Liu, & Posada, 2018). Additionally, Kaiseler, Polman and Nicholls (2012) found, that females would rate perceived stressors with higher stress-levels

than their male counterparts. However, the results of this study were obtained by a questionnaire the participant filled out in the presence of the researcher, which might have altered findings. Further, the mentioned studies were conducted with the purpose of examining gender difference of psychological stress, with most studies not measuring stress continuously.

Regarding self-reported stress, it therefore can be said that women in general are more likely than men to express stress to others.

## 1.3. The Current Study

The current study is, to the researcher's knowledge, rather innovative introducing continuous EDA and stress measurement for seven days in a row in a real life environment. This gives the unique possibility to study participants' physiological and psychological processes throughout their day. By measuring during the day for seven days, the great amount of data results in a more reliable analysis, since measurement errors get less significant. Furthermore, conducting the study under real life circumstances gives the advantage of obtaining results that have a high external validity. There is a lack of recent studies focusing on gender-specific differences in EDA which is why it is particularly interesting to stress this topic further. Despite the innovative set up of the study, the hypotheses are based on the previously introduced findings, since there is no reason to assume different outcomes.

The introduced findings regarding EDA stated that males have a higher SCL level as well as greater SCR (Morimoto, 1978; Edelberg 1971; Hare, Wood, Britain, & Frazelle, 1971). Based on these findings it is hypothesized that males will show greater SCL levels than females. Furthermore, it is hypothesized that males will show greater SCR levels than females. Finally, based on findings of Fowles (1986) it is hypothesized that men will show lower amplitudes than females.

Regarding stress, research states that women in general are more comfortable reporting emotions and therefore it can be assumed that stress will be more reported by females (Anderson, & Manuel, 1994). In accordance with this, most findings showed a tendency towards females experiencing, or at least reporting, more stress than males (Kaiseler, Polman, & Nicholls, 2012; Ye, Liu, & Posada, 2018; Li, Wu, & Johnson, 2018) This led to the hypothesis that women will report more stress than men.

## 2. Method

### 2.1. Participants

In the current study, the data of 44 participants was obtained through convenience sampling which was applied at two different moments of measurement. In 2017 the data of 21 participants was collected whereas in 2018, 23 participants were examined. The requirements to participate in the study were sufficient knowledge of the English language and owning a smartphone and a computer with an internet connection and a USB-Port. Participants were excluded if they did not, or could not e.g. due to technical errors, complete the entire experiment. In total six participants were excluded due to attrition, leaving 38 participants, for further data analyses. This research was approved by the Ethics Committee of the faculty of behavioral sciences of the University of Twente. More information on the participants of the current study is shown in Table 1.

Table 1.

*Group Statistics per Gender (Mean (M) age and Standard Deviation (SD); Age Range).*

| Gender | *N* Total | *N* Excluded | *M* Age (*SD*) | Age Range |
|--------|-----------|--------------|----------------|-----------|
| Men    | 18        | 1            | 21.76 (2.56)   | 19-27     |
| Women  | 26        | 5            | 22.04 (5.37)   | 19-45     |
| Total  | 44        | 6            | 21.92 (4.30)   | 19-45     |

*Note.* Information on mean age, standard deviation and age range, after exclusion of participants

## 2.2. Materials and Measures

The wearable device used in this study was the E4, measuring Blood Volume Pulse (BVP), Electrodermal Activity (EDA) and Skin Temperature (ST) (Garbarino, Lai, Bender, Picard, & Tognetti, 2005). For the current study, EDA was used as the physiological variable. EDA is measured by the E4 with a high range of values $(0,100)\mu S$ with a resolution of 900 picosiemens and a default sampling rate of 4Hz.

At the beginning of each data collection cycle, every participant received the E4, a charging cable and a Micro USB to USB cable for uploading the data and charging the device on a computer. The survey to measure the SR-Stress (see Appendix A) was filled in on the mobile phone of the participant. Therefore, the application mQuest was installed on the participants personal phone. The survey of the first run in 2017 contained four questions, two of which were about stress and the other two were about arousal. The survey was filled in every two hours on a Likert scale ranging from 0 to 10 regarding their emotions within the last two hours. The current survey contained two more questions, adding questions about valence, e.g. how pleasant they would rate their experience. Furthermore, the Toronto Alexithymia Scale (TAS-20) was filled in before and after the study. However, the data from the TAS-20 was not used in the current study since this study is a sub-study which does not

need the outcomes of the TAS-20 to answer the hypotheses.

## 2.3. Procedure and Design

The study was an observational study. The data collection took seven days per participant, whereby the physiological data was gathered through a wearable, measuring continuously physiological signals. For the psychological data, a fixed-time-based sampling method was used. During the first briefing, all participants had to read and sign an informed consent. Furthermore, participants had to fill in the TAS-20 and received the E4 with its gadgets as well as further instructions on uploading the data and using the mQuest application. Participants had to wear the device and answer the survey only while they were awake and had the opportunity to do so. The participants were asked to upload the data every night to their computer.

After seven days of data collection, the participants met with the researchers and returned the E4 with its gadgets. Finally, the participants filled in the TAS-20 and were invited to participate on a semi structured post-interview about the experiment and its burdens for further development of the study.

## 2.4. Analysis

Similar to Brouwer et al. (2018) Continuous Decomposition Analysis is used to calculate the mean tonic SCL and the number and mean peak amplitude of the skin conductance response (SCR) for every participant. Furthermore, the Data was checked for normal distribution by the means of the Shapiro-Wilk test and afterwards either the Mann-Whitney U test was conducted for non-normally distributed data, or an independent sample t-test was chosen for normally distributed data. In the case of gender differences in distribution also the non-parametric Mann-Whitney U test was chosen, since the median is used for calculation, and thereby the deviance from the mean or the differences between the means of the two groups

are neglected. In order to gain insight into the current data additional boxplots were created, thereby patterns and differences in the distribution of the data were made visible.

## 3. Results

Testing the normal distribution of the scores of SCL, SCR, AMP and SR-Stress per gender revealed that only scores of SR-Stress were normally distributed for both genders. In the case of SCL, SCR and AMP, either scores for both genders, or only one, were not normally distributed (Table 2).

Table 2.

*Results of the Shapiro-Wilk test on the normal distribution per gender of the*

*Variables SCL, SCR, AMP and SR-Stress*

| Variable | Gender | Statistic | df | *P* |
|---|---|---|---|---|
| SCL | Men | .59 | 16 | .000 |
| | Women | .80 | 20 | .001 |
| SCR | Men | .94 | 16 | .407 |
| | Women | .90 | 20 | .040 |
| AMP | Men | .75 | 16 | .001 |
| | Women | .83 | 20 | .006 |
| SR-Stress | Men | .90 | 16 | .090 |
| | Women | .95 | 20 | .396 |

*Note. p < .05 indicating a normal distribution of the investigated data*

Boxplots for men and women demonstrating their SCL, SCR and AMP scores (Figure 2 - 4) showed that in the case of AMP men's scores were more spread compared to women's, while in SCL scores no gender difference was apparent, and in the case of SCR women's scores seemed to be more spread out than men's.
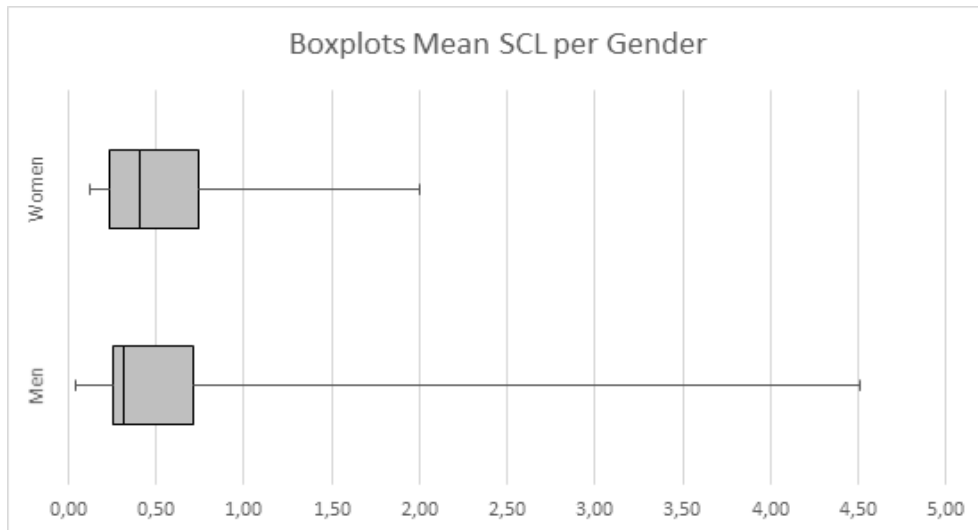


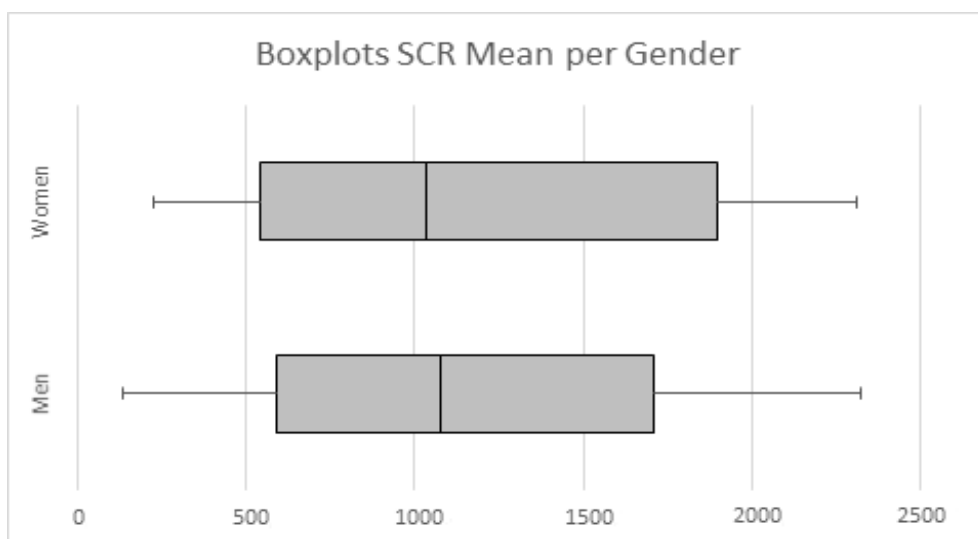*Figure* 2. Boxplots showing SCL Mean scores for men and women



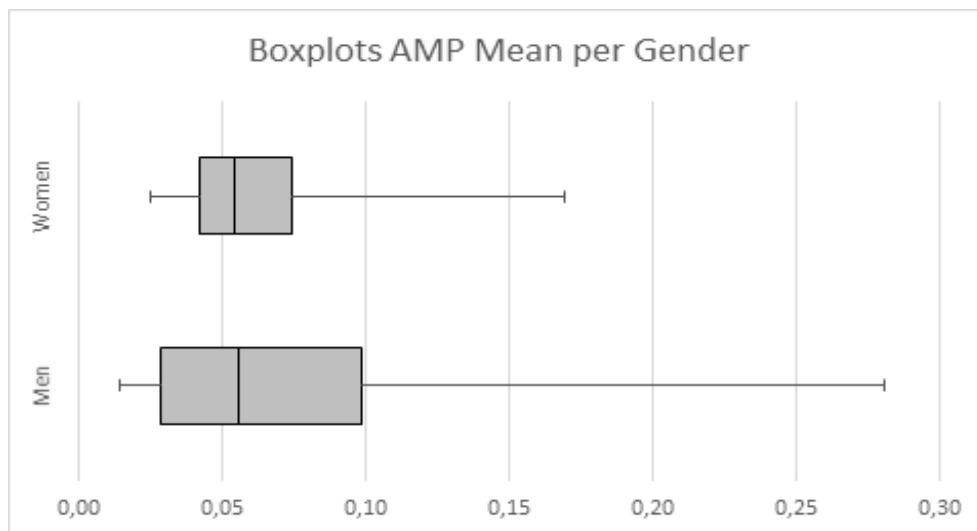*Figure* 3. Boxplots showing SCR Mean scores for men and women

*Figure* 4. Boxplots showing AMP Mean scores for men and women

Subsequently the Mann-Whitney U Test indicated that men and women did not significantly differ on the SCL, SCR or AMP (Table 3).

Table 3.

*Results of the Mann-Whitney U Test for SCL, SCR and AMP*

| EDA Variable | Mdn | | $U$ | $z$ | $p$ | $R$ |
|---|---|---|---|---|---|---|
| | Men | Women | | | | |
| SCL | .31 | .40 | 152 | -.26 | .814 | -.04 |
| SCR | 1074.18 | 1031.65 | 159 | -.03 | .987 | -.01 |
| AMP | .06 | .05 | 159 | -.03 | .987 | -.01 |

*Note.* $p < 0.05$

Visualizing the SR-Stress mean scores of men and women by the mean of boxplots (Figure 5) indicated that men and women scored quite similar, although the median of women is lower than the median of men's scores, the mean score is expected to be quite similar since both boxes do not seem to differ greatly.



*Figure* 5. Boxplots showing SR-Stress Mean scores for men and women

An independent samples t-test was conducted to compare the means of SR-Stress in men and women. There was not a significant difference in the scores of men (M = 4.23, SD = 1.90) and women (*M* = 4.03, *SD* = 1.69); *t*(36) = .36, *p* = .730.

## 4. Discussion

The aim of the current study was to examine whether there are statistically significant differences in the physiological and psychological processes of men and women. It was hypothesized that men will have a greater SCL as well as SCR level while women should reflect a greater AMP and SR-Stress level. Looking at the results, all hypotheses had to be rejected since no statistical significant effect of gender was found on the examined variables.

Looking at the graphics however, different patterns of distribution can be observed.

For SCL, the overall level of skin conductance response, no gender differences can be observed (Figure 2.); while for AMP and SCR the contrary has to be stated. In Figure 4 it can be seen, that the distribution in AMP for men is greater, which means there is more variance in the obtained data in relation to women. For SCR, women show a (slightly) greater distribution in relation to men, which is shown in Figure 3. Those differences in distribution are caused by individual differences i.e. outliers rather than group differences. For SR-Stress there is not much difference in distribution but in Figure 5 it is noticeable that most participants rated their stress levels rather low e.g. in the first half of the scale.

Looking back on the findings of previous research, the current findings were rather contrary to the researcher's expectations since the mentioned studies (Morimoto, 1978; Edelberg, 1971; Hare, Wood, Britain, & Frazelle, 1971; Fowles, 1986) did find significant effects of gender on all variables of interest for this study. The current study however, was done in a real life setting, gathering data continuously over seven days. This approach is rather new and innovative in comparison to the mentioned studies and could thereby have contributed to the dissimilar results. All previously mentioned studies regarding EDA were conducted before 1990 and measurement instruments got further developed over the years. Although the instruments measuring EDA were as precise as our devices of today, the execution of measurements were different. Similar to the other studies, Hare, Wood, Britain, and Frazelle (1971) for instance used Beckman cream to facilitate the measurement of EDA, since it contains NaCl ions which also appear as salt in sweat and therefore is expected to disturb the electrodermal measurement just to a small extent (Boucsein, 2012). The mentioned studies used one or both hands to measure EDA (Boucsein, 2012) which would be rather disturbing in a real life study, it can be assumed that those studies were laboratory studies in contrast to the current study where the EDA was measured with a wearable on the wrist. In 1990, measurement instruments were too big to be carried around and the

circumstance of sitting in a laboratory, attached to a big device, could have influenced the stress and EDA levels of the participants. This could explain the previously found higher outcomes of the measured variables. The wearable devices on the other hand can be easily disregarded in everyday life. Laboratory studies measure under perfect conditions e.g. adding specific stimuli to evoke reactions. However, the external validity of laboratory studies has to be questioned in some degree, since the conditions found in a laboratory are rarely similarly present in the real world. This is also reflected in the different outcomes comparing previous research with the current study. It might be that gender differences can be observed under laboratory conditions, but those differences cannot be observed under real life conditions. In addition to the real life setting, the data was gathered continuously seven days in a row which results in more data per person than by measuring just over several minutes or even hours. The more data available the less important the individual differences, and small measurement errors can be evened out. The large amount of data also compensates the fact that the current study, in general, had a rather small sample size of about 20 participants per gender.

In addition to the outcomes of EDA, also the results of stress measurement were contrary to the earlier mentioned literature. Ye, Liu, & Posada's study (2018) for instance also was conducted at a University which leads to the assumption, that the circumstances of theirs and the current study were quite similar. However, the main distinction to the current study lays in the time of measurement. Ye, Liu, & Posada measured stress twice a year, while in the current study stress was measured several times a day, seven days in a row. This could have led to different outcomes in stress measurements, since participants may rate their stress level different if they compare it to two hours ago instead of a year ago. Furthermore, the continuous measurements let the participant think more about their stress levels which also might have altered the rating. Anderson, & Manuel (1994) stated that females in general are more comfortable with expressing and reporting emotions. One of their arguments for this

statement is that it is not socially desirable for men to admit emotions linked with weaknesses in public. By using a survey, conducted on the personal phone, anonymity is increased and thereby this problem might have been bypassed.

In additional analysis another interesting outcome can be observed. Participants in 2017 in general reported less stress than participants in 2018.[2] While conducting the survey, participants had to rate their own stress levels on a scale from 0 to 10. To some participants it was not clear if '5' referred to the point of reference, with '6' meaning 'lightly stressed', or if '0' was supposed to be the reference point, meaning that '1' would be 'lightly stressed'. This could have several reasons, one of them being, that in 2018 a new question about valence, how pleasant their experiences were, was added to the survey. This question was the first whereby not pleasant experiences, were rated from '0' to '4' and pleasant experiences, were rated from '6' to '10', which made '5' a clear point of median reference. This could have led the participants to assume, that all questions have to be rated that way leading to a higher reported stress level in general.

Since there is a great body of research stating that there are differences in gender which could not be confirmed in the current study, this gives reason to stress this topic again in future research.

Before repeating the study a third time, it is advised to determine precisely how the scale of the questionnaire should be interpreted to avoid individual differences in answering the questions. Furthermore, a possibility to report activities could be useful to link the results of physiological or psychological data to real life activities. This could give greater insight into the underlying causes of physiological or psychological response. Additionally,

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[2] significant difference was found between gathered SR-Stress mean scores of 2017 and 2018 with scores of 2018 being significantly higher than 2017. See Appendix B for table 4.-6.

introducing follow up measurements after a specific point in time could give more balanced results by compensating for temporary life stressors e.g. exam week vs. vacation time.

Furthermore the topic of gender differences in reporting emotions could be stressed by conducting interviews about their stress levels with one group, while conducting a survey on the phone with another group. Since interviews cannot be conducted seven days in a row, every two hours, this would be a separate study with the main aim being, getting insight in gender differences in emotion reporting.

## 4.1. Conclusion

Through continuous measurements over seven days under everyday life circumstances physiological as well as psychological processes were examined to shed light on gender differences. Despite this permanent monitoring no differences, attributable to gender, could be found, which leads to the conclusion that men and women do not differ in those processes and therefore both stem from the same planet - Planet Earth.

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# Appendix

## Appendix A: mQuest Survey

*All questions were to be rated on a scale from 0 to 10.*

How intense were your emotions during the last two hours?

How much stress did you experience during the last two hours?

How pleasant was your experience during the last two hours?

**Appendix B: Additional Analysis Stress-level 2017/2018**

Table 4.

*Results of the Shapiro-Wilk test on the normal distribution per round of the SR-Stress.*

| SR-Stress Round | Statistic | df | *p* |
|---|---|---|---|
| 1 | .95 | 18 | .440 |
| 2 | .96 | 20 | .577 |

*Note. p < 0.05.* SR-Stress Round indicating the moment of data gathering, (1= 2017, 2=2018).

Table 5.

*Number of Participants (N), Mean (M) and Standard Deviation (SD) of their SR-Stress scores in round one and two.*

| SR-Stress Round | *N* | *M* (*SD*) |
|---|---|---|
| 1 | 18 | 2.51 (0.90) |
| 2 | 20 | 5.57 (0.81) |

Table 6.

*Results of the Independent-Samples t-test on the effect of gender on SR-Stress.*

| | *t* | df | *p* |
|---|---|---|---|
| SR-Stress | -11.05 | 36 | .000 |

*Note. p < 0.05*