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Emotional Breathing: Respiration patterns associated with emotions elicited by film-clips

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Abstract

Previous studies show the close relation between emotions and physiological parameters like respiratory responses. The aim of this experiment is to find differentiable patterns for the six basic emotions combining heart rate, respiratory patterns and facial expression. 70 subjects were investigated, affected by the emotions amusement, anger, fear, disgust, sadness, surprise and during a neutral state. The emotions were induced by short film-clips and tested with a questionnaire filled out by the participant. In addition facial electromyography (fEMG) data of the participants was collected while viewing the film-clips. The data for the breathing patterns were collected via a breathing belt containing a piezo element.

The results indicate a significant change in breath rate and heart rate and illustrate an affect-related respiratory response for disgust and amusement, as well as for anger and surprise. This confirms the hypothesis that different breathing patterns depend on the emotional states. These different emotional states can be perceived as a change of action tendencies and explained by fitness increase in an evolutionary context.

1. Introduction

The role of physiological states in emotions has been a controversial issue for a long time. According to James (1884) an emotion is the feeling responding to internal physiological changes which directly follow the perception of the exciting fact. It is not the physiology that follows the emotion but vice versa. We feel fear when running from a predator as a reaction to the increasing heart rate, breathing frequency etc. Cannon (1987) questions James' statement and suggests the physiological reactions are too slow and diffuse to induce emotions. He states that similar bodily changes were found during different emotional states and even a shot of adrenalin which alters the physiological condition, does not induce a change in emotion. Many studies have been dedicated to this contestation, e.g. Bloch and Santibanez-H. (1972) showed that during emotional activation, respiration and facial changes occurred which were distinctive for each emotional revival. They designated this correlation as the “emotional effector patterns”. Bloch and colleagues connected emotions with defined respiratory rhythms, the degree of muscle tension, relaxation, degrees of eye- and mouth opening and postural attitudes. For their experiment they advised actors to simulate these physiological parameters and found out that the participants adapted to the played emotions. Their behaviour changed from a “robot-like” stage to a more natural one, inducing the emotion their are supposed to play. Santibanez-H. and Bloch (1986) concluded that on the one hand the emotional stimulus activated bodily reactions -confirming Cannon's theory (1929), on the other hand the feedback generated by these patterns activated feelings, which militates in favour of James' theory (1884).

This discussion gives an interesting basis for research on the nature of emotions and their origins. There are different methods of inducing emotions: Film-clips (Gomez, 2005; Boiten, 1998),

pictures (Gomez 2004, Danuser-Nideröst 2001) and predominantly, reproduction of memories (Hess, 2001; Bloch, 1992; Philippot, 2002; Rainville, 2006). In this case participants imagine a situation in which they felt an intense emotion in the past and try to reproduce it, sometimes under hypnosis (Dudley, 1964; Bloch, 1991). The specificity and number of emotional states investigated can be limited to valence and arousal (Gomez, 2004; Gomez, 2005; Danuser-Nideröst 2001), increase to a wider range like joy, anger, sadness, fear, disgust, amusement, tenderness, suspense, relaxation, depression (Hess, 2000; Philippot, 2002; Rainville, 2006; Boiten, 1998; Dudley, 1964) or include expressions like crying and laughing (Bloch 1991, Bloch, 1992).

An established parameter of identifying emotions and tension is EMG dissipation. Usually facial EMG (fEMG) is used to detect the extent and type of facial expression via activity of muscles like corrugator, levator, zygomaticus, frontalis, orbicularis oculi, masseter (Gomez, 2005; Rainville, 2006; Hess, 2001). As already manifested in many studies, the face expresses emotions very accurately and acts a communicative role in interpersonal relations (Mahyar et al. 2011). It is essential to rate a person's intention and predict his/her behaviour when living in a social group. The necessity of recognizing someone's emotional state made us sensitive to facial expressions.

Respiration can be measured with various instruments e.g. Pneumotachograph, yet commonly breathing belts are used to investigate breathing patterns. Results suggest that with increasing arousal, inspiratory time and total breath duration shorten and mean inspiratory flow, minute ventilation and thoracic breathing increases (Gomez 2004). Danuser-Nideröst (2001) found a longer inhalation time and a decrease in inhalation flow with increasing valence, where as Gomez (2005) did not find any influence of valence on respiration. In order to specify emotions and their correlation to physiological changes, this work investigates the emotions amusement, anger, fear, disgust, sadness and surprise. Our hypothesis states that for each emotion a specific

respiratory pattern can be assigned, accompanied by specific facial muscle contraction and different heart rates.

2. Methods

2.1. Participants

The participants were 99 volunteers (49 males and 50 females) with an average age of 25.73 years, ranging from 18 years to 61 years. They were recruited on campus, the criteria for taking part in the study was German as mother language.

2.2. Film clips

To induce the emotions anger, fear, disgust, surprise and sadness, participants were shown short film-clips that were chosen after Rottenberg's suggestions (2007) and cut according to his instructions. Yet the highest recommended clip for the emotion amusement does not exist in a German version, which forced us to use a non validated alternative, a clip showing a laughing baby. We decided to take this clip as it does not appeal to a specific type of humour. The movies are publicly available and the cut clips vary in length between 30 seconds and 4 minutes (table1). In addition a seventh film clip was presented that was expected to be emotionally neutral, to be used as a baseline. The seven clips were presented on a 55 inch LCD screen with a distance to the participant of 1.25m and were played with German sound in random order. Table 1 shows the validation for the single film-clips (see 2.4). Participants rated the target emotion of each clip higher than the other emotions (e.g. amusement for the amusement clip) except the fear clip for which surprise and disgust are slightly higher. Aside from this, our results suggest that the film-clips elicited the expecting emotions.

Emotion	Film	Length of clip	Amusement	Anger	Disgust	Fear	Sadness	Surprise
Neutral	„Sticks Screensaver“ (youtube)	00:03:26	0.82 (1.26)	0.74 (1.53)	0.05 (0.28)	0.26 (1.05)	0.14 (0.73)	1.07 (1.71)
Amusement	„baby laughing“ (youtube)	00:01:40	**5.45 (2.26)**	0.12 (0.64)	0.14 (0.81)	0.43 (1.34)	0.14 (0.73)	1.12 (1.89)
Anger	„Cry Freedom“	00:02:31	0.83 (1.63)	**5.58 (2.32)**	2.82 (2.88)	1.99 (2.29)	4.85 (2.63)	2.3 (2.39)
Disgust	„Pink Flamingos“	00:00:49	2.13 (2.36)	0.72 (1.59)	**6.44 (2.16)**	0.43 (1.22)	0.47 (1.35)	4.39 (2.73)
Fear	„Silence of the lambs“	00:03:37	1.74 (2.09)	2.18 (2.73)	**3.26 (2.56)**	3.12 (2.46)	2.03 (2.86)	3.23 (2.52)
Sadness	„Return to me“	00:04:00	2.3 (2.23)	0.83 (1.61)	0.29 (0.87)	1.43 (2.06)	**5.65 (2.26)**	3.96 (2.50)

Table 1. List of emotions, films and length of respective clips. Validation for each emotion rated with a scale from 0 (not at all/none) to 8 (extremely/a great deal): mean (standard deviation), bold= highest value of the movie.

2.3. Physiological parameters

Facial EMG was used to measure the intensity of muscle contraction during the film-clips. Electrode placement and adjustments were chosen according to the Guidelines for Human Electromyographic Research by Fridlund and Cacioppo (1986) (figure 1). In the beginning the relevant parts of the face were cleaned with abrasive gel and 70% Isopropyl alcohol to increase the conduction of the skin. 9mm gold electrodes (MLAWBT9 EEG Flat Electrodes, ADInstruments) were filled with conduction gel and attached to the left side of the face via adhesive tape. The following muscles were chosen: M. corrugator supercilii major, M. frontalis, M. levator labii superioris alaeque nasi and M. orbicularis oculi. According to the Facial Action Coding System (Investigator's Guide) of Ekman and colleagues (2002), this combination of activity of facial muscles covers the representation of the six basic emotions. The range of the collected data was set to 500 µV with a sampling rate of 1 kHz. To reduce noises we set the notch filter to 50 Hz and added a high pass filter at 10 Hz and a low pass filter at 1 kHz, as suggested by Fridlund and Cacioppo (1986). In addition participants were filmed with a web cam (Logitech HD Pro Webcam) that was placed underneath the screen in order to record movements that influence the physiological data. In order to measure the respiration patterns we used a breathing belt (MLT 1132 Piezo Respiratory

Belt Transducer, ADInstruments) that was placed right underneath the Sternum. To measure the heart rate, we used a heart frequency sensor (SP0180 Polar Transmitter) which was connected to the receiver (MLAC35IST Polar Receiver Interface Cable, ADInstruments) via Bluetooth. It was placed around the chest, above the breathing belt and directly attached to the skin. The data were collected by two Dual Bio Amps (ADInstruments) and passed on to the PowerLab 8/35 (ADInstruments). For digitizing and saving the data we used the software LabChart 7 (ADInstruments).

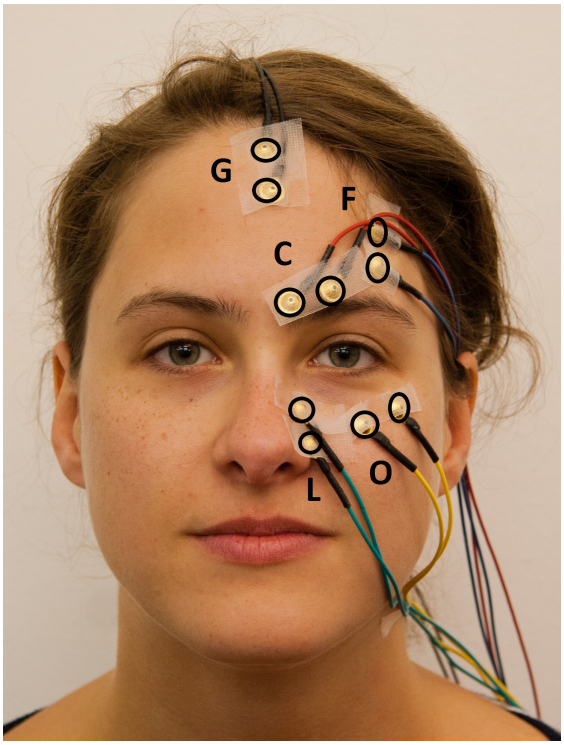

Figure 1. Electrode placement on the four muscles C= corrugator, L= levator, O= orbicularis, F= frontalis and G= grounding.

2.4. Questionnaires and Cognitive task

The post-film questionnaire was used to determine the emotional state of the participants during the single film-clips. Participants rated 18 different emotions from 0 (not at all/none) to 8 (extremely/a great deal). This questionnaire is recommended by Rottenberg (2007) and published

in the book “Handbook of Emotion Elicitation and Assessment”. After the questionnaire, participants had to solve an easy cognitive task, the Stroop test. The cognitive task acts as a non emotional distractor, avoids a carry over effect and reduces the participants self-consciousness (Rottenberg, 2007). The questionnaire and cognitive task were worked on manually.

2.5. Design and Procedure

For synchronizing and transforming the data, a virtual emotion presenter program was written by Karl Grammer (see figure A in appendix). Before the session started, the procedure of the experiment was explained to the participants who then signed a consent form. Yet the purpose of the experiment and the exact measurements were not mentioned to avoid participants influencing the results consciously or unconsciously, as especially breathing behaviour and face muscle contractions can be controlled voluntarily. After this the heart frequency sensor, the breathing belt and the EMG electrodes were attached to the participants. For the rest of the experiment, the participant sat on a chair in front of the screen separated from the experimenter by a dividing wall (figure 2). The dividing wall was placed laterally and behind the participants to create a secure environment and decrease the feeling of being observed. In addition there was less distraction so that the participant could concentrate fully on the film-clips. The program started with a 35 sec. rest period (black screen) to allow the participant to calm down and acclimatise to the situation. Subsequently the first film-clip was played, with a 35 sec. break afterwards (black screen). Only during the film-clip and the first break data was recorded and the participant was filmed in order to record movements like coughing and sneezing causing artefacts in the data. Then the time for filling out the questionnaire and the cognitive task started and was terminated by the experimenter when the participant finished. Afterwards there was a second break of 35 sec.

(black screen) for the participant to calm down before the next film-clip started. This procedure was run through 7 times with different film-clips shown in random order. At the end of the experiment participants were asked whether they actively/consciously controlled their breathing or face muscle activity during the film-clips and the breaks. In the end the aim of the experiment was explained to the participants.

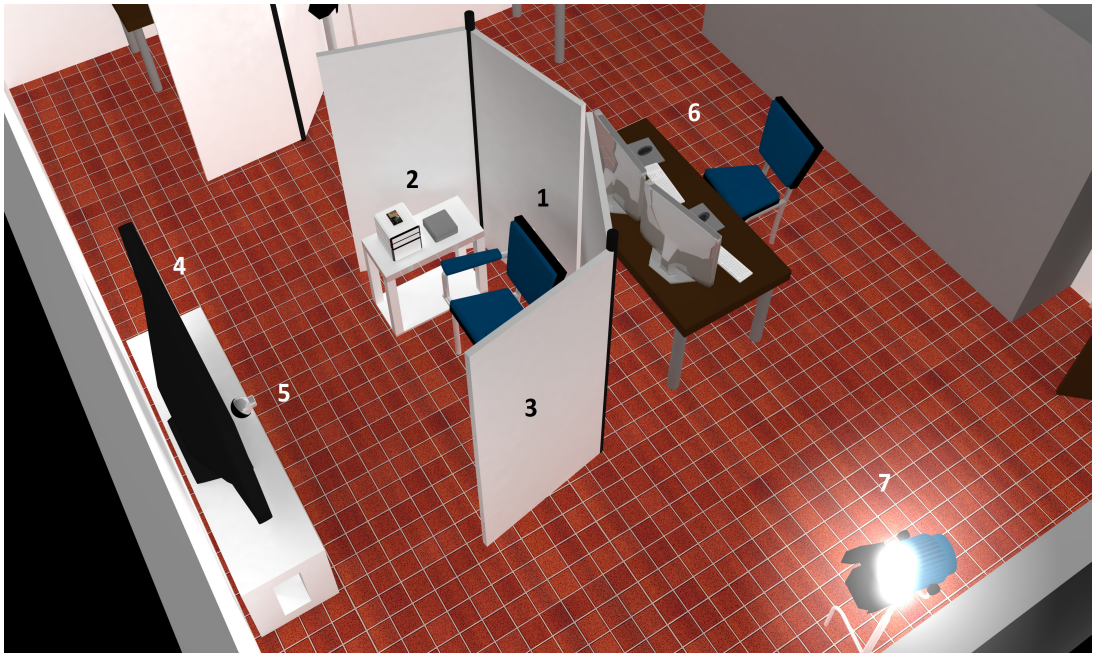

Figure 2: Setup of the experiment. 1= chair for the participant, 2= PowerLab, BioAmp and arduino board, 3= dividing wall, 4= LCD Screen, 5= web cam, 6= control station, 7= lights.

2.6. Data reduction

Not all of the data could be used due to equipment and recording errors, movement artefacts (like coughing, yawning), contained breathing (stated by the participants) etc. Finally we used the data of 70 participants for the emotions Anger, Fear and Sadness, 71 participants for Disgust and Surprise and 72 participants for Amusement. For the multivariate test only 57 participants were included which contained all 7 movies.

2.7. Processing of the data

The computed program transformed the data into time series, tagged all minima and maxima from each curve (figure B in appendix) with a frequency of 700 data points per window and a blurring of the curve with a Gaussian smoothing of 500. In addition the curves were inverted from the negative to the positive according to Fridlund and Cacioppo (1986). The curve calculations were computed after Grammer (1999) and Koppensteiner (2009). The different variables of the heart were calculated from curves consisting of the different heart rates at a time. Subsequently the following parameters were calculated for the heart: Heart rate, speed total which refers to the mean speed of change in heart rate, speed on which applies to the speed of increase in heart rate, speed off which refers to the speed of decrease in heart rate, amplitude total which applies to the mean extent of change in heart rate, amplitude on which refers to the extent of increase of heart rate and amplitude off which applies to the extent of decrease of heart rate. In addition the turbulence was calculated which refers to the irregularity of change in heart rate. The respiration parameters were calculated from the breathing curves at which speed total applies to the mean speed of inspiration and expiration, speed on refers to the speed of inspiration and speed off applies to the speed of expiration. Amplitude total stands for the total mean respiration volume, amplitude on applies to the volume of inspiration and amplitude off to the volume of expiration. The turbulence refers to the irregularity of the respiratory curve. In addition the electrical activity of the four face muscles were calculated. In the next step the data of each participant and film were divided into three parts, of which only the second part (the last 35 sec. of the film-clip) was analysed, for some time is necessary to build up the emotion and to give an insight in the story. An exception is the amusement film-clip. In this case participants' emotions decreased with time as there is no change in the story line. For the amusement data we used the

first part of the film-clip.

2.8. Statistics

We used a Multivariate test (repeated measurement MANOVA) to review the correlation within the parameters and Paired t-Tests to compare the differences in physiological parameters elicited by emotions to the neutral condition. The results used for all graphs and table 2 were z-scored.

3. Results

3.1. Descriptive Statistics

The participants showed a mean heart rate of 75.388 beats/minute(bpm) (male = 74.449 bpm, female = 76.327 bpm) with a standard deviation of 12.991 bpm (male = 12.236 bpm, female = 13.746 bpm) and a breath rate of 17.806 breaths/min (m = 16.663 breaths/min, f = 18.948 breaths/min) with a standard deviation of 5.386 breaths/min (m = 5.793 breaths/min, f = 4.943 breaths/min). These results describe the neutral condition.

3.2. Facial Expression

A multivariate test yielded a significant effect of the emotional stimuli on the muscle activity. Wilk's Lambda = 0.065, $F(24, 33)= 19.646$, $p< 0.001$, $\eta p= 0.935$. According to Mauchly's test of sphericity, sphericity could not be assumed for the activity of the four muscles. This is why we chose the Greenhouse Geisser test which obtained significant effect for all four muscles individually. Corrugator: $F(3.310, 185.374)= 36.371$, $p< 0.001$, $\eta p= 0.394$, frontalis: F(2.908,

162.863)= 21.887, p< 0.001, ɲp= 0.281, orbicularis: F(2.606, 145.928) = 55.251, p< 0.001, ɲp= 0.497, levator: F(2.819, 157.842)= 66.319, p< 0.001, ɲp= 0.542. The following paired t-Tests show the results of the comparison of facial muscle activity between the respective emotions and the neutral condition. The activity of corrugator differs significantly from the baseline activity in the neutral condition for every elicited emotion (amusement and sadness p= 0.002, anger, fear, disgust and surprise p< 0.001). The activity of frontalis is significantly higher for amusement, disgust and surprise, as does the activity of orbicularis with p< 0.001 for all. Levator activity is significantly higher for amusement, anger, disgust and surprise with p< 0.001 for all emotions. Except for corrugator, non of the muscles show a significant change in activity for fear and sadness compared to the neutral condition.

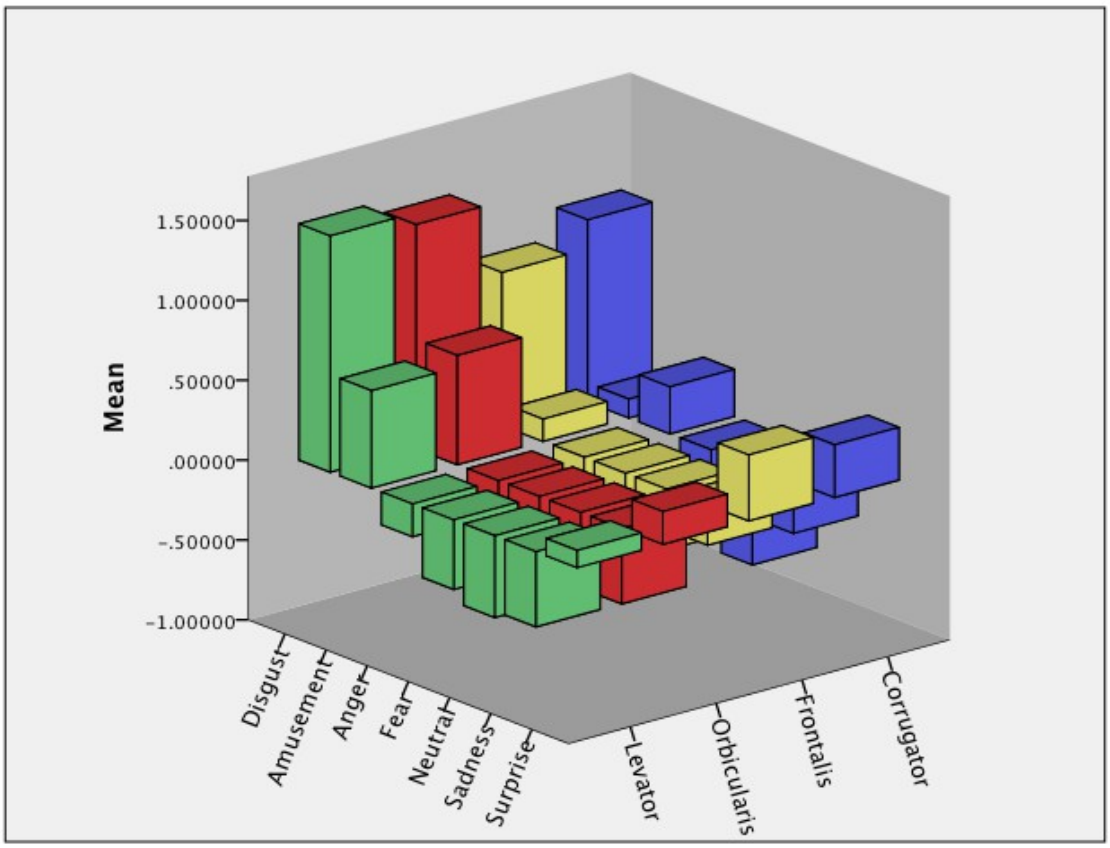

Figure 3: The z-scored data as mean of the muscles activity of frontalis, corrugator, levator and orbicularis for the emotions anger, fear, disgust, amusement, sadness and surprise.

3.3. Respiration Parameter

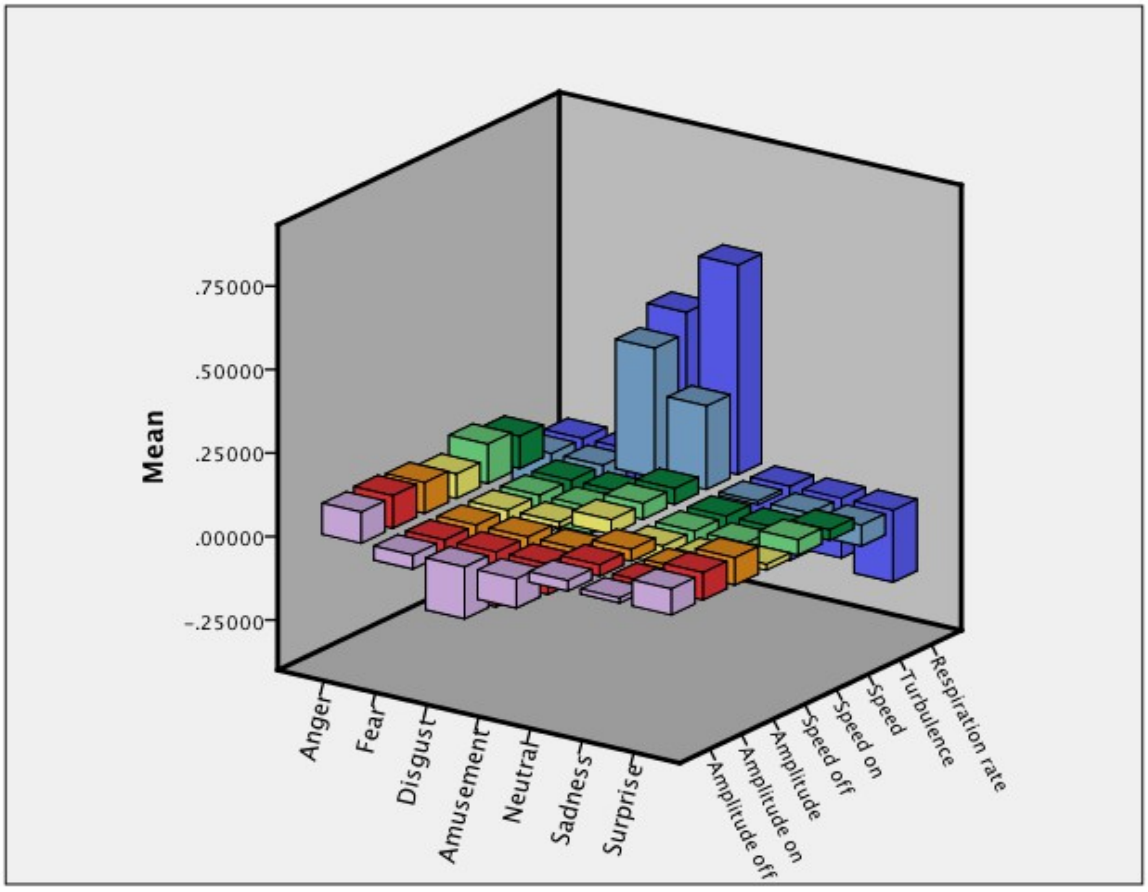

Figure 4: The z-scored data as mean of the dependent variables: Respiration rate, speed total (speed), speed on, speed off, amplitude total (amplitude), amplitude on, amplitude off and the turbulence for each of the emotions anger, fear, disgust, amusement, sadness and surprise.

A multivariate test yielded a significant effect of the emotional stimuli on the respiration parameters: Wilk's Lambda = 0.110, $F(43, 14)= 2.634$, $p= 0.026$, $\eta p= 0.102$. According to Mauchly's test of sphericity, sphericity could not be assumed for any of the dependent variables except for turbulence. This is why we chose the test for assumed sphericity for the respiration turbulence and the Greenhouse Geisser test for the residual parameters. Significant effect was obtained for respiration rate $F(4.780, 267,691)= 14.008$, $p< 0.001$, $\eta p= 0.200$ and turbulence $F(6, 336)= 4.577$, $p< 0.001$, $\eta p= 0.076$. The other parameters did not show significant effects. The following paired t-

Tests show the results of the comparison between the respective emotions and the neutral condition. Compared to neutral the respiration rate is significantly higher for amusement $p < 0.001$ and disgust $p < 0.001$, it is lowest for surprise. The total respiration speed is significantly higher for anger $p = 0.009$ and amusement $p = 0.020$ and is lowest for sadness. The speed of inspiration is significantly higher for anger $p = 0.012$ and amusement $p = 0.024$ and lowest for disgust. The speed of expiration is significantly higher for anger $p = 0.015$ and amusement $p = 0.026$ and is lowest for fear. The total respiration volume including the volume of inspiration and expiration are significantly lower for disgust $p = 0.032$, $p = 0.025$, $p = 0.042$, respectively and highest for surprise, yet not in a significant manner. The respiration turbulence is significantly higher for amusement $p = 0.001$, disgust $p = 0.006$ and significantly lower for anger $p = 0.037$ (table 2).

3.4. Heart Rate

A multivariate test yielded a significant effect of the emotional stimuli on the heart parameters. Wilk's Lambda = 0.124, $F(43, 14) = 2.297$, $p = 0.047$, $\eta p = 0.162$. According to Mauchly's test of sphericity, sphericity could not be assumed for the heart parameters, except for turbulence. This is why we chose the test for assumed sphericity for the heart turbulence and the Greenhouse Geisser test for the residual parameters. Significant effect was obtained for heart rate $F(4.923, 275.662) = 6.534$, $p < 0.001$, $\eta p = 0.104$ and turbulence $F(6, 336) = 3.184$, $p = 0.005$, $\eta p = 0.054$. The other parameters did not show significant effects. The following paired t-Tests show the results of the comparison between the respective emotions and the neutral condition. Viewing the disgust, anger and surprise movies was accompanied by a heart rate significantly different to neutral: $p < 0.001$, $p = 0.018$, $p = 0.006$ respectively. The results are negative, meaning lower than the neutral condition. During the amusement clip participants heart rate increased, yet not in a significant

manner. The physiological change for fear is positive, yet varies only slightly from that of the neutral state. During the sadness clip the heart rate decreased, neither enough to cause a significant change. The amplitude on differed significantly in anger p= 0.041. Disgust and amusement show differences in turbulence, p=0.003, p<0.001 respectively (table 2).

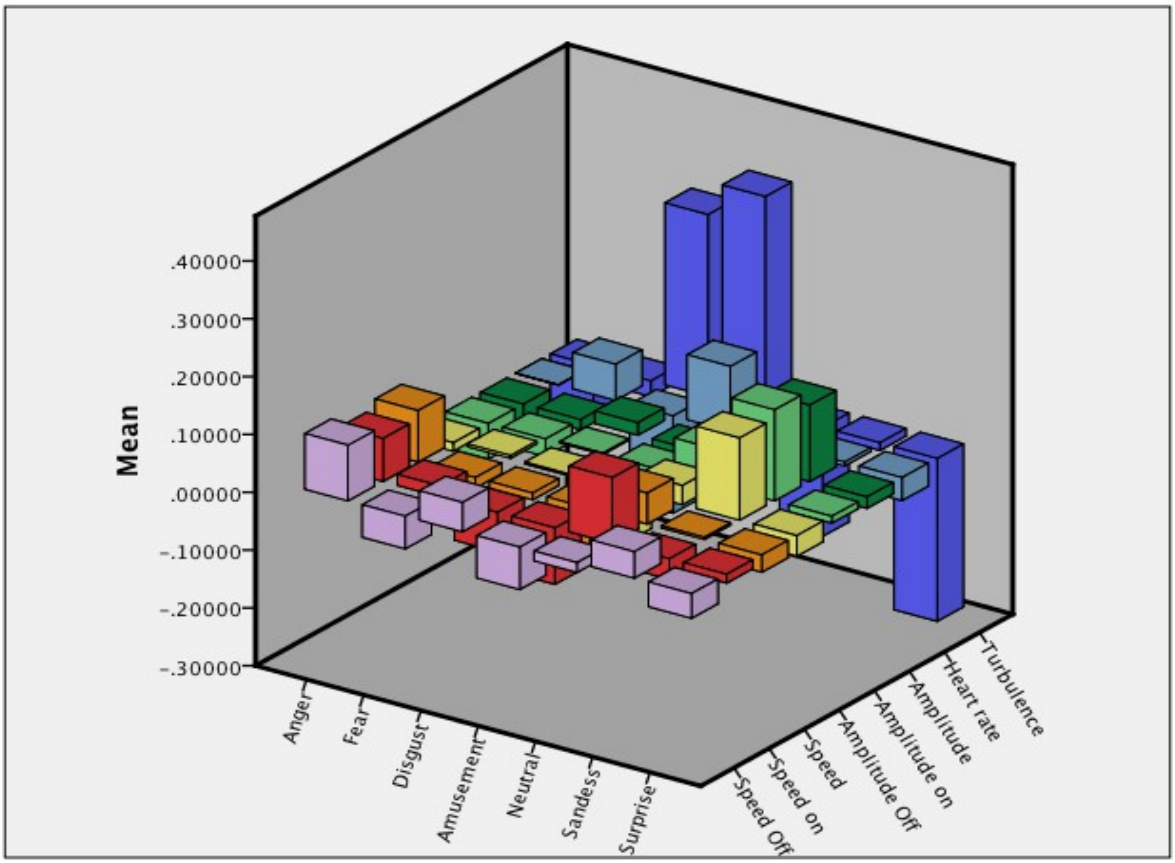

Figure 5: The z-scored data as mean of the dependent variables: Heart rate, speed total (Speed), speed on, speed off, amplitude total (Amplitude), amplitude on, amplitude off and the turbulence for each of the emotions anger, fear, disgust, amusement, sadness and surprise.

Table 3 illustrates the different patterns of the parameters that reached significant results for the multivariate as well as for the paired t-test. The four parameters show a different combination of increase, decrease or no significant change for each emotion compared to neutral, except for fear and sadness.

	Parameters	Anger	Fear	Disgust	Amusement	Neutral	Sadness	Surprise
	Respiration rate	-0.052 (0.913)	-0.110 (0.903)	0.450 (1.039)	**0.627 (0.753)**	-0.222 (1.127)	-0.179 (1.015)	-0.215 (0.900)
	Speed	**0.096 (1.151)**	-0.054 (0.884)	-0.046 (1.036)	0.047 (0.911)	-0.061 (0.958)	-0.071 (0.846)	0.031 (1.067)
	Speed on	**0.117 (1.228)**	-0.038 (0.913)	-0.079 (0.996)	0.047 (0.911)	-0.062 (0.983)	-0.067 (0.848)	0.046 (1.039)
Respiration	Speed off	**0.073 (1.076)**	-0.063 (0.865)	-0.017 (1.048)	0.043 (0.907)	-0.056 (0.917)	-0.069 (0.860)	0.017 (1.105)
	Amplitude	**0.092 (1.157)**	-0.040 (0.837)	-0.157 (0.889)	-0.090 (0.730)	0.035 (1.055)	0.013 (0.947)	0.081 (1.147)
	Amplitude on	**0.097 (1.152)**	-0.039 (0.832)	-0.164 (0.878)	-0.091 (0.727)	0.033 (1.050)	0.014 (0.951)	0.082 (1.156)
	Amplitude off	**0.093 (1.163)**	-0.042 (0.834)	-0.155 (0.876)	-0.087 (0.727)	0.031 (1.047)	0.015 (0.950)	0.078 (1.148)
	Turbulence	-0.231 (0.982)	-0.136 (0.918)	**0.387 (1.056)**	0.250 (0.827)	-0.010 (1.099)	-0.050 (0.936)	-0.062 (0.914)
	Heart rate	0.000 (0.988)	0.062 (1.033)	-0.169 (0.977)	**0.112 (1.065)**	0.040 (0.999)	-0.006 (1.022)	-0.039 (1.018)
	Speed	**0.089 (1.129)**	-0.018 (0.838)	-0.011 (0.968)	-0.092 (0.761)	0.053 (1.304)	0.004 (0.797)	-0.030 (0.965)
	Speed on	0.074 (1.064)	0.019 (0.904)	-0.068 (0.884)	-0.098 (0.754)	**0.114 (1.356)**	-0.035 (0.796)	-0.015 (0.948)
Heart	Speed off	**0.096 (1.208)**	-0.056 (0.773)	0.051 (1.059)	-0.073 (0.768)	-0.017 (1.189)	0.046 (0.825)	-0.043 (0.974)
	Amplitude	-0.051 (1.097)	-0.018 (0.988)	0.021 (0.931)	-0.034 (0.808)	0.046 (1.077)	**0.132 (0.970)**	-0.020 (1.023)
	Amplitude on	-0.061 (1.058)	-0.030 (0.973)	0.002 (0.909)	-0.035 (0.777)	0.062 (1.121)	**0.158 (1.012)**	-0.012 (1.032)
	Amplitude off	-0.014 (1.105)	0.005 (0.956)	-0.003 (0.921)	-0.093 (0.729)	0.033 (1.121)	**0.142 (1.010)**	-0.036 (0.989)
	Turbulence	-0.091 (1.032)	-0.027 (1.083)	0.315 (0.989)	**0.373 (0.725)**	-0.188 (1.044)	-0.013 (0.918)	-0.282 (0.823)
	Corrugator	0.294 (0.826)	-0.364 (0.468)	**1.142 (1.422)**	0.118 (0.472)	-0.621 (0.366)	-0.324 (0.636)	0.330 (1.002)
	Frontalis	-0.219 (0.749)	-0.415 (0.567)	**0.959 (1.596)**	0.139 (0.577)	-0.380 (0.474)	-0.251 (0.532)	0.413 (0.992)
Muscles	Orbicularis	-0.399 (0.384)	-0.387 (0.383)	**1.405 (1.619)**	0.685 (0.880)	-0.482 (0.354)	-0.473 (0.422)	0.204 (0.666)
	Levator	-0.205 (0.661)	-0.435 (0.346)	**1.480 (1.442)**	0.610 (0.700)	-0.512 (0.313)	-0.471 (0.490)	0.107 (0.762)

Table 2: The z-scored means of the dependent variables: heart rate, respiration rate, speed, speed on and off, amplitude, amplitude on and off and turbulence for heart and respiration, for the emotions anger, fear, disgust, amusement, sadness and surprise: Mean (standard deviation).

Parameters	Anger	Fear	Disgust	Amusement	Sadness	Surprise
Respiration rate	→	→	↑	↑	→	→
Resp. Turbulence	↓	→	↑	↑	→	→
Heart rate	↓	→	↓	→	→	↓
Heart Turbulence	→	→	↑	↑	→	→

Table 3: Overview of increase → decrease ↓ and no significant change → in respiration and heart results compared to neutral.

4. Discussion

4.1 Samples

According to Faller (1984) the mean heart and breath rate for healthy adults move towards 70 beats per minute and 15 breaths per minute respectively. The results of our participants are slightly higher which can be attributed to the unusual situation (equipped with machinery) and the slightly uncomfortable circumstances.

4.2. Facial Expression

A non-verbal way of displaying emotions is via facial muscle contraction. In our results evidence for change in facial expression was found for all emotions, yet the results do not match with Ekman's Facial Action Coding System (2002) see table 4.

Emotion	this study	Ekman
Anger	C L	C O L
Fear	C	C F
Disgust	C F O L	L
Amusement	C F O L	O
Sadness	C	C F O
Surprise	C F O L	C F O L

Table 4: Comparison between muscle activity of Ekman's and this study during emotions. C= corrugator, F= frontalis, O= orbicularis, L= levator.

Ekman (2000) suggests that while being angry corrugator, orbicularis and levator are active, yet he states that the emotion can also occur without any one of these 3 muscles. While being disgusted he states that the levator is active, during fear corrugator and frontalis and while being amused the orbicularis is activated. When being sad corrugator, orbicularis and frontalis are contracted, when

being surprised it's only frontalis. Yet the data of our study coincides with the results of Hess's work about facial mimicry, emotional contagion and decoding accuracy (2000). During the film-clips inducing sadness and anger the corrugator activity is highest, following levator activity with a lowest contraction of orbicularis. During amusement, orbicularis activity is highest, following levator activity and the lowest activity of orbicularis. Disgust caused the most intense reaction of our participants regarding facial expression. Oaten et al. (2009) states that the expression of being disgusted is universal and is expressed and understood by people blind and deaf from birth. As already manifested in many studies, our face expresses emotions very accurately and acts a communicative role in interpersonal relations (Mahyar et al. 2011). It is important to rate a person's intention and predict one's behaviour when living in a social group. The necessity of recognizing someone's emotional state made us sensitive to facial expressions. The best example is the “Duchenne-smile”, established by Ekman (1990). It arises from the French anatomist Duchenne de Boulogne who stated that only true feelings activate the zygomaticus major and the orbicularis oculi in combination. The person lifts not only the corner of the mouth but also contracts the muscle underneath the eye. Without the activation of the orbicularis oculi, which is involuntary, it is only a fake smile. Without even knowing this gives us the impression of a real smile and lets us know that our counterpart is of positive intention, which is very important for the social life in groups. However, our results and comparisons to other works suggest that facial expression might not be as determined as assumed and is influenced by individual character and non verbal expression generally.

4.3 Physiological Patterns

Emotions can be perceived as a change of action tendencies (Frijda, 1986). This indicates

physiological changes in the individual for an increase of one's fitness. Cosmides and Tooby (2000) state that the perception system will be programmed according to the present emotion and for instance increases the sensitivity of senses.

Anger: According to Buss (1999) anger evolved towards cheaters to punish them for violating social contracts and avoid repetitions of wrong behaviour. Haidt and Sabini (2000) illustrate that participants of their study rated endings of Hollywood films most satisfying when the cheater was punished in the end. The "recalibration theory of anger" (Sell et al., 2009) says that anger increases the value of the issue the angry person intends to improve. His study suggests that in women attractiveness and in men strength increased the probability of being angry. This suggests that physical strain plays an important role in improving one's situation with anger, which goes with our results for respiration speed.

Fear: According to Marks (1987) fear is the unpleasant feeling that occurs when faced with a realistic danger. Bracha (2004) and Marks (1987) described six different ways of reacting to fear and coping with danger: Freezing, fleeing, fighting, submission or appeasement, fright or faint. Freezing is a successful first reaction to concentrate and analyse the situation of one's circumstances. Running without knowing the enemy and its position might be counterproductive. Bracha (2004) concludes that this state of „stop, look and listen" succeeds as most mammalian carnivores and to a lesser extend male humans rather detect moving objects than colours. These circumstances can be compared with the situation of our fear movie. The protagonist is walking through several rooms and corridors of a cellar, searching for the murderer. The participant is not „eye in eye" with the enemy but rather searching for him. The situation requires high concentration and sensitive senses instead of strength to fight, which goes along with the participants report of feeling excitement during the movie. This state of freezing when facing a

danger could be an explanation for the low impact on the physiological parameters. In addition it has to be metioned that fear was not rated highest for this movie, one reason might be the high recognition value of the movie. The fact that in Rainville's experiment (2006) the emotion fear was felt to a lower extend than the other target emotions, suggests that fear is difficult to induce in the laboratory.

Disgust: According to Rozin (1996) body waste and especially faeces cause the strongest feeling of disgust which is due to the toxins and parasites making faeces harmful to humans (Buss 1999). After the „disease avoiding hypothesis“ this should be the case especially for disease causing substances cross culturally. Rozin's study (1996) illustrates that Americans as well as Japanese rated faeces and other body waste the most disgusting substances. This explains the intense reactions to our disgust movie which shows a women eating fresh dog faeces. The physiological behaviour of the participants indicate the avoidance of taking deep breaths and inhaling possible harmful substances.

Amusement: According to Schwab (2004) contentment arises in save situations, is characterized by inactivity and does not result in specific tendencies of action. He states that positive emotions generally increase attention and serve the improvement of physiological and intellectual as well as social resources and with it the own fitness. In our experiment participants showed intense physiological reactions to the amusement movie, yet in this case it has to be distinguished between contentment and amusement in the sense of laughing. According to Bloch (1991) tenderness results in regular and even breaths compared to laughing which causes sharp and rapid answers in breathing. The latter can be compared with our results and reflects a higher arousal.

Sadness: According to Nesse (1994) sadness is closely related to depression and illustrates

the experience of loss. Andrew (2009) suggests that depressed mood serves an adaptive purpose and refers to this as the “analytical rumination hypothesis”. It helps us to disengage a hopeless task that might cause more losses and by this helps to concentrate on new ventures. This goes with our results and the ones of Phillipot (2002) which hardly show any physiological reactions and suggest rather a handling of past events.

Surprise: Surprise is a state in which an unexpected event occurs that might lead to a startle response. The use of this emotion is to interrupt an ongoing action as fast as possible to be ready for a new one. This state only lasts very short and is replaced quickly by a new emotion like fear, confusion etc. When being surprised we inhale quickly and hold breath for a short while before exhaling again. According to Schwab (2004) evolutionary theories assume that there is no specific physiological profile for surprise, which resembles our described results.

4.4 Limitations

First of all it has to be mentioned that inducing emotions with movies is non trivial. Compared to pictures, movies give ongoing fluent information and represent a dynamic process. This makes it difficult to limit the feelings to only one constant emotion. Another issue is the reliability of the participants. This was a very intimate experiment, participants are urged into situations that happen to be uncomfortable and cause stress. Some participants seemed to hold back their reaction towards emotions, maybe to prevent being transparent to a stranger, which might be a natural defence mechanism. This behaviour influences the answering of the questionnaire, yet can hardly be prevented. In addition the questionnaire shows disadvantages as most of the film-clips caused additional feelings to the target emotion. Some time was necessary to build up the emotion, or to “tell a story” to increase the effectiveness. E.g. in the sadness film-

clip a couple is happily dancing to a romantic song in the first part. After a sudden cut they are in a hospital, the woman is dying. During the first part participants felt amused, as they enjoyed the romantic dance in the beginning. We reduced the physiological effect of the additional emotion by only analysing the data of the last 35s of the movie, yet this is not possible for the questionnaire. This can be prevented by either choosing different film-clips or modifying the questionnaire.
The results of the facial expression might be slightly manipulated by the presence of electrodes and the tape that fixed the electrodes. Some participants mentioned that they held back muscle reaction to not lose the electrodes. These participants were excluded, but might not have been the only ones. In addition it seemed that during the neutral movie some participants were blinded by the bright light and the neon like colours of the movie, causing contraction of corrugator and in lesser extent of frontalis.

4.5. Conclusion

This experiment constitutes a complex combination of physiological and psychological methods and theories and gives insight in the consciousness and unconsciousness of the participants. Even though the results for fear do not show the expected effect, the residual emotions illustrate a distinguishable pattern for the physiological parameters. This supports our hypothesis and underlines different theories in evolutionary psychology that focus on the action tendencies towards emotions.
Even though the question of James and Cannon could not be solved by this work, it gives a significant insight into the correlation of emotions and physiological answers.

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Appendix

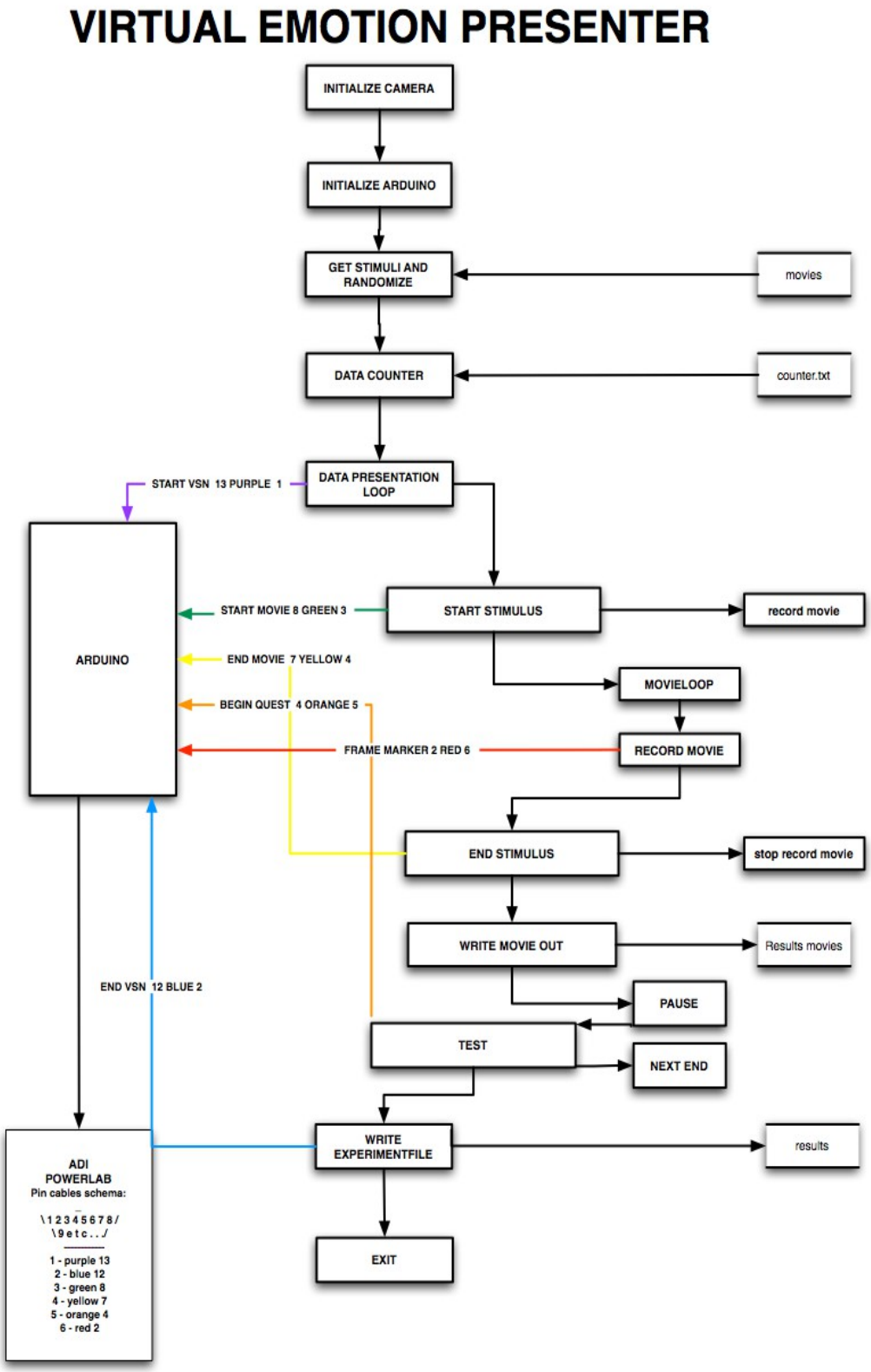

Figure A: the structure of the virtual emotion presenter program (p.10)

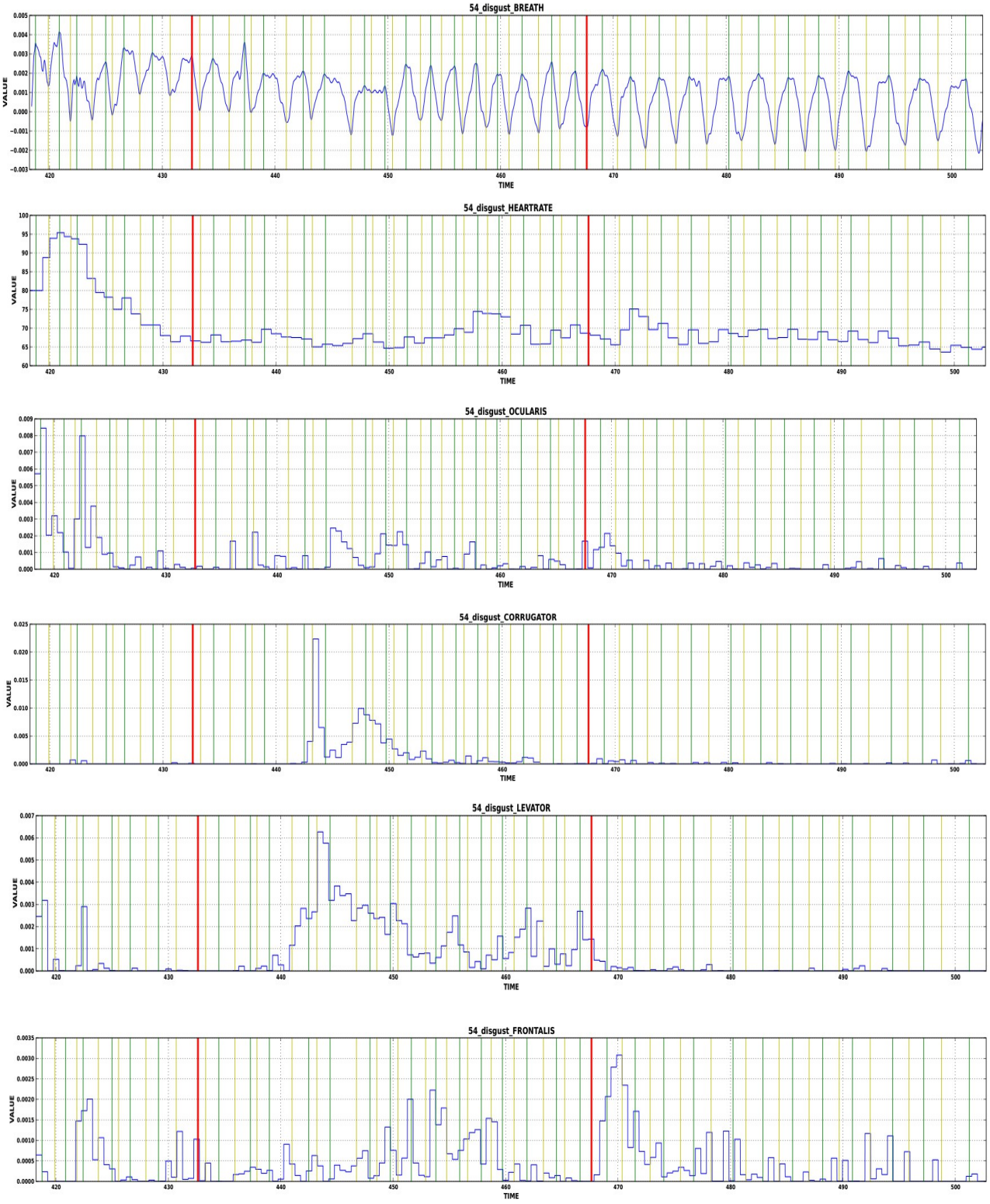

Figure B: activity curves for breathing, heart and the four muscles orbicularis, corrugator, levator and frontalis for the emotion disgust. The curves show the whole movie divided in three parts (red) with minima (yellow) and maxima (green). (p.12)

Zusammenfassung

Viele Studien beschäftigten sich bereits mit dem Zusammenhang zwischen Emotionen und physiologischen Parametern wie der Atmung. Das Ziel dieser Arbeit ist es Muster zwischen den sechs Grundemotionen zu finden die sich zusammensetzen aus Herzrate, Atemparameter und Gesichtsausdrücken. Es wurden 70 Versuchspersonen untersucht, während sie unter den Emotionen Wut, Angst, Ekel, Freude, Traurigkeit und Überraschung standen. Die Emotionen wurden mittels kurzen Film-clips induziert und validiert mit Fragebogen die der Proband ausfüllte. Die Daten für die Atemmuster wurden mit einem Atemgurt aufgenommen der ein Piezoelement enthält, zusätzlich wurde eine Gesichts Elektromyogramm (gEMG) Ableitung durchgeführt.

Die Ergebnisse zeigen eine signifikante Veränderung der Atem- und Herzrate und illustrieren damit eine aus dem Affekt entstandene respiratorische Antwort auf Ekel und Freude, so wie auf Wut und Überraschung. Dies bestätigt unsere Hypothese dass unterschiedliche Atemmuster mit verschiedenen emotionalen Zuständen zusammenhängen. Diese unterschiedlichen emotionalen Zustände können als Änderung der Handlungsbereitschaft verstanden werden und erklären eine Erhöhung der Fitness im evolutionären Kontext.

Curriculum Vitae

Studies

Bachelor of Science in the field of *Cell biology/ Physiology,* University of Salzburg (2012).

Bachelor Thesis 1: „Enzyme activity in mouse and rat- Trypsin and Chymotrypsin“.
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Master of Science in the field of *Behaviour-, Neuro- and Cognition biology,* University of Vienna (2014).

Master Thesis: „Emotional Breathing: Respiration patterns associated with emotions elicited by film-clips“.

Work experience:

Half-year employment in the FP7 EU project CADDY. Assignments in organization, planning experiments and data collection. (2014)

4-week internship at the Institute for Clinical Neuroscience and Medical Psychology at Heinrich-Heine-University Düsseldorf. (2013)

Event management for the Federal Ministry of Education, Arts and Culture. (2012)

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Half-year employment as Key Account Manager at Frey Packaging Ireland.(2007)

Several student jobs as secretary, personal assistant, call center agent etc.

Experience abroad:

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