



Challenges on Emotion Induction with the International Affective Picture System

Studienarbeit am Institut für Algorithmen und Kognitive Systeme

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1. Introduction

During the last decades, the interest in studying human emotional behavior has been constantly increasing. To analyze emotional behavior in scientific studies, it is necessary to have a method to induce different emotions. Therefore, numerous methods have been developed for emotion induction. These methods can be assigned to different classes ranging from self imagination to presentation based methods of films, music, or pictures to medicament-induced techniques. Depending on the design of a study, these methods may be more or less appropriate.¹

One of the major problems in emotional research is the lack of comparability between studies which use different methods for emotion induction. Comparisons between those studies are often difficult up to impossible. Moreover, stimuli that are used for emotion induction in one laboratory are in most cases not available to other laboratories. Recreation of those experimental materials from descriptions in the literature is not easy and often results in different stimulus material.

Standardized material for emotion induction can help to solve this problem and provides many advantages. Probably the most important advantage is the comparability of the results of different studies. Moreover, it is easy to exactly replicate an experiment. In addition, it allows a better experimental control of the stimulus selection.

For this reason, Lang et al. (2005) created the international affective picture system (IAPS) which provides a standardized set of visual stimuli for emotion induction and, therefore, allows comparability of studies among different laboratories. The IAPS currently includes more than 900 pictures as well as normative ratings of these pictures averaged across all subjects, across male subjects, and across female

¹For more details about different emotion induction methods please refer to Gerrards-Hesse et al. (1994); Westermann et al. (1996).

subjects. The number of pictures is constantly enlarged. The pictures from the IAPS are available to everybody for research purposes.

1.1 Goals of this Thesis

This thesis is part of an experiment conducted by Schaaff (2008). In this experiment 90 pictures from the IAPS were used to induce the emotional states *pleasant*, *neutral*, and *unpleasant* while the electroencephalographic signals of the subjects were recorded. Following, the recorded data was used to build a system for emotion recognition from electroencephalographic data.

This thesis critically analyzes the selection of the pictures used for emotion induction in this experiment and compares the subjects' ratings with the ratings from the IAPS. Moreover, we conducted an additional study where participants from the first study were asked to rate the pictures from the experiment again about six months after they had taken part in the first experiment. The aim was to find out how far the ratings from both sessions differ from each other.

1.2 Structure of this Thesis

In chapter 2 we give an overview of the IAPS. This includes a general description of the IAPS as well as an outline of the rating procedure and a cross-cultural comparison of IAPS ratings. Chapter 3 describes the process of data collection. In chapter 4 we analyze the data obtained by the experiment and compare how far the ratings of the participants who took part in the experiment differ from those of the IAPS. Moreover, we analyze in what way the subjective ratings of the participants change when rating the pictures again some months later. Finally, in chapter 5 we discuss our results.

2. The International Affective Picture System

This chapter describes the theoretical background of the international affective picture system (IAPS). In section 2.1 we introduce the basic idea of the IAPS. Next, the method to rate the pictures is illustrated (2.2) followed by a description of the rating procedure (2.3). Section 2.4 deals with the distribution of the IAPS pictures in the affective space. In this context we also address the differences of the distribution which is caused by variation gender, cultural background, and age.

2.1 Introduction

The IAPS was developed by Lang et al. (2005). It consists of nearly 1000 photographs for visual emotion stimulation and is extended continuously.

There are several reasons for using pictures as affective stimuli. First, pictures have the clear ability to evoke emotions. Second, it is relatively easy to edit, catalogue, and distribute these stimuli. Finally, pictures are static stimuli which can be of advantage for the initial investigation of emotion. Stimuli like films or stories can contain dynamic changes such as movement, narrative development. Especially when investigating physiological signals like electrical brain signals or heart rate, dynamic changes of the stimuli can complicate the analysis.

The pictures of the IAPS are standardized on the basis of ratings of their valence, arousal, and dominance. Valence refers to the quality of an emotion (from unpleasant to pleasant) while arousal describes the activation level (from calm to excited). Dominance is an indicator for the control a person feels to have over a situation (from weak to strong). These ratings reflect the three axes of the dimensional model of emotions which was first postulated by Spencer (1890) and extended by Wundt

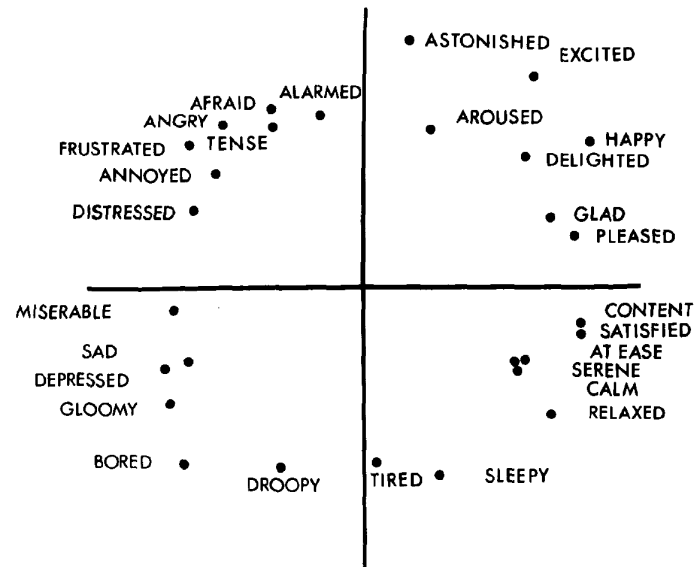


Figure 2.1: Circumplex model of affect (Russel, 1980)

(1896). Following this model, it has repeatedly been confirmed that valence, arousal, and dominance are the most important dimensions for judgments about emotional stimuli. For instance, Osgood (1952) validated this model by factor analysis. Russel and Mehrabian (1977); Russel (1979, 1980) found that pleasure and arousal account for most of the major proportion of variance in affect scales while dominance accounts only for a small amount. Figure 2.1 shows the two-dimensional circumplex model of affect as suggested by Russel (1980).

2.2 The Self-Assessment Manikin

The rating of the IAPS stimuli is done by using the Self-Assessment Manikin (SAM). The SAM was developed by Lang (1980); Hodes et al. (1985) and is an effective measure for self-report emotion recognition. Emotions are rated on a 9-point-scale by the three dimensions valence, arousal and dominance. Each dimension is represented by five graphic figures. For valence ratings, SAM ranges from a figure with a smiling face to a sad figure. Arousal ratings are illustrated by a figure which ranges from eyes wide open to sleepy eyes. For dominance ratings, the scale ranges from a small to a large figure. Figure 2.2 shows the SAM scale for all three dimensions. Participants of a study can mark any of the figures or the box between the figures which leads to a 9-point-scale.

To determine how far it is possible to compare SAM ratings to the scores derived from the semantic differential scale¹, Bradley and Lang (1994) performed a study

¹The semantic differential scale for emotional ratings consists of 18 bipolar adjective pairs and was devised by Mehrabian and Russel (1974).

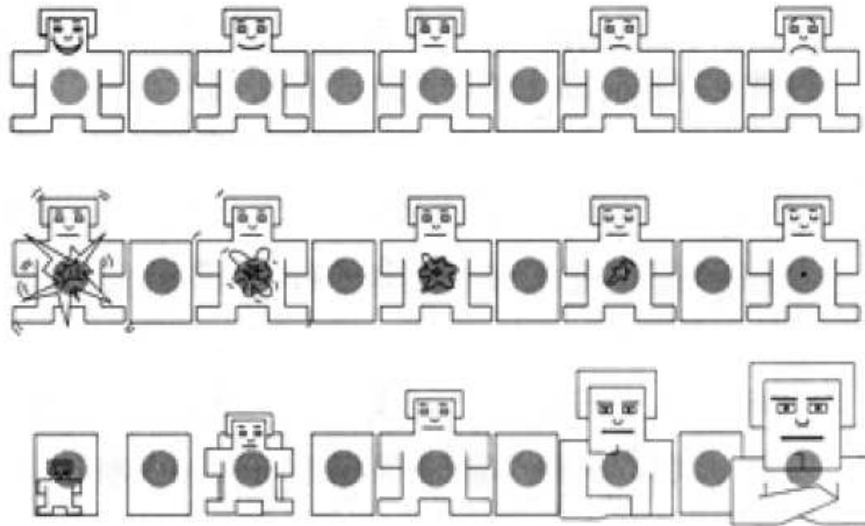


Figure 2.2: SAM scale for valence (top), arousal (middle), and dominance (bottom) (Lang et al., 2005)

were pictures were rated on both scales. For ratings of valence and arousal near perfect agreement of both scales was obtained. However, dominance ratings for both scales differed from each other. Bradley and Lang (1994) hypothesized that this could result from the fact that "SAM reflects the subject's feelings of control in the situation, whereas the semantic differential scale may index whether the pictured object is perceived to be low or high in control". Ratings on both scales proved, that valence and arousal account for the most variance and that SAM is able to quickly evaluate these dimensions.

2.3 Rating Procedure

The IAPS consists of 16 picturesets and is extended constantly. In each rating study, approximately 60 pictures are presented to about 100 participants (half men half women) in groups from 8 to 25 people. The pictures vary in pleasure, arousal, and semantic content. All pictures are in color and are selected such that the affective quality is communicated quickly.

Each study begins by a practice pictureset illustrating the range of contents of the pictures. All pictures are shown for six seconds followed by a rating period of 15 seconds. During the rating period participants have to rate the picture according to its arousal, valence, and dominance on the SAM scale (see section 2.2).

2.4 The Affective Space

When arranging the means of all pictures in a 2-dimensional space defined by mean valence and arousal ratings, we obtain a boomerang-shaped distribution. To illus-

trate the distribution, we plotted the mean valence and arousal ratings for men and women. Figure 2.3 includes the mean values for all pictures from the IAPS that were available at the time of our study. High values on the valence scale correspond to pleasant pictures, low values to unpleasant pictures. Similarly, high values on the arousal scale correspond to high arousing pictures and vice versa. The shape of the

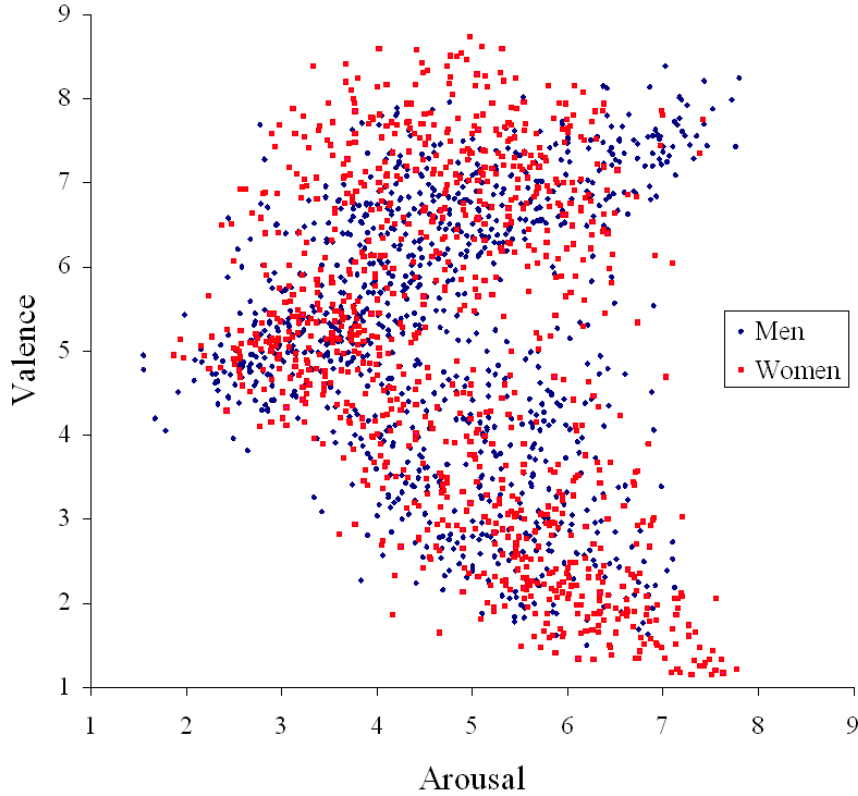


Figure 2.3: Mean picture ratings in a 2-dimensional space

distribution reflects the empirical facts that arousal increases for pictures that are rated more pleasant or unpleasant and that pictures which are rated as neutral on the valence scale are rated less arousing than other pictures.

2.4.1 Gender Differences

Regarding individuals' ratings Bradley and Lang (2007) differ between individuals which are negatively or positively biased. A negative bias exists if there is a negative linear relationship between pleasure and arousal ratings as these subjects tend to primarily rate unpleasant pictures as arousing. In contrast, a positive bias indicates a positive linear relationship between pleasure and arousal ratings.

These rating biases show significant differences between men and women. Bradley and Lang (2007) report that approximately 40 percent of the male subjects show a positive bias and 15 percent a negative bias whereas only 16 percent of female

subjects show a positive bias but 30 percent a negative one. This indicates that male subjects tend to rate pleasant pictures as more arousing compared to unpleasant pictures whereas female subjects perceive unpleasant pictures more arousing than pleasant pictures. This relationship is also reflected in Figure 2.3. To substantiate the gender differences, we computed correlations for ratings of male and female subjects. The results in table 2.1 confirm the findings of Bradley and Lang (2007) as

		All pictures	Pleasant pictures ⁽¹⁾	Unpleasant pictures ⁽²⁾
Men	r	0.009	0.627	-0.594
	N ⁽³⁾	955	522	428
Women	r	0.370	0.347	-0.758
	N ⁽³⁾	955	498	453

⁽¹⁾ Valence ratings > 5

⁽²⁾ Valence ratings < 5

⁽³⁾ Please note that pleasant and unpleasant pictures do not add up to 955 as pictures with a mean valence rating of 5.0 were not considered.

Table 2.1: Comparison of means and paired t-test for IAPS and subjects' ratings (p < 0.001 for all r)

ratings of female subjects are correlated more negative than ratings of male subjects.

2.4.2 Cross Cultural Differences

The IAPS is based on data which was collected from students at the University of Florida in the United States. To make sure that the shape of the affective space is cross-culturally consistent, several studies have been conducted to prove this consistency. Bradley (1994) reported a high stability among German, Italian and Swedish subjects. Although - compared to German and North American ratings - Swedish participants assigned lower arousal ratings whereas Italian Participants rated the pictures as generally more arousing. In a validation study for Belgium, Verschuere et al. (2001) found a strong correlation for all dimensions of the IAPS. A validation study for Brazilian participants which was conducted by Ribeiro et al. (2005) proved a high correlation to the North American ratings for pleasant pictures. However, arousal ratings differed from the North American ratings in the way that less arousal was attributed to pleasant pictures whereas more arousal was attributed to neutral and negative pictures. Similarly, Moltó et al. (1999); Vila et al. (2001) proved that Spanish people perceive the IAPS pictures as more arousing and less dominant than the IAPS norms while valence ratings are quite similar. Nevertheless, the shape of the affective space was quite similar for all validation experiments.

2.4.3 Influence of Age

The ratings of the IAPS were collected mainly from psychology students which means that they represent especially the emotional perception of younger adults. However, there have been several studies that younger and older adults differ in their emotional behavior. For instance, Lawton et al. (1992) found that older adults have a higher emotional control and mood stability while they show a decreased surgency and psychophysiological responsiveness to emotional stimuli and are less sensation seeking. This is also reflected in the ratings of the IAPS. In a study with 504 pictures from the IAPS, Grühn et al. (2008) found that older adults (63 - 77 years) tended to rate pictures more extreme on the valence scale than younger adults (18 - 31 years), i.e. pleasant pictures were perceived as more pleasant and unpleasant pictures as more unpleasant. Moreover, pleasant pictures were rated as less arousing by older adults while they rated unpleasant pictures as more arousing than younger adults.

3. Data Collection

This chapter gives an overview about the experimental conditions of this study. After an overview about the subjects who participated in this study (3.1), section 3.2 describes the stimuli selected for this study. Section 3.4 gives a description of the experimental procedure.

3.1 Participants

Twenty three subjects participated voluntarily in this study. 20 of them were male, three were female. Mean age of male participants was 25.85 years ($SD = 1.95$; range: 23 - 30 years), female participants had a mean age of 27.00 years ($SD = 3.00$; range: 24 - 30 years). Out of these subjects 19 were right handed (17 male, 2 female), four were left handed (3 male, 1 female). Most subjects had a German cultural background. Only one of the male subjects had a Bulgarian background and one of the female subjects a Chinese background.

3.2 Stimulus Selection

For the current study, 90 pictures were selected from the IAPS consisting of 30 pleasant, 30 neutral, and 30 unpleasant pictures based on the valence and arousal ratings. For pleasant pictures, two different picturesets were selected for male and female participants which differed in ten pictures. While pictures for male participants included more pictures of erotica, female participants were shown more pictures of happy families. Neutral pictures included neutral faces and household objects. Unpleasant pictures included mutilated bodies and scenes of attack and threat. Pictures of spiders and snakes were not used as there might be great differences between valence ratings of phobic and non-phobic participants. The pictures

belonging to the different groups were selected such that valence ratings were distinct. The mean valence ratings of the IAPS pictures for men and women are shown in Table 3.1.

	Men				Women			
	Mean	SD	Min	Max	Mean	SD	Min	Max
Pleasant	7.78	0.24	7.41	8.39	8.17	0.31	7.54	8.74
Neutral	4.91	0.30	4.36	5.49	4.98	0.30	4.12	5.69
Unpleasant	2.15	0.28	1.63	2.59	1.52	0.23	1.15	1.88

Table 3.1: Mean valence ratings of IAPS pictures for men and women

3.3 Materials

Ninety color pictures described in 3.2 were used for the experiment. In the first part of the experiment, pictures were presented on a 19" TFT wide screen monitor (Belinea 1945 S1W) using the UKA EEG Studio. Subjects were seated approximately 1 m from the screen. For the first part of the experiment - which is subject of the current thesis - we used paper copies of all pictures with a size of 9.5 x 7.3 cm.

3.4 Procedure

The rating procedure was part of a study described in Schaaff (2008). The experiments took place in the afternoon in the same room in the computer science building of the University of Karlsruhe(TH). First, subjects were asked for personal data like age, vision, handedness and state of health. After reading the experimental instructions and signing a consent form that data can be used for research purposes, the first part of the experiment started. In this part, subjects were presented pictures on a 19" TFT wide screen monitor while there EEG-signals were recorded. A more detailed description of this procedure can be found in Schaaff (2008). After this part was finished, subjects were given a pile of hard copies of all pictures they had seen in the first part of the experiment. They were asked to sort these pictures according to their subjective emotional perception. These subjective ratings of the pictures were used for further analysis. Contrary to the original IAPS ratings, which are done on a 9-point scale, we used only a 3-point scale for valence ratings representing the three categories pleasant, neutral, and unpleasant. One reason was, that we did not need the fine granularity of the SAM scale. Besides that, the rating of all 90 pictures used for emotion induction would have cost much more time on a 9-point scale as on the 3-point scale. This was not desirable as all participants who took part in this experiment did this voluntarily without any remuneration.

3.5 Summary of Collected Data

In this study we collected the subjective ratings of IAPS pictures from 24 subjects. Out of these 23, 20 were male and three female. As we used different picturesets for male and female participants and the number of female participants was too small to allow any conclusions, we used only those ratings obtained from male subjects. Each of the 20 male participants rated a total of 90 pictures from the IAPS, 30 from each emotion category (pleasant, neutral, unpleasant).

4. Analysis

In this chapter we analyze the results of the experiment described in 3.4. As subjects were asked to sort the pictures according to the three categories pleasant, neutral and unpleasant we assigned the following values to these categories to obtain a metric scale for further analysis:

- unpleasant: 1 (equivalent to SAM valence ratings from 1 to 3)
- neutral: 2 (equivalent to SAM valence ratings from 4 to 6)
- pleasant: 3 (equivalent to SAM valence ratings from 7 to 9)

According to the IAPS rating scale, unpleasant pictures have the lowest value, whereas pleasant pictures are assigned the highest value.

As we used different picture sets for male and female subjects, in the following only the ratings of the 20 male subjects are investigated. This is because we only had three female subjects and, therefore, not enough data for a reliable analysis which is even more severe as we used different picturesets for male and female participants. All tests are performed at an alpha level of 0.05, i.e. the error probability is smaller than 5 percent.

In section 4.1 we start with an analysis of the valence ratings of the subjects. Next, we compare the ratings of a subset of ten subjects from two rating sessions (4.2). Finally, in section 4.3 the ratings obtained in our study are compared to the ratings from the IAPS.

4.1 Analysis of Subjects' Valence Ratings

Overall, we obtained a mean rating of 1.986 (SD = 0.728) for all pictures. Table 4.1 shows mean ratings, standard deviation and range of the pictures of the particular

emotion category. The mean valence ratings for each picture in the current study can be found in Appendix B.1.

Emotion	Mean	SD	Min	Max
Unpleasant	1.083	0.117	1.00	1.45
Neutral	2.042	0.082	1.90	2.25
Pleasant	2.832	0.148	2.50	3.00

Table 4.1: Mean, standard deviation and range of the pictures of the different emotion categories (N = 30)

The ratings for each picture from the 20 participants are displayed in Figure 4.1. It is obvious, that ratings for pleasant pictures are more ambiguous than those for unpleasant pictures. 14 of the unpleasant pictures were rated as unpleasant by all participants compared to only four of the pleasant pictures. A possible explanation can be seen in the picture content. Unpleasant pictures contained primarily pictures of mutilation, attack and human / animal threat which have a clear negative loaden content. The most frequently mentioned reason why some of the unpleasant pictures (especially pictures of attack) were assigned to another category was that some of the pictures looked very posed. The reasons for pictures that ought to be pleasant

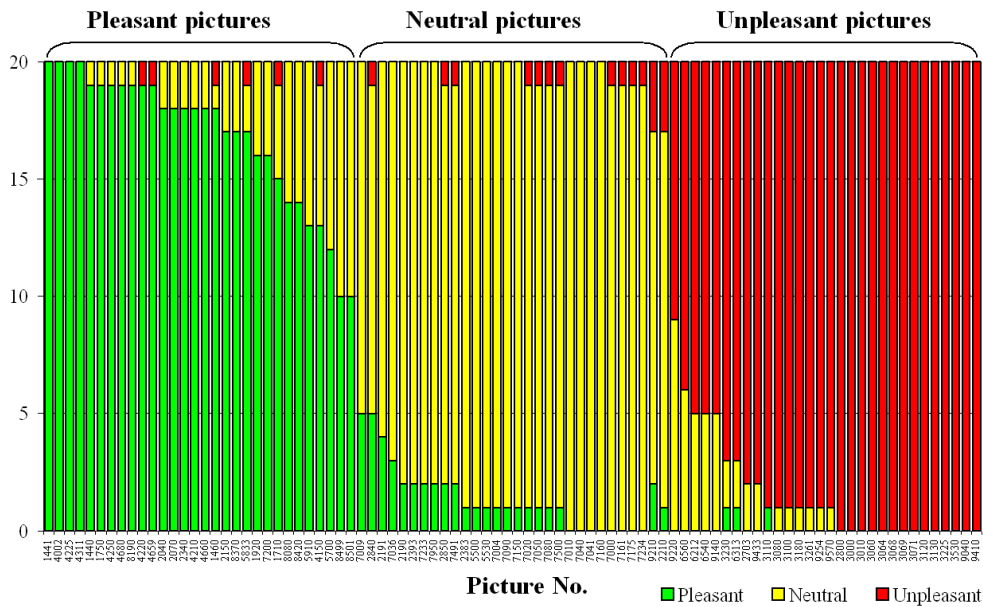


Figure 4.1: Mean subjects' ratings for the IAPS pictures

but were assigned to other categories were more diverse. For instance, one picture was rated as neutral by half of the participants as it showed a lot of dollar notes.

Some participants reasoned that they would have felt different if it had been euro notes, others said that money is not important for them. Another ambiguous picture showed people in a rollercoaster. Some of the participants stated that they did not like rollercoasters, others were not sure if the people in the rollercoaster had fun or were frightened. Same reasons apply for pictures of tubing or sailing. There were also some opposite sex erotica that were rated as neutral or even unpleasant. In most of the cases participants stated that the style of the women was no longer contemporary. Most of the neutral pictures contained household objects and neutral faces. The ratings of these pictures was often influenced by personal preferences. For instance a picture showing a cup was often rated as pleasant as it was associated with a cup of coffee. Another picture showing a boy playing chess was perceived as pleasant from those participants who liked playing chess. On the other hand, pictures that showed objects like an ironing board were rated as unpleasant as they were linked with housework.

To determine whether the subject's valence ratings differ significantly for all emotion conditions we use the mean valence ratings of the three conditions and compare them with paired t-tests. The mean valence ratings for each subject are depicted in Appendix B.2.

Emotion	Mean	SD	Comparison with	t	p
Pleasant	2.832	0.130	Neutral	21.678	< 0.001
Neutral	2.042	0.074	Unpleasant	50.792	< 0.001
Unpleasant	1.083	0.079	Pleasant	43.324	< 0.001

Table 4.2: Comparison of subject's valence ratings ($N = 20$, $df = 19$)

Table 4.2 shows, that the subjects valence ratings differ significantly for all emotion conditions, i.e. valence varies systematically with the corresponding emotion condition.

4.2 Temporal Differences

Images can have a different influence on a person's emotional state depending on the physical and mental state on the day of testing. Therefore, we asked a subset of 10 subjects to rate the pictures again about six months after the main experiment.¹ The rating procedure was the same as described in section 3.4. The only difference was that we did not do EEG recordings before the rating.

Table 4.3 shows, that for most subjects the ratings of both sessions are highly correlated. The number of pictures which were rated the same ranges from 64 to 87.

¹Unfortunately, we could not use data of all subjects as many of them were no longer in Karlsruhe during the data collection for the second session.

Subject ID	Correlation ⁽¹⁾	Number of matches
01	0.900	79
02	0.922	81
03	0.984	87
06	0.911	80
08	0.751	66
09	0.870	78
10	0.873	75
14	0.850	73
15	0.878	78
43	0.693	64

⁽¹⁾ $p < 0.001$

Table 4.3: Correlation between first and second rating session for each subject ($N = 90$, $p < 0.001$)

The results indicate that subjects' ratings change depending on the current daily condition of the subject.

Besides this, we compared the mean picture ratings from both sessions. From the first session we included only the ratings of those subjects who also took part in the second session. Figure 4.2 illustrates the ratings from both sessions. The detailed results can be found in Appendix B.3. The results in Table 4.4 show significant

	Session 1	Session 2
Mean (SD)	1.989	1.941
Standard Deviation	0.733	0.716
t (significance)	3.509 (0.001)	

Table 4.4: Comparison of means and paired t-test for both sessions ($N = 90$, $df = 89$)

differences between the ratings from both sessions. It has to be pointed out that we used only a very small sample size of 10 subjects which might have influenced this result. However, there are a lot of other possible explanations for the different ratings between both sessions. Probably the most important reason for different ratings is the physical and mental state of the subject at the time of the rating. Moreover, the interval between both sessions was quite long. During this time many things in a person's environment may have changed and influenced his / her personality. Another factor is the order in which the picture were presented which was different

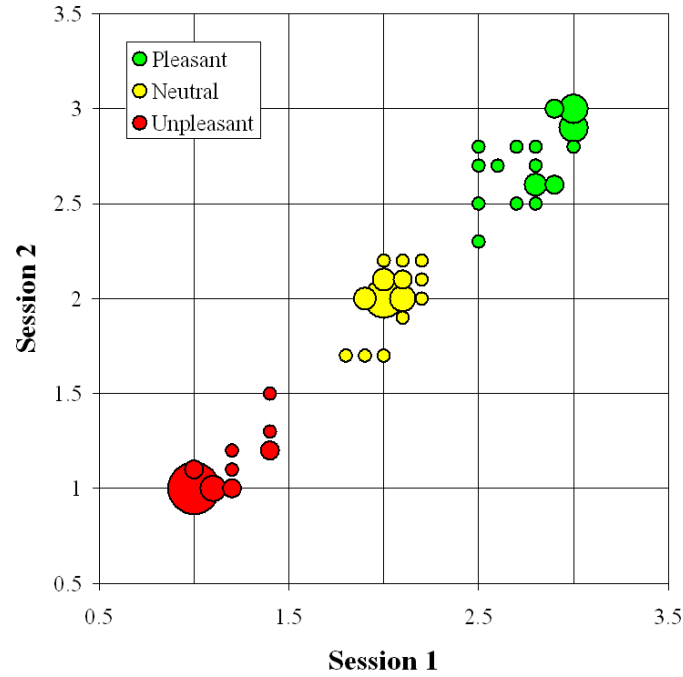


Figure 4.2: Mean subjects' ratings from the first and the second session (bubble size indicates the number of pictures with a certain rating)

in both sessions. If a neutral picture is shown after a picture which displays for instance a mutilated body, the likelihood that the neutral picture is perceived as positive is greater as if it is shown after another neutral picture.

4.3 Comparison to IAPS Ratings

A correlation analysis between mean subjects' ratings and the IAPS ratings for male subjects shows a high positive correlation between both ratings ($r = 0.968$; $p < 0.001$). This allows the assumption, that the ratings from the male subjects in our study are quite similar to those from the IAPS. Figure 4.3 shows the mean subjects' ratings with the corresponding IAPS ratings for each picture. The regression line in this figure also reflects the high correlation.

To verify this correlation, we performed a paired t-test. For this purpose, the 9-point scale of the IAPS ratings was converted to a 3-point scale as it was used in our experiment.

Table 4.5 shows the results of the paired t-test which is not significant. These results suggest, that apparently IAPS ratings do not differ significantly from subjects' ratings at an alpha level of 0.05.

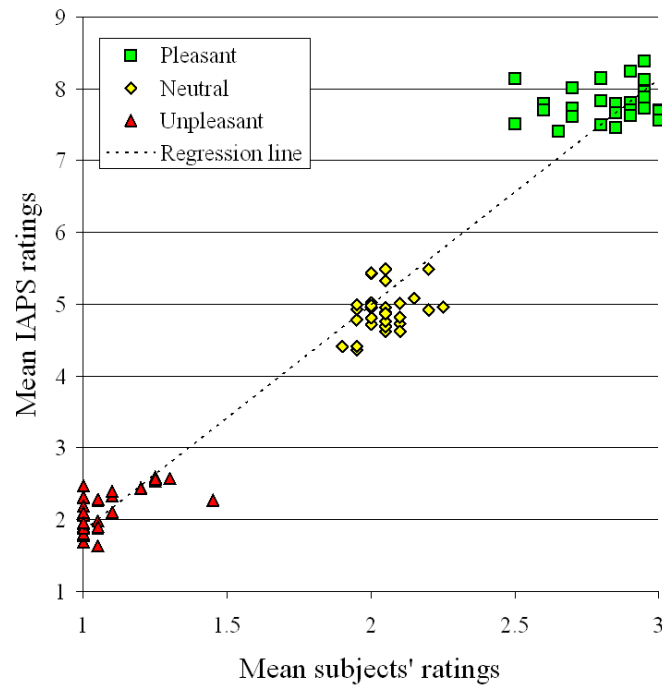


Figure 4.3: Mean subjects' ratings with corresponding IAPS ratings (male ratings only)

	IAPS ratings ⁽¹⁾	Subjects' ratings
Mean (SD)	1.942	1.986
Standard Deviation	0.601	0.728
t (significance)	1.959 (0.053)	

⁽¹⁾ converted to a 3-point scale

Table 4.5: Comparison of means and paired t-test for IAPS and subjects' ratings (N = 90, df = 89)

5. Discussion and Conclusion

In this thesis we evaluated the subjective ratings of IAPS pictures from participants that took part in an emotion recognition experiment (Schaaff, 2008). We named several reasons why participants assigned pictures to other classes than those suggested by the IAPS. Nevertheless, we found highly significant differences between user ratings for pictures belonging to different classes (see 4.1). Although, the findings in this thesis showed, that subjective picture ratings of the participants often differed from the mean ratings from the IAPS these differences were not significant. However, it is nearly impossible to find a set of pictures which is perceived similar by all participants in terms of its valence ratings. Therefore, when using the IAPS for emotion induction, it might be helpful to perform a pre-study to analyze whether pictures show the desired effect. This could help to reduce the number of ambiguous pictures. Moreover, it is absolutely essential to integrate the subjective ratings of a participant in the evaluation of the study if pictures are used to evoke a certain emotional state. This is even more important as we found in section 4.2 that ratings of the same subjects from two sessions may differ significantly.

Besides the choice of the right pictures, it is also important to carefully chose the participants of a study. As we illustrated in chapter 2, cultural background, age and sex can also have an influence on how the pictures are perceived. Therefore, subjects should optimally have the same cultural background and be of a similar age. Problems with gender differences can be avoided by choosing different picturesets for male and female participants.

Nevertheless, the IAPS has been proven to be an efficient method for emotion induction. One of its major advantages can be seen in its reproducibility which also allows a comparison of studies from different laboratories.

A. IAPS-picturesets

Description	Slide No.	Men		Women	
		Valence	Arousal	Valence	Arousal
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Seal	1440	7.96 (1.59)	4.76 (2.25)	8.43 (1.44)	4.47 (2.82)
Family	2340	7.65 (1.36)	5.35 (2.03)	8.34 (1.10)	4.53 (2.29)
Mountains	5700	7.70 (1.36)	5.94 (2.28)	7.54 (1.56)	5.44 (2.38)
Brownie	7200	7.50 (1.78)	4.90 (2.67)	7.77 (1.71)	4.85 (2.55)
Sailing	8080	7.73 (1.25)	7.12 (1.95)	7.73 (1.43)	6.25 (2.34)
PolarBears	1441	7.71 (1.17)	3.84 (2.10)	8.14 (1.33)	4.00 (2.55)
Skier	8190	8.13 (1.29)	6.41 (2.60)	8.08 (1.48)	6.16 (2.57)
Kitten	1460	7.80 (1.47)	4.20 (2.69)	8.58 (0.76)	4.42 (2.60)
Rafting	8370	7.67 (1.19)	6.46 (2.22)	7.86 (1.37)	6.98 (2.25)
Puppies	1710	8.02 (1.21)	5.53 (2.07)	8.59 (0.99)	5.31 (2.54)
Bunnies	1750	7.89 (1.26)	4.21 (2.22)	8.59 (0.75)	4.02 (2.40)
Tubing	8420	7.61 (1.61)	5.71 (2.42)	7.90 (1.50)	5.41 (2.34)
Rollercoaster	8499	7.51 (1.47)	6.69 (1.71)	7.70 (1.36)	5.56 (2.61)
Porpoise	1920	7.83 (1.29)	4.21 (2.49)	7.94 (1.61)	4.31 (2.57)
Beach	5833	8.15 (1.19)	6.37 (2.37)	8.27 (0.99)	5.14 (2.79)
Money	8501	8.14 (1.24)	6.86 (2.00)	7.67 (1.97)	6.02 (2.50)
Fireworks	5910	7.41 (1.20)	5.37 (2.32)	8.16 (1.15)	5.80 (2.75)
Baby	2150	7.46 (1.60)	4.66 (2.37)	8.31 (1.49)	5.29 (2.83)
Baby	2070	7.69 (1.59)	4.02 (2.30)	8.50 (1.28)	4.84 (2.97)
Baby	2040	7.63 (2.01)	4.33 (2.19)	8.74 (0.64)	4.97 (2.85)

Table A.1: Pleasant pictures for all subjects

Description	Slide No.	Men		Women	
		Valence	Arousal	Valence	Arousal
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Couple	2530	7.25 (1.84)	4.23 (2.03)	8.25 (1.10)	3.80 (2.17)
Couple	2550	7.37 (1.20)	4.15 (2.03)	8.14 (1.53)	5.16 (2.67)
Sunset	5830	7.37 (1.80)	4.98 (2.40)	8.54 (0.82)	4.88 (2.86)
IceCream	7330	7.29 (2.21)	4.54 (2.55)	7.96 (1.49)	5.54 (2.53)
Baby	2660	7.28 (1.59)	4.09 (2.20)	8.18 (1.24)	4.76 (2.56)
Seagulls	5831	7.07 (1.10)	3.93 (2.28)	8.05 (1.00)	4.79 (2.59)
Father	2160	6.87 (1.87)	5.31 (2.10)	8.16 (1.28)	5.03 (2.25)
Father	2165	6.74 (1.39)	3.89 (2.24)	8.29 (1.17)	5.05 (2.67)
Father	2057	7.16 (1.31)	4.32 (1.98)	8.39 (0.94)	4.73 (2.75)
Family	2360	6.98 (1.76)	3.65 (2.02)	8.20 (1.59)	3.67 (2.52)

Table A.2: Pleasant pictures for female subjects

Description	Slide No.	Men		Women	
		Valence	Arousal	Valence	Arousal
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
EroticFemale	4002	7.69 (1.48)	7.15 (1.81)	4.14 (1.82)	3.72 (2.30)
AttractiveFem	4150	7.80 (1.36)	6.41 (2.18)	5.36 (1.44)	3.44 (1.98)
EroticFemale	4210	8.25 (1.30)	7.80 (1.90)	3.13 (1.66)	4.31 (2.47)
EroticFemale	4220	7.81 (1.74)	6.64 (1.90)	5.61 (1.31)	4.00 (1.95)
EroticFemale	4225	7.57 (1.43)	6.94 (1.83)	5.15 (1.37)	4.40 (2.16)
EroticFemale	4250	8.39 (0.93)	7.02 (2.02)	5.18 (1.55)	3.31 (2.07)
EroticFemale	4311	7.56 (1.38)	7.35 (1.81)	5.89 (1.68)	6.08 (2.32)
EroticCouple	4659	7.70 (1.64)	7.43 (1.80)	6.15 (2.01)	6.47 (2.18)
EroticCouple	4660	7.63 (1.30)	6.92 (1.74)	7.22 (1.40)	6.31 (1.95)
EroticCouple	4680	7.73 (1.61)	5.94 (2.30)	6.91 (1.92)	6.07 (2.26)

Table A.3: Pleasant pictures for male subjects

Description	Slide No.	Men		Women	
		Valence	Arousal	Valence	Arousal
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
Man	2190	4.73 (1.25)	2.27 (1.72)	4.90 (1.31)	2.50 (1.86)
Secretary	2383	4.62 (1.24)	3.49 (1.90)	4.79 (1.44)	3.36 (1.79)
Chess	2840	4.92 (1.79)	2.31 (1.88)	4.90 (1.23)	2.55 (1.76)
Mushroom	5500	5.49 (1.67)	2.82 (2.58)	5.34 (1.49)	3.18 (2.25)
RollingPin	7000	4.93 (0.35)	2.73 (1.86)	5.06 (1.10)	2.15 (1.70)
Plate	7233	5.01 (1.21)	2.51 (1.74)	5.15 (1.66)	2.96 (2.05)
Building	7491	4.87 (0.94)	2.60 (1.95)	4.79 (1.09)	2.24 (1.87)
Rain	9210	4.41 (1.85)	2.89 (2.05)	4.64 (1.82)	3.26 (2.20)
Farmer	2191	5.49 (1.49)	3.63 (2.10)	5.14 (1.71)	3.60 (2.17)
Tourist	2850	4.69 (1.40)	2.58 (1.79)	5.69 (1.22)	3.38 (2.01)
Mushroom	5530	5.33 (1.64)	2.87 (2.47)	5.44 (1.57)	2.87 (2.12)
Spoon	7004	4.89 (0.60)	2.09 (1.75)	5.14 (0.59)	1.94 (1.60)
NeutFace	2210	4.41 (1.33)	2.72 (1.92)	4.60 (0.98)	3.44 (1.74)
Factoryworker	2393	4.82 (1.08)	2.90 (1.80)	4.92 (1.05)	2.95 (1.95)
Mug	7009	4.96 (1.05)	2.69 (1.95)	4.89 (0.96)	3.26 (1.96)
Basket	7010	4.95 (1.43)	1.55 (1.36)	4.92 (0.48)	1.97 (1.58)
Fan	7020	5.02 (1.22)	2.15 (1.71)	4.94 (0.88)	2.19 (1.72)
Shipyard	7036	5.08 (1.02)	3.47 (2.09)	4.71 (1.10)	3.18 (1.98)
DustPan	7040	4.72 (1.19)	2.46 (1.86)	4.66 (1.00)	2.90 (1.99)
Baskets	7041	4.96 (1.14)	2.68 (1.76)	5.02 (1.11)	2.53 (1.79)
HairDryer	7050	4.81 (0.71)	2.59 (1.79)	5.04 (0.87)	2.90 (1.82)
Fork	7080	5.43 (1.26)	1.98 (1.63)	5.10 (0.88)	2.67 (1.99)
Book	7090	4.95 (1.54)	2.30 (1.90)	5.44 (1.35)	2.92 (2.15)
Umbrella	7150	4.76 (0.73)	2.66 (1.68)	4.69 (1.19)	2.56 (1.83)
Fabric	7160	4.98 (0.97)	3.06 (2.08)	5.05 (1.19)	3.08 (2.09)
Pole	7161	4.99 (0.86)	2.79 (1.81)	4.97 (1.16)	3.15 (2.14)
Lamp	7175	4.78 (1.18)	1.55 (0.96)	4.95 (0.80)	1.87 (1.48)
IroningBoard	7234	4.36 (1.41)	2.83 (1.79)	4.12 (1.73)	3.05 (1.99)
Building	7500	5.44 (1.36)	3.46 (2.23)	5.23 (1.50)	3.08 (2.15)
Tissue	7950	4.62 (1.26)	2.30 (1.89)	5.17 (1.12)	2.27 (1.77)

Table A.4: Neutral pictures

Description	Slide No.	Men		Women	
		Valence	Arousal	Valence	Arousal
		Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)
SadChildren	2703	2.33 (1.53)	5.73 (1.99)	1.59 (0.87)	5.81 (2.47)
SadChild	2800	2.31 (1.36)	4.94 (1.97)	1.41 (0.79)	5.87 (2.13)
Mutilation	3000	1.69 (1.47)	6.74 (2.37)	1.17 (0.54)	7.63 (2.11)
Mutilation	3010	2.19 (1.42)	7.12 (1.75)	1.29 (0.82)	7.44 (2.21)
Mutilation	3060	1.94 (1.39)	6.89 (2.08)	1.66 (1.71)	7.34 (2.10)
Mutilation	3064	1.78 (1.26)	5.44 (2.70)	1.15 (0.44)	7.30 (2.22)
Mutilation	3068	2.47 (1.92)	6.44 (2.46)	1.18 (0.70)	7.09 (2.49)
Mutilation	3069	2.10 (1.66)	6.70 (2.60)	1.32 (1.01)	7.33 (2.20)
Mutilation	3071	2.06 (1.59)	6.61 (2.13)	1.69 (1.14)	7.10 (1.95)
Mutilation	3080	1.63 (1.11)	6.84 (2.06)	1.33 (0.75)	7.61 (1.81)
BurnVictim	3100	1.88 (1.14)	5.88 (2.34)	1.35 (0.96)	7.02 (2.02)
BurnVictim	3110	2.10 (1.56)	6.43 (2.26)	1.47 (0.89)	6.98 (2.04)
DeadBody	3120	1.80 (1.32)	6.20 (2.55)	1.33 (0.74)	7.49 (1.96)
Mutilation	3130	1.90 (1.57)	6.56 (2.11)	1.26 (0.68)	7.39 (1.97)
BatteredFem	3180	2.27 (1.33)	5.17 (2.05)	1.67 (0.90)	6.19 (2.24)
Mutilation	3225	2.06 (1.24)	5.39 (2.41)	1.66 (1.20)	6.32 (2.43)
DyingMan	3230	2.44 (1.50)	5.00 (2.35)	1.67 (0.99)	5.75 (2.04)
Tumor	3261	1.98 (1.19)	5.51 (2.70)	1.70 (1.43)	5.92 (2.60)
Attack	3530	2.10 (1.53)	6.85 (2.13)	1.51 (1.00)	6.80 (2.07)
Soldier	6212	2.59 (1.47)	5.47 (2.44)	1.81 (1.41)	6.53 (2.35)
Attack	6313	2.43 (1.42)	6.54 (2.11)	1.61 (1.22)	7.27 (2.29)
Attack	6540	2.53 (1.84)	6.51 (2.27)	1.86 (1.14)	7.14 (1.98)
Attack	6560	2.57 (1.49)	6.17 (2.28)	1.78 (1.23)	6.86 (2.52)
StarvingChild	9040	1.88 (1.17)	5.10 (2.11)	1.50 (0.97)	6.44 (2.00)
Cow	9140	2.56 (1.42)	4.90 (2.29)	1.88 (1.26)	5.79 (2.04)
Cemetery	9220	2.27 (1.61)	3.83 (2.33)	1.86 (1.46)	4.16 (1.84)
Assault	9254	2.28 (1.51)	5.57 (2.45)	1.88 (1.22)	6.33 (2.26)
Soldier	9410	1.96 (1.56)	6.38 (2.26)	1.20 (0.58)	7.54 (1.78)
DeadMan	9433	2.39 (1.38)	5.00 (2.65)	1.35 (0.71)	6.71 (2.27)
Dog	9570	1.90 (1.40)	5.84 (2.41)	1.47 (1.00)	6.45 (2.19)

Table A.5: Unpleasant pictures

B. Data

B.1 Mean Valence Ratings by Picture

Slide No.	Description	Emotion Category	Mean (SD)
1440	Seal	Pleasant	2.95 (0.22)
1441	PolarBears	Pleasant	3.00 (0.00)
1460	Kitten	Pleasant	2.85 (0.49)
1710	Puppies	Pleasant	2.70 (0.57)
1750	Bunnies	Pleasant	2.95 (0.22)
1920	Porpoise	Pleasant	2.80 (0.41)
2040	Baby	Pleasant	2.90 (0.31)
2070	Baby	Pleasant	2.90 (0.31)
2150	Baby	Pleasant	2.85 (0.37)
2190	Man	Neutral	2.10 (0.31)
2191	Farmer	Neutral	2.20 (0.41)
2210	NeutFace	Neutral	1.90 (0.45)
2340	Family	Pleasant	2.90 (0.31)
2383	Secretary	Neutral	2.05 (0.22)
2393	Factoryworker	Neutral	2.10 (0.31)
2703	SadChildren	Unpleasant	1.10 (0.31)
2800	SadChild	Unpleasant	1.00 (0.00)
2840	Chess	Neutral	2.20 (0.52)
2850	Tourist	Neutral	2.05 (0.39)
3000	Mutilation	Unpleasant	1.00 (0.00)
3010	Mutilation	Unpleasant	1.00 (0.00)
3060	Mutilation	Unpleasant	1.00 (0.00)
3064	Mutilation	Unpleasant	1.00 (0.00)

Slide No.	Description	Emotion Category	Mean (SD)
3068	Mutilation	Unpleasant	1.00 (0.00)
3069	Mutilation	Unpleasant	1.00 (0.00)
3071	Mutilation	Unpleasant	1.00 (0.00)
3080	Mutilation	Unpleasant	1.05 (0.22)
3100	BurnVictim	Unpleasant	1.05 (0.22)
3110	BurnVictim	Unpleasant	1.10 (0.45)
3120	DeadBody	Unpleasant	1.00 (0.00)
3130	Mutilation	Unpleasant	1.00 (0.00)
3180	BatteredFem	Unpleasant	1.05 (0.22)
3225	Mutilation	Unpleasant	1.00 (0.00)
3230	DyingMan	Unpleasant	1.20 (0.52)
3261	Tumor	Unpleasant	1.05 (0.22)
3530	Attack	Unpleasant	1.00 (0.00)
4002	EroticFemale	Pleasant	3.00 (0.00)
4150	AttractiveFem	Pleasant	2.60 (0.60)
4210	EroticFemale	Pleasant	2.90 (0.31)
4220	EroticFemale	Pleasant	2.90 (0.45)
4225	EroticFemale	Pleasant	3.00 (0.00)
4250	EroticFemale	Pleasant	2.95 (0.22)
4311	EroticFemale	Pleasant	3.00 (0.00)
4659	EroticCouple	Pleasant	2.90 (0.45)
4660	EroticCouple	Pleasant	2.90 (0.31)
4680	EroticCouple	Pleasant	2.95 (0.22)
5500	Mushroom	Neutral	2.05 (0.22)
5530	Mushroom	Neutral	2.05 (0.22)
5700	Mountains	Pleasant	2.60 (0.50)
5833	Beach	Pleasant	2.80 (0.52)
5910	Fireworks	Pleasant	2.65 (0.49)
6212	Soldier	Unpleasant	1.25 (0.44)
6313	Attack	Unpleasant	1.20 (0.52)
6540	Attack	Unpleasant	1.25 (0.44)
6560	Attack	Unpleasant	1.30 (0.47)
7000	RollingPin	Neutral	1.95 (0.22)
7004	Spoon	Neutral	2.05 (0.22)
7009	Mug	Neutral	2.25 (0.44)
7010	Basket	Neutral	2.00 (0.00)
7020	Fan	Neutral	2.00 (0.32)
7036	Shipyards	Neutral	2.15 (0.37)
7040	DustPan	Neutral	2.00 (0.00)

Slide No.	Description	Emotion Category	Mean (SD)
7041	Baskets	Neutral	2.00 (0.00)
7050	HairDryer	Neutral	2.00 (0.32)
7080	Fork	Neutral	2.00 (0.32)
7090	Book	Neutral	2.05 (0.22)
7150	Umbrella	Neutral	2.05 (0.22)
7160	Fabric	Neutral	2.00 (0.00)
7161	Pole	Neutral	1.95 (0.22)
7175	Lamp	Neutral	1.95 (0.22)
7200	Brownie	Pleasant	2.80 (0.41)
7233	Plate	Neutral	2.10 (0.31)
7234	IroningBoard	Neutral	1.95 (0.22)
7491	Building	Neutral	2.05 (0.39)
7500	Building	Neutral	2.00 (0.32)
7950	Tissue	Neutral	2.10 (0.31)
8080	Sailing	Pleasant	2.70 (0.47)
8190	Skier	Pleasant	2.95 (0.22)
8370	Rafting	Pleasant	2.85 (0.37)
8420	Tubing	Pleasant	2.70 (0.47)
8499	Rollercoaster	Pleasant	2.50 (0.51)
8501	Money	Pleasant	2.50 (0.51)
9040	StarvingChild	Unpleasant	1.00 (0.00)
9140	Cow	Unpleasant	1.25 (0.44)
9210	Rain	Neutral	1.95 (0.51)
9220	Cemetery	Unpleasant	1.45 (0.51)
9254	Assault	Unpleasant	1.05 (0.22)
9410	Soldier	Unpleasant	1.00 (0.00)
9433	DeadMan	Unpleasant	1.10 (0.31)
9570	Dog	Unpleasant	1.05 (0.22)

Table B.1: Mean valence ratings by picture for all male participants

B.2 Mean Valece Ratings by Subject

Subject ID	Pleasant	Neutral	Unpleasant
01	2.70	2.00	1.10
02	2.93	2.00	1.00
03	2.97	1.97	1.00
05	2.77	2.00	1.07
06	2.87	2.00	1.03
07	2.73	2.00	1.07
08	2.83	2.03	1.13
09	2.93	2.07	1.20
10	2.80	2.20	1.03
13	3.00	2.07	1.00
14	2.80	2.03	1.17
15	2.90	1.93	1.10
16	2.90	2.03	1.03
17	2.63	2.00	1.00
41	2.80	2.03	1.13
42	2.97	2.10	1.00
43	2.73	2.03	1.17
44	3.00	1.97	1.00
45	2.87	2.20	1.20
46	2.50	2.17	1.23

Table B.2: Mean valence ratings by subject

B.3 Comparison of Mean Valence Ratings by Picture from Two Sessions

Slide No.	Emotion Category	Session 1	Session 2
		Mean (SD)	Mean (SD)
1440	Pleasant	3.00 (0.00)	2.90 (0.10)
1441	Pleasant	3.00 (0.00)	3.00 (0.00)
1460	Pleasant	3.00 (0.00)	2.90 (0.10)
1710	Pleasant	2.80 (0.18)	2.80 (0.18)
1750	Pleasant	3.00 (0.00)	2.90 (0.10)
1920	Pleasant	2.80 (0.18)	2.60 (0.27)
2040	Pleasant	3.00 (0.00)	2.60 (0.27)
2070	Pleasant	3.00 (0.00)	2.60 (0.27)
2150	Pleasant	2.80 (0.18)	2.50 (0.28)
2190	Neutral	2.10 (0.10)	2.10 (0.10)
2191	Neutral	2.10 (0.10)	2.20 (0.18)
2210	Neutral	1.80 (0.18)	1.70 (0.23)
2340	Pleasant	2.80 (0.18)	2.60 (0.49)
2383	Neutral	2.00 (0.00)	2.00 (0.00)
2393	Neutral	2.10 (0.10)	2.00 (0.00)
2703	Unpleasant	1.20 (0.18)	1.10 (0.10)
2800	Unpleasant	1.00 (0.00)	1.00 (0.00)
2840	Neutral	2.00 (0.22)	2.10 (0.32)
2850	Neutral	2.10 (0.32)	2.00 (0.00)
3000	Unpleasant	1.00 (0.00)	1.00 (0.00)
3010	Unpleasant	1.00 (0.00)	1.00 (0.00)
3060	Unpleasant	1.00 (0.00)	1.00 (0.00)
3064	Unpleasant	1.00 (0.00)	1.00 (0.00)
3068	Unpleasant	1.00 (0.00)	1.00 (0.00)
3069	Unpleasant	1.00 (0.00)	1.00 (0.00)
3071	Unpleasant	1.00 (0.00)	1.00 (0.00)
3080	Unpleasant	1.10 (0.10)	1.00 (0.00)
3100	Unpleasant	1.10 (0.10)	1.00 (0.00)
3110	Unpleasant	1.00 (0.00)	1.00 (0.00)
3120	Unpleasant	1.00 (0.00)	1.00 (0.00)
3130	Unpleasant	1.00 (0.00)	1.00 (0.00)
3180	Unpleasant	1.00 (0.00)	1.10 (0.10)
3225	Unpleasant	1.00 (0.00)	1.00 (0.00)
3230	Unpleasant	1.10 (0.10)	1.00 (0.00)
3261	Unpleasant	1.00 (0.00)	1.00 (0.00)

Slide No.	Emotion Category	Session 1	Session 2
		Mean (SD)	Mean (SD)
3530	Unpleasant	1.00 (0.00)	1.10 (0.10)
4002	Pleasant	3.00 (0.00)	3.00 (0.00)
4150	Pleasant	2.50 (0.28)	2.50 (0.50)
4210	Pleasant	2.80 (0.18)	2.60 (0.49)
4220	Pleasant	3.00 (0.00)	3.00 (0.00)
4225	Pleasant	3.00 (0.00)	3.00 (0.00)
4250	Pleasant	2.90 (0.10)	3.00 (0.00)
4311	Pleasant	3.00 (0.00)	2.90 (0.10)
4659	Pleasant	3.00 (0.00)	2.90 (0.10)
4660	Pleasant	3.00 (0.00)	2.80 (0.18)
4680	Pleasant	2.90 (0.10)	3.00 (0.00)
5500	Neutral	2.00 (0.00)	2.20 (0.18)
5530	Neutral	2.10 (0.10)	2.10 (0.10)
5700	Pleasant	2.60 (0.27)	2.70 (0.23)
5833	Pleasant	2.90 (0.10)	2.60 (0.49)
5910	Pleasant	2.50 (0.28)	2.70 (0.23)
6212	Unpleasant	1.40 (0.27)	1.20 (0.18)
6313	Unpleasant	1.20 (0.40)	1.20 (0.18)
6540	Unpleasant	1.40 (0.27)	1.20 (0.18)
6560	Unpleasant	1.40 (0.27)	1.30 (0.46)
7000	Neutral	1.90 (0.10)	2.00 (0.00)
7004	Neutral	2.10 (0.10)	2.00 (0.00)
7009	Neutral	2.20 (0.18)	2.20 (0.18)
7010	Neutral	2.00 (0.00)	2.00 (0.00)
7020	Neutral	2.00 (0.00)	2.00 (0.00)
7036	Neutral	2.20 (0.18)	2.10 (0.10)
7040	Neutral	2.00 (0.00)	2.00 (0.00)
7041	Neutral	2.00 (0.00)	2.10 (0.10)
7050	Neutral	2.00 (0.22)	2.00 (0.00)
7080	Neutral	2.10 (0.10)	2.00 (0.00)
7090	Neutral	2.00 (0.00)	2.00 (0.00)
7150	Neutral	2.00 (0.00)	2.10 (0.10)
7160	Neutral	2.00 (0.00)	2.00 (0.00)
7161	Neutral	1.90 (0.10)	2.00 (0.00)
7175	Neutral	2.00 (0.00)	2.00 (0.00)
7200	Pleasant	2.90 (0.10)	2.60 (0.27)
7233	Neutral	2.10 (0.10)	1.90 (0.10)
7234	Neutral	2.00 (0.00)	1.70 (0.23)

Slide No.	Emotion Category	Session 1	Session 2
		Mean (SD)	Mean (SD)
7491	Neutral	1.90 (0.10)	2.00 (0.00)
7500	Neutral	2.00 (0.00)	2.00 (0.00)
7950	Neutral	2.20 (0.18)	2.00 (0.00)
8080	Pleasant	2.70 (0.23)	2.50 (0.28)
8190	Pleasant	3.00 (0.00)	3.00 (0.00)
8370	Pleasant	2.80 (0.18)	2.70 (0.23)
8420	Pleasant	2.70 (0.23)	2.80 (0.18)
8499	Pleasant	2.50 (0.28)	2.80 (0.18)
8501	Pleasant	2.50 (0.28)	2.30 (0.23)
9040	Unpleasant	1.00 (0.00)	1.00 (0.00)
9140	Unpleasant	1.20 (0.18)	1.00 (0.00)
9210	Neutral	1.90 (0.32)	1.70 (0.23)
9220	Unpleasant	1.40 (0.27)	1.50 (0.28)
9254	Unpleasant	1.10 (0.10)	1.00 (0.00)
9410	Unpleasant	1.00 (0.00)	1.00 (0.00)
9433	Unpleasant	1.20 (0.18)	1.00 (0.00)
9570	Unpleasant	1.00 (0.00)	1.00 (0.00)

Table B.3: Mean valence ratings by picture from two sessions for a subset of ten male subjects

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