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The effect of affective pictures on pain unpleasantness

Research Rapport

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Abstract

A lot of research has been devoted to understand the relation between pain sensitivity and the psychological state of the individual. Considerable disagreement as to the direction of the relation still exists. The question remains whether emotional states modulate the pain sensitivity. This study examines the effects of 2 experimental emotional dimensions (valence and arousal level) on pain unpleasantness. Subjects were exposed to three different affective pictures (neutral, pleasant and pain related) which varied in their degree of arousal and valence. During the presentation of a picture, an electrical stimulus was applied to the left forearm. There were two different electrical stimuli, one below the pain threshold (nonpainful) and one above (painful) the pain threshold. Participants had to rate the pain unpleasantness on a VAS. Our analyses revealed that the emotional state of a person did not modulate the pain unpleasantness when the data was not separated on gender. However, when we separated the men from the women and the two different stimulus intensities (nonpainful and painful stimuli), the analyses revealed that the VAS scores of women who received nonpainful stimuli were modulated by the picture categories. Pain related pictures caused a higher pain unpleasantness compared to the neutral and pleasant pictures. This modulation corresponded with our empathy hypothesis: seeing pictures with people in pain induces pain unpleasantness. However, there were no significant findings for women who received painful stimuli and for men there were no significant findings at all. What we can conclude is that the emotional state of women, who received nonpainful stimuli, influenced their pain unpleasantness.

Introduction

It is widely believed that pain (an unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage (Merskey, 1997)) is, in part, mediated by the emotional state of a person. This state is often estimated on two dimensions: valence (which is defined in terms of pleasantness, or in other words how positive or negative a person feels) and arousal (which reflects the subjective state of how active (excited or calm) a person feels). It is unclear however, which emotional state is responsive for the modulation of pain sensation, because different studies found different results. In general there are two different theories, which suggest different modulation effects of the emotional state on pain perception. These theories are the motivational priming theory and the empathy theory.

The motivational priming theory proposes that there are two opponent motivational systems, one system is appetitive (approaching behaviour) and the other system is aversive (avoiding behaviour). Activation of a system primes subsequent responses emanating from that system, while inhibiting responses from the opposing system (Lang, 1995; Vrana, Spence & Lang, 1988). When the appetitive system is primed by, for example viewing pleasant images, the defensive response is inhibited. When the aversive system is primed by viewing unpleasant images, defensive behaviours increase in magnitude (Vrana, et al., 1988). Following this line of reasoning one could argue that the meaning of the pain stimulus can be modified by positive and negative affect: evoked negative emotions lead to a more thorough processing of noxious stimulation while evoked positives emotions lead to a more thorough processing of pleasant stimulation and also a less thorough processing of pain perception.

An alternative possibility, of the same theory is that arousal could be the decisive factor of the level of activation of both the appetitive and aversive systems. This however, is only the case when the arousal level is high enough (Lang, 1995), so people who are highly aroused (by for example watching pain related or pleasant pictures), will value a noxious stimulus less painful than people who are not aroused. The explanation for such an effect is that arousal is closely related to distraction, which means that when people watch pictures high in arousal, their attention will be drawn away from other stimuli they received as for example a noxious stimulus. This decrease in attention will cause a reduction of the pain sensation (Arntz, Dreessen & Merckelbach, 1991). The prediction that pictures high in arousal engage the attention is shown by placing respondents in a free-viewing context; it appeared that they tend to spend more time looking at both pleasant and unpleasant pictures with increasing levels of arousal (Leventhal, 1992).

The second theory had still another view on the influence of emotional states / pictures on pain unpleasantness: empathy is the determining factor. Empathy is a complex form of psychological inference in which observation, memory, knowledge, and reasoning are combined to yield insights into the thoughts and feelings of others (Ickes, 1997). The ability to detect the immediate affective state of another person is considered to be a part of empathy (Trevarthen, 1979). The role of empathy on modulating pain sensations is clarified by Jackson, Meltzoff and Decety (2005). The results of their study showed that pain unpleasantness was significantly higher for pictures with painful stimuli compared with the pain unpleasantness of the neutral pictures, because the participants seemed to feel the pain themselves. From another study of Godinho, Magnin, Frot, Perchet and Garcia-Larrea (2006), the results showed that pain intensity reports significantly increased when painful stimuli were concomitant to images showing humans in pain, whereas pictures with identical emotional values but without somatic content failed to modulate pain.

Since these two theories suggest three different influences of affective pictures on pain unpleasantness, it is still unclear which emotional state has the largest modulation effect on the pain unpleasantness. De Wied and Verbaten (2001) already tried to examine this obscurity. They wanted to research whether attention, priming or pain cues mediated the effects of affective pictures on pain tolerance. To examine this they conducted two experiments, experiment 1 tested whether attention mediated the effects of affective distracters on pain tolerance, or whether cognitive processes of priming and appraisal best accounted for the effects. They used three categories of affective pictures: pleasant, neutral and unpleasant. Experiment 2 was conducted to examine the role of pain cues in pictures in the effects of negative affect on pain tolerance. In this last experiment the unpleasant pictures of experiment 1 were used and assigned to a pain-cue set or a non-pain cue set. To measure the pain tolerance they used a cold pressor test in both experiments: this measurement is done by requiring a participant to place their hand in an ice water container for as long as they can. Once the pain is unbearable (pain tolerance level) the participant removes his / her hand out of the water. In the experiments, pictures were presented while the participants had their hand in the water, when the hand was pulled out of the water the picture disappeared of the screen. The results of experiment 1 revealed that pain tolerance scores were significantly higher for pleasant pictures and significantly lower for the unpleasant pictures compared to neutral pictures, with a linear trend. This trend was consistent with the priming motivation theory. The results of experiment 2 showed that respondents who viewed non-pain pictures tolerated the cold water for a longer period of time than respondents who viewed pain pictures. These latter results supported the empathy theory: seeing someone in pain evokes higher pain perception or lower pain tolerance.

The results of the experiment of de Wied and Verbaten (2001) definitely showed some remarkable cues for the fact that emotional states indeed modulate the pain perception, however there were also some disadvantages in their experiments. The most important weaknesses of de Wied and Verbaten (2001) were that they (1) used a cold pressor test, (2) not determined the arousal values in the second experiment for the pain and nonpain pictures and (3) that they could not compare the pain and non-pain pictures to neutral and pleasant pictures, since these pictures were rated by different participants. The disadvantage of the cold pressor test is that the participants could stop the presentation of the unpleasant picture by withdrawing their hand out of the water. The fact that the unpleasant picture disappeared could be the reason the participants pulled their hands back, rather than the actual pain they felt in their hand. Further because the arousal levels of the pain and nonpain pictures were not determined, it is not 100% sure that empathy modulated pain tolerance: arousal could also be the determining factor. Namely, when the nonpain pictures had a higher arousal level than the pain pictures, the heightened pain tolerance in the pain pictures could also be due to the lower arousal level and not to the pain property in the pictures.

Since there were shortcomings in the experiment of de Wied and Verbaten (2001) their results did not provide convincing conclusions and it is thus still unclear which emotional state of a person modulates the pain perception. To further examine the question of which emotional state modulates the pain perception we conducted an experiment in which the emotional state of a person was influenced by means of neutral, pleasant and pain related pictures. Neutral pictures caused a medium valence and a low arousal state, pleasant pictures caused both high valence and arousal states, and pain related pictures caused a low valence and a high arousal state. During the presentation of a picture, the participant was exposed to an electrical stimulus which was evoked by a constant current stimulus generator, which produced electrical shocks / stimuli on the arm. Next, the pain unpleasantness of the stimulus was judged on a visual analogue scale (VAS). This is an instrument that tries to measure (for example) the amount of pain, ranged across a continuum from none to a maximum tolerated amount of pain. Operationally a VAS is usually a horizontal line, 100 millimetres in length, anchored by word descriptors at each end and in the middle, as illustrated in Figure 1. The participant marked the point on the line that he / she felt to represent the perception of the pain unpleasantness. This scale of pain has been demonstrated to be a reliable generalizable internally consistent measure of clinical and experimental pain sensation intensity (Price, McGrath, Rafii & Buckingham, 1983; Price & Harkins, 1987), a separate measure of pain sensation intensity and pain unpleasantness (Price et al., 1983) and a relatively sensitive measure of effects of analgesic treatments (Price, Harkins, Rafii & Price 1986). An important related advantage of VAS for the participants is that, unlike whole numbers and words, they provide an unlimited number of possible responses along a single continuum (Scott & Huskisson, 1976). However, this advantage can also be seen as a disadvantage, since it makes the VAS data more difficult to analyse.

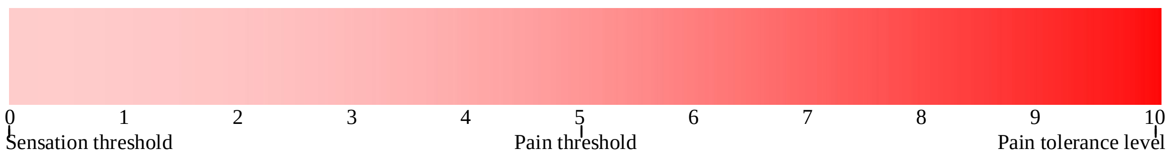

Figure 1

The visual analogue scale we used in our experiment, at which participants could mark how intensive the electrical stimulus felt

Although our experiment had some similarities with the experiment of de Wied and Verbaten (2001), the two experiments also differentiated on some remarkable points: we removed the disadvantages of the experiment of de Wied and Verbaten (2001). First we used a constant current stimulus generator, which produced electrical stimuli and could measure pain unpleasantness. This is different form the cold pressor task because in our experiment participants did not have the opportunity to stop the presentation of the pictures by withdrawing their hands from the water. Further we determined the arousal levels of all the pictures, so we could be sure what the cause of the pain influence is. The last obvious dissimilarity of our experiment compared to the one of de Wied and Verbaten (2001) was that we had the opportunity to compare the pain related pictures with the neutral and pleasant pictures within the subjects, so we knew exactly what the differentiations were between all the picture categories in our experiment.

Because of the discord between findings of earlier experiments, we had multiple expectations of our study. These expectations were based on the two theories discussed before. Our application of the motivational priming theory predicted that exposure to pain related images (low in valence) should activate the aversive system and amplify pain, whereas pleasant images (high in valence) should activate the appetitive system and reduce pain. In other words, if the motivational priming theory played a determining role, pain unpleasantness would be determined by valence, where the pain unpleasantness would be highest in pain related pictures, medium in neutral pictures and lowest in pleasant pictures. This was called our motivational priming hypothesis and is already illustrated by for example Vrana et al. (1988), Greenwald et al. (1998) and De Wied and Verbaten (2001). All the experiments showed a linear trend of pain unpleasantness, where negative pictures caused an induced pain unpleasantness and positive pictures a reduce pain unpleasantness, compared to neutral pictures.

However, if emotional distraction had a larger influence on pain unpleasantness by drawing attention away from the electrical stimulus, arousal had a determining role. In this way, pain unpleasantness would be reduced by pictures high in arousal (pleasant and pain related pictures), relative to pictures low in arousal (neutral pictures), this was our attention hypothesis. Leventhal (1992) also studied this emotional distraction, his findings were that people seem to focus their attention more to something high in arousal compared to an object low in arousal. This focusing of attention (for example on an arousing picture) seemed to be the reason for less attention to the rest of the environment, for example a electrical stimulus and this caused a lower pain unpleasantness (Arntz et all., 1991).

Our last hypothesis, the empathy hypothesis could be seen as a variant of the motivational priming hypothesis, only here pleasant pictures would not reduce the pain unpleasantness, on the contrary, pain related pictures would still enhance pain unpleasantness. This effect of affective pictures on pain unpleasantness is already shown by Jackson, Meltzoff and Decety (2005). They revealed that pain related pictures caused a higher pain unpleasantness than pictures with no pain. If this emotional process was the strongest, pleasant and neutral pictures would cause a similar pain unpleasantness whereas pain related pictures caused a high pain unpleasantness.

To sum up, we wanted to examine whether pain unpleasantness was mediated by the valence scores in pictures (motivational priming theory), by the arousal scores in pictures (attention dependent) or by the degree of pain in pictures (empathy), see Figure 2. Besides these three hypotheses of the theories, we also wanted to make sure that the intensity of the electrical stimuli (nonpainful and painful) caused different pain unpleasantness.

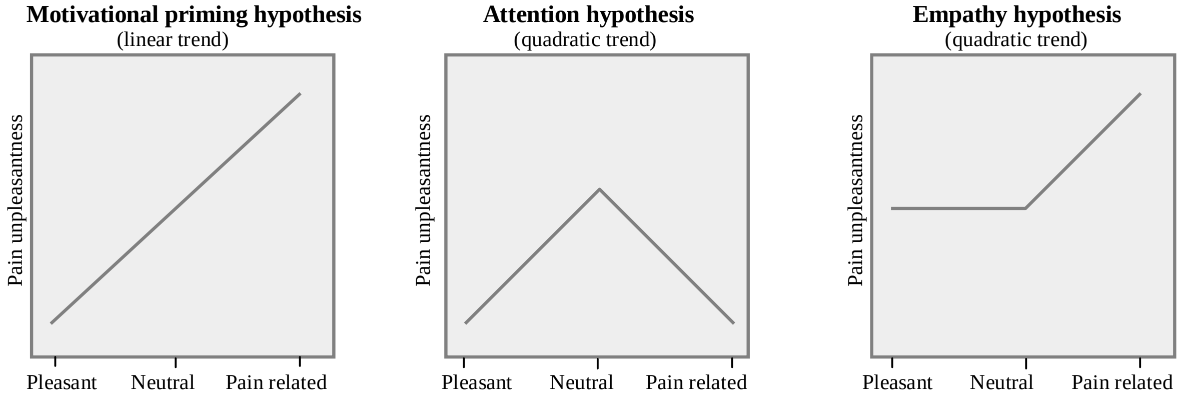

Figure 2

The three hypotheses in graphics. We expect to find a linear trend if priming or appraisal is the dominant factor and a curvilinear trend when attention is the dominant factor. If empathy is dominant factor, we expect to find the trend shown in the third graphic.

To carry out our experiment, we first sought pictures that represented the three different affective picture categories (neutral, pleasant and pain related) in their degree of arousal and valence levels we mentioned before. Almost all the images were taken from the International Affective Picture System (IAPS) of Lang, Bradley and Cuthbert (2005), which includes images that have already been rated as representative examples on valence and arousal. Prior validation studies indicated that these stimuli provide an effective method for evoking emotional reactions (Lang, 1995; Lang, Bradley & Cuthbert, 1999). To verify that the pictures evoked the right levels of valence and arousal comparable to our prior norms, we ran a pilot test (experiment 1) with two different picture sets. Both the picture sets included the three picture categories (pleasant, neutral and pain related) and were rated on their valence and arousal levels. The set which most complied with the norms of the valence and arousal scores, was chosen to use in our actual experiment (experiment 2). To decide which set was the most suitable, the subjects in the pilot test rated the degree of pleasantness (valence) and arousal elicited by the images on an 11-point scale.

Our choice of which of the two sets we used in the real experiment was first dependent on the valence and arousal values of the three different categories of affective pictures. All the picture categories needed to differ from each other in their valence and arousal scores: neutral pictures should have a medium valence score of approximately 5 and a arousal score of lower than 5; pleasant pictures should score higher than 5 on both valence and arousal and pain related pictures should score lower than 5 on valence and higher than 5 on arousal. Further, it was important that the mean arousal and valence scores of the pictures were well clustered for each category. For example, the arousal and valence scores of the pleasant pictures should not overlap with the neutral pictures. In other words, the spread of the scores within a picture category should be minimal, but between the categories maximal.

For the most proper picture set, we finally studied whether gender affected the arousal and valence scores of the different picture categories. The reason we wanted to examine this is because Lang et al. (2005) showed in their study that men and women rated pictures different on valence and arousal. More researchers have found differences between men and women in the effects of emotional influences. For example Bradley, Codispoti, Sabatinelli and Lang (2001) concluded that women showed a broad disposition to respond with greater defensive reactivity to aversive pictures, whereas increased appetitive activation was apparent for men only when viewing erotica. Possible mediators of these sex differences in emotional responses are biological and sociocultural factors. These findings were important to our study because we wanted to examine the influences of the emotional state on pain unpleasantness. If it appeared that there are significant differences between the genders on their emotional states, we needed to take this into account in experiment 2.

With the chosen picture set, we finally carried out the actual experiment and by means of the gathered data of experiment 1 we could determine the influence of the different picture categories (emotional states) on the pain unpleasantness.

EXPERIMENT 1

Method

Participants

Two hundred and three healthy people (138 females, 61 males and 4 people whose age and sex was unknown) aged between 18 and 53 years (mean = 20.7, SD = 3.7) participated voluntarily in the study. There were no criteria the participants should meet.

Materials

We used two different picture sets (picture set 1 and 2), both sets included 120 different digital colour pictures: 40 pictures for each of the three picture categories (pleasant, neutral and pain related). The pictures from picture set 1 were intuitively chosen. In other words, the pictures were chosen on basis of personal arousal and valence perception. The pictures of picture set 2 were chosen by means of the valence and arousal scores, which were already established by the IAPS. The identification numbers and the picture description of the chosen IAPS pictures are shown in Appendix A. Because the IAPS does not have sufficient pain related pictures, we chose to fill up the deficit of images showing painful events in set 1 by 36 pictures from other researchers. We used 27 pictures from a research of Jackson, Brunet, Meltzoff and Decety (2006), which show painful events of right hands and feet. Another nine pictures came from a study of Ogino, Nemoto, Inui, Saito, Kakigi and Goto (2007), these were pictures including needle insertion. In set 2 we did not use any pain related pictures of the IAPS, but used pictures of Jackson et al. (2006) and of Ogino et al. (2006).

Table 1 shows the mean valence and arousal values of the pictures that were used in the pleasant, neutral and pain related categories of picture set 1 and 2 according to the IAPS. In the IAPS the pictures were valued on a 9-point scale, however we chose to value the pictures on an 11-point scale. The reason for this is because the 11-point scale is more sensitive than a 9-point scale and in experiment 2 we also used an 11-point scale.

	Set 1		Set 2	
Pictures	Valence (SD)	Arousal (SD)	Valence (SD)	Arousal (SD)
Pleasant	6.94 (0.68)	5.48 (0.83)	7.16 (0.48)	4.93 (0.32)
Neutral	5.00 (0.34)	2.84 (0.57)	5.05 (0.29)	2.67 (0.43)
Pain related	15.61 (0.31)	19.46 (0.31)	-	-

Table 1

Mean arousal and valence values of the IAPS pictures that were used for the pleasant, neutral and pain images. IAPS norm scores were transformed from a 9 to 11 point scale and now ranged from 0 (low arousal, low valence) to 10 (high arousal, high valence)

Task

The participants had to rate 120 pictures (either the pictures of set 1 or the pictures of set 2) on their valence or arousal. To rate their personal level of valence or arousal, the participants marked a location on an 11-point scale, which best reflected their present feelings. There were four different scales in experiment one, two scales for each emotional state (valence and arousal). The valence scales ranged from pleasant (0) to painful (10) and from unhappy (0) to happy (10). The arousal scales ranged from boring (0) to exciting (10) and from stressful (0) to soothing (10).

Procedure

As mentioned before, there were four different 11-point scales and each participant rated the pictures of only one picture set and on only one scale. This means that there were eight groups of participants, four groups who rated the pictures of picture set 1 and four groups who rated the pictures of picture set 2. Further a participant only rated the pictures on one emotional state, either valence or arousal. The reason participants only rated one picture set and on only one scale is to overcome interscaling effects: we did not want participants to be influenced by a prior scale while they rated pictures on a second scale. The valence scales differed from each other in that the two 11-point scales were inverted compared to each other. The arousal scales differed in the same way as the valence scales. See Table 2 for the description differences between the scales, the number of participants and mean age of each four scales separately.

The 120 pictures were presented in a random order on a computer screen with a speed of 2 seconds per picture. Participants could pause the pictures at any time if the presentation rate appeared to be too fast. There were blocks of 10 pictures where after a black slide was presented to signal the participant that the next 10 pictures would be presented. Pictures were rated on an 11-point scale (0-10) by means of a paper and pencil test.

	Scale	N (men/women)	Mean age
Set 1	Valence (0 = pleasant/unhappy - 10 = painful/happy)	52 (17/32)	21.82
	Arousal (0 = boring/stressful - 10 = exciting/soothing)	52 (22/29)	20.47
Set 2	Valence (0 = pleasant/unhappy - 10 = painful/happy)	49 (12/37)	20.41
	Arousal (0 = boring/stressful - 10 = exciting/soothing)	50 (10/40)	20.29

Table 2

The descriptions of the scales and the number of participants per scale in the pilot test, with corresponding mean ages

Apparatus

We used a Pentium IV 3.00 GHz computer with 1 GB RAM and 128MB video memory. The computer screen has a resolution of 1024 x 768, 32 bit, 70 Hz and 96 dpi. The subjects sat at about 60 centimetres in front of the screen.

Statistical analyses

The effect of the picture categories on the emotional states of the participants was assessed using the chi square test and the one-way repeated measures ANOVA.

Almost all the data from experiment 1 was analysed with a chi square test. The reason we chose the chi square test is because we got to face the irregular ratings of the scales. The chi square test investigates whether distributions of categorical variables differ from each other. In our case, the chi square statistic compared the counts of the VAS scores (dependent variable) between the three picture categories (independent variable). It measured for example if the valence score 1 was just as often given for pleasant pictures than for pain related pictures. What we tested was thus if there was a relation between the category of the affective pictures and the valence and arousal ratings of the participants, or in other words, if the valence and arousal scores significantly differed between the picture categories.

We also chose to analyse some of the data with a one-way repeated measures ANOVA, which is a very popular analysing device among examiners in this field of research (Price, Bush, Long & Harkins, 1994; Godinho, et al., 2006; Cepeda & Carr, 2003). The one-way repeated measures ANOVA tested if the means of the conditions (the mean scores of a person on valence and arousal for pleasant, neutral and pain related pictures) are similar or different from each other. In this analysis the within factor was the category of the picture and the dependent variables were the valence and arousal scores of the picture on the 11 point scale.

Results

The mean valence and arousal scores on the 11-point scales are displayed in Table 3 per picture category.

	Picture set 1		Picture set 2	
Picture Categories	Valence (SD)	Arousal (SD)	Valence (SD)	Arousal (SD)
Pleasant	7.19 (2.09)	5.08 (2.66)	7.87 (2.00)	4.24 (2.74)
Neutral	5.06 (1.72)	2.84 (2.25)	5.79 (2.28)	2.83 (2.27)
Pain related	2.00 (1.75)	7.31 (2.27)	2.05 (1.77)	7.18 (2.14)

Table 3
The mean scores and standard deviations of arousal and valence for each picture category and set separated

Valence

For picture set 1 we found significant influences of the picture categories neutral and pain related on the valence scores (χ^2 = 2,305.28; df = 10, $p < 0.001$), this was also the case for neutral and pleasant pictures (χ^2 = 1,503.40; df = 10, $p < 0.001$) and also for pain related and pleasant pictures (χ^2 = 3,009.97; df = 10, $p < 0.001$). As can be seen in Table 3, highest valence ratings were obtained for the pleasant pictures (7.19), and lowest for the pain related pictures (2.00), with mean valence ratings for the neutral pictures (5.06). These effects were also found for picture set 2 (χ^2 = 2,295.84; df = 10, $p < 0.001$; χ^2 = 962.66; df = 10, $p < 0.001$; χ^2 = 3,131.25; df = 10, $p < 0.001$ respectively). Here again pleasant pictures were rated the highest (7.87), neutral pictures medium (5.79) and pain related pictures scored lowest on valence (2.05). These analyses showed that for both picture sets the valence scores were affected by the picture categories: people felt more positive when they saw pleasant pictures and more negative when they saw pain related pictures in comparison with neutral pictures. See Appendix A for an example of the chi square analysis (cross table) we performed with SPSS, with a corresponding bar chart of the valence scores.

Further, the mean valence scores of both picture sets met the criteria: neutral pictures had a valence score of approximately 5, pleasant pictures had a valence higher than 5 and pain pictures had a valence lower than 5 (see Table 3).

Arousal

For picture set 1, we found a significant influence of the picture categories neutral and pain related on the arousal scores (χ^2 = 2,241.32; df = 10, $p < 0.001$), this influence was also significant for the neutral and pleasant pictures (χ^2 = 800.36; df = 10, $p < 0.001$). For the completeness we also analysed the difference between the arousal scores of the pain related and pleasant pictures. It turned out that these scores also significantly differed between the picture categories (χ^2 = 730.39; df = 10, $p <$ 0.001). Neutral pictures scored lowest on arousal (2.84), pleasant pictures scored medium (5.08) and pain related pictures scores highest on arousal (7.31). Again these influences were also found for picture set 2 (χ^2 = 2,115.40; df = 10, $p < 0.001$; χ^2 =341.04; df = 10, $p < 0.001$ and χ^2 = 1,093.75; df = 10, $p < 0.001$ respectively). In picture set 2 neutral pictures received also the lowest arousal scores (2.83), pleasant pictures scored medium (4.24) and pain related pictures scored highest (7.18). The arousal scores are (just as the valence scores) affected by the picture categories: people felt exited while they viewed pleasant and pain related pictures and calm when they viewed neutral pictures.

For the mean arousal scores of picture set 1 and 2, we acknowledged that all the criteria for the minimum and maximum rating scores were met, except for the pleasant pictures of picture set 2. The goal was to reach a mean arousal score above 5, whereas the score of set 2 merely reached a rating of 4.24 (see Table 3).

Picture category separation

See Figure 3 for the scattered mean valence and arousal scores per participant. By means of a two-way repeated measures MANOVA, with picture category as the within subjects variable, picture set as the between subjects variable and valence and arousal as dependent variables it was shown that the picture sets differed in their valence and arousal ratings ($F_{(2, 98)}$ = 7.17; p = 0.001).

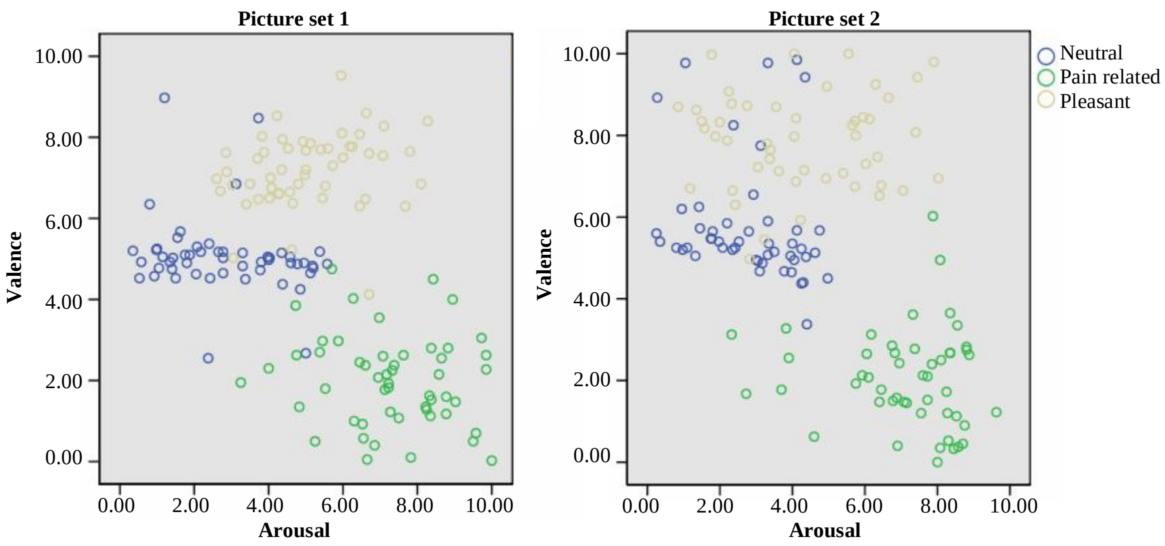

Figure 3

For both the picture sets, the scattered mean valence and arousal scores of the participants for each picture category

Next we tested whether the arousal and valence differences between the picture categories are set dependent. See Table 4 for the difference scores between the picture categories within the picture sets. With the same test as before (MANOVA), it appeared that when taken valence and arousal together, there was no significant interaction effect between picture set and picture category ($F_{(4, 96)} = 2.01$; $p = 0.099$), however the significance level of 0.099 showed that there was a trend. When we analysed this further, we found a significant difference between the picture sets when neutral and pain related pictures were compared to each other on their valence scores ($F_{(1, 99)} = 4.20$; $p = 0.043$). It appeared that picture set 2 showed a larger difference between the valence scores of neutral and pain related pictures (3.74) compared to picture set 1 (3.06), see Table 4. Picture set 1 and 2 were similar in their valence differentiations between pain related and pleasant pictures ($F_{(1, 99)} = 2.78$; $p = 0.099$) and also between pleasant and neutral pictures ($F_{(1, 99)} = 0.06$; $p = 0.806$). There were no significant differences between the two sets in their arousal scores per picture category ($F_{(2, 198)} = 1.50$; $p = 0.214$).

	Picture set 1		Picture set 2	
Picture Categories	Valence	Arousal	Valence	Arousal
Pleasant - Neutral	2.13	2.24	2.08	1.41
Neutral – Pain related	3.06	-4.47	3.74	-4.35
Pain related – Pleasant	-5.19	2.23	-5.82	3.56

Table 4

The mean difference scores of arousal and valence between all the picture categories

Picture set choice

On basis of the analyses results, we chose picture set 1 for experiment 2. The reason for this decision was the low mean arousal score for the pleasant pictures of picture set 2. It merely reached 4.24 while it should have reached at least an arousal score of 5.00. Although the picture categories of picture set 2 differed better compared to picture set 1, this difference was not that convincing, since the first analysis already revealed an insignificant interaction effect between picture set and picture category. Because we found it more important that the picture categories reached the right mean valence and arousal scores, we chose picture set 1 to use in experiment 2.

Gender differences

First of all, we calculated the mean arousal and valence scores of both men and women from picture set 1. The scores are divided among the three affective picture categories, see Table 5 and Figure 4.

	Men		Women	
Conditions	Valence (SD)	Arousal (SD)	Valence (SD)	Arousal (SD)
Pleasant	6.80 (2.25)	4.75 (2.57)	7.30 (1.99)	5.23 (2.66)
Neutral	4.73 (1.84)	2.85 (2.13)	5.22 (1.67)	2.89 (2.31)
Pain related	2.57 (2.01)	6.96 (2.30)	1.70 (1.54)	7.53 (2.23)

Table 5

The mean scores and standard deviations of the arousal and valence scores from men and women on each picture category

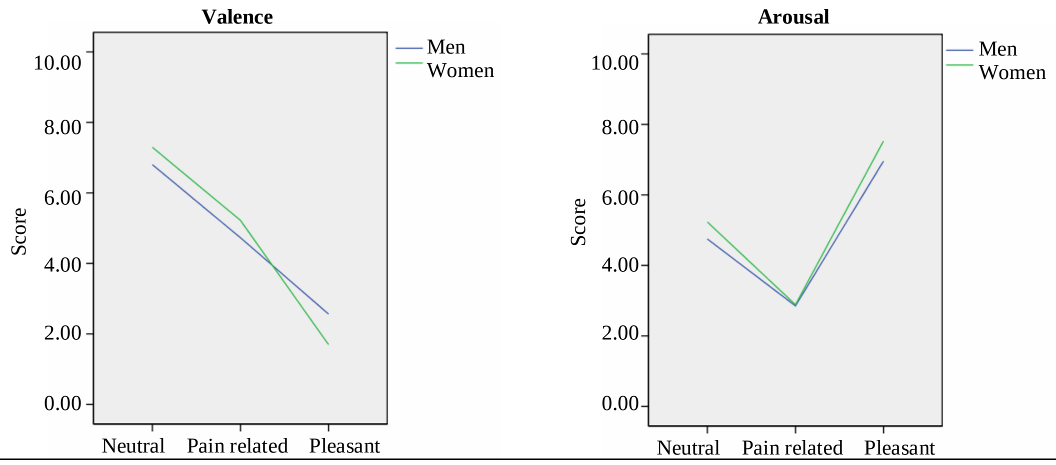

Figure 4

The mean scores of men and women on valence and arousal for each picture category

To see whether there were differences between the valence and arousal scores of men and women, we first discuss the chi square test results; they revealed that the valence scores are influenced by gender in all the picture categories, in neutral pictures women gave higher scores (5.22) than men (4.73) ($\chi^2 = 53.29$; df = 10, $p < 0.001$), for pain related pictures the opposite was true, men gave higher scores (2.56) than women (1.70) ($\chi^2 = 119.65$; df = 10, $p < 0.001$) and for pleasant pictures women again gave higher valence scores (7.30) compared to men (6.80) ($\chi^2 = 52.38$; df = 10, $p < 0.001$). This effect of gender was also present in the arousal scores: gender had a significant relation with arousal scores in neutral pictures, where women gave higher scores for all the pictures: neutral pictures (2.89) ($\chi^2 = 27.35$; df = 10, $p = 0.002$), pain related pictures (7.53) ($\chi^2 = 88.28$; df = 10, $p < 0.001$), and pleasant pictures (5.23) ($\chi^2 = 29.91$; df = 10, $p = 0.001$) compared to men (2.85; 6.96 and 4.65 respectively). This meant that gender in fact is a mediating factor for both arousal and valence scores.

Further, when analysing the data with a one-way repeated measures ANOVA with picture category as the within subject factor and gender as the between subject variable, gender again appeared to have an interaction effect on the valence and arousal scores in the picture categories ($F_{(2, 46)} = 184.79$; $p < 0.001$; $F_{(2, 48)} = 127.02$; $p < 0.001$ respectively). This indicated that the differences between men and women were not all the same in the picture categories. In Figure 4 this interaction effect is visible: the lines of men and women are not parallel.

Discussion

In this experiment we investigated the emotional response (valence and arousal) to different sorts of affective pictures, namely pleasant, neutral and pain related pictures. From these two sets, we wanted to choose the set which was most consistent with our valence and arousal criteria.

Our results showed that both picture sets were almost equal in their mean valence scorings per picture category. All the categories of picture set 1 differed from each other, just as picture set 2. Further, the mean arousal and valence scores of all the picture categories met the criteria of our prior norms.

The arousal scores, on the other hand, had different results. Here both sets again did meet the criteria of different arousal scores per picture category: in both sets the neutral pictures differed in their scores with the pleasant and pain related pictures. However, not all the arousal scores of picture set 2 met the criteria: the pleasant pictures of this set did not evoke an arousal score above 5.

The group differentiation analyses showed that when picture set 1 was compared with picture set 2, they were almost similar except for one point: in picture set 2 the pain related pictures differed more in their valence scores of the neutral pictures compared to picture set 1.

Although the picture categories of picture set 2 were more separated, we chose picture set 1 to use in experiment 2, because the analysis showed that the difference between picture set 1 and 2 were not that compelling and also because picture set 1 had a higher arousal score (above 5) in the pleasant picture category, the pleasant pictures of picture set 2 scored lower than 5 and that was a big disadvantage for picture set 2.

For picture set 1 we directly analysed whether there were any differences between men and women on their valence and arousal ratings, since other experiments established that affective pictures did not have the same effect on men and women (Bradley et al., 2001). The results told us that gender did influence the ratings of the two different emotional dimensions. Men tended to rate valence higher on pain related pictures than women did and men rated valence lower on neutral and pleasant pictures compared to women. For the arousal scores men gave lower scores compared to women on all the picture categories.

However, because some participants took part in the experiment anonymous (no gender and age information was known), we could not use their scores in the mean gender valence and arousal scores. This caused that not all the arousal scores of men reached the minimum rating criteria. This is the case for the arousal ratings of pleasant pictures. These ratings were namely supposed to be higher than 5, this was the case when men and women were taken together, their arousal score was 5.06. However, the mean arousal score for the pleasant pictures of men only merely reaches 4.75. We should take this fact into consideration with the findings of experiment 2.

EXPERIMENT 2

Method

Participants

Nineteen healthy right-handed people (9 females and 10) aged between 18 and 25 years (mean = 20.74, SD = 2.33) participated in the study. They did not have knowledge about the purpose of the experiment. Most of them signed in for the experiment by an Internet site used by the University of Twente to recruit subjects. Participants, who took part in the experiment via the site, got credits for their participation. There were also seven subjects who participated voluntarily.

Criteria for the participants were that they were right-handed; had a normal or corrected to normal sight; were older than 18 years and younger than 25; did not have any pain sensation not caused by the experiment; did not use any drugs in the past month; did not have psychological or neurological disorders; did not use coffee, thee or cola in front of the experiment; did not drink alcohol 24 hours ahead of the experiment.

All the subjects gave their written informed consent after the explanation of the experimental protocol. The study was approved by the ethics committee of the Radboud University (Nijmegen) and the University of Twente.

Materials

We used picture set 1 for the experiment, for picture description and identification numbers of the IAPS see Appendix B. Participants needed to respond to the stimuli on a VAS on the computer.

Task

Participants had to judge an electrical shock / stimulus evoked by a constant current generator that was given during the presentation of different pictures. The experiment contained 120 images belonging to three affective categories: images showing painful events, images showing pleasant events, and images evoking rest (neutral events), three examples of the pictures are visible in Figure 5.

Figure 5

Example of pleasant (A), neutral (B) and pain related (C) images

Electrical stimuli

There were two different electrical stimuli, nonpainful (below pain threshold: a VAS score lower than 5) and painful (above pain threshold: a VAS score higher than 5). The participants were not aware of the amount of different electrical stimuli. The nonpainful and the painful stimuli were equal in mA, however during the nonpainful stimuli, the electrical shock of 2 milliseconds was just given once, but when a person received a painful stimulus, the same stimulus was given 5 times in a row, with 5 milliseconds between each shock. We determined the mA in front of the experiment by exposing the participants to subsequent electrical shocks by use of a program called HyperTerminal. We started with 0.1 mA (with duration of 2 milliseconds and a repetition of 5 times) and raised every time with 0.1 mA. The participants had to judge the stimuli on the VAS. The painful stimulus was established on three quarters between the pain threshold (VAS score 5) and on pain tolerance level (VAS score 10). To be sure we had two electrical stimuli from which one is below the pain threshold (nonpainful) and the other one is far enough above pain threshold (painful), we conducted a small test of six different pain stimuli, which the participant needed to value on the VAS (a recheck). This is important because the participants could habituate to the electrical stimuli and rate them lower than they did before. If habituation occurred and participants rated the painful stimuli below a VAS of 7, we re-establish the mA values.

The chosen current for the experiment varied among the participants between 1.2 and 7.2 mA, with a mean of 3.65 mA. The mean VAS score of the nonpainful stimulus in the experiment was 3.6 and the painful stimulus had a mean VAS score of 7.2.

Procedure

When the participant entered the room we introduced ourselves as the researchers who guided the experiment. Next the participant received information about the experiment on paper and filled in the Annett Handedness Inventory and the Thayer Mood scale. The subject was verbally informed about how the experiment should continue and that he or she had the opportunity to stop at any time he or she wanted. Finally we asked the participant if he or she used medicines or feels pain at the moment.

Next dead skin of the left forearm of the participant was removed by use of a nail file. This is an important step because we wanted to reduce the impedance. Low impedance is necessary to conduct the electrical shocks. The maximum impedance was 30 kOhm. We cleaned the arm with alcohol and the two electrodes of the constant current stimulus generator were connected to this arm with tape. The electrodes were placed in the length of the arm and were filled with conduction gel so the electrical stimulus was conducted and received well. The electrode most closely to the hand send the shock (this is the place the participants really felt the shock), the other electrode took the electrical shock back in.

When the electrodes were correctly connected to the arm of the participant, we verified the nonpainful and painful stimuli. Once the value of the electrical stimuli was established, we did a short recheck (see above: *electrical stimuli*).

Before the experiment started, we explained to the participants that an electrical stimulus that is painful (above pain threshold), should be valued above a VAS score of 5. Next, the experiment started with two practice trials, after this the lights were dimmed and the real experiment began. We went to the room next to it with a see-through mirror from our side. The experiment consisted of four blocks with 30 pictures and 30 electrical stimuli each. Between the blocks, a pause of 3 minutes was given. The sort of electrical stimulus was semi random assigned to the pictures, which means that in one picture category of 40 pictures there were 20 pictures with nonpainful stimuli and 20 pictures with painful stimuli. This semi random assignment gave us the opportunity to compare the electrical stimuli within a picture category.

The experiment took about 2 hours from which 40 minutes were used for the actual test. The reason for the spare time of 1 hour and 20 minutes is because in this experiment EEG was also measured and this preparation was time-consuming.

Setup Trial

The experiment began with a black screen with a white fixation cross in the middle for 6 seconds. Hereafter a picture was presented and participants were allowed to move their eyes across the screen. Three till three and a half seconds after the onset of the picture, an electrical stimulus was presented (interstimulus interval). Then 3 seconds after the pain stimulus, the VAS is shown. When the participant clicked on a spot of the VAS, the next black screen appeared. See Figure 6 for the time spam. The reason we varied the time between onset of the picture and electrical stimuli is to avoid anticipation: by varying the interstimulus interval the participants could not predict the onset of the electrical stimuli.

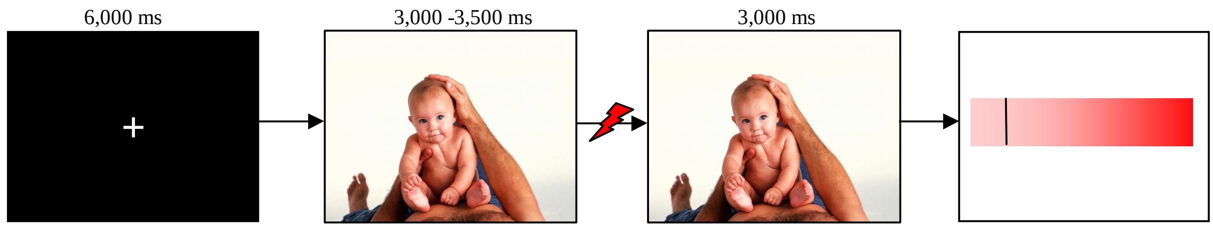

Figure 6

Time spam of sequence of the trials in the experiment. First a black screen with a white fixation cross for 6,000 milliseconds, then is the picture presented, 3,000 till 3,500 milliseconds hereafter the electrical stimuli ( ) is given, in the mean, the picture stays on the screen and will be for another 3,000 milliseconds and then the VAS appears on the screen on which the participants need to rate their pain level.

Apparatus

We used a Pentium IV 3.00 GHz computer with 1 GB RAM and 128MB video memory. The computer screen had a resolution of 1024 x 768, 32 bit, 70 Hz and 96 dpi. The subjects sat about 60 centimetres in front of the screen. For the electrical stimuli we used a Constant Current Stimulus Generator (2005.101) from the Radboud University in Nijmegen.

Statistical analysis

The effect of the emotional contents of the images on the pain unpleasantness was assessed using the one-way repeated measures ANOVA and the chi square test.

To explicitly test differences between the VAS ratings of experimental pain, each participants mean VAS rating of each intensity and picture category served as the dependent variable in a repeated measures analysis of variance (ANOVA), with picture category (pleasant, neutral and pain related) and stimulus intensity (painful and nonpainful) as within variables and gender as between variable.

Because the VAS scores are subjective scores, these scales are of most value when looking at change within individuals, and are of less value for comparing across a group of individuals at one time point (Conover & Iman, 1981). For this reason we ranked the VAS scores of each participant individually from 1 till 120 (each participant rated 120 electrical stimuli). These ranked scores could only be analysed by the chi square test.

Because of gender differences in response to both pain (Derbyshire, Jones, Gyulai, Clark, Townsend & Firestone, 1997; Keogh and Birkby, 1999) and the affective pictures from the IAPS, we not only analysed men and women together, but also separately.

Results

One-way repeated measures ANOVA

We performed a one-way repeated measures ANOVA with the within and between variables just mentioned in *statistical analysis*. The mean normal and ranked VAS scores for men and women are displayed in Table 6.

Gender	Intensity of the stimuli	Normal scores (SD)
Men	Nonpainful	-178.37 (173.68)
	Painful	152.38 (150.23)
Women	Nonpainful	-270.91 (104.28)
	Painful	120.16 (116.55)
Total	Nonpainful	-222.20 (152.14)
	Painful	137.12 (136.22)

Table 6

Mean normal VAS scores and standard deviation of both men and women from nonpainful and painful stimuli

Electrical stimulus

There was a significant effect of the stimulus intensity on the pain unpleasantness (VAS scores) ($F_{(1, 17)}$ = 125.38; $p < 0.001$): painful stimuli evoked a higher pain unpleasantness (137.12) on the VAS compared to nonpainful stimuli (-222.20).

There was no interaction effect between intensity of the stimuli and gender ($F_{(1, 17)}$ = 0.89; p = 0.363), this meant that the difference of VAS scores between painful and nonpainful stimuli were the same for both men and women and that painful stimuli evoked different VAS ratings of both men (152.38) and women (120.16) than the nonpainful stimuli (-178.37 and -270.91 respectively).

Picture category

The mean normal VAS scores of men and women for the different picture categories and for the nonpainful and painful stimuli are visible in Table 7 and Figure 7.

		Normal scores (SD) per picture category		
Gender	Stimulus intensity	Pleasant	Neutral	Pain related
Men	Nonpainful	-180.65 (170.36)	-186.23 (168.22)	-168.23 (182.51)
	Painful	157.54 (149.57)	138.23 (149.33)	161.38 (151.51)
Women	Nonpainful	-297.06 (87.04)	-278.83 (95.40)	-236.83 (118.95)
	Painful	106.35 (118.39)	118.69 (10.94)	135.44 (121.68)
Total	Nonpainful	-235.79 (149.01)	-230.09 (145.94)	-200.72 (159.22)
	Painful	133.29 (137.92)	128.97 (131.55)	149.09 (138.62)
	Total	-51.25 (143.51)	-50.56 (138.75)	-25.82 (148.92)

Table 7

Mean normal VAS scores and standard deviation of both men and women of nonpainful and painful stimuli and for each picture category

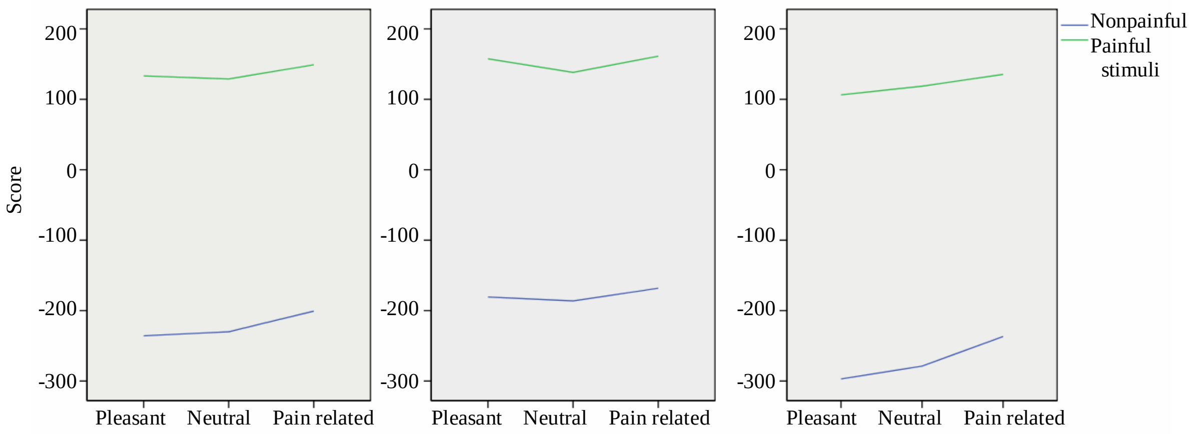

Figure 7

Graphic of the mean male and female normal VAS scores for each picture category and of the two different electrical stimuli

There seemed to be a main effect of picture category on the normal VAS scores ($F_{(2, 16)} = 7.95$; $p = 0.004$) where pain related pictures were rated the highest on the VAS (-25.82), pleasant pictures the lowest (-51.25) and neutral were rated medium on the VAS (-50.56). Picture category also had an interaction effect with gender ($F_{(2, 16)} = 5.48$; $p = 0.015$), but not with the intensity of the electrical stimuli ($F_{(2, 16)} = 1.96$; $p = 0.173$). This indicated that when men and women were analysed together the VAS scores differed between the different picture categories, however the interaction effect of gender with picture category suggested that the genders were not equally influenced by the picture categories. For this reason we also analysed the data of men and women separately.

Men were not influenced by the picture categories ($F_{(2, 8)} = 3.12$; $p = 0.100$). There was also no interaction effect between picture category and the intensity of the stimuli ($F_{(2, 8)} = 0.52$; $p = 0.611$). This indicated that the pain unpleasantness of men was not influenced by the picture categories: the mean VAS scores per picture category were the same. The insignificant interaction effect suggested that the difference between the VAS scores of painful and nonpainful stimuli were the same over all the picture categories.

The VAS scores of women however did seem to differ significantly between the picture categories ($F_{(2, 7)} = 6.51$; $p = 0.025$). This meant that at least one picture category caused higher / lower pain unpleasantness during an electrical stimulus compared to other picture categories. To further analyse this significant finding, we split the data in high and low stimulus intensity.

For the low intensity stimuli there was a significant affect of picture category on VAS ratings ($F_{(2, 7)} = 14.45$; $p = 0.003$): pain related pictures scored significantly higher on the VAS (-236.83) compared to neutral pictures (-278.83) ($F_{(1, 8)} = 7.70$; $p = 0.024$); the pain related pictures also scored significantly higher compared to pleasant pictures (-297.06) ($F_{(1, 8)} = 27.61$; $p = 0.001$); the VAS scores during the pleasant pictures were comparable with the VAS scores during neutral pictures ($F_{(1, 8)} = 3.95$; $p = 0.082$). When women received nonpainful electrical shocks, they tended to judge the stimuli given during the presentation of the pain related pictures more painful than stimuli given during the presentation of pleasant or neutral pictures. When the data was further analysed it appeared that there was a quadratic trend between the normal VAS scores of the picture categories ($F_{(1, 8)} =$

30.46; p = 0.001). In the quadratic trend the pain related pictures affected higher pain unpleasantness compared to the pleasant and neutral pictures.

The VAS scores of the painful stimuli however do not differ significantly between the three picture categories ($F_{(2, 7)}$ = 1.22; p = 0.350). When women received painful electrical shocks, they judged the stimuli the same in all the picture categories.

Chi square test

Electrical stimulus

First again the mean VAS scores (ranked) of the nonpainful and painful stimuli for both men and women are visible Table 8.

Gender	Intensity of the stimuli	Ranked scores (SD)
Men	Nonpainful	31.84 (18.59)
	Painful	89.16 (20.30)
Women	Nonpainful	31.78 (18.64)
	Painful	83.04 (26.17)
Total	Nonpainful	31.81 (18.61)
	Painful	86.26 (23.45)

Table 8

Mean ranked VAS scores and standard deviation of both men and women from nonpainful and painful stimuli

The dependent factor of the chi square test was the ranked VAS scores and the independent factor was the intensity of the electrical stimuli. The results revealed that the intensity of the electrical stimuli did have a significant relation with the ranked VAS scores (χ^2 = 1,740.52; df = 220, p <0.001). In other words: the ranked VAS scores were affected by the height of the electrical shock, the scores were higher for the painful stimuli (31.81) compared to the nonpainful stimuli (86.26), see Table 8.

Picture category

See Table 9 and Figure 8 for the mean ranked VAS ratings separated on picture category, stimulus intensity and gender.

Gender	Stimulus intensity	Ranked scores (SD) per picture category: Pleasant	Neutral	Pain related
Men	Nonpainful	31.27 (17.92)	29.66 (17.69)	34.58 (19.84)
	Painful	90.23 (19.93)	86.30 (21.12)	90.96 (19.60)
Women	Nonpainful	25.97 (16.67)	30.53 (17.99)	38.84 (18.95)
	Painful	80.53 (24.93)	83.48 (26.19)	85.02 (27.28)
Total	Nonpainful	28.76 (17.52)	30.07 (17.81)	36.60 (19.31)
	Painful	85.64 (22.93)	85.01 (23.66)	88.15 (23.71)

Table 9

Mean ranked VAS scores and standard deviation of both men and women of nonpainful and painful stimuli and for each picture category

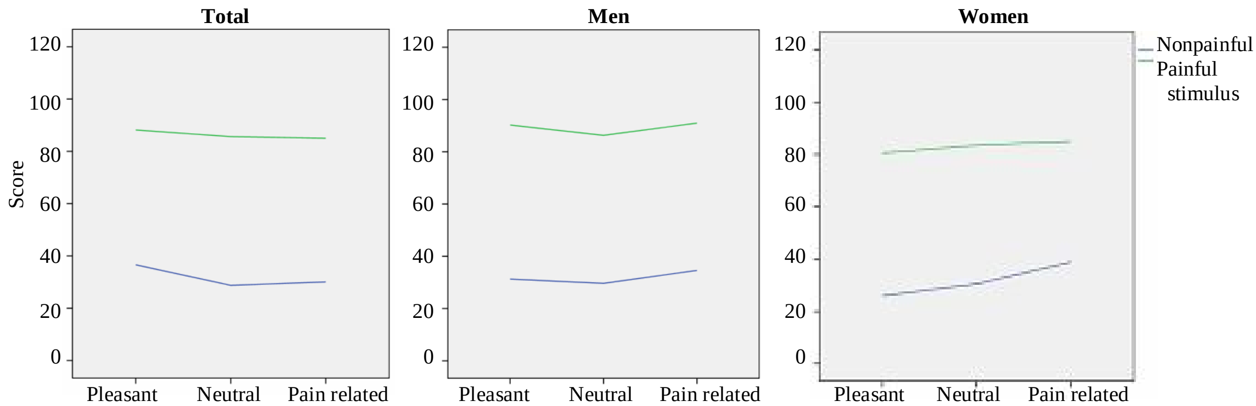

Figure 8

Graphic of the mean male and female ranked VAS scores for each picture category and of the two different electrical stimuli

We first analysed men and women together to see whether picture category modulated pain unpleasantness. The result from this test was that there was no significant relation found between the picture category and all the ranked VAS scores (χ^2 = 484.62; df = 440, p = 0.070).

However, when we split the data in the VAS scores of painful and nonpainful stimuli, there was one significant finding. For the nonpainful stimuli picture categories did seem to had a significant effect on the picture category on the ranked VAS scores (χ^2 = 6,318.72; df = 268, p = 0.019), where electrical stimuli during the pleasant pictures were rated the lowest (28.76), electrical stimuli during the neutral pictures were scored medium (30.07) and electrical stimuli during the pain related pictures scored the highest (36.60). The VAS scores of the painful stimuli did not show a significant effect for the ranked VAS scores (χ^2 = 305.45; df = 312, p = 0.594). Picture categories again did not affect the female VAS scores during painful stimuli, however all the participants together rated the nonpainful stimuli different between the picture categories.

It appeared that male participants were not influenced in their ranked VAS scores form the nonpainful stimuli (χ^2 = 220.71; df = 236, p = 0.755). The VAS data from the painful stimuli are just as indistinguishable. The ranked VAS scores of men also showed no significant effect of the picture categories (χ^2 = 262.76 df = 256, p = 0.372).

Conversely, the chi square test on the ranked VAS scores of women who perceived nonpainful stimuli did seem to be significantly influenced by the picture categories (χ^2 = 262.86; df = 218, p = 0.020), in which pleasant picture stimuli were ranked the lowest (25.97), the stimuli of the pain related pictures the highest (38.84) and neutral picture stimuli scored medium (30.53). The ranked VAS scores of women who received painful stimuli did not show significant effects of the picture categories (χ^2 = 215.30; df = 246, p = 0.922).

Discussion

In experiment 2 we wanted to examine whether the picture categories (which vary in their valence and arousal levels) affect the pain unpleasantness of the participants evoked by painful and nonpainful shocks (electrical stimuli).

The VAS scores of both men and women were significant influenced by the intensity of the electrical stimuli. The painful stimuli were rated higher on pain unpleasantness than the nonpainful stimuli. This effect was clear at both the nonparametric and parametric analysis (chi square test and one-way repeated measures ANOVA). The one-way repeated measures ANOVA revealed that the differences between painful and nonpainful stimuli VAS ratings were the same for men as for women.

The VAS ratings of men and women together seemed to be affected by the picture categories, however gender also seemed to have an effect on the VAS scorings. The fact that men and women react different on affective pictures and on pain is already established by Lang et al., 2005 and Bradley et al., 2001. For this reason men and women were analysed separately.

It appeared that the affective pictures did not modulate the pain unpleasantness in men, this was the case for the painful and the nonpainful stimuli. Women on the other hand did show that a part of their ratings were modulated by the affective pictures, however, this only was the case with the nonpainful stimuli, here pleasant and neutral pictures received lower pain unpleasantness scores than the pain related pictures.

General discussion

What we wanted to examine in these experiments was whether the emotional state can be influenced in such a way that the pain perception is modulated. Before we started with the experiment we set out three hypotheses, the motivational priming hypothesis (valence or feelings of pleasantness modulates the pain unpleasantness, where higher level of valence indicates lower pain unpleasantness), the attention hypothesis (arousal modulates the pain unpleasantness, the higher the arousal, the lower left attention and the lower the pain unpleasantness) and the empathy hypothesis (empathy causes people to judge the pain unpleasantness higher when they see other people in pain).

Although we first wanted to test the hypothesis by using all the data together, it appeared however that men and women are differently influenced by affective pictures (Lang et al., 2005; Bradley et al., 2001).

Our data results revealed that the three picture categories (pleasant, neutral and pain related) did not cause different pain unpleasantness of the electrical stimuli on men. According to experiment 1, men were influenced in their emotional states by the pictures, so the pictures did cause change in their valence and arousal levels. However, these changes seemed to have nothing to do with the pain perception of men, their emotional state is according to our experiment not a factor of their personal experience of pain.

The pain unpleasantness of women, on the other hand, did seem to be modulated by the different picture categories. Although, this only is the case for the nonpainful stimuli. The ratings of women who perceived electrical shocks under their pain threshold were higher when they saw pain related pictures and lower when they saw pleasant or neutral pictures. However, the painful stimuli were rated the same for every picture category.

So, the only significant finding was that women’s VAS rating of nonpainful stimuli were induced by looking at other people in pain. This finding is consistent with our empathy hypothesis, since the pain unpleasantness evoked by electrical stimuli during the representing of a pain related picture is significantly higher compared to the pain unpleasantness during neutral and pleasant pictures. The reason this data supports the empathy theory and not the motivational priming theory is because the

VAS scores of neutral and pleasant pictures do not differ significantly, which is a criterion for the motivational priming theory.

Now the possible reasons why there is only one significant finding over these four groups (men who perceived painful stimuli, men who perceived nonpainful stimuli, women who perceived painful stimuli and woman who perceived nonpainful stimuli). The reason men are not affected in their VAS ratings by the different pictures could be that their valence scores are less extreme than the valence scores of women for the picture categories. In experiment 1 we measured the valence and arousal values of the three picture categories and we also divided these scores between men and women. From the data of this experiment we could conclude that women judged the pain related pictures significant lower in valence than men did, men gave this picture category a mean valence of 2.56, while women only valued this picture category 1.70. It could be that the valence score of 2.56 was not low enough for men to affect their pain sensations. This difference between the ratings of the pain related pictures could be explained by Bradley et al. (2001). Their results showed that women responded with greater defensive reactivity to aversive pictures (low in valence). This supports the idea that in fact women do value negative pictures (pain related pictures) lower in valence in comparison with men. The fact that women's valence scores were lower than those of men, could thus be the reason that women were affected by the pain related pictures in their pain unpleasantness, but men not. That lower valence scores affects pain perception was already shown in experiments of Vrana et al. (1988), Greenwald et al. (1998) and De Wied and Verbaten (2001).

The fact that the VAS scores of women (and men) were not modulated during the painful stimuli could be explained by the fact that below the pain threshold different pain levels can be easier distinguished than pain stimuli above pain threshold. We already noticed this during determining the pain thresholds of the participants in front of the experiment. On average there was 0.5 mA from sensation threshold to pain threshold (0 to 5 on the VAS), while there was 3.2 mA from pain threshold to pain tolerance (5 to 10 on the VAS). Many subjects did not even have the idea that after the VAS of 6, the shocks became stronger. This could indicate that the participants did have the feeling that the stimulus was stronger, but on the scale visualized this not as strongly as they did for stimuli below the threshold, because the ratings varied more in front of the pain threshold on the VAS than after the threshold. Another reason for this could be that the cursor in our VAS appeared at the same point of the previous determined pain unpleasantness. This could cause the tendency to judge one electrical stimulus the same as the one before. A further downside of this fact is that some participant thought the cursor went back to the middle of the VAS line and because of this thought they unintentionally chose the wrong VAS score.

A last explanation of the few significant findings can maybe be dedicated to the wrong picture set. Since picture set 1 was chosen for experiment 2, while one of the analyses revealed that picture set 2 was better. The analyses revealed that for picture set 2 there was more separation between the individual valence scores of the picture categories, which of course is important while the valence scores are supposed to affect the pain unpleasantness. This could mean that perhaps when there was another picture set used in experiment 2 with more separation between the picture groups qua valence and arousal scores, they may in fact cause significant pain unpleasantness modulations. Possibly the emotional states can be better influenced by virtual reality or movies instead of simple pictures and maybe personal memories can be used to generate the wanted emotional state since it is known that memories can be triggered and that emotions can be experienced all over again (van der Kolk, 2002).

To be able to indicate if there is a reason for the few significant findings and what these reasons are, further examinations is required.

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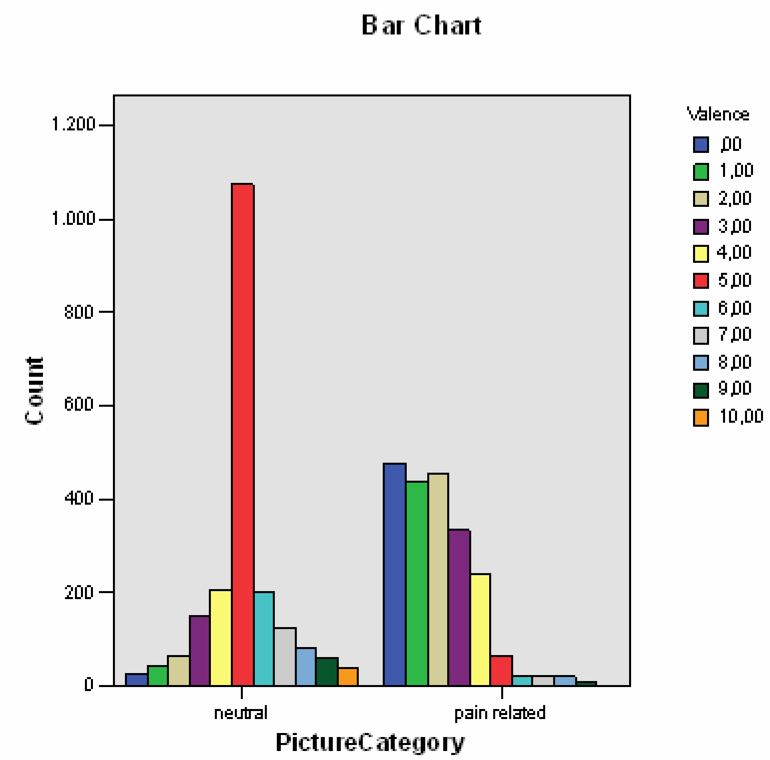
Appendix A



PictureCategory * Valence Crosstabulation

			Valence											Total
			,00	1,00	2,00	3,00	4,00	5,00	6,00	7,00	8,00	9,00	10,00	
PictureCategory	neutral	Count	28	43	67	149	208	1076	202	125	82	62	38	2080
		Expected Count	252,0	240,0	260,0	241,5	224,5	571,5	111,5	72,5	51,5	35,0	20,0	2080,0
	pain related	Count	476	437	453	334	241	67	21	20	21	8	2	2080
		Expected Count	252,0	240,0	260,0	241,5	224,5	571,5	111,5	72,5	51,5	35,0	20,0	2080,0
Total		Count	504	480	520	483	449	1143	223	145	103	70	40	4160
		Expected Count	504,0	480,0	520,0	483,0	449,0	1143,0	223,0	145,0	103,0	70,0	40,0	4160,0

Appendix B

Picture set	Picture category	Identification number	Picture description
1	Neutral	5500	Mushroom
		5510	Mushroom
		5520	Mushroom
		5530	Mushroom
		5531	Mushroom
		5532	Mushroom
		5533	Mushroom
		5534	Mushroom
		6150	Outlet
		7000	Rolling pin
		7002	Towel
		7004	Spoon
		7006	Bowl
		7009	Mug
		7010	Basket
		7020	Fan
		7025	Stool
		7030	Iron
		7031	Shoes
		7034	Hammer
		7035	Mug
		7040	Dust pan
		7041	Baskets
		7050	Hair dryer
		7060	Trash can
		7080	Fork
		7090	Book
		7095	Headlight
		7100	Fire hydrant
		7110	Hammer
		7140	Bus
		7150	Umbrella
		7170	Light bulb
		7175	Lamp
		7179	Rug
		7190	Clock
		7211	Clocks
		7224	File cabinets
		7233	Plate
		7234	Ironing board
	Pain related	9582	Dental exam
		9584	Dental exam
		9592	Injection
		9594	Injection
	Pleasant	2057	Father
		2058	Baby
		2150	Baby
		2160	Father
		2165	Father

Picture set	Picture category	Identification number	Picture description
		2352	Kiss
		4279	Erotic female
		4320	Erotic female
		4531	Erotic male
		4534	Male dancer
		4641	Romance
		4653	Erotic couple
		4658	Erotic couple
		4659	Erotic couple
		4680	Erotic couple
		4683	Erotic couple
		4690	Erotic couple
		4750	Nude female
		7330	Ice cream
		7400	Candy
		7460	French fries
		7470	Pancakes
		7480	Pasta
		8031	Skier
		8080	Sailing
		8161	Hang glider
		8162	Hot air balloon
		8185	Sky divers
		8186	sky surfer

Picture set	Picture category	Identification number	Picture description
		8200	Water skier
		8210	Boat
		8260	Motorcyclist
		8280	Diver
		8465	Runner
		8490	Roller coaster
		8500	Gold
		8501	Money
		8502	Money
		8503	Money
		8531	Sport car
2	Neutral	1616	Bird
		2190	Man
		2200	Neut face
		2221	Judge
		2381	Girl
		2393	Factory worker
		2480	Elderly man
		2499	Neutral male
		2570	Man
		2580	Chess
		2840	Chess
		2850	Tourist
		2880	Shadow

Picture set	Picture category	Identification number	Picture description
		2890	Twins
		2980	Food basket
		5390	Boat
		5500	Mushroom
		5510	Mushroom
		5731	Flowers
		5740	Plant
		7000	Rolling pin
		7002	Towel
		7004	Spool
		7006	Bowl
		7009	Mug
		7010	Basket
		7020	Fan
		7040	Dust pan
		7041	Baskets
		7050	Hair dryer
		7080	Fork
		7090	Book
		7175	Lamp
		7187	Abstract art
		7233	Plate
		7235	Chair
		7490	Window

Picture set	Picture category	Identification number	Picture description
		7491	Building
		7705	Cabinet
		7950	Tissue
	Pleasant	1340	Women
		1463	Kittens
		1590	Horse
		1640	Coyote
		1811	Monkies
		1999	Mickey
		2058	Baby
		2150	Baby
		2160	Father
		2224	Boys
		2340	Family
		2346	Kids
		2352	Kiss
		2550	Couple
		4601	Romance
		4603	Romance
		4624	Couple
		5551	Clouds
		5660	Mountains
		5830	Sunset
		5849	Flowers

Picture set	Picture category	Identification number	Picture description
		7200	Brownie
		7220	Pastry
		7250	Cake
		7260	Torte
		7289	Food
		7291	Chicken
		7330	Ice cream
		7350	Pizza
		7400	Candy
		7460	French fries
		7580	Desert
		8033	Ice skater
		8120	Athlete
		8162	Hang glider
		8220	Runners
		8280	Diver
		8350	Tennis player
		8510	Sport car
		8540	Athletes