UiT NORGES ARKTISKE UNIVERSITET

Department of Clinical Dentistry

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The sights and sounds of dental treatment

Negative emotions and pain experience

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Contents

1 Abstract

1.1 Background – aim

The dental treatment situation is full of sensory impressions for the patient. This can be the sound of drilling or scaling, sights of blood or needles or the sensation of pain. These sensory impressions might induce negative emotions for the patient. In this study we want to investigate the relationship between sensory impressions (sights and sounds), emotions, and pain experience. We also want to investigate if there is a relationship between sensory impressions and emotions. If there is an association between these factors it can help practitioners better understand their patients and their reason for feeling uncomfortable in a dental treatment situation, and help develop better treatment approaches to those individuals who experience dental fear and anxiety because of sensory impressions.

2 Introduction

2.1 Pain and dental anxiety

The concept of pain appears central to dental anxiety and fear. Possible reasons for patients´ fear could be earlier experiences of pain or expectations of future pain. Research underscores that pain is an important yet unfortunate aspect of clinical dentistry, with 20-30 percent of the Norwegian adults indicating that their last clinical visit was experienced as moderately, or worse than moderately, discomforting (1). Also, high percentages report having endured at least one highly painful or unpleasant treatment session (1, 2). One study showed that over a five year period 42.5 percent of patients reported having at least one painful experience at the dentist, while 19 percent reported moderate to severe pain (3). The link between former experience of pain in dental settings and dental fear is documented in many studies (4-8)**.** A study of which elements from the dental treatment situation people were overwhelmingly afraid of, showed that invasive procedures (e.g., extracting teeth) and pain itself was the most anxiety provoking stimuli (9). In addition, children who have had experiences with invasive and orthodontic treatment seem to have more dental anxiety (10). Despite the salient role of pain in dental treatment and dental phobia one rarely sees treatment goals related to pain expectations and experiences. Common treatment approaches often bypass the concept of pain and focus on related or more general concepts such as “discomfort”, “unpleasantness”, et cetera, instead. Even though significant improvement with regards to dental anxiety can be experienced without focusing specifically on pain perception, the challenge is that future experiences of pain, for example when injecting anesthesia, during invasive procedures might trigger a relapse into dental phobia and/or avoidance of the dental service. More knowledge is required concerning the role of pain in dental phobia and how this impacts the treatments approaches.

2.2 Pain experience and contextual information

It has been documented that psychological states affect the pain experience. For instance negative emotional states such as depression appears to lower pain tolerance (11) and anxiety-sensitivity. Anxiety-sensitivity is the tendency to be fearful of anxiety-related sensations. Together with negative emotional states, anxiety-sensitivity appears to make pain experiences more negative (12). Furthermore, pain experiences are shown to be susceptible to "priming effects", where pain experiences are influenced by contextual information (pain cues) such as negative words or pictures (13). This perspective is highly relevant to dental phobia since the dental treatment situation is full of potential pain cues and contextual information. Pain experiences related to dental procedures have been extensively studied, and several studies have linked dental anxiety to pain experiences.

For instance, patients with high dental anxiety report more pain during dental injections than patients with lower anxiety levels (14). Imagined pain to hypothetical scenarios is higher when the scenario involves anxiety compared to calmness and safety (15). A clinically relevant issue that has not been extensively researched is the relationship between the experience of pain and general sensation. For in instance, there might be a tendency for anxious individuals to interpret or label ambiguous or low intensity stimuli as "painful" due to heightened sensitivity to pain (e.g., a form of general sensitization; see (16).

Phobic patients´ fear is often triggered by the presence or expected presence of specific stimuli (e.g., objects, situations, animals etc.). In dental phobia this includes treatment related stimuli such as seeing particular instruments or hearing different sounds. Treatment of the phobia will normally require exposure to the feared stimuli in order to extinguish the conditioned fear response. However, in situations where the feared stimuli are contextual and/or relational, the exposure paradigm is challenged. This would require non-specific exposure to treatment, expanding over several treatment sessions without doing any actual dental work or treatment. This would be costly- and time consuming. It is important to know more about how contextual information or sensory impressions affect individuals in dental settings. At the dentist's office, there are many potential triggers for stress, such as the high pitched and loud sound from the drilling or suction, the sight of blood, gloves or instruments, smell of different chemicals and the feeling of losing control when someone gets close to you.

Video materials have been successfully used to induce emotional states in research participant. In a study were the role of positive emotions were investigated the participants were first given a task which induced negative emotions like nervousness and anxiety and therefore also increase in the cardiovascular activity. They were directly after this divided into groups and shown a video of positive, neutral or negative valence. The group that watched the video with negative valence had a prolonged increase in cardiovascular activity, while the participants who watched the positive or neutral video showed a faster cardiovascular recovery (17). Another study showed that video with negative valence induced more anxiety, sadness and anger than video with neutral valence (18).

It is important to know how individuals react to the sounds and sights of dental treatment situations, especially if this affects the experience of pain. If a relationship is found, more effective treatment approaches can be developed for those who experience anxiety or increased stress levels because of this. It is also useful to dental personnel to know how individuals react too sounds and sights during dental treatment. That way they can adapt the treatment approach to each patient and get more conscious about how this affects the patient.

2.3 Pain perception

Pain perception is a subjective process because it is sensitive to feelings and beliefs that a person has about pain, which implies that pain perception is not only influenced by noxious sensory input (19). For instance, how a person experiences pain has to do with the focus of attention. When distracted from pain, the pain is perceived as less intense, but when the attention is focused on the pain its intensity increases. The attention processes associated with pain is not the only process influencing pain perception. Prior experiences and the expectation of pain together with mechanisms supporting experience and expectations have influence on the perception of pain. The fact that pain stimulus is recognizable allows us to interpret signs that are signaling disappearance and appearance of pain sensation. A schematic model of pain develops in our brain based on previous pain experience and stimuli associated with it. This allows us to make predictions on future situations that is, or potentially can be, painful. This schematic model of pain is under influence from other factors as well, and in particular influenced by perceived threats of pain. Attentional processes promote and drive distraction from unpleasant stimulus and this involves some or fairly little cognitive change. However the re-interpretation that we do volitionally reassesses the threatening stimulus's value and this relies on these cognitive changes. Thus, the attention focus and the prediction of perceived threats of pain will affect pain perception. Also, if the attention is focused on something else than pain it will most likely act as a distraction from pain stimulus.

2.4 Hypothesis

Based on this review of pre-existing research we have the following hypotheses:

1) Video and sound materials from invasive dental procedures will be more strongly associated with negative emotions than video and sound materials from a dental hygiene procedure (dental flossing).
2) Video with sound will be more effective than only sound in inducing negative emotions.
3) We expect that pain experience is associated with negative emotional state, and we therefore expect that pain levels will be significant higher after receiving video/sound stimuli with a negative emotional valence.

3 Material and method

3.1 Materials

3.1.1 Video and sound stimuli

Before the experiment we made video and sound materials of presumed negative and neutral valance. Video was recorded in 720p HD-format using a Zoom Q2HD camera, and sound was recorded using the Soundman "Studio" binaural microphone system. This form of recording involved placing the microphones in the ears of the person who volunteered to be filmed and recorded. The system records the sound as if perceived by the human ear.

The film with presumed negative valance was a recording of sound and video from a surgical extraction of a wisdom tooth. This surgery was performed by one of the clinical supervisors at the University dental clinic in Tromsø. The patient was a dental student. The reason for choosing a dental student as patient was based on the need to record a good quality sound effect. The crucial part during the filming was that the surgeon and assistant had to be quiet during the procedure. Because of patient care considerations it was therefore not suitable to ask a "regular" patient to be recorded.

The film with presumed neutral valance was sound and video of a dental hygiene procedure: a student brushing her teeth and using dental floss and mouth rinse. We choose this as neutral valance due to the fact that this is a daily task for most people, as well as a task that provides sound effects.

The test subjects that only heard sound listened to the sound from each of the videos recorded. The videos and the sound clips all lasted the same amount of time. Approximately 5 minutes.

3.1.2 Induction and measurement of pain

In this study, pain was induced by contact heat stimuli to the right volar forearm. This was done with a 30 x 30 mm aluminum contact thermode (Pathway, Medoc, Israel). The electrode had a baseline temperature of 32 degrees Celsius when applied to the arm. The duration of the pain stimuli was 15 sec with a plateau for approximately 10 sec at the target temperature 47º C. The degree of 47º C was predefined because most people find this uncomfortable.

During each pain stimulus the participants reported their pain experience on the electronic VAS-scale called COVAS. This is a scale from 0-100 where 0 represent "no pain" and 100 represent the "most intense pain imaginable". By letting the patients put a number on their pain experience it is possible to measure and compare pain experiences between individuals.

3.1.3 Measurement of dental anxiety

In order to get an indication of how anxious the participants were of receiving dental treatment, which could be an important covariate in the current study, the Modified Dental Anxiety Scale (MDAS) was used (20). This scale consist of five questions describing different situations with regards to dental treatment and asks the participants to indicate degree of anxiety on a 1 – 5 Likert scale (1 = "not anxious"; 5 – "extreme anxious"). The MDAS is most commonly used as a sum-score (5 - 25), where the cut-off indicating extreme dental anxiety / dental phobia is 19 (See Appendix 2).

3.1.4 Measurement of emotion

During the procedure the subjects completed a questionnaire on how they were feeling and how aroused they felt. This questionnaire included two questions which were:

1. On a scale from 0 to 10 where 0 indicate "calm" and 10 indicate "nervous", how do you feel right now?
2. On a scale from 0 to 10 where 0 indicate "relaxed" and 10 indicate "tense", how do you feel right now?

3.2 Recruitment

Eighty (80) participants were recruited using an advertisement on the web page for students at the UiT – The Arctic University of Norway. The advertisement stated that we were searching for healthy volunteers between 18-40 years of age. The volunteers chosen had to sign a consent form stating that they had no history of severe medical illness, previous or current psychiatric disorders including any diagnosed heart-failure or arrhythmias, renal disease, cancer, epilepsy, chronic pain conditions, depression, bipolar disorder, schizophrenia, or disabling developmental disorders, e.g. autism. Those willing to participate could not use any prescribed medications with the exception of birth-control pills (See Appendix 1). All participants received a gift card worth 300, - NOK for reimbursement of expenses (e.g., bus-tickets, taxi, time-consumption, parking fee etc.)

On the information posted on the website there was some information regarding the project and our contact information. Through this we received close to 150 inquiries for more information regarding the project.

3.3 Design and procedure

The 80 participants were randomly distributed into a factorial design with a within-subjects factor (order of presentation: neutral vs. negative valence) and a between-groups factor (video vs. sound), as well as a control group receiving no stimuli. This gave us a total of five experimental conditions (see Table 1).

Table 1. Conditions and stimuli

Condition	Order of Stimuli: Trial 1 - Trial 2
1. Video with sound	Video neutral – Video negative
2. Video with sound	Video negative – Video neutral
3. Sound	Sound neutral – Sound negative
4. Sound	Sound negative – Sound neutral
5. Control	No stimuli

Note: The condition in each group is shown in the left column. The right column shows the order in which the test subjects watched or heard the different sight and sound stimuli.

The test subjects were given a condition randomly. This was done by making a randomized list of the conditions from 1 to 80. The first test subject was numbered 101 and received condition number 1 on the list and so on. In the end all conditions contained sixteen (16) test subjects.

Upon arrival for the appointment the subjects signed a consent form and answered two questionnaires, one about dental fear and one about general fear in different situations. The actual procedure was carried out on the laboratory on the 4th floor of the Dental building in Tromsø. This room is designed like a dental treatment room. It contains a dental chair with a functioning dental unit. During the procedure, which lasted for approximately 45 minutes, the test subjects were seated in the dental chair.

To give the test subjects the heat stimuli we used a thermode set to 47 degrees Celsius. We chose this temperature because this is a temperature which is uncomfortable to most people. We fastened the thermode to the underarm of the left hand. This was moved two times during the procedure to get accurate measurements because of skin adaptation.

The operator then proceeded to inform the test subject that they would be seated in the chair for approximately 30 minutes, and that there would be minimal talking during these 30 minutes. Furthermore that they would grade the emotion form when tapped on the shoulder and instructed on how to use the electronic COVAS pain scoring system form 1-100 during the whole procedure.

The sound and video files were played from a laptop computer attached to a screen in front of the test subjects and noise-cancelling headphones. The negative and neutral video and sound lasted the same amount of time, approximately 5 minutes. The subjects in the control group wore headphones without noise cancelling enabled.

After fastening the thermode and giving information about the emotion form and COVAS, the procedure carried out in the following steps:

1. Grading from 0-10 on emotion form (EMO1; baseline emotion)
2. Heat stimuli two times lasting 15 sec at a time with a 60 sec pause between (baseline pain)
3. Video/sound/nothing (trial 1: stimuli)
4. Grading from 0-10 on emotion form (EMO2; trial 1: emotion)
5. Move thermode
6. Heat stimuli two times lasting 15 sec at a time with a 60 sec pause between (trial 1: pain)
7. Move thermode
8. 5 minute pause
9. Video/sound/nothing (trial 2: stimuli)
10. Grading from 0-10 on emotion form (EMO3; trial 2: emotion)
11. Heat stimuli three times lasting 15 sec at a time with a 60 sec pause between (trial 2: pain)

3.4 Ethical Considerations

In order to carry out our research we had to apply to REK – Regional Committees for Medical and Health Research Ethics to get approval for our project. REK evaluates if the research is ethically correct, that the privacy of the participants is properly handled, what advantages and risks the project has, as well as the degree of use in the research.

4 Results

4.1 Descriptive analyses

Of our 80 participants there were 50 (62.5 %) females and 30 (37.5 %) males. Mean age was 22.7, with a range from 19-31 years of age.

4.1.1 MDAS

The mean score on the MDAS was 8.55, with a range of 5 - 18. No differences were found between male and female participants. It could be a problem for the current design if the distribution of MDAS-scores differed between the experimental conditions despite randomization procedures. To check for this a dichotomous variable was calculated based on the mean and the distribution of high and low MDAS scores in the experimental conditions were checked using cross-tabulation. A Chi-square test shows us that the distribution of high and low MDAS scores were not deviating from the expected distribution ($\chi^2(4) = .38$, p = ns).

4.1.2 Negative emotions

The subjects answered the emotion form three times. The mean emotion scores for the three trials are shown in Table 2, marked EMO1, EMO2, and EMO3, with higher scores indicating higher levels of nervousness and unrest (i.e., negative emotions). As can be observed scores are relatively low, and scores decrease from first to the last trial (EMO1 = 2.32; EMO2 = 2.12; EMO3 = 1.91) indicating that participants felt less activated and nervous as the procedure proceeded. No differences in emotion score was found between males and females.

4.1.3 Pain experience

The subjects received repeated pain stimuli at three times during the procedure; two trials at baseline and mid-experiment, and three trials at the end of the experiment (in total 7 trials). The thermode was moved before trials 3 and 5. The overall mean of pain experience was 40.48, with a range from 0 to 99. Figure 1 illustrates mean pain measurement for all 7 trials, which shows that participants habituate to the pain stimulus. They report more pain on the first stimulus (trials 1, 3, and 5) and considerably less pain on the following trials.

Table 2. Summary of descriptive analyses

Variable	*N*	*M*	*Range*
Age	80	22.7	19-31

Variable	*N*	*Percentage*
Sex		
Male	30	37.5
Female	50	62.5

Variable	*N*	*M*	*SD*
<u>Dental Anxiety</u>			
MDAS sum score	78	8.55	2.55

Variable	*N*	*M*	*SD*
<u>Emotion score</u>			
EMO1	79	2.32	1.99
EMO2	79	2.12	1.51
EMO3	80	1.91	1.57
EMO overall	80	2.10	1.36

Variable	*N*	*M*	*SD*
<u>Pain experience</u>			
Baseline pain	75	37.39	23.63
Trial 1: pain	75	40.74	26.89
Trial 2: pain	75	38.22	27.78
Pain overall	80	40.48	26.84
Male overall pain	30	34.27	20.88
Female overall pain	50	44.20	29.42

Figure 1: Mean pain measurements for all 7 trials

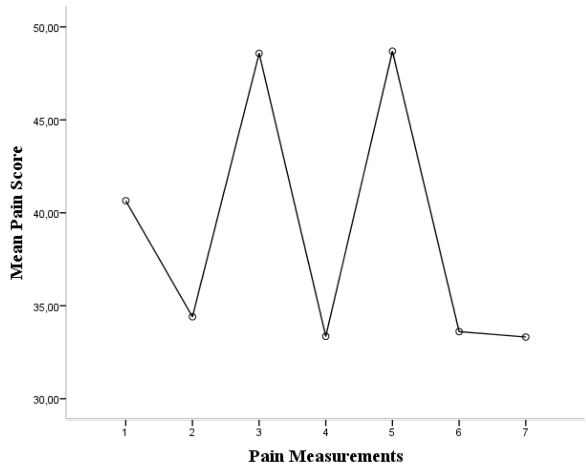
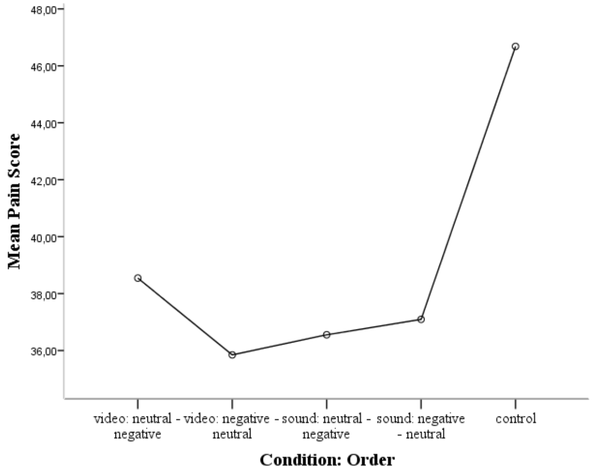


Figure 2: Mean overall pain reported in each condition



4.2 Hypothesis testing

4.2.1 Negative emotions and stimulus materials

Two hypotheses were tested concerning the ability of the video and sound stimulus materials to induce negative emotions. First, we expected the sound and video from the invasive dental procedure to be more strongly associated with negative emotions than the sound and video from the dental flossing procedure. An illustration of median emotion scores by condition are shown in Figure 3.

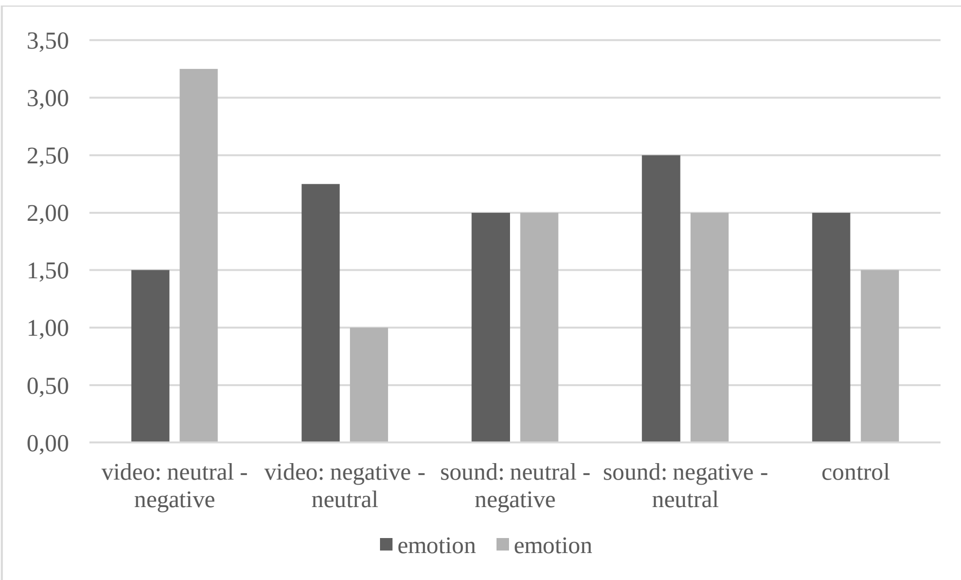


Figure 3. Median emotion score by order and experimental trials (baseline not included).

A descriptive analysis shows that there is an overall difference in medians between emotion scores after presumed negative stimuli (Median = 2.50) and presumed neutral stimuli (Median = 1.50). Since the data were not normally distributed, a non-parametric was performed to investigate how order of presentation (neutral-negative vs. negative-neutral) influenced emotion score. The results indicate that observed emotion scores deviated significantly from expected scores for the experimental trials, trial 1 ($\chi^2(2) = 8.61$, $p < .05$) and trial 2 ($\chi^2(2) = 14.27$, $p < .01$). This was not the case for baseline emotion measurements ($\chi^2(2) = .39$, $p <$ .ns). Multiple-comparisons where then performed using Mann-Whitney U-test with Bonferroni-correction, showing that there is a significant difference between presumed negative and neutral materials for the second experimental trial (*U* = 257,00, p < .01), but not for the first experimental trial although the p-value is indicating a strong tendency (*U* = 342.50, p = .07). (See also Figure 3). The hypothesis is therefore partially supported.

In order to test the second hypothesis, that video was more effective than sound only to elicit negative emotions, a Kruskal-Wallis H-test was performed with sound and video condition as dependent variable and emotion score as independent variable. The test results show a predicted rank order, with video ranked higher than sound for emotion score on both trials However, the test statistic indicates a significant differences only for trial 2, $\chi^2(3) = 14.68$, $p < .01$. Mann-Whitney U-tests with Bonferroni-correction were performed for multiple comparisons. The results indicate that in trial 2 the invasive video elicited significantly more negative emotions than video (*U* = 38.50, $p < .01$) and sound (*U* = 64.00, $p < .05$) of the hygiene procedure, but not the sounds of the invasive procedure (*U* = 94.00, *p* = ns). The hypothesis that video is superior to sound in eliciting negative emotions is not supported for the current materials. An illustration of the differences between the groups is shown in Figure 4.

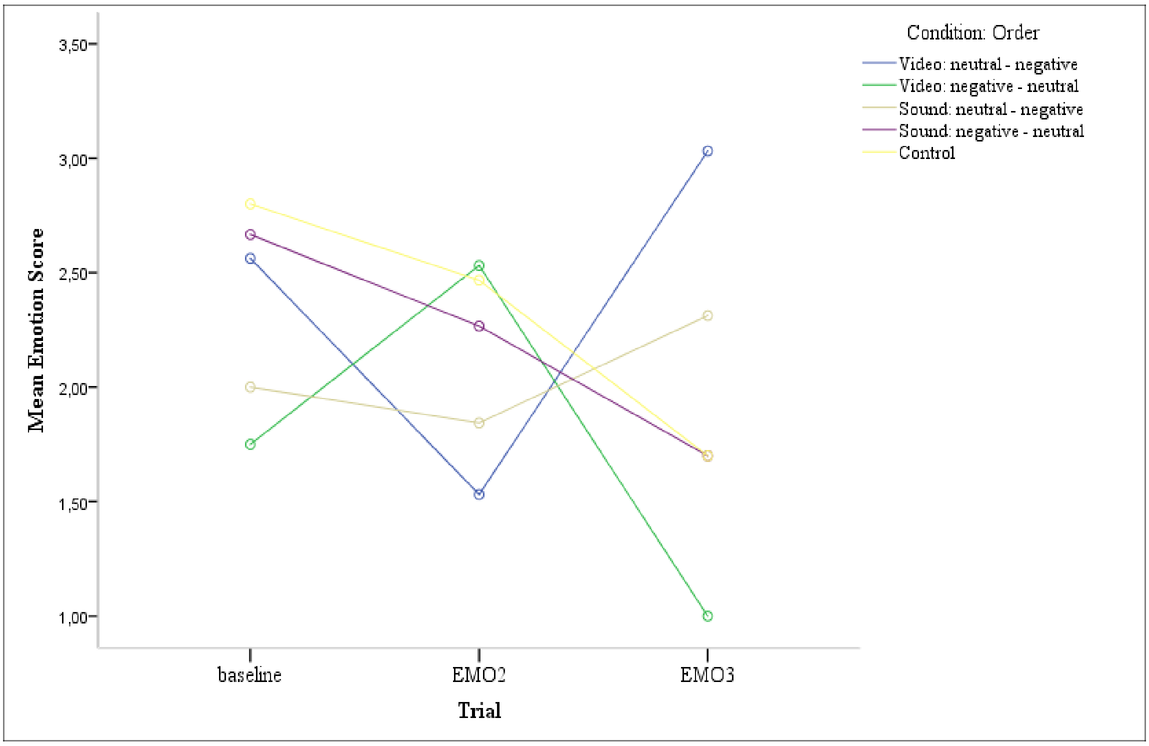


Figure 4. Mean Emotion Score for each trial by Condition

4.2.2 The effect of video and sound on pain experience

We expected that pain levels would be significantly higher after receiving sensational stimuli with negative emotional valence. Pain measurements were averaged for each trial and used for the analyses, yielding three mean scores (baseline pain, trial 1: pain and trial 2: pain). Since pain-data were non-normally distributed, a Kruskal-Wallis H-test was performed with pain scores (median baseline and median experimental trials) as a dependent variable and condition as independent variables. The analysis does not show that the participants who received sensational stimuli with negative valence experienced more pain than the participants who received sensational stimuli of neutral emotional valence or the control group. Of the five groups it was the participants in the control group who reported the highest pain experience (see Figure 2).

5 Discussion

The results give mixed support for the hypotheses. First, video and sound from an invasive dental procedure appears to elicit more negative emotions than video and sound from a dental hygiene procedure, but no difference was found between video and sound from the invasive procedure. In addition, the effect of stimulus materials on emotions between the different conditions appears larger towards the end of the experiment. No support was found for the hypothesis that negative emotions triggered by sound or video impacted pain experience.

5.1 Effect of video and sound on emotions

One of the purposes of the experiment was to investigate if video and sound from an invasive dental procedure would elicit more self-reported negative emotions and higher arousal than video and sound from an at-home dental hygiene procedure. We found that there is an overall difference in reported emotion between the negative and neutral stimuli. However, the emotion score was generally low and it decreased during the procedure. The low score on reported emotion form may be caused by the fact that the participants that volunteered had low or no pre reported dental fear and anxiety. The decrease in reported emotions during the procedure can be explained by adaptation to the situation. When individuals volunteer to participate in a clinical study they face an unknown situation, including unfamiliar events and people. In the information about the study provided during the recruitment phase, there was information about the measuring of pain. This may be an explanation for arousal and nervousness when arriving at the location and in the beginning phase of the procedure.

The differences in reported negative emotions are larger between the conditions at the end of the procedure (the second trial) than at the baseline and first trial. A reason for this might be that at the beginning of the procedure the participants are more concentrated on other factors than the sensational stimuli, for instance filling out the emotion form and using the COVAS. In addition the participants might have been distracted by the operator. Since the mean emotional score decreases during the procedure it can indicate that the participants get used to the situation and environment. When the participants adapted to the situation they could focus their full attention on the video or sound presented. When the attention is focused on the video and sound it is likely to believe that it induces larger differences in emotions depending on the valance of the sensational stimuli.

5.2 Pain stimulus

Pain is a difficult sensation to measure because of its subjectivity. We can state this because of the large range difference reported on the COVAS scale. It is likely that the subjects compared the heat pain stimuli in this study to other painful experiences they have had, even though we specifically told them not to do this. Those participants who have had previous experiences of pain might have been influenced by memories when they reported pain in this study.

It should also be mentioned that the pain stimuli our test subjects received possibly was not perceived as relevant in a dental situation. The heat stimulus on the forearm is not pain associated with a dental treatment situation. Additionally the test subjects were not required during any point of our procedure to open their mouth and let a practitioner take a look intraorally. This is something people subjectively can perceive as intrusive and experience as a feeling of losing control and powerlessness, as well as feeling embarrassed. These emotions are especially associated with dental fear and anxiety (21). Since our procedure did not include any actual elements from a dental treatment situation, other than sitting in the dental chair these emotions may not have been induced and in turn effect the pain results. In addition there are no individuals in our test group with dental fear and anxiety. If individuals with dental fear and anxiety had been included in the study as well as more elements from the dental treatment situation, the perceived pain experience might have been different. The procedure would then also replicate an actual dental visit better and perhaps the reported pain would be higher.

In this study we expected that video and sound with negative sensational stimuli would induce higher pain experience than neutral valance sensational stimuli or no stimuli at all. However, the current analysis does not support this hypothesis. The control group reported the highest levels of pain overall and there were no significant difference on reported pain between negative and neutral sensational stimuli. The fact that the control group experienced the most pain can possibly be explained by that the groups receiving sensational stimuli experienced a distraction effect while the control group had no distraction from the pain stimuli.

5.3 Male vs. Female

We see a tendency that the females report more pain than males. This is in line with large amounts of research on the topic of gender differences regarding pain experience. In both experimental pain and clinical pain, it is observed that females perceive more pain than males. The cause for this is believed to have multiple factors, including different biological factors. One of the main factors contributing is assumed to be sex hormones. The biological factors will affect the response to different types of pain, whether it is acute or chronic. But the degree of differences between the genders varies among studies (22, 23). An additional reason for the differences might be that all three research assistants were females. The male test subjects may want to show that they do not experience the heat stimuli as painful while trying to impress the operator (24). This may cause them to underreport pain.

5.4 Limitations

The duration of the stimulus materials, video and sound, may have been too long, which can contribute to an adaptation to the sight and sound stimulus. Also because of the length and that the subjects have to fill out the emotion form prior to receiving the heat stimuli, there may be too much time passing between receiving the sensational stimuli until they receive the pain stimuli. This can in turn affect the report of the pain because of a distraction effect between sensory input and pain stimuli.

We also suspect that the negative video possibly is not negative enough. The video itself does not show any blood or intraoral clips. If this had been included, it could have had a more "negative" effect on the test subjects and therefore have given more impact on the pain experience. We see in our results that the mean score of the emotion form is low and suspect that this is a contributing factor for the low pain experience.

Because we used the student web page at the University to recruit the test subjects we have a narrow age range in our test group as well as a narrow range of student's from different study programs. We got an overload of volunteers from the programs Clinical Dentistry, Psychology and Medicine and these programs are therefore heavily represented in our test groups. We believe that the reason for the female overrepresentation (62.5 %) is that the study programs that are most represented also has a majority of female students. As well as the factor that in Norway there is a majority of female students attending higher education. Per the first of October 2015 there were 79.3 % female students at higher education programs in health-, social-, and athletics according Statistics Norway (25).

Due to the fact that we recruited people from a plaque on the University web page we assume that nobody with severe dental anxiety will volunteer to participate in a study including dentistry and pain. The results on MDAS support this. The highest score on MDAS in our test group was 18. Which is right below the cut of score of 19, and the mean score was 8.55.

It can be argued that the temperature for the pain/heat stimulus set to 47 degrees Celsius on all test subjects was not painful enough. With a range of 0-99 reported pain on the COVAS it is obvious that some of the subjects do not find the set temperature painful at all while others found it very painful. Due to this, we assume this has an effect on our results and how there are no significant answers supporting our pain hypothesis.

6 Conclusion

The results of the study shows that sensational stimuli of negative emotional valence induces negative emotions in participants, but the link between negative emotions and pain experience is not supported by the current analyses. Video and sound materials of an invasive dental procedure gives higher levels of negative emotions than video and sound materials of a dental hygiene procedure, but video is no more effective than sound. Also, effects related to emotions are larger towards the end of the experiment, pointing to the role of attentional effects on emotional activation and arousal. In our study the control group reported the most pain, which might be related to a lack of distraction effects for these participants.

More research is needed on how sensational impressions in dental treatment situations affect patients' emotions and pain experience. A challenge in future research might be to design a realistic experience of a dental treatment situation. It can be difficult to recruit participants who experience dental fear and anxiety and the ethical aspect of pain has to be taken into account.

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