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Do unpleasant sounds influence pain tolerance? The relationship between negative emotions, dental soundscapes and pain tolerance

Trine Torstensen and Hanne Brobakk

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Supervisor: Jan-Are K. Johnsen

Abstract

Background: Dental treatment might involve invasive and potentially painful procedures, and most people report having experienced some degree of pain and negative emotions related to dental treatment. Experiences of painful treatment appear related to development and maintenance of dental anxiety. Since it has been documented that negative emotions influence perception of pain we sought to investigate if sound stimuli from dental treatment are perceived as unpleasant and how this might influence pain tolerance.

Materials and Method: Fifty-six participants, 32 females and 24 males, were randomly distributed to listen to binaural audio recordings (soundscapes) from either a dental treatment situation or a walk at the beach. Participants rated the sounds for unpleasantness, and pre- and post measurements of pain tolerance were made with the PainMatcher device.

Results: The results show that the sounds in the intervention group was perceived as more unpleasant ($M = 4.32$, $SD = .83$) than the sounds in the control group ($M = 2.28$, $SD = 1.34$), $t(54) = 6.99$, $p < .001$. No difference was found between pre and post pain tolerance measurements for the “dental” and “nature” groups. However, when groups were made based on self-reported unpleasantness, there was a difference in post pain tolerance measurements indicating that participants exposed to an unpleasant soundscape exhibited lower pain tolerance ($M = 18.69$) than participants perceiving sounds as less unpleasant ($M = 25.90$), $F(1) = 6.87$, $p < .05$.

Conclusion: There was no significant reduction in pain tolerance between pre and post measurements based on the predetermined groups. Significant pain tolerance reduction was found for post measurements when the participants were divided in groups according to their self-reported unpleasantness.

Introduction

The interest in dental pain and how to relieve it has been central in dental research and development for several years (Butler & Finn, 2009; Dobek, Beynon, Bosma, & Stroman, 2014; Hauck, Metzner, Rohlffs, Lorenz, & Engel, 2013; McCaul & Malott, 1984; Nilsson, Unosson, & Rawal, 2005; Roy, Peretz, & Rainville, 2008). Today, local anesthetics greatly ease otherwise painful treatment, but still many patients are suffering from dental anxiety and dental phobia often in fear of a possible painful experience. Several different "analgetic" alternatives have been suggested, including hypnosis, psychological therapy, and music.

The International Association for the Study of Pain defines pain as; "*An unpleasant sensory and emotional experience associated with actual or potential tissue damage, or described in terms of such damage.*" They also state that; "*pain always is subjective, and each individual learns the meaning of the word due to experiences relating injury in early life. It is a sensation, is always unpleasant, and therefore also an emotional experience*" (IASP, 2014). The same association defines tolerance level as: "*The maximum intensity of a pain-producing stimulus that a subject is willing to accept in a given situation*".

Despite today's procedures with local anesthesia available during dental treatment, research underscores that pain is an important yet unfortunate aspect of clinical dentistry. The impact of subjective experiences of pain might be important on several levels: Pain experiences could be considered a cause of patient`s fears, trough conditioning or as part of a traumatic experience, or pain expectations and sensations might be considered aspects sustaining the phobia. Former research (Vassend, 1993) has shown that 20-30 percent of the Norwegian adults endured moderate or worse than moderate discomfort during their last clinical visit. Studies have shown that a high percentage of adults reported having experienced at least one very painful or unpleasant treatment session in their lives (44-48 %; (Armfield, 2010); 60 % (Vassend, 1993)). Fifty-six (56) percent experienced dental treatment in general as very painful. The same study reported that dental anxiety was significantly related to pain ratings, with several explanations discussed e.g inadequate anesthesia, fear induced inadequate anesthesia or former memories and emotion related to dental pain. A longitudinal study showed that over five years, 42,5 % of patients reported having a painful experience at the dentist, while 19 % report moderate to worse pain (Maggirias & Locker, 2002; Vassend, 1993). Children's experiences with invasive (and orthodontic) treatment appear to correlate with high dental fear or anxiety (Rantavuori, Sihvonen, Tolvanen, & Lahti, 2013).

Dental anxiety is the fear of seeking or receiving dental care, and is less severe than dental phobia. Dental phobia is defined as an irrational severe fear that provokes immediate anxiety when disposed to the stimuli, and in a dental situation often leads to avoidance or anxiety that results in panic attack (Pottera, Kinnera, Tellezb, Ismailc, & Heimberga, 2014). Dental phobia patients normally do not visit the dentist at all, or cope with appointments in emergency situations even while in great discomfort (Vassend, 1993). They can be separated from patients with less intense dental anxiety, which may feel nervous or fearful before the appointment, but still manage to undergo the treatment.

Unconditioned aversive stimuli result in pain or discomfort and are associated with harmful or damaging events. By applying an aversive stimulus immediately following a specific behavior, the likelihood of repeating this behavior in the future is reduced. This phenomenon creates fear and avoidant behavior towards the stimulus. In this way, the earlier dental treatment experiences may have an influence in the development and sustaining dental fear. (Berge, Veerkamp, & Hoogstraten, 2002; Biederman et al., 1990; Donovan & Spence, 2000; Gullone, 2000; Locker, Shapiro, & Liddell, 1996; Poulton et al., 1997; Stevenson, Batten, & Cherner, 1992). Previous studies found that endogenic personality factors like age, gender, personality, and fear in family members have an association with children's dental fear (Klaassen, Veerkamp, & Hoogstraten, 2007; Lahti, Rantavuori, Hausen, Seppä, & Kärkkäinen, 2004; Nicolas et al., 2010; Poulton, Waldie, Thomson, & Locker, 2001; Tickle et al., 2009; Tolvanen, Rantavuori, Hausen, Lahti, & Seppä, 2009; Townend, Dimigen, & Fung, 2000). High levels of dental fare often occur during childhood. The effects of invasiveness and what procedures that causes dental fear are less studied, but children who have undergone invasive procedures like tooth extraction are more likely to have a higher dental fear. (Berge et al., 2002; Lahti et al., 2004; Milsom, Tickle, Humphris, & Blinkhorn, 2003; Poulton et al., 2001; Rantavuori et al., 2013).

Emotions and experiences of pain

Research have shown that anxiety provoking stimulus may ether increase or decrease the experience of pain. It depends on the nature of the stimulus; pain related anxiety would increase the perception of pain, while pain irrelevant anxiety will not significantly influence pain. (Absi & Rokke, 1991; Janssen, Arntz, & Bouts, 1998; Roy, Lebuis, Hugueville, Peretz, & Rainville, 2012; Roy et al., 2008). There has been found substantial correlations between dental anxiety and ratings of pain and discomfort associated with dental treatment (Maggirias & Locker, 2002; Vassend, 1993). Two studies showed avoidant dental patients had higher state anxiety and lower tolerance for dental pain (electrical tooth pulp stimulation), but not non-dental pain (electrocutaneous stimulation of the left forearm), compared to patients with low levels of fear. There were no differences in pain thresholds between the two groups (Klepac, Dowling, & Hauge, 1982).This would again be referable to the dental setting where most patient has the assumption of, or experience of pain: ((44-48%: (Armfield, 2010); (60%:(Vassend, 1993); (Maggirias & Locker, 2002)). This assumption or experience is a possible trigger for anxiety, which in turn sensitize the patient, which leads to hyperalgesia.

Several interventions have been tested to try to modulate pain and discomfort, and it is found that pleasant music relives pain and decreases stress and anxiety through relaxation and distraction (Dobek et al., 2014; Hauck, Lorenz, & Engel, 2007; Hauck et al., 2013; Moll et al., 2002; Roy et al., 2012; Roy et al., 2008). Music is one of the oldest known methods to sooth pain and is widely used during treatment of chronic pain (Dobek et al., 2014; Hauck et al., 2013; Nilsson et al., 2005). However, little is known about the specific neural mechanisms of pain modulation through emotions and distraction created by music. It has been suggested that deep and strong emotions evoked by music modulates the patients pain processing by altering the activity of the delta and gamma bands in the central nerve system, and that this process influences the descending pain modulatory pathways (Blood & Zatorre, 2001; Blood, Zatorre, Bermudez, & Evans, 1999; Dobek et al., 2014; Gomez & Danuser, 2004; Hauck et al., 2013; Moll et al., 2002; Roy et al., 2012).

<u>*Memory*</u>

These results show that pain experiences can be modulated by emotional states activated by different stimuli (e.g. music, memories, etc). Since it has been documented that painful dental treatment is associated with dental fear and anxiety (negative emotional states), it follows that associated stimuli could influence pain experiences in accordance with these results, for instance cause hyperalgesia. Patients' previous experience with pain during dental treatment has been identified as a major trigger for dental anxiety (Berge et al., 2002; Locker et al., 1996; Nicolas et al., 2010). Research underscores that the main concern and most anxiety provoking stimuli is undergoing invasive dental treatment due to expected pain (Oosterink, Jongh, & Aartman, 2008). The link between former experience of pain in clinical situations and dental fear is well documented (Jongh, Muris, Horst, & Duyx, 1995; Kent, 1984, 1985; Oosterink et al., 2008; Wright, Lucas, & McMurray, 1980).

Memory gap.

Emotions is described as a *"mobilization and synchronization of five organismic subsystems as a response to a cognitive evaluation of external or internal stimulus events that are a major concern to the organism"* (Bruun & Ahm, 2015; Scherer, 2005). Emotions are often thought to be linked to a specific event. Short and insignificant events are not remembered but salient events are remembered in respective of duration (Scherer, 2005). There has been proven a discrepancy between concurrent emotions and the recollection of this memory after a given situation (Bruun & Ahm, 2015; Hyman & Loftus, 1998; Miron-Shatz, Stone, & Kahneman, 2009). Scherer's descriptions of emotions as short-lived are supported by empirical observations of the discrepancy between current and retrospective ratings of emotions and pain, also called the memory-experience gap (Bruun & Ahm, 2015; Linton & Melin, 1982; Miron-Shatz et al., 2009; Redelmeier & Kahneman, 1996).

Kent conducted a study in 1984 where he asked patients before the procedure what degree of pain they expected during the procedure (Kent, 1984). He then compared the pre-result with the post-result where the patient described the actual pain they felt. There was a large discrepancy, especially for anxious patients undergoing invasive treatment. Anxious patients expected more pain than they experienced. The non-anxious patients were fairly accurate in their estimations. In 1985, Kent conducted a study regarding patient's recollection of acute pain 3 months after dental treatment. Showing, that anxious patients in particular reports higher pain at the follow-up appointments than previously described (Kent, 1985). This underscores the theory that patient's memories of pain experience are reconstructed over time in order to become consistent with their existing level of fear. These results show that patients' reports of acute pain given 3 months after a dental appointment are often different from reports given immediately after the appointment. Another study to emphasize these findings are (Eli, Baht, Kozlovsky, & Simon, 2000) who found that retrospective pain 4 weeks after oral surgery is correlated with dental anxiety, while directly after surgery there was no correlation. Anxious patients in particular reported more pain at follow-up than they had previously reported. These findings are consistent with the hypothesis that patients' memories of experienced pain are reconstructed over time in order to become consistent with their existing levels of anxiety.

Distraction

In addition, audio distraction is a non-invasive non-damaging technique that in some medical settings are added to other treatments to help relax and to cope with pain, so called "Music therapy" (Standley & Hanser, 1995). For dental procedures with music supressing sounds from drilling (Ikefuji, Suhara, Nakayama, Nishiura, & Yamashita, 2014), Gardner and Licklider (1960; as cited in(Brown, 1989)) *"found that out of 1000 patients that 65 % had complete suppression of pain, 25 % had suppression enough that no analgesia was required and 10 % had less than adequate relief of pain. The patients regulated the auditory stimuli volume themselves to suppress the drilling sounds."* Mechanisms involving pain perception and distraction are unclear and controversial

Music with suggestions and under patient control, has proven to have salutary effects for dental patients in reducing pain (Brown, 1989). Studies from laboratory research have suggested that sound stimulation does not raise pain threshold but does affect tolerance levels (Brown, 1989; Robson & Davenport, 1962). A study done on children, 4-6 year-old, studied the effect of music during dental treatment. It reported no reduction in anxiety, pain or uncooperability, but 90 % of the children reported when asked that they enjoyed listening to the music during treatment (Aitken, Wilson, Coury, & Moursi, 2002)

Hypothesis

This project seeks to utilize soundscape recordings to investigate the relationship between negative emotions and pain tolerance in dental treatment. Since many patients have an association between dental treatment and negative emotions, we would expect immersive soundscapes related to dental treatment to influence sensations and subjective experiences related to pain, the project has the following research hypotheses:

1) Exposure to a dental soundscape will lower pain tolerance in participants compared to exposure to a neutral soundscape
2) Evaluation of painful former dental treatment or experiences retrospectively (in accordance with the memory-experience gap) will yield higher pain-scores in individuals exposed to a dental soundscape (negative emotions) than to a neutral soundscape.

Methods

Study design

The study is a pretest-post-test control group design. The participants are randomly distributed into two groups; intervention (I) group and control group (C). Both groups follow the same experiment protocol, only differentiated by the different soundscapes. The intervention group will listen to a soundscape from a dental treatment setting and the control group will listed to a soundscape from a natural setting.

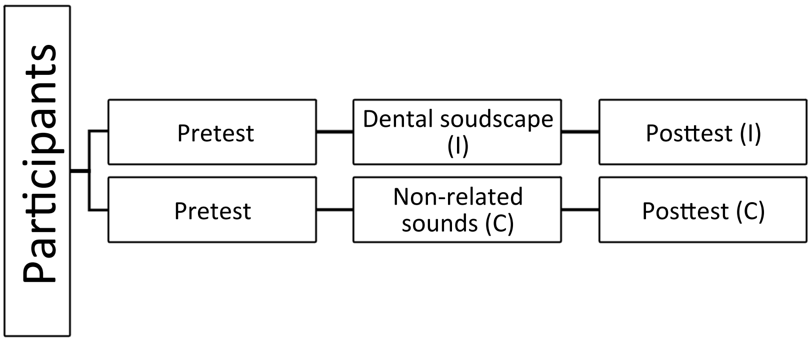

Figure 1. Experiment design

Materials

The Pain Matcher measurement device (by Cefar Medical AB) was used to elicit pain or discomfort, and measure pain tolerance. This device has been used in research of pain threshold in mostly medical settings and is a low cost, non-invasive method for measuring pain data (Nielsen, Nørgaard, Rasmussen, & Kehlet, 2007). The device is run by two 1,5 AA batteries, and the measurement unit consists of a circuit board generating a weak electric current (maximum 15 mA and 13 kohm) across two electrodes. Measurements are performed with the participant gripping the electrodes with a left-handed pincer-grip (thumb and index finger) witch create contact between the electrodes and following electric current stimulation.

The electrical current consists of rectangular pulses at 10 Hz with 10 mA amplitude, which is gradually increased by 4 µs rises in pulse width, from zero to a maximum 396 µs. This occurs over a total 99 steps and ceases when the individual releases their grip on the device. The result is displayed on a LCD screen, on a scale from 1 to 99, which is directly related to the pulse width. Higher Pain Matcher values indicate higher sensory and/or pain thresholds.

This means that if the device is pressed for example 10 seconds, and you get a measurement result, the next time you press, you may hold for longer or shorter time, and still get the same measurement result. This is to prevent the participants from competing with themselves to improve their score by pressing the device longer.

No negative side-effects have been reported in the available literature (Alstergren & Förström, 2003; Käll, Kowalski, & Stener-Victorin, 2008; Lundeberg et al., 2001; Nielsen et al., 2007; Persson, Westermark, Merrick, & Sjölund, 2009).

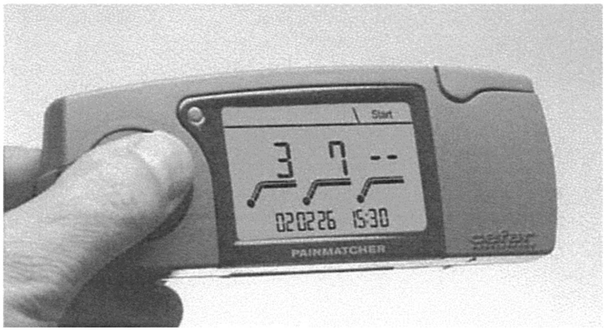

Figure 2. The PainMatcher™ measurement device.

The dental soundscape was recorded using the soundman “Studio” binaural microphone system (see Figure 3). These were placed in one of the experimenter`s ears and sound recordings of various treatments were made: ultrasonic scaling, hand scaling, turbine, suction and exploring. The sounds were selected based on what the experimenters judged as possible “unpleasant” or “pain associated” sounds based on their clinical experience. The binaural microphones were fed into a Zoom R8 studio interface, and the sounds were edited using Cubase LE Elements 7 software on a MacBook Pro computer. The separate recordings were then edited into one sound file lasting approximately five minutes. The neutral soundscape was selected from a public domain selection of binaural recordings. It was of a walk at the beach, listening to the waves, and lasted for approximately five minutes.
The experiment soundtrack was played through VLC on a MacBook Air computer. Volume was decided and set at a comfortable level by both experimenters, and standardized. A noise-cancelling headphone, Goldring NS-1000, was used.

Figure 3. Soundman dummy head and binaural in-ear microphones.

Procedure

Participants were recruited at the Faculty for Health Sciences at the UiT, Arctic University of Norway. Participants accepting to contribute to the study received non-vital information about the study; that we were two odontology students conducting a study regarding sound and pain. Individuals who agreed to participate were brought to a neutral room where they were introduced to the experimenter who was conducting the experiment. When entering the experimenting room, participants were greeted and seated in front of a table with the experiment materials. In order to achieve informed consent, brief information about the experiment was given, including the different protocol steps. The participants were again asked if they wanted to participate, and those that did were included in the study.

The participants were introduced to the Pain Matcher measurement device. The experimenter explained and demonstrated how the pain matcher worked; holding the Pain Matcher in a firm grip with both hands, and with the left hand thumb and index finger on the electrodes. They were informed about the variation in current acceleration between measurements; holding 10 seconds during multiple measures can generate different pain threshold scores. Participants were explained that we were measuring pain tolerance levels, and thereby that the purpose was to press the diodes for as long as they could. They also were informed that they were free to release their grip at any time. The participants then got to try the Pain Matcher for a few seconds, just to get the feeling of how it operated. The pain matcher was then reset by the experimenter and prepared for measurements.

The Pain Matcher was used to make three pre-test pain tolerance measurements. The participant placed the headphones and was instructed to listen to the soundscape. The experimenter started the soundtrack related to the participant`s respective group (intervention or control group), and leaved the room. As the soundscape finished, the experimenter reentered the room to measure post-test pain tolerance level.

Finally, the participants received a computer-based questionnaire measuring demographic information, evaluation of former painful/ unpleasant treatment experiences, dental anxiety score (Modified Dental Anxiety Scale), evaluation of sound-quality and sound unpleasantness (validity). Both pre- and post pain tolerance measurements were registered manually at the end of the questionnaire by the experimenter, and information was saved using an electronic questionnaire hosted by Limesurvey (see Appendix for questionnaire).

The procedure lasted for approximately 15 min. At the end of their participation, they were offered oral and written information about the study. All participants received a lottery ticket of 25 NOK as a reward for their participation. The Regional Committee for Medical and Health Research Ethics approved the study design.

Results

Descriptive analyses

The study included 56 participants of which 32 were female and 24 were male. Mean age was 23 years old (range 18 – 32 years). The majority (60.7 %, $N = 34$) attended the dentist at regular intervals. Participants were randomly distributed into two conditions: intervention group ($n = 32$) and a control group ($n = 24$).

Participants in both intervention and control groups were asked to indicate the unpleasantness of the sounds they heard on a scale from 1-5 (1 = not unpleasant; 5 = very unpleasant). The results show that the sounds in the intervention group was perceived as more unpleasant ($M = 4.32$, $SD = .83$) than the sounds in the control group ($M = 2.28$, $SD = 1.34$), $t(54) = 6.99$, $p < .001$. Also, the perceived realism of the dental soundscape was investigated where participants had to indicate on a scale from 1-5 (1 = not accurate, 5= very accurate) whether the sounds were perceived as accurately representing an appointment at the dentists'. Participants indicated that they found the sounds only moderately realistic ($M=2.63$, $SD= 1.13$).

Sex differences

Due to former research indicating a difference in how females and males perceive pain, we looked at whether participant sex influenced pain threshold measurements. Both pre and post pain thresholds appeared influenced by sex with males reporting higher thresholds (pre M = 27.48; post M = 27.42) than females (pre M = 17.14; post M = 17.55).

Dental Anxiety

Participants had an average MDAS sum score of 10.5 (SD = 2.84), with females (M = 10.78, SD = 3.05) scoring higher than males (M = 9.08, SD = 2.24); t(54) = 2.30, p < .05.

Table 1. Summary of descriptive analyses.

Variable	*N*	*Mean*	*Range*
Age	56	23.00	18-32 years
Variable	*N*		*Percentage*
Sex			
Male	24		42.86
Female	32		57.14
Variable	*N*	*Mean*	*SD*
Realism of dental soundscape (1-5)	32	2.63	1.13
Unpleasantness (1-5)	56	3.41	1.49
Intervention Group	32	4.32	.83
Control Group	24	2.28	1.34
Variable	*N*	*Mean ± SD*	*Mean ± SD*
Pain tolerance		Pre Measurements	Post Measurements
Male	24	27.48 ± 11.05	27.42 ± 12.01
Female	32	17.14 ± 6.84	17.55 ± 7.31
Variable	*N*	*Mean*	*SD*
MDAS	56	10.50	2.84
Male	24	9.08	2.24
Female	32	10.78	3.05

Hypotheses testing

The effects of soundscape on pain tolerance. In order to investigate Hypothesis 1 a repeated measures analysis of variance (ANOVA) was performed with Pain Tolerance measurements as within group independent variables (Pre and Post), condition (Intervention Group versus Control Group) as a dependent variable, and Sex (female, male) and Dental Anxiety (MDAS sum score) as covariates. Pre and post pain scores were obtained by using the median of the three separate measurements. The analysis reveals an overall difference in pain tolerance between intervention group and control group, $F(1)=5.54$, $p < .05$, but no within group difference between pre and post measurements for the intervention group.

Due to the low realism scores of the dental soundscape it was decided to perform ANOVA with Unpleasantness Scores (High vs Low; the variable mean was used to separate the groups, with 4-5 = high and 1-3 = low) as a dependent variable, Sex (female, male) and Dental Anxiety (MDAS sum score) as covariates, and only Post Pain Tolerance measurements as an independent variable. Thus, we disregard the hypothesized difference in soundscapes (dental vs. natural) and focus only on the perception of either soundscape as more or less unpleasant and the post measurements of pain tolerance. This analysis yielded a significant difference in post pain tolerance measurements between the unpleasantness groups indicating that participants perceiving the soundscape as unpleasant exhibit lower pain tolerance ($M = 18.69$) than participants perceiving sounds as less unpleasant ($M = 25.90$), $F(1) = 7.17$, $p < .05$ (See Figure 4).

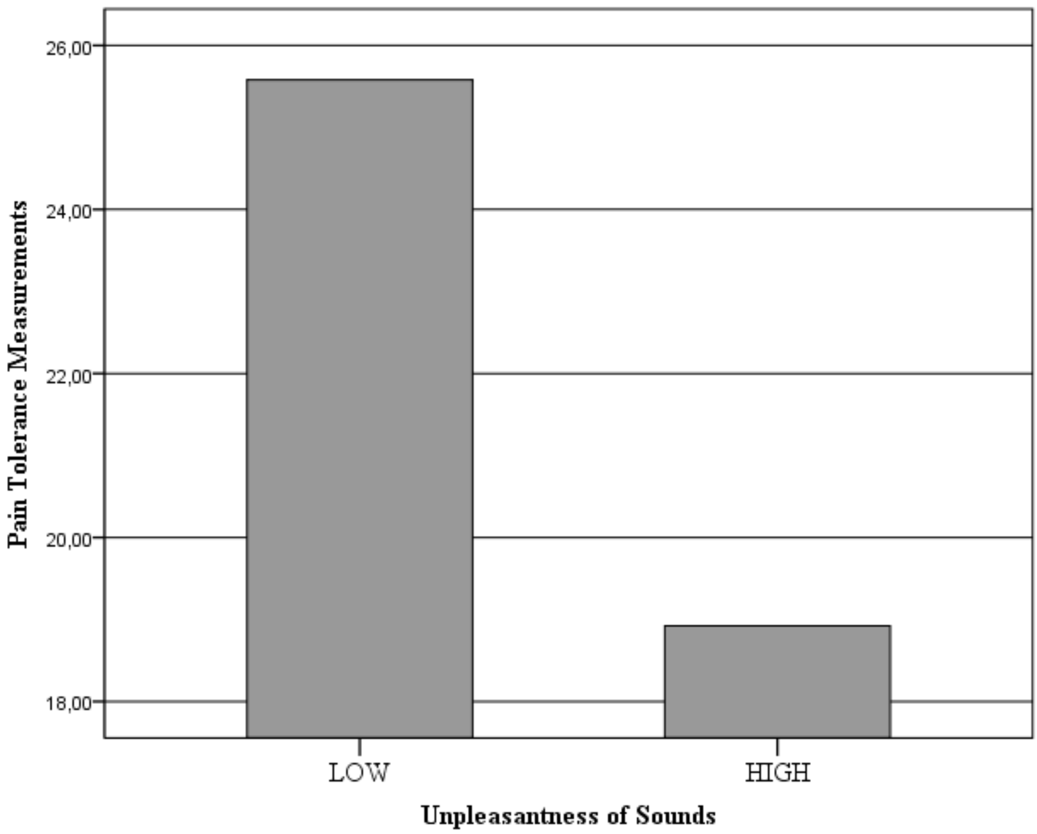

Figure 4. Differences between post pain tolerance measurements for high and low ratings of unpleasant sounds.

<u>*The effects of soundscape on evaluation of former experiences.*</u> Participants were asked to indicate whether they had prior painful experiences at the dentist's office (yes/no) and 78.6 percent indicated that they had such experiences in the past (44 participants; 27 female, 17 male). The forty-four participants indicating former painful experiences were also asked to indicate the severity of the pain experienced in retrospect from 1 – "not particularly painful" to 5 – "very painful": over 40% (18 participants) indicated 4 (14 participants, 9.1 %) or 5 (4 participants, 31.8 %), while 45.5% indicated 3 (20 participants) and 13.6% 1 (3 participants, 6.8 %) or 2 (3 participants, 6.8%). No statistical relationship was found between sex and former painful experiences.

To investigate Hypothesis 2, that exposure to dental soundscapes might influence retrospective evaluation of painful dental experiences, a scale from 1 to 6 was composed using the severity scores reported (2 – 6) and the indication of no painful prior experiences as 1 (i.e., 1 = "no prior pain", 6 = "very painful prior experience(s)"). This variable was used as an independent variable in a t-test, to test mean differences in retrospective pain for the intervention group (M = 3.32, SD = 1.64) and the control group (M = 3.92, SD = 1.55). No difference in retrospective evaluation was found.

Discussion

The present study was conducted to test whether auditory information from a dental treatment context could influence measurement of pain tolerance (Hypothesis 1) and retrospective evaluation of former painful treatment experiences (Hypothesis 2). However, the research hypotheses were not directly supported by the results. Hypothesis 1; Exposure to a dental soundscape will lower pain tolerance in participants compared to exposure to a neutral soundscape. This hypothesis is based on former research showing that pain experiences is affected by emotional states (Dillmann, Miltner, & Weiss, 2000; Swannell, Brown, Jones, & Brown, 2016; Wieda & Verbaten, 2001) and we have argued that participants will get a lowered pain tolerance because the dental soundscape would provoke unpleasant emotions. Hypothesis 2; Evaluation of painful former dental treatment or experiences retrospectively (in accordance with the memory-experience gap) will yield higher pain-scores in individuals exposed to a dental soundscape (negative emotions) than to a neutral soundscape. This hypothesis is based on the research where induction of a negative emotional state through a soundscape, would promote emotions from previous painful events (Bruun & Ahm, 2015; Linton & Melin, 1982; Miron-Shatz et al., 2009; Redelmeier & Kahneman, 1996).

While participants in the intervention group on average rated the dental soundscape as more unpleasant than participants in the control group, it is an interesting point that some participants in the control group also found the “neutral” soundscape quite unpleasant. and. This has been a problem discussed in several studies, among others; (Blood et al., 1999; Gomez & Danuser, 2004). In these studies, it was instead decided that the participants picked the soundtracks themselves or bring their favorite song, since the perception of what is pleasant and unpleasant is highly variable among people. Thus, it could have been more fruitful to create a procedure where participants selected stimuli based on perceived and individual unpleasantness.

Previous studies show that music evokes emotions in the participants, but that there was no change in pain measurements after unpleasant music. A significant reduction in pain was reported to in response to comfortable music (Roy et al., 2012; Roy et al., 2008). This indicate that pain thresholds and tolerance is more likely to be dependent on the participant`s feelings or emotions evoked by the sound, than the sound itself. Like Sachs has demonstrated by creating a pleasurable experience using sad music (Sachs, Damasio, & Habibi, 2015). With this in mind, it is plausible that negative/ unpleasant emotions may trigger pathways in the central nerve system that induces hyperalgesia. To convert this concept to our study; The dental soundscape should not trigger a decrease in pain tolerance if the participant does not possess negative or anxiety provoking experiences that can be related to the sounds. In contrast, if the participant has negative experience with sound sequences of our control group soundtrack, like a phobia against birds or water, then a reduction of the pain tolerance may be induced. Others may enjoy these sounds and get an increase in pain tolerance. We believe this was the main problem causing the inconclusiveness when using the intervention versus control group division.

In addition to the potential lack of negative experiences to dental treatment, the dental soundscape were regarded only moderately realistic, and some participants might have found the natural soundscape unpleasant. Thus, we suspect that the pre-determined conditions; dental soundscape versus natural soundscape; and the a priori assignment of negative versus neutral valence to these conditions might be unfortunate. Instead, one might focus more on the feeling of unpleasantness, reported by the participants after listening to the soundscape, and less on the original assumptions. Using unpleasantness as a condition for making new groups, we found a significant pain tolerance difference in the expected direction (lowered for negative valence / unpleasantness).

The hypothesis concerning retrospective pain evaluations was based on research showing that memories of painful experiences in the past are not always reliable (Bruun & Ahm, 2015; Linton & Melin, 1982; Miron-Shatz et al., 2009; Redelmeier & Kahneman, 1996). If we look at the intervention group, the soundscape is representative to a regular dental hygienist appointment (scaling) and dentist appointment (turbine). Our goal was to remind the participants of this, hopefully a familiar situation, by making them feel like they were being treated in a dental chair. Even participant that have no cavities done would be familiar to most of the sounds, like sucking noise, exploratory sounds and scaling. From here, the participant themselves decide actively or passively to be affected by the sounds, or not at all. By using randomly selected students at UiT, we may have recruited people with the wrong kind of anxiety for our study, or people with no negative recollection about dental treatment. It is no longer common for this age- and social group to have great treatment need and previous dental treatment experience. In this manner, participants in the intervention group who were unaffected by the sounds would dilute our result, and vice versa, those who got affected negatively by the control soundscape.

Most of our participants were at relatively young age, and visited the dentist regularly. Many participants reported that they had never had cavities and had mostly pleasant visits at the dentist or dental hygienist. If the participants had never experienced a very painful treatment, they probably would not have any bad emotions evoked by the dental sounds. There may be reason to believe that if the study had included elderly people, with memoires from painful dental treatments without local anesthesia, the results might have differed.

Potential Limitations

The pre measurements of pain tolerance should be approximately the same between the test and control groups due to randomized distribution of participants in intervention and control group.. However, this was not the case in our study. This might be due to a unlikely coincidence in which participants with higher pain tolerance by accident got selected into the control group. A higher number of participants could have helped to solve this issue (the original design aimed for 80 participants).

Research suggests that the Pain Matcher apparatus measures more of an unpleasantness than actual pain (Käll et al., 2008), and comments from some of our participants support this notion. It was described by the participants as a “different” kind of pain, and more of an “unpleasant feeling”, though not directly as pain. We experienced with some of the participants that reached higher Pain Matcher scores, that they were unsure if they released their grip because of muscle contraction form the electric current or because of pain.

A study by (Persson et al., 2009) showed the validity of the Pain Matcher doubtful, compared with VAS-scale. Other studies find the Pain Matcher “a reliable method for pain assessments, with lack of random individual disagreement and with no statistical evidence of systematic disagreement in position or in concentration” . Pain Matcher is often used in combination with a VAS scale for pain recording and measurement, as the studies just mentioned. The Pain Matcher shows less variation in measurement results over time compared to VAS. The device has been well accepted by patients in medical studies of pain (Stener-Victorin, Kowalski, & Lundeberg, 2002).

Conclusion

Through our study, we did not find solid evidence to support our hypothesis. Our hypothesis that dental sounds will lower pain tolerance compared to relaxing sound, is inconclusive due to reported non-realistic sound. We could not find a significant relation to previous dental pain during treatment and lowered pain tolerance after listening to our dental soundscape. However, we did find a significant reduction in pain tolerance measured with the Pain Matcher when focusing on self-reported unpleasantness to soundscapes, with high unpleasantness associated with lowered pain tolerance.

To our knowledge there has been no former research on this subject. Therefore, our study design is constructed to be a foundation and inspiration for other studies on the relation between dental anxiety/phobia and pain. And we hope that our discussion and conclusion may aid others following this study path. This study design definitely needs more time and resources than we were provided, but we think it may yield significant and important information to better comprehend patients with dental phobia and anxiety.

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Appendix

Spørreskjema

Elektronisk spørreskjema via Limesurvey.

Opplevelse av lyder og smerteoppfatning

Formålet med denne undersøkelsen er å undersøke om det finnes en sammenheng mellom ulike lyder og smerteoppfatning blant studenter på Universitetet i Tromsø.

Dette prosjektet er forskning på anonyme data via et elektronisk spørreskjema. Data kan ikke knyttes opp mot enkeltpersoner. Ved å trykke "neste" samtykker du i å delta i denne undersøkelsen.

Demografi

Kjønn
Velg kun en av følgende:
○ Kvinne
○ Mann

Alder
Vennligst skriv her:

Går du regelmessig til tannlege/tannpleier?
Velg kun en av følgende:
○ Ja
○ Nei

Når var ditt siste besøk hos tannlege/tannpleier?
Vennligst skriv her:
Måneder _____
År _____
Oppgi svar i måneder og år.

Hvor langt har du kommet i ditt nåværende studium? Oppgi semester eller år.
Vennligst skriv her:
Semester _____

Modified Dental Anxiety Scale

1. Dersom du visste du skulle til tannlegen i morgen, hva ville du føle?
Velg kun en av følgende:
- ○ A. Jeg ville se frem til det som en ganske hyggelig opplevelse
- ○ B. Det ville være det samme for meg, ikke bety noe
- ○ C. Det ville gjøre meg litt urolig
- ○ D. Jeg ville bli redd for at det skulle bli ubehagelig og vondt
- ○ E. Jeg ville bli svært redd med tanke på hva tannlegen kanskje skulle gjøre

2. Når du venter på tannlegens venteværelse, eller venter på å bli hentet til tannlegen, hvordan føler du deg da?
Velg kun en av følgende:
- ○ A. Avslappet
- ○ B. Litt urolig
- ○ C. Anspent, nervøs
- ○ D. Redd, engstelig
- ○ E. Så redd at jeg av og til begynner å svette eller nesten føler meg syk

3. Hvordan føler du det når du sitter i tannlegestolen og venter på at tannlegen skal borre i tannen/tennene dine?

Velg kun en av følgende:

- A. Avslappet
- B. Litt urolig
- C. Anspent, nervøs
- D. Redd, engstelig
- E. Så redd at jeg av og til begynner å svette eller nesten føler meg syk

4. Tenk deg at du sitter i tannlegestolen for å få rengjort tennene dine. Hvordan føler du deg når tannlegen tar frem instrumentene for å fjerne tannstein?

Velg kun en av følgende:

- A. Avslappet
- B. Litt urolig
- C. Anspent, nervøs
- D. Redd, engstelig
- E. Så redd at jeg av og til begynner å svette eller nesten føler meg syk

5. Hvis du måtte ta bedøvelse («sprøyte») for behandling av en jeksel i overkjeven, hvordan ville du føle deg?

Velg kun en av følgende:

- A. Avslappet
- B. Litt urolig
- C. Anspent, nervøs
- D. Redd, engstelig
- E. Så redd at jeg av og til begynner å svette eller nesten føler meg syk

Smertefulle erfaringer – tannlege

Har du noen gang opplevd tannbehandling som var smertefull eller ubehagelig?

Velg kun en av følgende:

- Ja
- Nei

Når du tenker tilbake på den mest smertefulle eller ubehagelige behandlingen du kan huske, hvor smertefull eller ubehagelig synes du den var? 1 = ikke særlig smertefull/ubehagelig - 5 = svært smertefull/ubehagelig

Svar kun på dette hvis følgende betingelser er oppfylt:

Svaret var 'Ja' ved spørsmål '11 [s1]' («Har du noen gang opplevd tannbehandling som var smertefull eller ubehagelig?»)

Velg kun en av følgende:

- 1
- 2
- 3
- 4
- 5

Lydkvalitet og opplevelse av situasjon [det reformulerte spørsmålet «Synes du lydene du hørte var ubehagelige?» stilles til kontrollgruppa]

Hvor realistisk synes du lydene var for situasjonen (behandling hos tannlege/tannpleier)? 1 = ikke realistiske - 5 = svært realistiske

Velg kun en av følgende:

- 1
- 2
- 3
- 4
- 5

Synes du lydene du hørte var ubehagelige? 1 = ikke ubehagelige - 5 = svært ubehagelige
Velg kun en av følgende:

- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5

Takk for at du ville delta. Kontakt (jan.a.johnsen@uit.no) dersom du vil få mer informasjon om undersøkelsen.

Forespørsel om deltakelse i forskningsprosjektet

Lyd og smerteopplevelse

Bakgrunn og hensikt

Dette er et spørsmål til deg om å delta i en forskningsstudie for å undersøke sammenhengen mellom inntrykk fra omgivelsene, for eksempel lyder, og smerteopplevelse.

Hva innebærer studien?

Studien vil for deg som deltaker bestå av tre ulike deler:

1. Smertemålinger – du vil få en praktisk demonstrasjon av et måleverktøy (PainMatcher) for å måle ulike sider av smerteopplevelse. Deretter vil du i tre omganger måle sensorisk terskel, smerteterskel og smertetoleranse. Målemetoden gjør at du selv har kontroll over hvor mye smerte og ubehag dette medfører. Prosjektmedarbeiderne vil gi deg nødvendig informasjon under demonstrasjonen om hvordan målingene skal utføres. For mer informasjon om PainMatcher, se s. 2 «Informasjon om PainMatcher» i dette informasjonsskrivet.
2. Lyd – du vil deretter få høre på en serie lyder i hodetelefoner. Dette vil ta fem minutter.
3. Smertemålinger 2 og spørreskjema – du vil deretter bli bedt om å gjenta målingene fra 1. og fylle ut et kort spørreskjema. Spørreskjema vil fokusere på i hvilken grad du opplever angst for tannbehandling, opplevd stress i situasjonen, tidligere erfaring med smertefull eller ubehagelig tannbehandling og spørsmål om lydkvalitet (lydene du har hørt på).

Mulige fordeler og ulemper

Studien vil kunne gi resultater som påvirker behandling og tilbud til pasienter som er redde for å gå til tannlegen. Det vil ikke være fordeler for deg som person. Ulempen med deltagelse er at smertemåling vil oppleves ubehagelig/smertefullt. Du vil selv ha full kontroll over hvor ubehagelig eller smertefullt det vil være.

Hva skjer med informasjonen om deg?

Det vil ikke samles inn informasjon under studien som kan brukes til å identifisere deg, og data vil analyseres på gruppenivå. Det vil følgelig ikke være mulig å identifisere deg i resultatene av studien når disse publiseres.

Frivillig deltakelse

Det er frivillig å delta i studien. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke til å delta i studien. Dette vil ikke få konsekvenser for deg. Om du nå sier ja til å delta, kan du senere under gjennomføringen eller etter gjennomføring trekke tilbake ditt samtykke. Fordi data er anonyme vil det ikke være praktisk mulig å slette data etter at du har forlatt lokalet.

Dersom du har spørsmål til studien, kan du kontakte førsteamanuensis Jan-Are K. Johnsen, IKO, UiT på epost jan.a.johnsen@uit.no / 77649131

INFORMASJON OM PAINMATCHER – bruksmåte og teknisk informasjon

PainMatcher er en håndholdt enhet drevet av 2 stk AA batterier som gir elektrisk impuls til en bruker gjennom at man trykker inn to elektroder med venstre hånds tommel og pekefinger (pinsettgrep). Dette vil få PM til å øke strømføring mellom elektrodene i størrelsesorden 10Hz – 15mA og i økende pulsvidde fra 0 til 396 µs i 99 steg, og dette oppleves da som et økende ubehag eller smerte lokalt i fingrene som holder elektrodene. Du vil kunne avbryte målingen ved å slippe grepet på elektrodene. PM gir måleverdier som tall (0-99), som indikerer grad av smerte/ubehag. Det er ikke dokumentert negative effekter, skader eller bivirkninger ved bruk av PM i litteraturen.

Denne enheten vil i prosjektet benyttes til å måle smertetoleranse (hvor lenge du ønsker å holde grepet). Prosjektmedarbeiderne vil demonstrere enheten for deg, og gjennomgå målemetodene muntlig før hver måling.

Samtykke til deltakelse i studien

Jeg er villig til å delta i studien og har mottatt 1 stk Flax-lodd:

(Signert av prosjektdeltaker, dato)

Jeg bekrefter å ha gitt informasjon om studien:

(Signert, rolle i studien, dato)