UiT The Arctic University of Norway

Faculty of Health Science, Institute of Psychology (IPS)

Effects of Experimentally Induced Pain on Value-Based Decision-Making in Healthy Adults

Ina Klakegg

Master's Thesis in Psychology, PSY-3900, May 2022

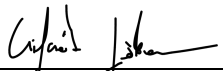
Foreword

The idea for this thesis was developed partly based on previous research on value-based decision-making completed by the neuroscience research-group at UiT. The evolution of the idea and the project was furthermore guided by my interest in pain-related research, as potentially making the lives of those who suffer with chronic pain easier and better is a cause that is very dear to my heart. Fortunately, when I reached out to Gabor Csifcsák he was interested in supervising me, and together with two other master-students we were able to develop and design the overarching project. The data-collection was a collaborative effort between me and the two other students, and I completed all analyses and writing myself with the continuous guidance of Gabor.

To my amazing supervisor Gabor Csifcsák: Thank you for all your guidance, feedback, supervision and collaboration throughout this process. You truly have been an invaluable asset, and I have learnt so much from you and from working on this thesis. My data collection-collaborators, Caroline Angen and Anastasija Kuprejeva, also deserve my gratitude. Thank you for the last two years, especially for all the good times in the lab.

I also wish to express my gratitude to all the people from IPS who participated in the pilot study. Other thanks go out to everyone who participated in the main study and endured an hour of pain for this thesis. Lastly, I also want to thank my friends and family for believing in me and supporting me during this process, as they always do.

Ina Klakegg
Master-student



Gabor Csifcsák
Supervisor

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Abstrakt

Hver dag tar vi valg som påvirker velferden vår. På grunn av dette, er det essensielt at vi har utgangspunkt for å ta best mulig valg for å minimere unødvendige tap og lidelser. Noen grupper kan være spesielt sårbare og utsatte for å ta mistilpassede valg, eksempelvis de som lider med kronisk smerte. Akkurat nå finnes det ingen klar kobling mellom smerte og valgtakning i litteraturen, men det er derimot forskning som viser at visse aversive stimulanser påvirker graden av Pavlovian bias i forhold til valgtakning. Dette kan indikere at smerte kan påvirke valgtakning på en lignende måte som andre aversive stimulanser. I denne studien testet vi hvorvidt smerte ville være en modulator for graden av Pavlovian bias i (N = 50) friske, norsktalende voksne. Vi utviklet en protokoll for å påføre smerte på en trygg og effektiv måte, og brukte denne protokollen parallelt med en orthogonalisert Gå/IkkeGå verdi-basert valg-takningsoppgave i form av et kortspill. Spillet besto av 5 blokker (runder), hvorav blokkene 2 og 4 var manipulerte blokker med enten varm eller smertefull stimulering. Vi fant at smerte generelt ikke hadde en effekt på ytelsesnøyaktigheten, men så noen indikasjoner på at smerten økte det Pavlovian biaset i det aversive domenet. Selv om denne effekten ikke var særlig sterk, kan den være sterkere i pasienter som lider med kroniske smerter, noe som leder dem til å ta mistilpassede valg i hverdagen. Fremtidig forskning bør forsøke å replisere funnene som er detaljert i denne studien med et større, mer mangfoldig utvalg.

Nøkkelord: Valgtakning, Eksperimentell Smerte, Pavlovian Bias

Abstract

Every day we make decisions that influence our well-being. Because of this, it is crucial that we make the optimal decisions possible to minimize unnecessary loss or suffering. Some groups might be more vulnerable to making maladaptive choices, such as those suffering with chronic pain, which is associated with various cognitive impairments. As it currently stands there is not a clear link between pain and decision-making strategies in the literature, but there is however research showcasing that other aversive stimulus indeed do affect our reliance on the Pavlovian Bias regarding decision-making, suggesting that pain might influence it in a similar fashion as the other aversive stimuli. In this study we tested whether pain would be a modulator of the degree of Pavlovian bias in (N = 50) healthy Norwegian-speaking adults. We developed a protocol for safely and effectively inducing tonic heat pain and used this protocol in parallel with an orthogonalized Go/NoGo value-based decision-making card-game. The game consisted of 5 blocks, where block 2 and 4 was paired with a manipulation of either a painful or warm stimulation. We found that pain overall had no effect on task performance accuracy, but there was some indication that pain increased Pavlovian bias in the aversive domain. Although this effect was not very strong, it could be stronger in patients suffering with long-term (chronic) pain, leading them to make more maladaptive decisions in everyday life. Future studies should try to replicate the findings detailed in this thesis with a larger and more diverse sample.

Keywords: Decision-Making, Experimental Pain, Pavlovian Bias

Effects of Experimentally Induced Pain on Value-Based Decision-Making in Healthy Adults

Every day we make choices that effect our health and resources. Because of this, it is crucial that we make the most optimal decisions possible in order to maximize our well-being and minimize unnecessary loss or suffering. Certain neural and psychological systems are involved in the process of decision-making, and knowledge of how these systems work could aid us in reducing the probability of relying on decision-making strategies that are maladaptive. This could especially be helpful for developing strategies that are adapted to certain vulnerable groups´ needs, such as for instance people suffering with chronic pain. This vulnerable group is rather sizable, with an estimation of 19% of the adult European population belonging to it (Moriarty et al., 2011).

Main Characteristics of Value-Based Decision-Making

Value-based decision-making (VB-DM) refers to decision-making situations where the alternatives of action are associated with a subjective (or sometimes objective) value that is placed upon the outcome of the choice (Rangel et al., 2008). Being in an optimal position to make appropriate decisions in situations where the choice potentially results in a reward or punishment is therefore crucial to our well-being. The strategies for choosing in such situations are affected by automatic preparatory behaviors and have been theorized to be governed by various neural and learning systems.

Instrumental and Pavlovian learning systems are thought to coexist and compete for behavioral control in associative learning theory (Dorfman & Gershman, 2019). For the instrumental processes, the learning of stimulus-outcome associations is thought to occur through an active process of trial-and-error. The Pavlovian process on the other hand is more automatic as well as non-instrumental, as it forms and relies on stimulus-outcome associations independently of our actions. Notably, it is the Pavlovian processes that are thought to be

responsible for reward-approach and punishment-inhibition behavior. This means that the Pavlovian systems encourages us to engage in behavior that makes us predict a reward, and avoid behavior that makes us predict a punishment, even if this results in maladaptive behavior (Dorfman & Gershman, 2019). This could be exemplified with for instance a patient avoiding doing recommended exercises because they are uncomfortable, even though they know the exercises would improve their condition over time. Pavlovian processes, which as stated previously are non-instrumental, will however also interact with and influence instrumental responses, which manifests as Pavlovian bias during action selection. If we are presented with a stimulus that makes us predict a reward, Pavlovian systems will encourage us to approach. However, once this association is formed, it will induce approach-like preparatory behavior that will facilitate obtaining the reward after it appears, strengthening the association through the instrumental system as well (Dorfman & Gershman, 2019).

Cognitive Impairments Associated with Chronic Pain

Knowledge of how different mental states and conditions affect our decision-making strategies is a crucial puzzle-piece in order to develop techniques in which we can better the situation for groups vulnerable to maladaptive tendencies. Neural systems involved in cognitive functioning are closely related to systems involved in pain processing, which is partly the basis for the hypothesis that cognitive functioning and chronic pain are possibly reciprocally modulated (Moriarty et al., 2011). This possible relationship has been studied in multiple variations, including research that have focused specifically on pain-related cognitive impairment. Patients with chronic pain have performed poorer than healthy controls in various cognitive tasks and areas, demonstrating cognitive deficits related to their condition as reported through multiple meta-analytic reviews and studies (Attridge et al., 2015; Berryman et al., 2014; Higgins et al., 2018; Lee et al., 2010; Mazza et al., 2018; Moriarty et al., 2011).

Firstly, attentional deficits have been demonstrated in patients with chronic pain both

through means of self-reports as well as experimentally (Moriarty et al., 2011). One possible explanation for chronic pain patients struggling with attention, could be that pain and attention both demand cognitive energy. In this regard, attention-demanding tasks would compete with the pain over limited cognitive resources, resulting in the pain gaining the most resources which in turn creates a deficit in attention (Moriarty et al., 2011). In relation to VB-DM, the rationale of limited cognitive resources proves rather convincing. If the presence of pain demands resources that would otherwise be reserved for attention, then it would follow that the pain-experience would increase the likelihood of relying on the automated Pavlovian bias in decision making. Pain as an aversive stimulus could also trigger behavioral passivity via the Pavlovian system, which could result in reduced exploration behavior and impaired coping in unfamiliar situations.

Secondly, in comparison to control groups, chronic pain patients have also been demonstrated to perform poorer in memory and learning tasks. These tasks revolve around spatial and verbal working memory recall, recognition memory and long-term spatial memory (Mazza et al., 2018; Moriarty et al., 2011). Like attentional processes, memory (recall especially) is generally assumed to be a demanding and goal-oriented process (Moriarty et al., 2011). Therefore, competition over limited cognitive resources might be a viable possible explanation for this impairment as well.

Thirdly, executive functioning has also been demonstrated to be impaired in patients with chronic pain. Executive functioning is a broad term, but generally refers to the neural processes involved in more complex cognitive tasks, such as planning, goal- directed behavior, initiation of action and assessing consequences of actions to name a few (Moriarty et al., 2011; Berryman et al., 2014). Importantly, emotional decision making and emotion regulation are also regarded to be executive processes that appear to be compromised in patients with chronic pain (Moriarty et al., 2011). Should pain influence executive

functioning, then people might rely more heavily on Pavlovian bias, as it is largely an automatic process which is assumed to be suppressed by an executive control mechanism even when it is inappropriate. Additionally, the Pavlovian system is sensitive to the emotional value of a stimuli, exemplified with often also being referred to as affective bias in literature (Pulcu & Browning, 2017). Therefore, as both pain and Pavlovian bias are tightly coupled with emotional responses, they might interfere with each other.

Additionally, there is a growing body of studies and theories pertaining to the notion that chronic pain itself can alter brain circuits and structures. The descending pain modulatory systems for instance, are involved with both endogenous pain control and coping, suggesting that controlling pain becomes increasingly difficult the more enduring and chronic it becomes (Bushnell et al., 2013). The nucleus accumbens is a brain region heavily associated with reward processing, and it has been shown to have a reduced volume in patients with chronic pain (Elvemo et al., 2015). This below-average size tendency has been hypothesized to be partly responsible for the reduced reward responsiveness often found in patients with chronic pain. Whether these cognitive impairments that are related to chronic pain are caused by the distribution of cognitive resources or by altering brain circuits and structures is not clear.

Depression and Anxiety as They Relate to Pain and VB-DM

As far as I am aware, there are no previous studies focusing on the impact of specifically pain directly on VB-DM strategies. As such, we cannot draw a straight line of literature between pain and VB-DM as of now. There is, however, research showcasing that other aversive stimulus indeed do affect our reliance on the Pavlovian Bias regarding VB-DM, suggesting that pain might influence it in a similar fashion as the other aversive stimuli. There is for instance, several studies that constitutes a strong relationship between depression, anxiety, stress and pain. Depression for instance, is a very common appearance in those with chronic pain. In fact, it seems that the longer the pain persists, the more depressive symptoms

can be found (Skevington, 1983). This would naturally imply that patients with chronic pain would suffer more depressive symptoms than the patients who experience pain for a shorter period. Either way, depression and its related symptoms such as a feeling of helplessness, have been found to be related to maladaptive pain-coping strategies (Samwel et al., 2006).

In relation to decision making, it seems that maladaptive decision-strategies are an intrinsic part of clinical conditions. Depression for instance, appears to alter reflexive emotional responses which, coupled with an impairment in Pavlovian forms of action inhibition, could suppress an automatic avoidance of aversive stimuli such as stressful situations. In a study by Huys et al. (2016) they aimed to examine how emotional reflexes impact adaptive decision-making in depression. They had a total of 40 participants, all of which had a DSM-IV-TR diagnosis at the time, who was going to be compared to a control group of 40 matched, healthy participants. The participants completed a Pavlovian-instrumental transfer (PIT) task. In the healthy controls the Pavlovian conditioned stimuli exerted action-specific effects, with appetitive stimuli boosting active approach, and aversive stimuli boosting active withdrawal or inhibition of action. In the depressed participants however, this action-specificity was absent. They concluded that depression was associated with abnormal influences over emotional responses on decision-making.

Impairments of emotional responses influencing Pavlovian bias in action-selection is however also supported in studies concerning other conditions than depression. In a study by Ousdal et al. (2017) they examined whether a single episode of severe traumatic stress influenced flexible instrumental decisions through impacting the Pavlovian system. Their participants were 26 survivors of the 2011 Norwegian terror attack at Utøya and 30 matched control subjects. They completed instrumental learning tasks, in which both Pavlovian and instrumental associations promoted either congruent or incongruent responses. They found that the survivors expressed a greater degree of Pavlovian interference on instrumental action-

selection. This finding suggests that in addition to depression, acute and extreme stressors also appear to increase susceptibility to Pavlovian influences in decision-making and action-selection.

The aim of the Current Project

Strong links between chronic pain and VB-DM has been presented through the review of the literature. As demonstrated, people suffering with chronic pain show various cognitive impairments, which either directly or indirectly affect different processes involved in decision-making, assumedly predisposing people with chronic pain to make maladaptive choices. The current project aims to develop a procedure for effectively and safely inducing tonic heat pain in healthy participants conducting a task for mapping decision-making strategies. The intention is to be able to examine whether adult participants not suffering from chronic pain rely on maladaptive strategies when experiencing pain in comparison to when the pain is absent. The results could be used to further develop a laboratory-based behavioral model for impaired decision-making, hopefully to reflect and resemble decision-making impairments found in patients suffering with actual chronic pain. The main hypothesis of this study is that the addition of pain will worsen performance (response accuracy) on the Go/NoGo-task. In accordance with this hypothesis, we expect that the participants in the pain group will showcase behavior that indicates a heavier reliance on the Pavlovian system when making decisions compared to the participants in the control group. Crucially, our Go/NoGo task is designed in a way that strong Pavlovian bias would result in worse response accuracy in "Pavlovian-conflict" trials. Therefore, this task can capture the hypothesized enhancement of Pavlovian bias during and following the administration of experimental pain. Alternatively phrased, we expect the participants in the pain-group to be less accurate (than the control group) in task-trials designed to induce Pavlovian conflict, as well as showcasing stronger Pavlovian bias through behaviors such as preferment of avoiding punishment rather than

approaching rewards.

Method

Participants

The sample used in this study was a part of a larger, overarching project where 100 participants were gathered in collaboration with two fellow master-students. The scope of the collaboration was much wider than is relevant for this specific analysis. Therefore, only the participants relevantly manipulated has been included in the current sample. The project was evaluated and approved by both REK (Regionale komiteer for medisinsk og helsefaglig forskningsetikk, REK reference-number 284408, see Appendix A) and by the internal research ethics committee at the University of Tromsø (UiT).

The participants of this study were N=50 Norwegian-speaking healthy adults between the ages of 19 and 30 (M_{age} = 22.7, SD = 3.3). Seeing as we were specifically looking at healthy adults, a lower age-limit was set at 18 years of age. The upper age-limit was set at 50 years old, partly due to concerns related to the chosen method of stimulation-deliverance (heat-thermode placed directly on skin). We were also searching specifically for healthy adults, and as such none of the potential participants could have or had any diagnoses, neither physical nor psychological. In order to participate, they also could not be using any medications that would influence the central nervous system (e.g., anti-depressants) or any analgesic medication (e.g., Paracetamol). Importantly, they could not have played a similar card-game based task previously either, as explicit knowledge of the task would influence their performance (see Appendix B for full overview of both information on the project and inclusion criteria).

The final sample size was determined for the whole overarching project, which investigated both the effects of a controllability manipulation (not relevant for the current thesis) and experimental pain induction on task performance (response accuracy and

Pavlovian Performance Bias, PPB). The project involved 4 experimental groups, out of which only 2 experimental groups are analyzed in this current thesis. Based on a priori power analysis (G*Power, version 3.1.9.2), the critical interaction between within- and between-subject factors (i.e., task block * pain manipulation) in a repeated-measures analysis of variance (ANOVA) with mild-to-moderate estimated effect size (Cohens´ f = .15), 90% statistical power (1-beta = .9) and 5% Type-1 error rate (α = .05), we determined that it would be sufficient to collect data from 100 participants in total (25 participants per group).

Part of the overarching project included having the participants answer a few personality questionnaires. This part of the project is not relevant for the present study and as such will not be described in detail. The scales the participants were measured on were BIS/BAS (Behavioral Inhibition/Activation Scale; Carver & White, 1994) which can be associated with the general reliance of participants on the Pavlovian valuation system, the BHS (Beck Hopelessness Scale; Beck et al., 1974) which is added in relation to a controllability manipulation not relevant for this study, and lastly NFC (Need for Cognition; Cacioppo & Petty, 1982). The NFC is an index describing a tendency to exert cognitive control in everyday life, and therefore, might be associated with control over suboptimally strong Pavlovian bias in our task. Participants also completed the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) where they indicated to which degree, they related to various affective states specifically in the previous month. This version of the PANAS (past), relating to affect in the last month will not be analyzed further, but a different version of the PANAS relating to current affective state, will be. The data collected from the other questionnaires will not be analyzed fully, but a series of independent samples *t*-tests confirmed that there were no significant underlying personality differences between the groups (see Appendix C).

Participation was fully voluntary, and the participants had to sign an informed consent

form (see Appendix D) prior to participation. They were told that participation would be compensated with a gift card of 300 NOK (Norwegian krone), and that should their performance on the card-game task be satisfactory they would receive an additional 100 NOK on the gift card. All participants were given 400 NOK gift cards regardless of performance and the promise of the extra 100 NOK was intended as an incentive for the participants to truly pay attention to the task. Recruitment was conducted through multiple different channels, but mostly through both hanging a poster around campus at the University of Tromsø and sharing the same poster on various social-media sites. For some participants, participation in any psychological study was recognized as an approved work-requirement for their course. Once the participants were in the lab, they also had to write their names and telephone numbers on a sheet in order to reach them in the event of anyone (experimenter or any participant, both past and present) testing positive for the covid-19 virus. Other covid-19 specific precautions were also implemented in the lab in accordance with relevant local guidelines and laws (see Appendix E for full overview of Covid-19 precautions applied in the lab).

Experimental Design

The study was a between-group design with group-affiliation as between-subjects factor. The participants ($N = 50$) were all randomly distributed into either the control group ($n = 25$, 8 men, $M_{age} = 21.8$, $SD = 2.6$) or the experimental group ($n = 25$, 7 men, $M_{age} = 23.4$, $SD = 3.6$). The control group will from now on be referred to as the "warm-group" and the experimental group will be referred to as the "pain-group". Because of the nature of the study (pain) and the computer-programs used in the lab, the experimenter was aware of group-memberships. The participants were not necessarily explicitly aware, but they were informed that they were either in the "mild pain"-group or the "pain"-group. They were semi-informed mostly because of the nature of the stimulation (pain) both as it is impossible for the

participant to be unaware of whether they are in pain or not, and as it relates to ethical considerations.

General Procedure

The data collection period started in September of 2021 and ended in February of 2022. When scheduling participants in the lab, a period of two hours was cleared per participant. Most participations lasted approximately 1,5 hours. The participants were seated in a separate room from the experimenter. Because the requitement and data collection were completed in cooperation with two other master-students, the procedure in the lab included a few more aspects than are relevant for this thesis. Only the relevant procedural aspects will be discussed in detail. The experiment consists of the participants´ answering some mood questionnaires (PANAS) both before and after the computerized task, completing a pain tolerance estimation and completing an orthogonalized card-game task with an evaluation of perceived success and control in between each block (with the addition of pain ratings after blocks 2 and 4). The experiments always ended with debriefing the participants and giving them their gift-cards.

The components of the procedure in the order they were conducted for each participant in the lab are: PANAS (pre), pain tolerance estimation, information about the card-game, a practice task, a quiz, completion of the main task coupled with the addition of some estimation tasks and finally another PANAS (post). These components will now be discussed in detail in the same order as applied in the lab, with one exception. Because the PANAS-questionnaires (pre and post) are identical they will only be detailed once, at the end.

Pain Induction and Developing the Pain Estimation Protocol: A Pilot Study

Pain is an aversive stimulus that has a subjectively perceived component. In the case of heat-based pain, applying the same temperature to different people might not be equivalent to inducing the same level of pain. Therefore, we needed to develop a standardized method or protocol for adjusting the heat-stimulation based off individual differences in pain perception

and tolerances so that the participants would experience approximately the same level of pain (or at least some pain at all). The piloting ran from May to August in 2021 and was divided into three phases.

All the participants in the pilot testing (38 trials in total) were affiliates (mostly professors and PhD-candidates) of the Institute of Psychology (IPS) at the University of Tromsø (UiT). We were limited to only recruiting affiliates due to not yet having received the approval of the REK committee or of the internal UiT research-ethics committee at this stage of the project.

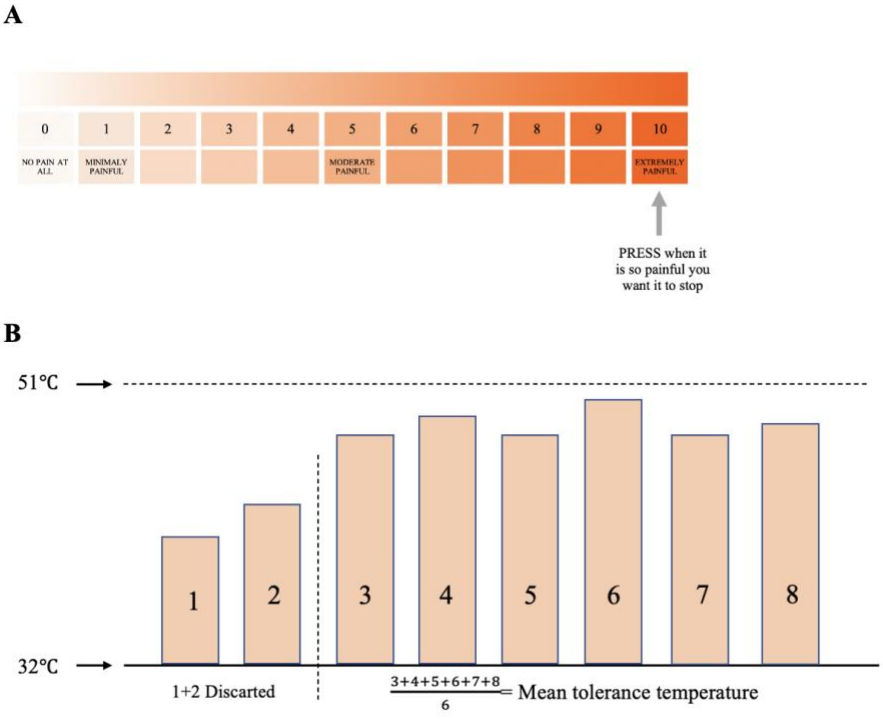
Phase One. For the first phase, the objective was to develop and test a method of estimating temperature and pain tolerances for each specific participant. Estimation was made using the "method of limits" (also commonly referred to as "method of levels"; Arendt-Nielsen & Chen, 2003), by running a gradual temperature increase eight times in a row per participant. The heat-stimulation was delivered to the inside of the forearm by using a pain and sensory evaluation system, specifically the Medoc PATHWAY, model CHEPS (contact heat-evoked potential stimulator; Medoc Advanced Medical Systems, Ramat Yishai, Israel). Conduction of the pilot study was completed in a laboratory where the participants were seated in a separate room from the pain stimulator. A 30 x 30 mm aluminum contact thermode (heat-stimulator) was placed on the forearm of the dominant hand of the participant and tightened according to verbally given feedback of comfort-level. The researcher then left the room in order to operate the Medoc PATHWAY with a computer-program pre-calibrated with the pain protocol parameters. The pre-set computer-program started at a baseline of 32℃ and gradually increased the temperature by a rate of 0.5℃ per second, with a maximum temperature limit of 51℃. The baseline temperature, temperature-increase rate and maximum cut-off point are all in accordance with recommendations and findings from research pertaining to thermal stimulation and activation of skin nociceptors (Arendt-Nielsen & Chen,

2003). The participants were required to press a mouse-button in order to stop the temperature-increase at the temperature suited to their threshold levels, based on directions given to them verbally by an experimenter beforehand. For the first three trials of the temperature testing, we gave them the verbal direction “press the button when it just becomes painful”. We intended to test for thresholds and to use suprathreshold temperature levels in the main experiment, but quickly realized that the results were very varied, and the verbal instruction had been interpreted differently from one participant to the next. Therefore, we decided that estimating tolerance levels rather than thresholds should give us a more dependent and reliable measure. Here, our aim was to apply sub-tolerance level temperatures during the task that the participants found painful but still tolerable throughout the “pain-blocks” of the card game. The updated verbal directions we used for the rest of the piloting was “press the button when it becomes so unbearable you want it to stop”. This direction had the understandable potential for slight misinterpretations. Therefore, it was combined with the further example of “if you imagine you are holding your hand under running water that gradually becomes warmer, when the reflex to pull your hand out strikes you, then you are at a comparable pain-level that we want you to be at when you press the button”. For the main study, the participants were also provided with a visual aid (see Figure 1, A) When they pressed the button, the computer-program instantly stopped the gradual increase and switched to a gradual decrease in temperature at the rate of 0.5℃ per second until it once again reached the baseline of 32℃. Should the participants not press the button before the machine reaches the maximum temperature of 51℃, the program would automatically start the temperature decrease itself. When the thermode reached the baseline, after an interstimulus interval of a random delay between 8-10 seconds, it started the process over again. This was repeated a total of eight times for each participant. After the data was collected, a mean tolerance temperature was calculated using only the last six rounds (see Figure 1, B). We excluded the

first two rounds of tolerance-estimation because we observed that those differed from the last six rounds for most of the participants. This tendency was discussed as possibly being attributed to stimulus novelty and pain-anticipation, which probably decreased once they knew what to expect pain-wise. This mean temperature was then concluded as each specific participants' tolerance. In the actual card-game task of this study, the duration of each block is approximately 7,5-8 minutes. We therefore need a pain protocol that is balanced between effectiveness and endurableness so that we do not inflict unjustifiable pain or encourage dropouts whilst at the same time applying a pain stimulation that is effective in potentially uncovering any effects in our sample later. The final pain tolerance estimation method used in the main study, is the method detailed in this first phase.

Figure 1.

Visualizations of the Pain Protocol.

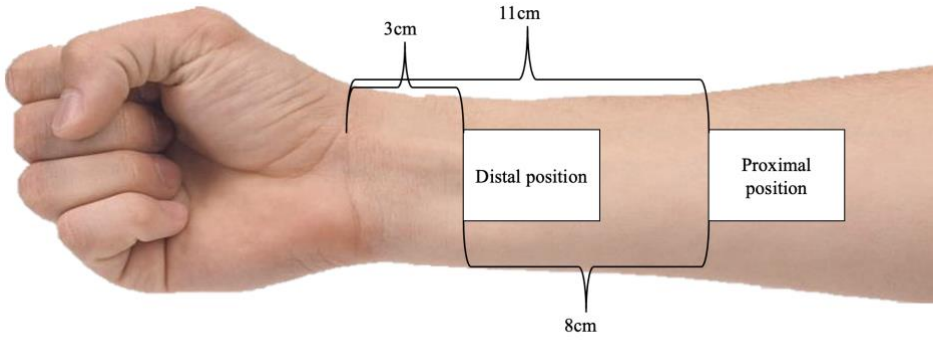


Note. (A) Graphic pain rating scale used as a visual aid in main study to better explain verbal instructions for estimation of tolerance. (B) Visual representation of phase 1 (process of estimating tolerance levels).

Phase Two. The purpose of the second phase was to establish if our pain-tolerance protocol was safe and tolerable, but still inducing relatively constant and moderately intense pain for a duration of 7.5 minutes needed for each of the manipulation-blocks in the main study. For the second phase we stimulated the participants with a temperature that was two degrees (2℃) below their previously determined pain tolerance level. After we completed the process detailed above regarding estimating pain tolerances, we subtracted 2℃ from the tolerance (but maintained a minimum stimulation temperature of 44℃ and a maximum of 46.5℃) and placed the thermode on the non-dominant arm. We stimulated the participants using the newly calculated temperature for two rounds, each with a duration of eight minutes, with a waiting-time in between the rounds of approximately also eight minutes. We never stimulated the same patch of skin twice in order to ensure that we minimized the risk of skin-damage or other undesirable side-effects, as well as prolonged habituation to the pain stimulus. The thermode was placed on the same forearm (non-dominant hand) for both rounds, and therefore we had pre-set measurements for where to place it on the skin. Measured from where the palm ends, one of the positions for the thermode was placed three centimeters towards the shoulders in a distal position. The other placement for the thermode was approximately 8 centimeters higher on the forearm than the first position (proximal position; see Figure 2). After the position is determined, the thermode is placed, and when the stimulation has lasted eight minutes the temperature decreased at a rate of 1℃ per second until it reached the baseline (32℃). After which, the participants were asked to rate their mean and peak pain. They rated their pain twice, once after each round.

Figure 2.

Visual Representation of the Thermode-Positions on the (Non-Dominant) Forearm.



Note. Copyright attribution for picture of forearm: https://png.is/f/hand-forearm-clip-art-hands-png-hand-image-free/6583587537158144-201901090614.html

Studies on pain perception and tolerance are not necessarily in complete agreeance, but there is generally a consensus that our nociceptors start to fire (send messages of pain to the brain) at around 43℃ (Arendt-Nielsen & Chen, 2003). Therefore, we had to stimulate the participants with a minimum of 44℃ in order to ensure that the nociceptors activated, even if their tolerance minus 2℃ was technically lower. Theoretically, the nociceptors should not be activated at 42℃ or below, which is the basis for deciding to stimulate the warm group at this temperature. Ultimately, this was not relevant for any of the participants in the second or third phase because we tested all the pilot-participants as if they would have been in the pain-group should they have been a participant in the main study. As a result of concerns to potential skin- or nerve-damage we also set an upper temperature limit of 46.5℃. In summary, we ended up concluding that for the pain stimulation the temperature we were to use would be their estimated tolerance minus 2℃, but never below 44℃ or above 46.5℃. Every participant in phases 2 and 3 of the piloting fit naturally within this range.

During the two rounds of this second phase, the participants continually reported experienced pain-levels using a digital CoVAS (computerized visual analogue scale; Medoc Advanced

Medical Systems, Ramat Yishai, Israel). The data collected through the CoVAS gave us an opportunity to recognize and identify tendencies and patterns in the participants´ pain experiences which provided a basis for assessment of our protocol. The first and second phase of the pilot study resulted in a potential pain protocol that seemingly provided a rather standardized method of inducing comparable pain-levels independently of natural variation in pain perception and management. Similar methods and systems (CHEPS and CoVAS) have successfully and effectively been used in highly comparable experimental settings, including at our laboratory at UiT (Aslaksen & Flaten, 2008; McDouall et al., 2021).

Phase Three. For the third phase we needed to test how the pain protocol would be experienced in tandem with the card-game task. Generally, the purpose of this phase was once again to test tolerability, safety and effectiveness. Additionally, the aim was to confirm that the pain was not distracting to the degree that they could not focus on the game, and that the ratings of pain (mean and peak) did not differ substantially between the 2 blocks (intervened with a non-pain block). Generally, in this phase we checked whether the participants would retrospectively rate the mean/peak pains differently when the pain was coupled with a version of the task compared to when they focused solely on the pain (in the second phase).

This phase was mostly a repetition of phase two (without the CoVAS) with the addition of the participants´ completing a version of the value-based decision-making card-game that the participants in the main study were going to play. In the complete version of the card-game there were five blocks or rounds, with blocks 2 and 4 designed. For the pilot study, the version used had three blocks where block one and three was when we introduced the painful stimulation and block two acted as the between-stimulation waiting period. Another addition to the third phase was that we randomized which placements (distal or proximal) we placed the thermode first in order to counterbalance any potential effects of placement regarding skin-thickness and/or nociceptor distribution.

Practice Task

Before the practice task, the participants were given an information sheet pertaining to the card-game and its rules (see Appendix F). The practice task was intended to give the participants additional practice with the rules, as well as giving them a preview of the visual layout of the task and its cards. For the practice task they had to complete a shortened version of the full card-game, consisting of just one block and four cards. Each of the four cards were repeated five times, totaling in 20 trials. Every participant (regardless of group-membership) had a response-feedback contingency of 70% correct outcomes and 30% false outcomes. This task was for practice-purposes only and the result were not collected or evaluated.

Quiz

Directly after the practice task ended, the participants were asked to fill in a quiz (see Appendix G) in order to ensure that the rules and central principles of the game were understood. Once every question on the quiz were filled in, incorrect answers were identified and explained by the experimenter. The participants were highly encouraged to ask all questions they may have had. Once the quiz was completed and corrected, the main task began.

Orthogonalized Go/NoGo Task

The card-game task was run in the lab on a portable computer with the PsychoPy software (Peirce, 2007). This is the main task, and it revolves around approaching rewards versus avoiding losses, requiring the participants to make decisions about which action (either pressing a key or withholding) to make when encountering a stimulus (card). Which cards to press on and which to withhold on was initially unknown to the participants, and they had to learn by trial-and-error.

The main orthogonalized Go/NoGo card-game task consisted of 5 experimental blocks, each with a duration of approximately 7,5-8 minutes. The blocks consisted of 20 trials

for each of the four experimental conditions ("NoGo-to-Win", "Go-to-Win", "NoGo-to-Avoid" and "Go-to-Avoid") resulting in 80 trials total per block. Each experimental condition was randomly assigned to one of the four cards chosen for that block. Which cards were associated with which experimental condition was consistent within the block, but changed between blocks. This essentially meant that at the start of each separate block the participant had to learn (through trial-and-error) which card to respond actively towards (press a key) and which to respond passively towards (not press the key). This process of trial-and-error learning had to be repeated for each new block, thus discouraging overlearning, as we investigated how our experimental manipulation (heat pain) influenced learning and decision-making without prior experience with a given card set. Each trial started with 1-1,5 seconds of a blank screen (the fixation phase) followed by a 2 second cue (card) during which they were expected to both identify and respond to the cue. In previous studies using a very similar task (such as the study by Csifcsák et al., 2020) they had a response-delay imbedded in each trial between observing the cue and responding to it. This delay has not been included in this current study. Another detour from the task used in the study by Csifcsák et al. (2020) is the removal of the so-called "go-cost". After having responded to the cue, the participants were presented with the resulting score (either 10, 0 or -10 points) on the screen for 1 second (see Figure 3B). The thermode was placed on the participants´ skin throughout the entire main task but was only active (emitting warm/painful stimulation) in the manipulated blocks (blocks 2 and 4; see Figure 3C). As detailed in the pilot study, the thermode was also moved from one placement to another on the same arm in between the manipulated blocks. The order of thermode placement (proximal or distal relative to the shoulder) was counterbalanced between the participants in order to eliminate any placement-related pain-effects (habituation or sensitization).

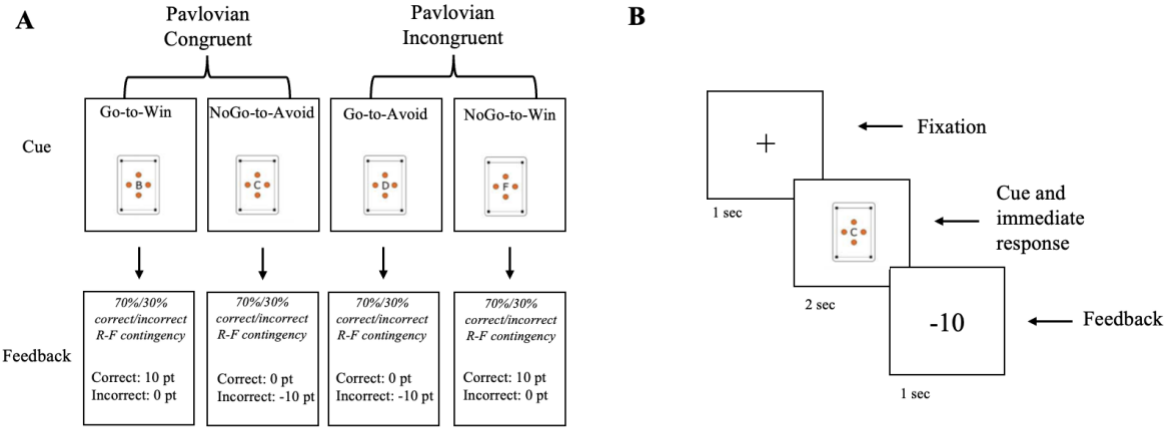
Cards. There were 24 different cards in total. Four of which were used for the practice task. The 20 remaining cards were used in the main task, which consisted of five blocks (or rounds) with four cards each (5 blocks x 4 cards in each round = 20 cards). All 24 cards differed in appearance, with different combinations of colors, symbols and letters (see Appendix H). For each block, the four cards were associated with a required action (either "Go" which is pressing the key or "NoGo" which is withholding keypress) and with an associated outcome (for correct response it is either "win" which is receiving 10 points, or "avoid" which is avoiding losing 10 points). The cards were also randomly assigned to an experimental condition which were either Pavlovian-congruent ("Go-to-Win" or "NoGo-to-Avoid") or Pavlovian-incongruent ("Go-to-Avoid" or "NoGo-to-Win"). The cards that are Pavlovian-incongruent induce a Pavlovian conflict, and therefore should require more mental effort to perform the correct response to relative to the non-conflict Pavlovian-congruent cards. For win-cards ("Go-to-Win" and "NoGo-to-Win") the correct response (pressing the key for "Go-to-Win" and withholding a press for "NoGo-to-Win") awards the participant 10 points and incorrect answers result in 0 points. For correct responses to avoid-cards (pressing key for "Go-to-Avoid" and withholding for "NoGo-to-Avoid") the participants are given 0 points, and -10 points for incorrect answers (see Figure 3A).

There was however also a response-feedback contingency for all the participants (regardless of group) at 70% correct outcomes and 30% false outcomes. This means that 30% of outcomes was false (for example either receiving 10 points when they responded incorrectly to win-cards or losing 10 points when they responded correctly to avoid-cards). The reasoning behind including a probabilistic mapping between responses and outcomes was that if the feedbacks were to be deterministic (meaning a 100/0% contingency) then every single correct response would be followed by the expected and favorable outcome, which would make the task relatively low-demanding and easy. The contingency of 70%/30%

correct/incorrect is probabilistic rather than deterministic, meaning that correct responses increase the probability of favorable outcomes and incorrect responses increases the probability of unfavorable outcomes. A probabilistic outcome contingency promotes continuous and habitual (rather than goal-oriented) learning either way both if the response is correct or incorrect.

Figure 3.

Complete Overview of the Behavioral Task.



C

Experimental Blocks	1	2	3	4	5
Warm group	No manipulation	Warm stimulation	No manipulation	Warm stimulation	No manipulation
Pain group	No manipulation	Painful stimulation	No manipulation	Painful stimulation	No manipulation

Note. (A) In each block, the participants were presented with four cards, each differing in action-requirement (Go or NoGo) and in their associated outcomes (reward or loss). For two card types, the action-requirement was congruent with the Pavlovian system ("Go-to-Win" and "NoGo-to-Avoid") whereas the other two cards induced Pavlovian conflict ("Go-to-Avoid" and "NoGo-to-Win"). For all cards and participants, there was a 70%/30% correct/incorrect response-Feedback (R-F) contingency. (B) In each block, the screen was blank (fixation-phase) for a second before the cue (card) was presented. The card was on screen for two seconds, during which the participants were required to decide of whether to respond or not as soon as possible within those two seconds. Immediately after the feedback (points received or lost) was presented on-screen for one second. The process then repeated for the next card. (C) The task consists of five blocks (or rounds) in which block 1, 3 and 5 the participants were only to focus on the task itself. Blocks 2 and 4 were the manipulated blocks in which we introduced a warm stimulation (42℃) to the warm-group and a painful stimulation (between 44-46.5℃) to the pain-group.

Evaluation Tasks

Success and Control Scales. At the end of each of the five blocks the participants were presented with two visual analogue scales ranging from 0 (*no success / no control)* to 100 (*completely successful / completely in control*). They were asked to indicate to which degree they felt they could control the outcomes by modifying their responses (control scale) and to which degree they felt they were successful in gathering points (success scales).

Pain Ratings. At the end of the second and fourth blocks the participants were presented with two additional visual analogue scales also ranging from 0 (*no pain at all*) to 100 (*most intense pain imaginable*). They were asked to indicate both how high the average pain they felt overall was throughout the block (mean pain scale) and how high the pain was when it was at its most intense (peak pain scale).

P*ANAS (Pre and Post)*

Both before (pre) and after (post) the main task the participants had to fill out a PANAS questionnaire (Positive and Negative Affect Scale; Watson et al., 1988; see Appendix I). The questionnaire for pre and post are identical. For this questionnaire they had to indicate to which degree they currently related to various affective states. The reasoning behind having the participants report moods and temperament both before and after completing a mentally straining task coupled with a painful element is to examine whether we find any patterns in mood changes both within and between the groups that might be a result of either the task or the manipulation.

Plan for Statistical Analysis

This study had a between-group design with Group as the between-subject factor. For the statistical analysis (except for data from the pilot phase of the pain protocol) repeated-measures Analyses of Variance (ANOVAs) were used to analyze the data. The aim was to examine how each of our factors (independent variables) influence our dependent variables.

The dependent variables in this study are the results from the PANAS questionnaires (conducted separately for the positive and negative affect sub-scores), the evaluation tasks (success, control, mean pain and peak pain), accuracy (ACC, measured as the ratio of correct responses relative to all responses, calculated for each block and card separately) and Pavlovian Performance Bias (PPB). PPB is divided into two index types; RBI (Reward Based Invigoration) and PBS (Punishment Based Suppression). The value of RBI is calculated as the number of "Go"-responses in "Win"-trials divided by the total number of "Go"-responses overall and the value of PBS is calculated as the number of "NoGo"-responses in "Avoid"-trials divided by total number of "NoGo"-responses overall. Both RBI and PBS values vary between 0 and 1, with higher values representing stronger Pavlovian bias for rewarding or aversive stimuli (i.e., the specificity of Go responses to Win cards for RBI, and the specificity of NoGo responses to Avoid cards for PBS). Should a participant have a disproportionately high value of RBI compared to PBS for instance, it indicates that that participant displays a behavior of preferring to approach rewards rather than avoid punishments.

The dependent variables listed above have differing within-subject factors. For the analysis of the evaluation tasks (success and control) the within-subject factor is Block (1-5 experimental blocks). For the PANAS variable, we conducted separate analyses for the negative and the positive scores, with the factor of Time (pre- and post-task) for both. For the pain ratings (both mean and peak) the within-subject factor is Block (2^{nd} and 4^{th} block). The factors for ACC are Block (1-5), Congruency (Pavlovian-congruent or incongruent cards) and Valence (win or avoid cards). Lastly, for PPB the factors are Block (1-5) and Index Type (RBI and PBS). Finally, in all analyses, experimental Group (warm or pain group) was entered as between-subject factor (except for the exploratory analysis, where Group was replaced by mean pain ratings added as a covariate, which will be explained in more detail

later). All statistical analyses were conducted using the statistical analyzation software JASP (2022, version 0.16.1).

Alpha level for significance was set at .05 for the omnibus ANOVA. For significant main effects or interactions, follow-up tests were conducted with Bonferroni-adjusted alpha-levels. Where Mauchly´s test indicated violation of the assumption of sphericity, Greenhouse-Geisser adjusted F- and p-values are reported, together with the corresponding correction factor (epsilon). Effect sizes (partial eta-squared) are also reported.

Results

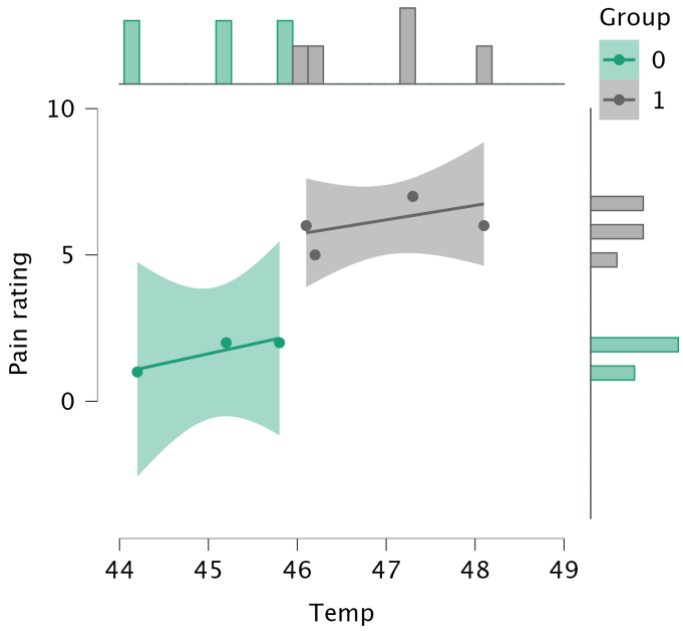
Pain Protocol

Phase One

As mentioned previously, in the first three trials we estimated thresholds, before deciding that estimating tolerance levels should give us a more reliable result. As presented on the plot, estimating tolerance (group 1) instead of thresholds (group 0) gave us temperatures that were more consistent. Tolerance-testing also resulted in both higher temperatures and higher pain ratings (see Figure 4).

Figure 4.

Scatterplot (with Histograms and Linear Regression Lines) Showing Temperatures and Pain Ratings in The First Phase of the Pilot.



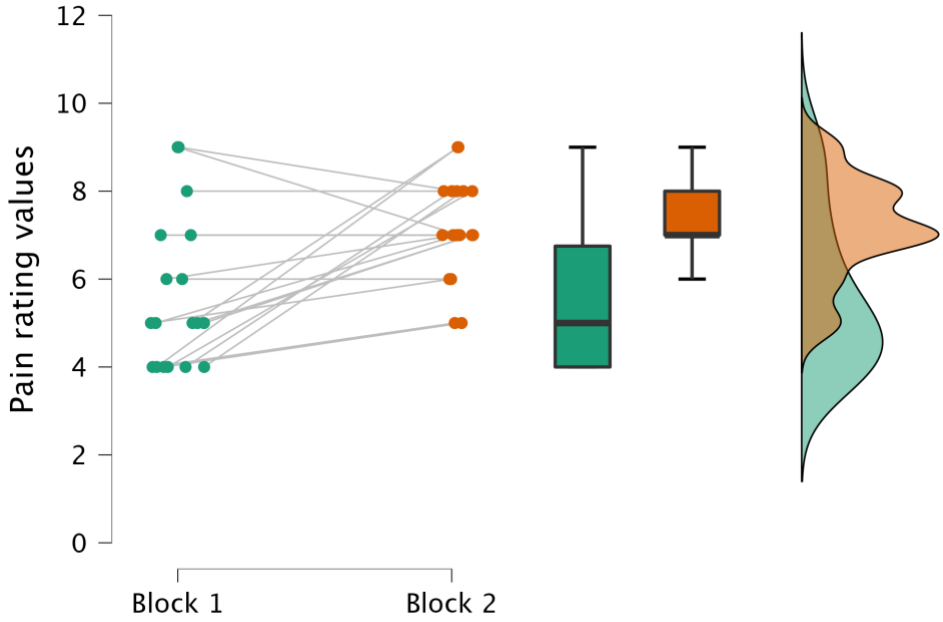
Note. Presented with 95% confidence interval. Group 0 = testing for threshold, Group 1 = testing for tolerance. Temp = temperature.

Phase Two

For the second phase of the pilot testing, we tested the pain protocol twice (2 rounds with 8-minute waiting period between) and asked participants to verbally rate the mean pain they experienced after each round. A paired-samples *t*-test indicated that there was a significant difference between the mean pain rating from round one and round two ($t(17) = -3.33$, $p = .004$, 95% Cl [-1.3, -.25], $d = -.79$). Important to note in relation to the second phase is that in the 18 trials (or experimental sessions), there was never a (verbal) pain-rating lower than four or higher than nine indicating that participants experienced at least moderate-level pain intensities (see Figure 5). There were not any of the pilot-participants who communicated (when asked) that the protocol was either not painful or unbearable.

Figure 5.

Raincloud Plot Depicting the Relationship Between Pain Ratings from the First and Second Round in the Second Phase of the Pilot.



The participants of the pilot-study were also asked to continuously report pain-experience with a CoVAS in the second phase. The CoVAS produces results in the form of graphs instead of numerical values, and as such must be analyzed qualitatively rather than quantitively. A rather consistent pattern was recognized, implying that the pain-experience brought on by the protocol we developed had a component of shared similarities between participants. By assessing the CoVAS outputs, we could also determine that in none of the 18 trials did the participant stay at either very high (9-10 pain rating) or very low (0-1 pain rating) for any notable stretch of time (during the 7,5 minutes of stimulation). There was also a reoccurring tendency for a build-up effect, where the pain was rated as low for the first few minutes with a subsequent steady rise at the 4–5-minute mark, often followed by a peak around 7 minutes. Considering skin-irritation and sensitivity, it was not unexpected for the

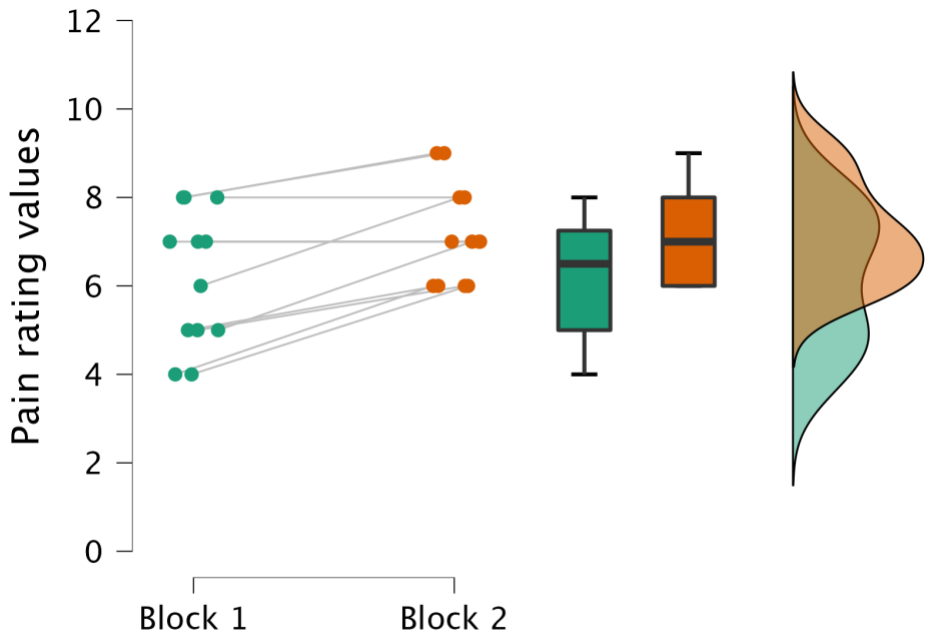
pain-ratings to climb slightly as the pain persisted. None of the participants reported excessive pain or skin irritation that would have required closer follow-up or medical intervention.

Phase Three

In the third phase of the pilot testing, we again tested the pain protocol twice (2 rounds of the card game with 8-minute break in-between) and had them rate the mean pain experienced after each round. A paired samples *t*-test revealed that once again there was a significant difference between the mean pain rating of round one and round two ($t(11) = -4.06$, $p = .002$, 95% CI[-1.9, -.41], $d = -1.2$). The tolerance estimates in the third phase (12 trials) ranged from 46.4℃ to 48,5℃, all within a suitable range for stimulation temperature between 44-46.5℃ (with stimulation temperature being tolerance minus 2℃; see Figure 6).

Figure 6.

Raincloud Plot of the Relationship Between Pain-ratings in the First and Second Round of the Third Phase of the Pilot.



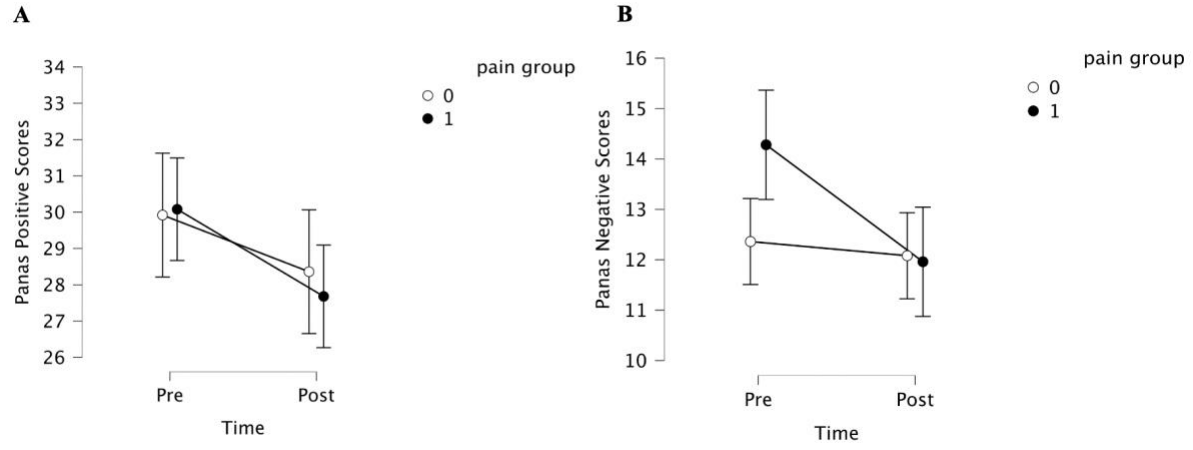
Positive and Negative Affective Schedule (PANAS)

For the results of the PANAS questionnaires, separate analyses were run for the positive and negative scores. For the positive scores, a significant main effect was found for Time ($F(1, 48) = 6.82$, $p = .012$, $\eta_p^2 = .124$), indicating that the positive scores from the PANAS significantly decreased from before to after completing the main task. However, neither the main effect of Group ($F(1, 48) = 0.02$, $p = .878$, $\eta_p^2 < .001$) nor the interaction term between Time and Group (Time * Group) were significant ($F(1, 48) = 0.31$, $p = .582$, $\eta_p^2 = .006$). In other words, there was a significant interaction between PANAS scores pre and post within the groups, but this difference was not significantly larger or smaller in one group compared to the other (see Figure 7, A).

For the negative PANAS scores, a significant main effect was found for Time ($F(1, 48) = 7.56$, $p = .008$, $\eta_p^2 = .136$). The interaction term of Time * Group was also significant, ($F(1, 48) = 4.65$, $p = .036$, $\eta_p^2 = .088$). The main effect of Group was however not significant ($F(1, 48) = 1.96$, $p = .168$, $\eta_p^2 = .039$). This indicates that the negative PANAS scores significantly differed from before main task to after main task, but also that this change significantly interacted some way with the groups. As seen on a descriptive plot (see Figure 7, B), the negative scores decrease after completing the main task but only for the pain-group. This direction of the group effect was not expected and is most likely not a result of our manipulation in the main task as they are driven by differences in the pre-task assessment. A post hoc test confirmed what was observed on the descriptive plot, namely that the significant Time * Group interaction was driven by the pre-scores, specifically from the negative pre-scores of the pain group to the negative post-scores of both the pain group ($M_{diff} = 2.32$, $SE = 0.67$, $p = .007$) and the warm group ($M_{diff} = 2.2$, $SE = 0.79$, $p = .035$).

Figure 7.

Descriptive Plots of the Results of the PANAS-Questionnaires.



Note. (A) Plot of PANAS positive scores. (B) Plot of PANAS negative scores. Both plots presented with 95% confidence interval. Pain group 0 = warm, 1 = pain.

Pain Ratings

Mean Pain Ratings

For the analysis of the mean pain ratings, there was not a significant main effect of Block ($F(1, 48) = 3.62$, $p = .063$, $\eta_p^2 = .07$), indicating that across the groups the mean pain ratings from block 2 did not significantly differ from the ratings of block 4. The interaction between Block and Group (Block * Group) was not statistically significant either ($F(1, 48) = 0.08$, $p = .781$, $\eta_p^2 = .002$). There was however a significant main effect found for Group, ($F(1, 48) = 25.6$, $p < .001$, $\eta_p^2 = .348$), indicating that the pain group reported significantly higher mean pain ratings (in both pain-blocks) than the warm group (see Figure 8, A).

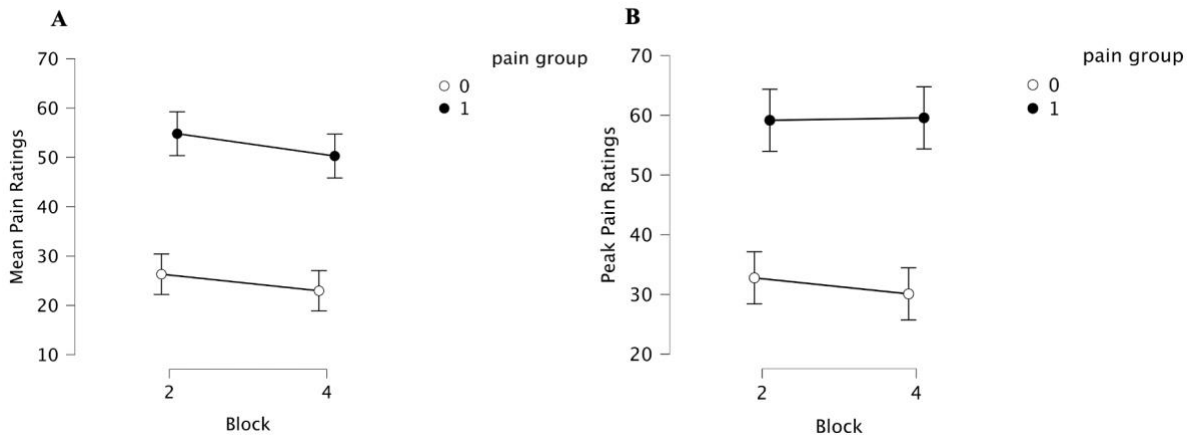
Peak Pain Ratings

The analysis of the peak pain ratings showed that there was not a significant main effect found for Block ($F(1, 48) = 0.24$, $p = .626$, $\eta_p^2 = .005$). This indicates that the peak pain ratings from block 2 did not differ significantly from the ratings of block 4 independently of group. There was not a significant effect found for the interaction term of Block * Group

either ($F(1, 48) = 0.44$, $p = .511$, $\eta_p^2 = .009$). Once again, there was a significant main effect found for Group ($F(1, 48) = 20.9$, $p < .001$, $\eta_p^2 = .303$). This indicates that the pain-group also reported significantly higher peak pain ratings (both pain-blocks) than the warm group (see Figure 8, B). It is very important that the main effect of group was significant for both mean and peak pain ratings, as this suggests that our pain-induction protocol was effective in distinguishing the pain-group from the warm-group.

Figure 8.

Descriptive Plots of the Pain-Ratings.



Note. (A) Mean pain ratings. (B) Peak pain ratings. Both plots presented with 95% confidence interval. Pain group 0 = warm, 1 = pain.

Pain Rating Categories

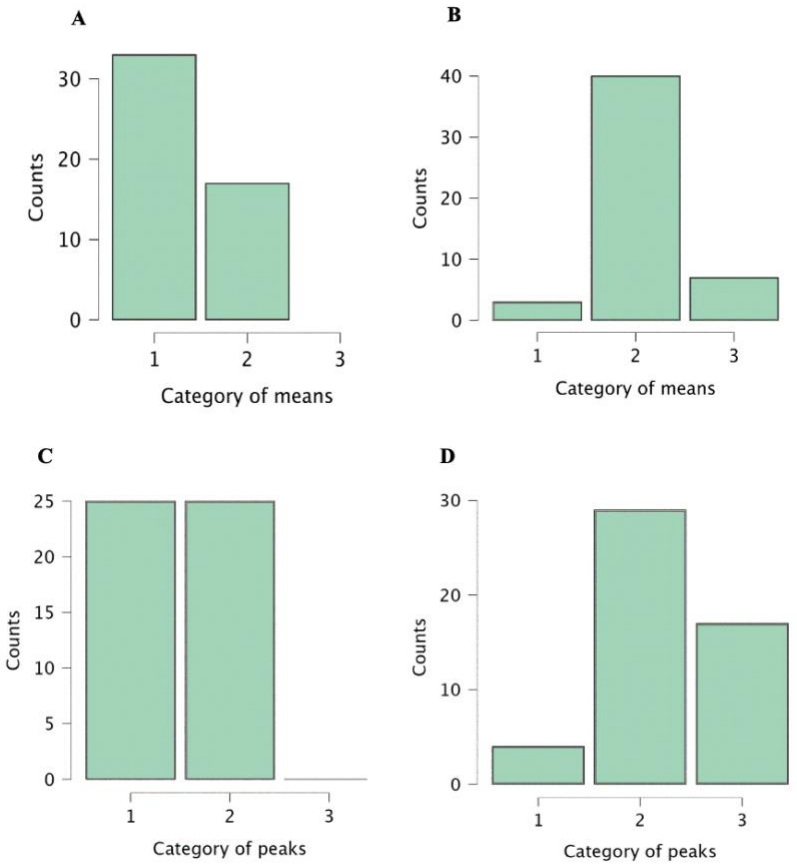
In the data-analysis process we also created three categories of the pain-ratings (from the 0-100 Likert scale), namely no/minimal pain (0-30), medium pain (31-70) and strong pain (>70). For the mean pain ratings, 66% of the warm-group participants belong in the no/minimal pain category and the remaining 34% belong in the medium pain category (see

Figure 9, A). For the pain-participants, only 6% belong in no/minimal pain, 80% to the medium pain and the last 14% to the strong pain category (see Figure 9, B).

For the peak pain categories, 50% of the warm group belonged to the no/minimal pain category, and the remaining 50% to the medium pain category (see Figure 9, C). For the pain group, only 8% reported peak-pain ratings in the no/minimal pain category, 58% in the medium pain and 34% in strong pain (see Figure 9, D). The reasoning behind including categories is to examine whether there is a significant number of warm-participants who rated their pain as high or pain-participants who rated their pain as low. The percentages of participants from the warm versus pain group show that the pain participants in general reported medium pain, whilst the warm group generally reported no/minimal pain. This means that although not all warm-participants rated their pain as low, the groups do differ in their pain-ratings in general.

Figure 9.

Distribution Plots of Categories of Mean and Peak Pain.



Note. (A) Distribution of category of means for warm participants. (B) Distribution of category of means for pain-participants. (C) Distribution of category of peak for warm participants. (D) Distribution of category of peaks for pain-participants.

Success and Control

Success

For the analysis of the reported perceived control ratings, there was not a significant main effect found for either Block ($F(4, 192) = 1.53$, $p = .193$, $\eta_p^2 = .031$) or Group ($F(1, 48) = 3.78$, $p = .058$, $\eta_p^2 = .073$). This indicates that reported control ratings did not differ between the groups or from one block to another. The interaction term between Block and Group (Block * Group) was not significant either ($F(4, 192) = 0.29$, $p = .887$, $\eta_p^2 = .006$),

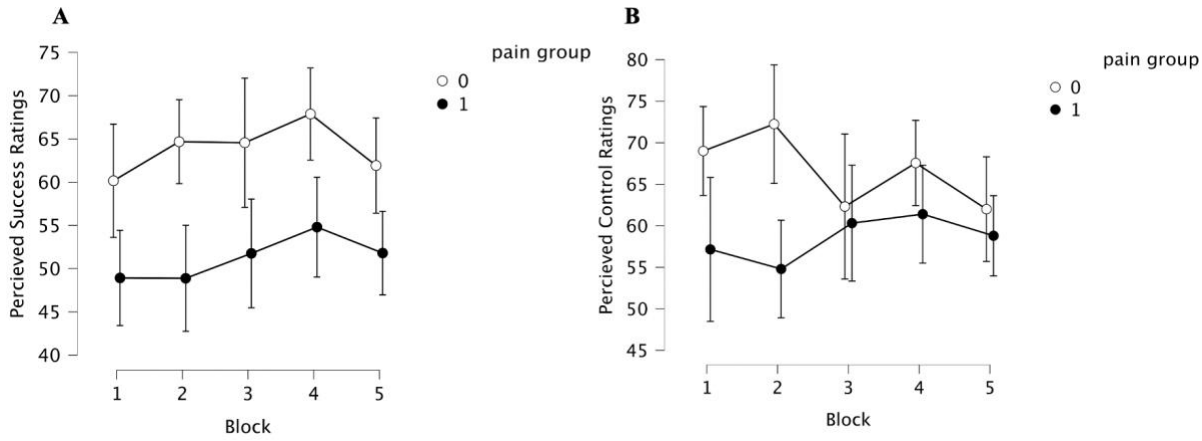
indicating that the groups (warm and pain) did not differ significantly in their degree of perceived control over outcomes (see Figure 10, A).

Control

For the control scales, there was not a significant main effect of either Block (F(2.9, 141.9) = 0.54, p = .654, η_p^2 = .011, ε = .739) or Group (F(1, 48) = 1.53, p = .222, η_p^2 = .31). The interaction term (Block * Group) was not significant either, (F(2.9, 141.9) = 2.02, p = .115, η_p^2 = .04, ε = .739). This indicates that the groups (warm and pain) do not differ significantly in their degree of perceived control over outcomes (see Figure 10, B). This is as expected, considering the relationship between response and outcome was not manipulated for the participants in the task other than the response-feedback contingency which was equal for both groups.

Figure 10.

Descriptive Plots of Success and Control Ratings.



Note. (A) Ratings of perceived success. (B) Ratings of perceived control. Both with a 95% confidence interval. Pain group 0 = warm, 1 = pain.

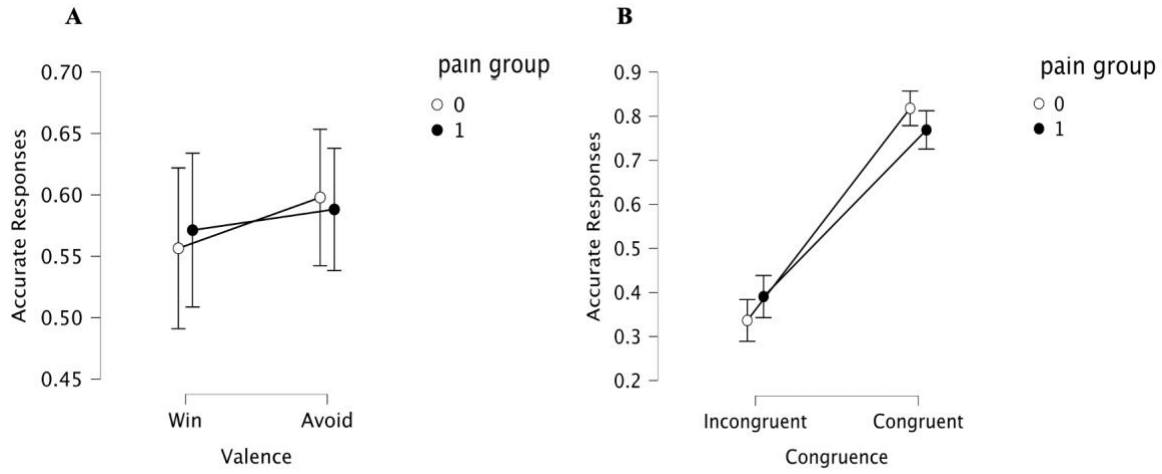
Accuracy

When examining the data collected in terms of the participants´ accuracy on the card-game task, we found a significant main effect of Valence (F(1, 48) = 8.68, p = .005, η_p^2 =

.153), implying that there was a significant difference between accuracy on "win"-cards and accuracy on "avoid"-cards. Generally, the accuracy was slightly higher for avoid-cards than win-cards both for the warm- and pain-group (see Figure 11, A). There was also a significant main effect of Congruence ($F(1, 48) = 80.6$, $p < .001$, $\eta_p^2 = .627$), which indicates that there was a significant difference between the accuracy on cards that induced Pavlovian conflict (incongruent) and accuracy on the cards that did not induce such a conflict (congruent). In both groups, the participants were considerably more accurate on Pavlovian congruent cards ("Go-go-Win" and "NoGo-to-Avoid"; see Figure 11, B).

Figure 11.

Descriptive Plots of Performance Accuracy.



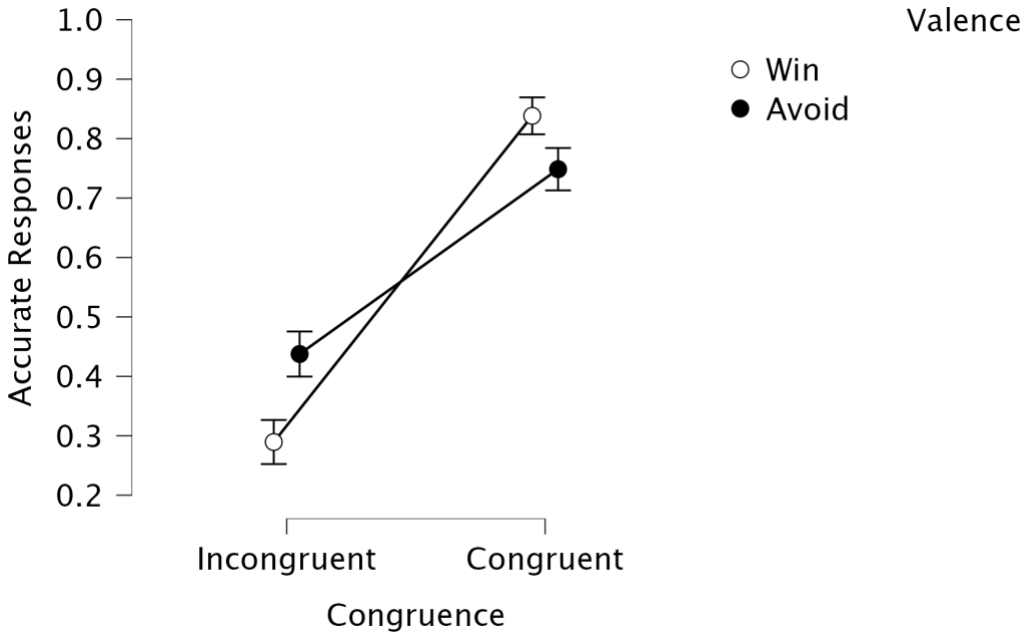
Note. (A) Plot of valence-accuracy (win- versus avoid-cards). (B) Plot of congruence-accuracy (Pavlovian congruent versus incongruent). Both presented with 95% confidence interval. Pain group 0 = warm, 1 = pain.

The statistical analysis revealed that the interaction between Valence and Congruence (Valence * Congruence) was also significant ($F(1, 48) = 16.6$, $p < .001$, $\eta_p^2 = .258$). This indicates that not only was there a significant difference between the valence-types (win or

avoid), but there was also a significant difference between two cards of the same valence with different congruency (or associated appropriate response; “Go” and “NoGo”). In fact, as seen on the descriptive plot of the interaction (see Figure 12), the cards with the highest (“Go-to-Win”) and the lowest (“NoGo-to-Win”) accuracy-scores were both win-cards. This was confirmed with a post hoc test, which indicated to all comparisons were significant (see Appendix J).

Figure 12.

*Descriptive Plot of the Valence * Congruency Interaction.*



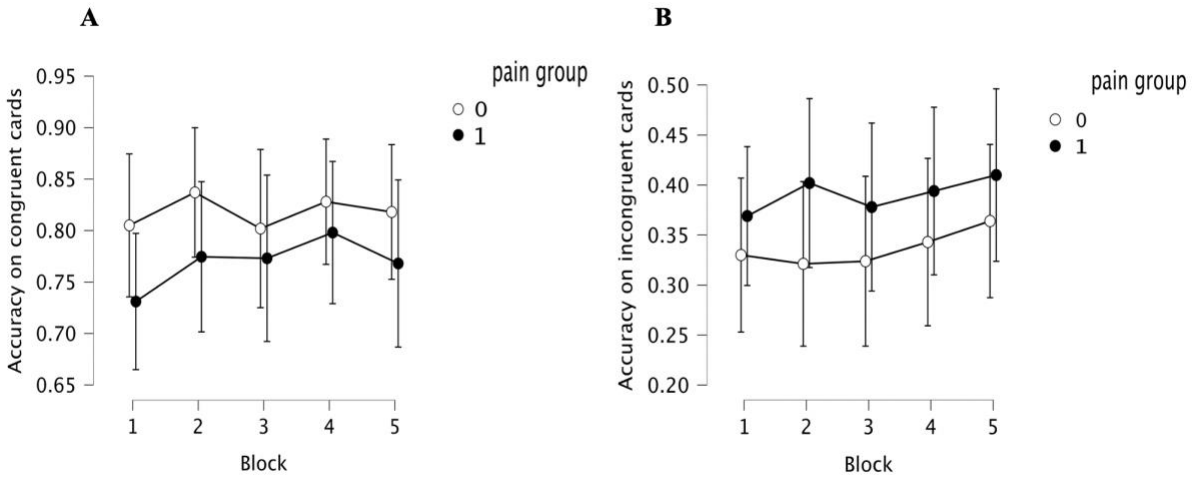
Note. Presented with a 95% confidence interval.

The three-way interaction between Valence, Congruency and Group was not significant ($F(1, 48) = 0.67$, $p = .417$, $\eta_p^2 = .014$). There were no other significant effects found in accuracy, and importantly no significant pain-related effects at all (see Table 1). Crucially, neither the Block * Group, nor the Block * Congruency * Group effects were

significant, although we expected them to be based on our hypothesis (see Figure 13, A & B; see Table 1).

Figure 13.

Descriptive Plots of Congruence-Accuracy Across Blocks.



Note. (A) Pavlovian congruent cards (NoGo-to-Avoid and Go-to-Win). (B) Pavlovian incongruent cards (NoGo-to-Win and Go-to-Avoid). Both plots presented with 95% confidence interval. Pain group 0 = warm, 1 = pain.

Our initial plan was to use pain as a grouping factor but given the null-effect coupled with the fact that some warm-participants rated their pain as high and some pain-participants rated their pain as low, we decided to also do an exploratory analysis where we removed the between-subject factor of Group (pain vs. warm stimulation), and instead added the mean of the mean pain-scores obtained from blocks 2 and 4 as a covariate. However, the analysis revealed that using mean pain ratings as a covariates had no notable effects on the results (see Appendix K).

Table 1. *Repeated Measures ANOVA for Accuracy with Group as Between Subject Factors.*

Cases	Sphericity correction	Sum of Squares	df	Mean square	F	η_p^2
Valence	None	.212	1, 48	.212	8.68*	.153
Valence*Group	None	.038	1, 48	.038	1.53	.031
Congruence	None	46.21	1, 48	46.21	80.62**	.627
Congruence*Group	None	.667	1, 48	.667	1.16	.024
Block	G-G	.157	3.53, 169.6	.044	1.57	.032
Block*Group	G-G	.032	3.53, 169.6	.009	0.31	.007
Valence*Congruence	None	3.536	1, 48	3.536	16.68**	.258
Valence*Congruence*Group	None	.142	1, 48	.142	0.67	.014
Valence*Block	G-G	.153	3.16, 151.9	.048	1.63	.033
Valence*Block*Group	G-G	.111	3.16, 151.9	.035	1.18	.024
Congruence*Block	G-G	.058	3.31, 158.9	.018	0.38	.008
Congruence*Block*Group	G-G	.033	3.31, 158.9	.01	0.22	.005
Valence*Congruence*Block	G-G	.073	3.08, 148.1	.024	0.92	.019
Valence*Congruence*Block*Group	G-G	.064	3.08, 148.1	.021	0.81	.017

Note. Sphericity Correction Greenhouse-Geisser denoted by "G-G". Type III Sum of Squares.
* Significant at Alpha level of .005. ** Significant at Alpha level of <.001.

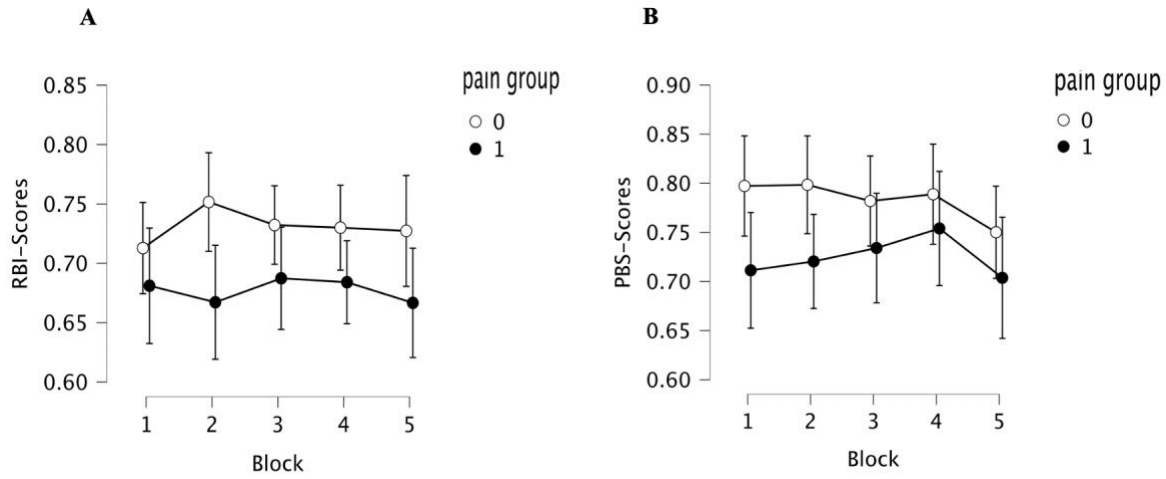
Pavlovian Bias

For the analysis of Pavlovian bias, we separated the card-game data into two behavioral indexes or scales. The RBI (Reward Based Invigoration) which contains responses to the cues in the card-game related to reward-approach behavior, and the PBS (Punishment Based

Suppression) which includes responses related to punishment-avoidance behavior. The analysis revealed that there was a significant main effect of Index ($F(1, 48) = 12.1$, $p = .001$, $\eta_p^2 = .202$), but not significant effects of either Group ($F(1, 48) = 1.35$, $p = .249$, $\eta_p^2 = .028$) or interaction-effect between Index and Group ($F(1, 48) = 0.03$, $p = .86$, $\eta_p^2 < .001$). In other words, there was a significant difference between reward-approaching and punishment-avoiding within the entire sample, but this difference was not significantly different between the groups (see Figure 14, A & B). Notably, (see Table 2). The interaction-effect between Index and Group when using mean pain ratings as covariates rather than pain as grouping factor, was not significant either (see Appendix L). Notably, the interaction between Block and Group was not significant ($F(3.38, 162.2) = 0.29$, $p = .852$, $\eta_p^2 = .006$). In other words, there was no effect of pain on PPB at all (see Table 2), which naturally contradicts what we expected in our hypothesis.

Figure 14.

Descriptive Plots of PPB-Scores Across Blocks.



Note. (A) RBI-values. (B) PBS-values. Both plots presented with a 95% confidence interval. Pain group 0 = warm, 1 = pain.

Table 2. *Combined Repeated Measures ANOVA Table for Both Normative and Relative Values of Pavlovian Bias with Group as Between Subjects' Factors.*

Cases	Sphericity correction	Sum of Squares	Df	Mean Square	F	η_p^2
Index	None	.312	1, 48	.312	12.13*	.202
Index*Group	None	<.001	1, 48	<.001	0.03	<.001
Block	G-G	.046	3.38, 162.2	.014	0.55	.011
Block*Group	G-G	.025	3.38, 162.2	.007	0.29	.006
Index*Block	G-G	.017	3.24, 155.5	.005	1.52	.031
Index*Block*Group	G-G	.02	3.24, 155.5	.006	1.82	.037
IndexRel	None	.008	1, 48	.008	0.59	.012
IndexRel*Group	None	.094	1, 48	.094	6.6*	.121
Block (2-5)	G-G	.045	2.41, 115.8	.018	0.75	.015
Block (2-5)*Group	G-G	.024	2.41, 115.8	.01	0.41	.009
IndexRel*Block (2-5)	G-G	.015	2.45, 118.1	.006	1.86	.037
IndexRel*Block (2-5)*Group	G-G	.001	2.45, 118.1	<.001	0.13	.003

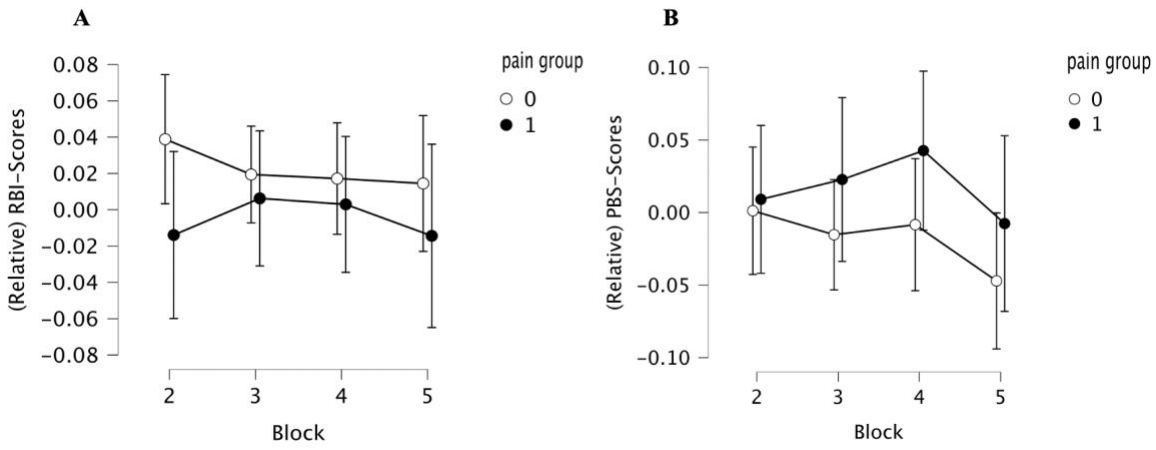
Note. Sphericity correction Greenhouse-Geisser denoted by "G-G". Type III Sum of Squares. *Significant at Alpha level of <.05.

In addition to the normative values of RBI and PBS, we also completed an exploratory analysis based on RBI- and PBS-scores from the last four blocks relative to the scores of the first block. This decision was based on the fact that the groups differed in RBI and PBS in block 1, and since we were only interested in how these indices change over the blocks (due to pain stimulation) we decided to normalize the values from blocks 2-5 relative to block 1 by

calculating difference scores. When analyzing the relative values, we discovered a significant interaction effect between Index and Group ($F(1, 48) = 6.6$, $p = .013$, $\eta_p^2 = .121$), meaning that when we compare the relative values from the pain group to the relative values of the warm group, they are significantly different (see Figure 15). Specifically, the difference between the groups is that the pain group displayed a general increase in punishment-avoidance relative to the first block (i.e., positive value for the group mean), while their reward-approach tendencies reduced (negative group mean). In contrast, the warm group displayed the exact opposite pattern (see Figure 16). Although the value of the partial eta squared (η_p^2) is at the upper end of the range of what would be considered a medium effect, a post hoc examination of the interaction (Index * Pain) did not result in any significant comparisons (see Appendix M). A simple main effect test did however result in a significant result for the interaction of the relative Index and the warm Group ($F(1, 48) = 6.8$, $p = .015$). Although this effect is statistically significant, it must be noted that due to the non-significant post hoc tests the effect is not very strong and should be replicated in a follow-up study.

Figure 15.

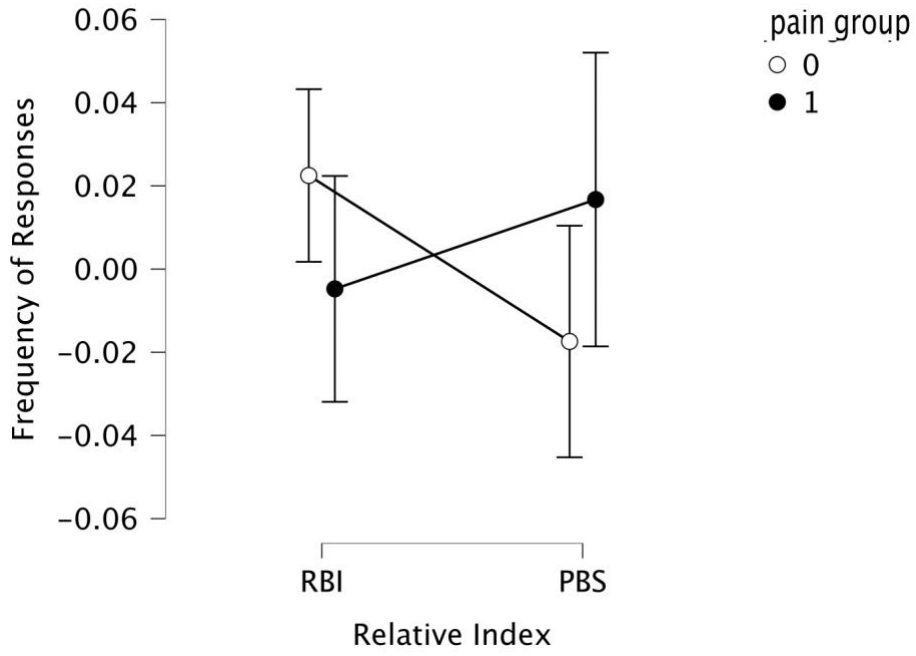
Descriptive Plots of Relative PPB-Scores Across Blocks.



Note. (A) Relative RBI scores. (B) Relative PBS scores. Both plots presented with a 95% confidence interval. Pain group 0 = warm, 1 = pain.

Figure 16.

Descriptive Plot of PPB-Scores with Relative Values.



Note. Plot presented with a 95% confidence interval. Pain group 0 = warm, 1 = pain.

Discussion

The aim of this study was to develop a method of safely and effectively inducing tonic pain in participants conducting a task for mapping decision-making strategies. In addition, we wanted to investigate the effects of pain on Pavlovian bias and performance on the decision-making card-game, where we generally expected pain to worsen performance, but more specifically, that this effect would be driven by enhanced Pavlovian bias in response to pain stimulation. We were able to thoroughly demonstrate the effectiveness of the Go/NoGo card-game task as it relates to influencing accuracy performance as well as generally inducing Pavlovian bias. However, in contrast to our hypotheses, pain effects were non-existent (response accuracy, planned analysis of changes in Pavlovian bias), and were observed only in our exploratory analysis. The results presented above will now be discussed in detail.

Pain Protocol and Pain Ratings

It was presented in the results-section that the pain ratings (both mean and peak) were significantly higher for the pain-group than the warm group. This result suggests that our pain protocol was effective in differentiating between warm and painful stimulation, and generally validates that our protocol worked as intended. However, it only validates that we successfully induced actual painful stimulation in the pain-group, it does not guarantee that the pain the pain-group experienced was painful enough to potentially unveil any pain-related effects in our VB-DM task. Should the pain need to be even more intense for any effects to reveal themselves in potential future studies of a similar nature, then there would most certainly be multiple ethical concerns that would need to be addressed.

PANAS

The PANAS scores showed a reduction of both positive and negative scores from before task to after task. The fact that positive and negative scores both decreased (rather than only one decreasing) suggests that the task was either exhausting or boring, and that it induced some degree of emotional blunting. However, we were not able to demonstrate any effects of pain on the PANAS scores. Technically, we did not test for if our pain protocol alone could induce changes in affect, but we do know that 1) the protocol in tandem with the task did not induce affect-changes and 2) the task alone did. It therefore still follows logical reasoning that we should conclude that the findings suggests that our pain protocol was not effective enough to induce changes in affect. The pain protocol was however not specifically designed to have any bearing on affective aspects, and as such this does not mean that the pain protocol was unsuccessful.

Success and Control

Neither the success- nor the control-ratings changed over the period of completing the task. This is in accordance with what we expected, as the contingency (70%/30%

correct/incorrect outcomes) was relatively high, and more importantly, constant across the blocks. As the ratio of expected outcomes versus "noise" stayed constant, the participants´ should not have felt less or more successful or in control from one block to the next.

Pain did not influence perceived success and control either. Even though pain was uncontrollable for the participants in the pain-group, this pain was task-unspecific (it was unrelated to the card game). It would seem the uncontrollable nature of the manipulation (pain) did not transfer to the controllability evaluations related to the task. This is in accordance with what we expected and is likely attributable to the technical unrelatedness of the pain and the task. In fact, we did not expect any group differences in perceived controllability of the outcome seeing as controllability was not differentially manipulated, or even manipulated at all save for the sample-universal 70/30% contingency.

Even though the experimentally induced pain in this study did not influence perceived controllability over outcomes, previous research suggests that this finding might not be generalizable to actual chronic pain patients. In fact, a feeling of Learned Helplessness (LH), defined as a belief that pain (and its consequences) is unavoidable, uncontrollable and unchangeable, is a concept very closely related to chronic pain (Samwell et al., 2007). LH and other related concepts, such as a decreased feeling of self-efficacy, have also been found to potentially have carry-over effects for chronic pain patients (Mayano et al., 2019). Carry-over (or transfer) effects in this instance refers to chronic pain patients carrying the feeling of uncontrollability from their condition to other, technically unrelated, aspects of their life. In summary, there is a theoretical basis for arguing that pain could have influenced perceived control if the sample was taken from adults suffering with chronic pain rather than a healthy sample, although at the present time this is speculative.

Performance Accuracy

There was an Interaction Between Valence and Congruency

We demonstrated in this study that conflict was stronger within the win domain, with performance accuracy being highest for Go-to-Win cards and lowest for NoGo-to-Win cards. This is in line with findings from previous research in the field (Cavanagh et al., 2013; Csifcsák et al., 2020; Guitart-Masip et al., 2014). There might be a justifiable evolutionary reasoning behind the avoid-domain inducing a weaker conflict-effect. It is less adaptive to withdraw from rewards than it is to initiate action in aversive situations (danger), exemplified in the natural fight-or-flight response. When in potentially dangerous (aversive) situations, animals typically display a freezing-response at first when encountering a threat, resulting in halting all previously ongoing actions. This freezing-response is then followed either by approach (fight) or escape (flight) behavior. Our natural facility for the fight-or-flight response might therefore predispose us to experience a weaker conflict-effect in aversive situations compared to potentially rewarding situations. In other words, we can speculate if it is possible that avoid-cards create less conflict because they are translatable to our innate fight-or-flight response (Go-to-Avoid = fight, NoGo-to-Avoid = flight).

Performance Accuracy did not Change Across Blocks

In this study we did not find a significant effect of Block. This is surprising, as we expected the participants to improve their accuracy on the task over time, as has been the case in similar tasks from previous research (Cavanagh et al., 2013; Csifcsák et al., 2021). We can speculate if the lack of a Block-effect is caused by insufficient time to learn enough from one set of cards (block) for it to give an advantage on the next card-set, although the time-aspect of each block is very similar to the task from Csifcsák et al. (2021) and they did find an effect of Block. The differences in findings between this study and the study by Csifcsák et al. (2021) might therefore be a result of the differences in the practical design of the task. The

discrepancy could be a result of the removal of the go-cost, or, more convincingly, because in this study we removed the fixation-phase between cue and response. Compared to the Csifcsák et al. (2021) study, the participants in this study were required to respond almost immediately after being presented with the cue (card). Maybe the speeded response-time with its decrease in deliberation-time resulted in more errors on conflict cards and generally made learning on this task more difficult.

Accuracy Performance was Higher on Pavlovian-Congruent Cards

We found that accuracy was higher on Pavlovian-congruent cards compared to Pavlovian-incongruent cards. This demonstrates that our card-game fulfilled its purpose, as it was designed to capture the interaction between Pavlovian and instrumental systems. The interaction between the systems is captured in the fact that people found conflicting cards (NoGo-to-Win and Go-to-Avoid) much harder to learn the correct responses to. Other similar studies have also found that performance accuracy is higher on Pavlovian-congruent cards, but the effect found in the current study is much larger than those found by for instance Csifcsák et al. (2020) or Csifcsák et al. (2021). This might be due to the removal of the fixation phase between the cue (card) and response. As mentioned above, the participants in our study had to respond almost immediately after being presented with the cue (card) which might have led to more errors on incongruent cards. Requiring the participants to respond immediately, thus discouraging deliberation, increases the usefulness of (and maybe adherence to) the fast and automatic Pavlovian system in this task.

Pain did not Influence Performance Accuracy

It is very important to note that there were no Block*Group or Block*Congruence*Group interaction-effects in our planned analysis (with Group as between-subject factor), and no Block or Block*Congruence effect when using mean pain as a covariate either, indicating that pain in this task did not influence performance accuracy.

One possible explanation for this could be that our pain protocol simply was not effective (strong) enough. As seen on the pain ratings, the protocol was successful in creating a rather clear stimulation-distinction between the groups, and the pain-group did report significantly higher levels of pain than the warm group did. The pain-group reporting higher levels of pain is however not interchangeable with saying that the pain-levels were high enough in the pain-group to uncover any potential effects. In other words, the stimulation temperature for the pain-group might have needed to be more intense for the pain to be distractive enough to influence (accuracy) performance on the task. There are some findings suggesting that had the stimuli (pain) been painful enough, it could have had reducing or interrupting effects on attention (Gong et al., 2019). Another possible explanation is the reverse, that instead of pain distracting them from the task, the task distracted them from the pain.

Alternatively, we did not find an effect simply because there is no effect to find. That is to say that if (in reality) pain does not interact with these types of decision-making situations in healthy adults, then naturally there would be no effect to find. The explanation of there simply not being an effect to find does however come across as unlikely, as we have already presented and detailed a strong theoretical background for suggesting that pain does in fact influence cognition (Attridge et al., 2015; Berryman et al., 2014; Higgins et al., 2018; Lee et al., 2010; Mazza et al., 2018; Moriarty et al., 2011).

Despite not finding a pain effect here in the healthy sample, it is entirely possible that the same protocol would be sufficient to modulate accuracy and Pavlovian bias in chronic pain patients. Their long-lasting symptoms can induce maladaptive cognitive changes, affecting how they respond to experimental pain as well, although at this time it is speculative. Additionally, as mentioned above, these patients might show stronger learned helplessness, and since LH can also be regarded as an extreme manifestation of PBS, pain in this protocol could magnify it even further, resulting in performance alterations.

Pavlovian Performance Bias (PPB)

There was an Across-Sample Tendency to act Correspondingly to Punishment Avoidance

Overall, both the pain- and the warm-group displayed behavior consistent with preferring to avoid punishment rather than approach rewards. Seeing as there was no group difference, it might be that preferring avoiding punishments rather than seeking rewards is an inherent human tendency, and not a result of our manipulation.

Additionally, similarly to the reasoning related to the accuracy Valence*Congruency interaction, PBS is the sensitivity to emit NoGo responses exclusively for avoid-cards. Since the NoGo-to-Win condition is the most difficult, people are unlikely to emit NoGo responses for win-cards, which pushes the PBS scores up. In contrast, Go responses are less specific for win-cards (hence the lower RBI-scores), and as Go-to-Avoid is also a viable option, it is generally regarded as less difficult than the other conflict card (i.e., NoGo-to-Win).

Pain Only Influenced PPB When Analyzing Normalized Difference (Relative) Scores

Contrary to out hypothesis, the raw pain scores did not influence reward-approach behavior or punishment-avoidant behavior. This lack of an effect was true both when using pain as a grouping factor, and when using mean pain as a covariate. We expected the pain stimulation to predisposition the pain group to exhibit a preparatory tendency and as such prime them to be more avoidant of potential threats (i.e., losses) than the warm group. This was not the case. The possible explanations for this outcome are the same as some possible explanations mentioned earlier. Either the pain might have not been intense enough to produce any effects or there is no effect to be found.

As a result of the null effect from the raw scores, we strayed from the originally planned analysis in order to also examine the data using normalized difference scores. As detailed in the results-section, when analyzing these relative scores normalized to values from the first block, pain increased punishment-avoidant behavior and decreased reward-seeking behavior

over the span of the task. This is in accordance with our hypothesis and suggests that pain does indeed increase dependency on the Pavlovian system as a decision-making strategy. As also mentioned in the results-section, although the effect was not small (the effect size estimate was at the upper-end of considered medium), the post hoc test did not show any significant results. Even still, the interaction for the relative values indicates that in the warm group RBI increased throughout the main task relative to the first block (value is larger than 0) and PBS reduced (value smaller than 0), while the opposite pattern was found for the pain group. This result corresponds to our hypothesis in the way that if pain increases Pavlovian bias, then it would do so more potently for Avoid-cards. This is because pain is an aversive stimulus itself and can therefore increase PBS that is generalized to a pain-dependent stimulus (the cards). No other factors or interactions were significant for either the normative or the relative values. It would be interesting to see whether future research that is either replicating this study or implementing a similar design are going to be able to replicate this finding.

Limitations and Future Research

There are some limitations in this present study that needs to be acknowledged. First, although a power-analysis did suggest that 25 participants per group would be sufficient, a larger sample would provide more accurate mean-values and increase the potential for finding significant effects. Larger sample sizes also improve the validation and reliability of studies, as well as strengthening any statements of generalizability. Our sample was also overall slightly skewed as far as gender goes, with a larger number of women than men. This skewed distribution between the genders was however equal in both groups so if there is an effect of the gender-skewness then it should be the same in both the groups. Also, although we recruited both on- and off-campus, there was undoubtedly more students than non-students who participated. The students were from multiple disciplines and fields, but a majority were studying psychology. Future research building on the current study should focus on gathering

a larger, more diverse sample, especially including older participants.

Second, the current study is limited to healthy adults only. This is not necessarily a limitation in and of itself, but it does mean that we can only generalize our findings to a healthy population. Suggestions of generalizing to patients suffering with chronic pain is purely speculative at this point, and future research on how pain influences decision-making could and should eventually turn their focus on recruiting participants who suffer with chronic pain. Once research on this topic has developed enough to have a solid pool of replicated findings, it can be used to create a laboratory-based behavioral-model for impaired decision-making which could potentially aid countless people suffering with chronic pain. Future research could also eventually transition into including other illnesses and conditions where decision-making could be impaired, such as depression and anxiety.

The third limitation in this study, is a very common limitation of laboratory-based research. Decision-making is very complex and context-based in real life, and such complexities and nuances are impossible to perfectly recreate in a lab. Naturally, conducting research in a lab gives us control over certain variables and stimuli that we could not have controlled in a natural environment, but follow-up studies could possibly devise a method for observing Pavlovian biases in decision-making in a more natural and real setting.

Another limitation is that in the data-collection process, there were only female experimenters. In the preliminary investigation by McDougall et al. (2021), they found that when the experimenter was female, the female participants rated their pain as worse (a trend also occurring in their CoVAS-rapports) compared to when the experimenter was male. Notably McDougall et al. (2021) did not find any effects of the experimenters´ gender in relation to pain thresholds, only in relation to pain ratings. It is possible that the female participants´ pain ratings in the current study were in some way influenced by the gender of the experimenters, but this would be purely speculative. Further investigation on the possible

effects of experimenters´ gender on pain-perception and -rating is needed and would be a highly interesting topic for potential future research. Even if it is only speculation, future pain-based research could prioritize having both male and female experimenters.

Conclusion

In this study we investigated whether pain had any influence on value-based decision-making strategies. We found that pain overall had no effect on task performance, but there was some indication that pain increased Pavlovian bias in the aversive domain. Although this effect was rather subtle, it could be stronger in patients suffering with long-term (chronic) pain, leading them to make more maladaptive decisions in everyday life. Future studies should try to replicate the findings detailed in this thesis with a larger and more diverse sample.

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Appendix A

Project-Approval from REK

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK nord	Susanne Ramstad	77660388	08.09.2021	284408

Gabor Csifcsak

Prosjektsøknad: Hvordan eksperimentell smerte og lav kontroll påvirker beslutningstaking hos friske voksne?
Søknadsnummer: 284408
Forskningsansvarlig institusjon: UiT Norges arktiske universitet

Prosjektsøknad godkjennes

Søkers beskrivelse

Formålet med prosjektet er å finne effekten av eksperimentelt-indusert termisk smerte og lavt/høyt nivå av kontroll på verdi-basert beslutningstaking hos friske voksne. Formålet er å etterligne den nedsatte beslutningstakingen i pasientene med kroniske smerter ved å utvikle en eksperimentell atferdsmodell ved å indusere smerte i friske voksne samt eksponere de for lav/høy kontroll. Ved å gjøre dette, kan vi komme et skritt nærmere mot å finne ut av hvordan verdi-basert beslutningstaking er hos individene som lever med kroniske smerter på daglig basis. Samt bidra med en studie som kan være hjelpsom i utviklingen av effektive intervensjoner som bidrar i forbedring av pasientenes liv.

Oppgaven som tester beslutningtaking i møte med gevinst og tap (verdi-basert) er kamuflert som et datastyrt kortspill der kontrollerbarheten over gevinst og tap er manipulert avhengig av hvilken eksperimentell gruppe deltakeren hører til. Smerteinduseringen (termisk varme-smerte) skjer også avhengig av hvilken eksp. gruppe deltakeren hører til. Vi har 4 eksperimentelle grupper, hver blir utsatt for en eksperimentell betingelse (mellom-gruppe design): 1. Kontroll (høy kontroll, ingen smerte), 2. Smerte (høy kontroll, smerte), 3. Kontrollerbarhet/lav kontroll (lav kontroll, ingen smerte), 4. Kombinert (lav kontroll, smerte).

Alle deltakere skal gå gjennom smertekalibleringen som har blitt utviklet og standardisert. Hver eneste individ skal få estimert sin individuelle maksimale smerteoppfattelsenivået ved å stoppe den gradvise temperaturstigningen 8 ganger (starter ved 32C og kan stige til maksimalt 50C) på rad. En aluminiumtermode blir plassert på innsiden av den dominante armen. Deltakeren blir instruert om å trykke en knapp for å stoppe stigningen når smerten er intens og man vil at den skal stoppe.

Etter at den maksimale gjennomsnittlige smerteoppfattelsenivået er estimert, trekker vi 2 grader Celsius fra den estimerte verdien. Denne temperaturverdien skal brukes i 2 av 5 blokker i 7.5 minutter mens deltakeren spiller kortspillet på PC-en. Denne temperaturverdien kan ikke overstige 46,5 grader Celsius og ikke være lavere enn 44C, fordi vi sikter mot å ha et moderat smertenivå og unngå hudskader. Termoden skal plasseres på innsiden av den ikke-dominante armen, først på den distale posisjonen og så

på den proksimale posisjonen. Viktig å merke seg at denne stimuleringen skjer i blokk 2 og 4, så deltakeren får en ca 7.5 minutters pause fra smertestimuleringen. På grunn av pausen og de forskjellige stimulasjonsplasseringene av termoden, vil vi unngå summeringseffekter.

I de to gruppene uten smerte skal de ha temperatur på 42C, mens de to gruppene med smerte vil ha smertestimulering på mellom 44C og 46,5C avhengig av deres maksimale smertenivå-estimatet.

Alle deltakere vil før eksperimentet besvare spørreskjemaet: Positive and Negative affect Schedule.
Etter kortspillet vil deltakerne besvare spørreskjemaer: Positive and Negative affect Schedule, Need for Cognition, Becks hopelessness Scale, Behavioral Inhibition System og Behavioral Activation System. Dette vil kunne belyse informasjon om eventuelle forskjeller i humør og personlighet spiller en rolle i hvordan man responderer på smerte og hvordan en blir påvirket av det i beslutningstaking.

Søknaden ble behandlet av REK nord i møte 26.08.2021. Vurderingen er gjort med hjemmel i helseforskningsloven § 10.

REKs vurdering

Søknaden ble behandlet av REK nord i møte 26.08.2021. Vurderingen er gjort med hjemmel i helseforskningsloven § 10.

Data/materiale

Det samles inn data fra spørreskjema/smertetest/kortspilloppgave.

Deltakere 100 friske voksne mellom 18-50 år, uten tidligere psykiske/nevrologiske/kroniske smertesykdommer, og som ikke tar medisiner som påvirker sentralnervesystemet.

Rekruttering

Rekruttering av deltakere vil skje via sosiale medier, verbale invitasjoner og plakater hengt opp på UiT sin campus. Potensielle deltakere som tar kontakt vil motta et informasjonsskriv. Hvis de fortsatt er interesserte, opprettes et tidspunkt for deltakelse. Deltakere vil bli gitt omtrent 1 måned for å bestemme om de vil delta eller ikke. Deltakere mottar et gavekort på kr. 400,-

Forespørsel/informasjon/samtykkeerklæring

I søknaden og i protokollen beskrives at deltakerne får utdelt et kodenummer som brukes under forsøket, og at underskrevet samtykkeskjema ikke kan kobles til de kodede dataene.

I informasjonsskrivet under avsnittet «hva skjer med opplysningene om deg», står det også i punkt 7 : *« Siden vi ikke samler inn personlig identifiserbar informasjon om deg som deltaker av studien, vil dataen vi samler inn under eksperimentet forbli 100% anonymt»* . Men i punkt 5 står det at prosjektleder har nøkkel som kobler den anonyme koden til personopplysninger. e. Så lenge det finnes en koblingsnøkkel er data ikke anonyme.

Det må avklares hvorvidt data er anonymet eller ikke. Informasjonen som gis i informasjonsskrivet må tilpasses til det valgte alternativet. Et avidentifisert datasett/anonyme data skal oppbevares i fem år etter prosjektslutt av kontrollhensyn.

Sekretariatet vurderer ellers informasjonsskrivet som dekkende for studien.

Vedtak

REK har gjort en helhetlig forskningsetisk vurdering av alle prosjektets sider og godkjenner det med hjemmel i helseforskningsloven § 10. Før prosjektet kan igangsettes må avklaringene det bes om over sendes REK. Skrivet sendes via prosjektmappen i REK-portalen.

Prosjektet er godkjent frem til omsøkt sluttdato 01.09.2023.

Av dokumentasjonshensyn skal opplysningene oppbevares i fem år etter prosjektslutt. Enhver tilgang til prosjektdataene skal da være knyttet til behovet for etterkontroll. Prosjektdata vil således ikke være tilgjengelig for prosjektet. Prosjektleder og forskningsansvarlig institusjon er ansvarlige for at opplysningene oppbevares indirekte personidentifiserbart i denne perioden, dvs. atskilt i en nøkkel- og en datafil.

Etter denne femårsperioden skal opplysningene slettes eller anonymiseres. Komiteen gjør oppmerksom på at anonymisering er mer omfattende enn å kun slette koblingsnøkkelen, jf. Datatilsynets veileder om anonymiseringsteknikker.

Vi gjør oppmerksom på at før prosjektet igangsettes må det foreligge et behandlingsgrunnlag for behandling av personopplysninger. Dette må forankres i egen institusjon.

Sluttmelding
Prosjektleder skal sende sluttmelding til REK på eget skjema via REK-portalen senest senest 6 måneder etter sluttdato 01.09.2023, jf. helseforskningsloven § 12. Dersom prosjektet ikke starter opp eller gjennomføres meldes dette også via skjemaet for sluttmelding.

Søknad om endring
Dersom man ønsker å foreta vesentlige endringer i formål, metode, tidsløp eller organisering må prosjektleder sende søknad om endring via portalen på eget skjema til REK, jf. helseforskningsloven § 11.

Klageadgang
Du kan klage på REKs vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes på eget skjema via REK portalen. Klagefristen er tre uker fra du mottar dette brevet. Dersom REK opprettholder vedtaket, sender REK klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag (NEM) for endelig vurdering, jf. forskningsetikkloven § 10 og helseforskningsloven § 10.

Med vennlig hilsen

May Britt Rossvoll

sekretariatsleder

Kopi til:

UiT Norges arktiske universitet
Anastasija Kuprejeva

Appendix B

Project Information Sheet with Inclusion Criteria

VIL DU DELTA I FORSKNINGSPROSJEKTET – *«Om eksperimentell smerte påvirker beslutningstaking hos friske voksne»*?

Institutt for Psykologi ved UiT - Norges arktiske universitetet

Utført av:
Caroline Alexandra Grant Angen (can050@uit.no) | Anastasija Kuprejeva (aku037@uit.no) | Ina Klakegg (ikl020@uit.no)

Under oppsyn av:
Førsteamanuensis Gábor Csifcsák (gabor.csifcsak@uit.no) | Professor Matthias Mittner (matthias.mittner@uit.no)

FORMÅLET MED PROSJEKTET OG HVORFOR DU BLIR SPURT

Vi spør deg om å delta i et forskningsprosjekt der vi studerer hvordan eksperimentell smerte påvirker beslutningstaking i et databasert kortspill. Utfallet fra denne studien kan hjelpe oss å få en bedre forståelse om samspillet mellom smerte og sentralnervesystemet, som videre kan føre til en bedre forståelse av kognitive utfordringer og problemer hos mennesker med kroniske smertelidelser.

Til tross for at dette prosjektet handler om smerte og kognisjon, vil vi trenge en kontrollgruppe som gjennomfører kortspillet uten at de får smertestimulering. Du blir tilfeldig puttet inn i enten en smertegruppe (høyere varme) eller en varmegruppe (lavere varme) når du ankommer laboratoriet. Vi vil estimere de individuelle smerteopplevelsesnivåene for begge gruppene.

Vi ser etter friske voksne mennesker innenfor aldersgruppen 18-50 år

- Du bør ha godt eller korrigert syn, kan ikke ha noen nåværende/tidligere psykiske, nevrologiske eller kronisk smertesykdommer (f.eks. depresjon, bipolar lidelse, epilepsi, migrene, alvorlig hodeskade, hjernekirurgi) og kan ikke ta medisiner som påvirker sentralnervesystemet (f.eks. antidepressiva, anti-epileptika). I tillegg er det viktig at du ikke har tatt noen analgetiske midler (smertestillende, f.eks. Paracet) samme dagen som forsøket skal gjennomføres
- Det er viktig at du får nok søvn på nettene før dagen, må ikke være under påvirkning av psykoaktive stoffer (f.eks. alkohol, narkotika) og at du ikke lider av bakrus
- Du har lov til å innta koffein (f.eks. kaffe, energidrikk) og nikotin (f.eks. røyk, snus) i henhold til dine vanlige rutiner
- Vi ber deg om å ikke ta på parfyme eller kosmetikk (f.eks. krem, anti-bac) på innsiden av begge for-armene

HVA INNEBÆRER PROSJEKTET FOR DEG?

I prosjektet vil vi innhente og registrere opplysninger om deg. Vi kommer ikke til å samle inn informasjon som gjør det mulig å identifisere deg som person. Vi kommer bare til å spørre deg om alder, kjønn og din dominante hånd samt estimere ditt smerteoppfattelsesnivå. Vi skal samle inn data om responsene dine under kortspillet for å lære mer om dine beslutningstakingsstrategier. Til slutt, vil vi samle inn spørreskjemaer som omhandler ditt humør og personlighet, ved bruk av validerte og velbrukte standardiserte spørreskjemaer.

- Du vil bli bedt om å komme til vårt laboratorium på Instituttet for Psykologi ved UiT - Norges Arktiske Universitet og signere informert samtykke ved ankomst. Datainnsamlingen vil vare i omtrent **90** minutter. En av våre forskere kommer til å instruere deg på veien
- Først vil du bli bedt om å fullføre ulike spørreskjema som omhandler ditt humør
- Videre, vi kommer til å estimere ditt individuelle smerteoppfattelsesnivå for å kunne finne ut av hvilken stimuleringsintensitet du skal ha under selve kortspillet. Vi vil estimere det på innsiden av din dominante for-arm
- Når dette er kartlagt, vil du bli bedt om å spille et datastyrt kortspill. Den vil bestå av 5 blokker, hvorav hver av dem varer i 7.5 minutter. Etter at du har spilt ferdig hvert av de fem rundene av kortspillet vil du bli spurt om å svare på to skalaer som måler (1) hvor suksessfullt du følte at din prestasjon var og (2) hvor mye kontroll du følte at du hadde under kortspillet. I blokk 2 og 4, vil vi introdusere varmebasert smerte (moderat intensitet) til huden på innsiden av for-armen på den ikke-dominante armen din som vil vare i 7.5 minutter (med en pause fra smerte i blokk 3). Etter begge stimuleringsperiodene vil du bli spurt om å rangere (3) toppnivået av smerte du følte og (4) gjennomsnittsnivået av smerte du følte i blokk 2 og 4 . Prosedyren er helt trygg, og blir brukt verden rundt av forskere for å bedømme hvordan smerte påvirker kognisjon i friske deltakere og i pasienter med varierende lidelser
- Etter kortspillet vil du bli informert til å besvare fire spørreskjemaer som omhandler ditt humør og andre aspekter av din personlighet ("PANAS" og "BHS" som spør om humør, "BIS / BAS" som handler om generelle holdninger og "NFC" Need for Cognition, som handler om hvor villig man er til å bruke mentale krefter)
- På slutten av eksperimentet vil du få et gavekort til Jekta Storsenter med en verdi av enten **300** eller **400 NOK**, avhengig av din prestasjon på kortspillet

MULIGE FORDELER OG ULEMPER

- Fordelen ved å delta på dette prosjektet er at du lærer mer om hvordan man måler påvirkningen av smerte på ens kognisjon i et laboratorium samt bidra til forskningen og samfunnet. I tillegg, vil du få et gavekort på **300 NOK** på Jekta Storsenter for din deltakelse. Ved tilstrekkelig prestasjon på kortspillet vil du kunne motta en bonus på **100 NOK**
- Vi induserer varmebasert smerte på huden av innsiden av for-armen din for 7.5 minutter, 2 ganger. Her forsøker vi å nå målet om å indusere et moderat nivå av smerte, som vil være ukomfortabelt. Vi tar i bruk et PATHWAY-system av bedriften Medoc (www.medoc-web.com/pathway), som er en veldokumentert og mye brukt enhet for å indusere varmebasert smerte på både friske voksne mennesker og andre pasientgrupper. Stimuleringsintensiteten vil bli avklart før vi starter selve kortspillet, slik vi finner en varme som er tilpasset akkurat deg og som er tolerabel over lengre tid. Vi kommer bare til å ta i bruk enheten innenfor dens trygge sikkerhetshetsrammer
- Du kan alltids stoppe smertestimuleringen i løpet av kortspillet hvis du føler at smerten er for intens og du ønsker at den skal stoppe. Det vil alltid være en knapp ved siden av deg som terminerer stimuleringen helt
- Som en etter-effekt av å ha blitt påført varmebasert smerte på huden vil du kunne oppleve rødhet og sensitivitet i disse områdene. Denne effekten er ikke farlig og er helt normal og vil vanligvis vare i og forsvinne etter ca. 12 timer. Skulle dette vedvare i over 24 timer, ber vi deg om å ta kontakt med forskningsansvarlig Gábor Csifcsák som har medisinsk kompetanse og er alltid tilgjengelig for kontakt (s. 4)

FRIVILLIG DELTAKELSE OG MULIGHET FOR Å TREKKE DITT SAMTYKKE

- Det er frivillig å delta i prosjektet
- Dersom du ønsker å delta, undertegner du samtykkeerklæringen (s. 5) når du får tildelt ditt deltakelsestidspunkt og kommer til vårt laboratorium
- Du har rett til å avbryte datainnsamlingen til enhver tid og å trekke din samtykke om studiedeltakelse uten å oppgi en grunn for din beslutning. I dette tilfellet blir data som er samlet hittil ødelagt og ikke brukt på noen som helst måte. Det vil ikke ha noen negative konsekvenser for deg hvis du ikke vil delta eller senere velger å trekke deg
- Du kan kreve innsyn i opplysningene som er lagret om deg, og opplysningene vil da utleveres innen 30 dager
- Du kan kreve at dine helseopplysninger i prosjektet slettes
- Adgangen til å kreve destruksjon, sletting eller utlevering gjelder ikke dersom materialet eller opplysningene er anonymisert eller publisert. Denne adgangen kan også begrenses dersom opplysningene er inngått i utførte analyser, eller dersom materialet er bearbeidet
- Dersom du senere ønsker å trekke deg eller har spørsmål til prosjektet, kan du kontakte prosjektleder (s. 4)

HVA SKJER MED OPPLYSNINGENE OM DEG?

- Opplysningene som registreres om deg skal kun brukes slik som beskrevet under formålet med prosjektet
- Eventuelle utvidelser i bruk og oppbevaringstid kan kun skje etter godkjenning fra REK og andre relevante myndigheter
- Du har rett til innsyn i hvilke opplysninger som er registrert om deg og rett til å få korrigert eventuelle feil i de opplysningene som er registrert
- Du har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene. Du kan klage på behandlingen av dine opplysninger til Datatilsynet og institusjonen sitt personvernombud
- Alle data blir samlet inn anonymt, og er kun merket med en spesiell kode. Nøkkelen som knytter den anonyme koden til personopplysninger vil være låst inne på kontoret til Gábor Csifcsák
- Du har rett på tilgang til dine data (smertepersepsjonsnivå, ytelse på beslutningstakingsoppgaven, resultatene av spørreundersøkelsene) ved forespørsel, men du må selv huske din deltakelsesdato og din deltakerkode
- Siden vi ikke samler inn personlig identifiserbar informasjon om deg som deltaker av studien, vil dataen vi samler inn under eksperimentet forbli 100% anonymt. Denne innsamlede dataen vil bli brukt for den hensikt å publisere resultater av vår studie i et vitenskapelig tidsskrift. Den innsamlede dataen vil bli presentert på gruppenivå og ikke på individnivå, noe som betyr at ingen individuelle data vil bli presentert i vitenskapelige publikasjoner eller universitetsoppgaver, bare resultater som ble oppnådd for hele gruppen av deltakere
- Publisering av resultater er en nødvendig del av forskningsprosessen. All publisering skal gjøres slik at enkeltdeltakere ikke skal kunne gjenkjennes, men vi plikter å informere deg om at vi ikke kan utelukke at det kan skje

- Vi vil også dele dataene med andre forskere for å legge til rette for vitenskapelig utvikling innenfor dette forskningsdomenet

DELING AV OPPLYSNINGER OG OVERFØRING TIL UTLANDET

Ved å delta i prosjektet, samtykker du også til at kodede opplysninger om dine smerterapporteringer, intensitet av smertestimuleringer, prestasjon på kortspillet og spørreskjema om humør og personlighet kan overføres til utlandet som ledd i forskningssamarbeid og publisering i tråd med formålet angitt innledningsvis. Disse anonyme, kodede dataene vil bli gjort tilgjengelig for andre forskere over hele verden for vitenskapelige hensikter. På bakgrunn av dette, vil vi bruke non-profitt Open Science Framework (osf.io), som er en plattform kun med hensikt å dele vitenskapelig forskningsdata og promotere transparens og et åpent forskningsnettverk.

- Ved å signere informert samtykke (s. 5), sier du deg enig i at data fra deg som deltaker kan bli delt med andre forskere. Andre forskere kan også ta i bruk denne dataen til å finne ut mer om eksperimentell smerte og dets påvirkning på beslutningstaking, og/eller hvorfor effekten av eksperimentell smerte på beslutningstaking blir påvirket av humør og personlighet. Vi planlegger å dele datainnsamlingen for en ubegrenset tidsperiode
- Vi ønsker også om å informere om at det er lovverket i det landet opplysningene oppbevares i som er gjeldene

FORSIKRING

Produktansvarsloven gjelder for dette prosjektet.

ØKONOMI

Du vil motta et gavekort på Jekta Storsenter i Tromsø av en verdi på 300 eller 400 NOK avhengig av din prestasjon. Dette forskningsprosjektet er finansiert av IPS, ved UiT og har ingen eksterne sponsorer. Forskerne og forskningsansvarlige på dette prosjektet har ingen interessekonflikter.

GODKJENNINGER

Regional komité for medisinsk og helsefaglig forskningsetikk har gjort en forskningsetisk vurdering og godkjent prosjektet **284408.**

Instituttet for Psykologi og prosjektleder Gábor Csifcsák er ansvarlig for personvernet i prosjektet.

Vi behandler opplysningene på linje med Personvernombud.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet eller ønsker å trekke deg fra deltakelse, kan du kontakte:

Forskningsansvarlig, Gábor Csifcsák | **gabor.csifcsak@uit.no**

+47 776 46 776

Dersom du opplever etter-effekter etter gjennomført studie som ikke går over etter 24 timer, kontakt:

Forskningsansvarlig, Gábor Csifcsák | **gabor.csifcsak@uit.no**

+47 776 46 776

Dersom du har spørsmål om personvernet i prosjektet, kan du kontakte personvernombudet ved institusjonen:

Personvernombud ved UiT, Joakim Bakkevold | **personvernombud@uit.no**

https://uit.no/om/art?p_document_id=594059&dim=179007

Appendix C

Table of Independent Samples *t*-test Comparing Personality Questionnaires Between the two Experimental Groups.

Independent Samples *t*-test

	t	df	p	Cohen's d
BAS-D	-0.315	43.056	0.754	-0.089
BAS-F	-0.140	45.617	0.890	-0.039
BAS-R	-0.251	47.681	0.803	-0.071
BIS	0.163	45.267	0.871	0.046
BHS	-0.166	36.741	0.869	-0.047
NFC	0.984	43.273	0.330	0.285
PANAS (Past, Pos)	-1.522	47.909	0.135	-0.431
PANAS (Past, Neg)	-0.878	36.809	0.386	-0.248

Note. Welch's *t*-test. Pos = positive sub-scores, Neg = negative sub-scores.

Appendix D

Consent Form

Samtykke

Jeg erkjenner herved at jeg forstår all informasjon beskrevet ovenfor, og jeg gir mitt samtykke til å delta i studien.

Jeg forstår at det er min rett til å avbryte studien når som helst, uten å måtte oppgi en grunn for min beslutning. I dette tilfellet vil alle data som allerede har blitt samlet bli ødelagt, og ingen av dataene vil bli brukt på hvilken som helst måte.

Alle data vil bli samlet inn og holdes anonymt og vil være tilgjengelig for de ansvarlige for denne studien. Resultatene av denne studien vil kun bli presentert i vitenskapelige publikasjoner eller på et universitet avhandling på gruppenivå.

Jeg forstår at dataene som blir samlet inn i denne studien samles inn for et forskningsformål og er ikke samlet inn for å etablere noen kliniske diagnoser. Derfor vil jeg ikke be om noen diagnostisk mening.

JEG SAMTYKKER TIL Å DELTA I PROSJEKTET OG TIL AT MINE PERSONOPPLYSNINGER BRUKES SLIK DET ER BESKREVET

Sted og dato

Deltakers signatur

Deltakers navn med trykte bokstaver

Appendix E

Information Sheet Pertaining to Covid-19 Guidelines

COVID-19 Information sheet

Dette forskningsprosjektet er utført av Gabor Csifcsak og Matthias Mittner. Utførelsen av selve eksperimentet blir gjennomført av forskningsassistent Caroline Alexandra Grant Angen.

Denne forskning er en del av et forskningsprosjekt ved IPS, UiT og vil foregå på lab 5.562. Utstyret brukt i dette eksperimentet er følgende:

- Tastatur
- Pupil måler (Eyelink Portable Duo)
- Pen og papir for utfyllelse av spørreskjema

Eksperimentet vil bli utført av Caroline Alexandra Grant Angen på maks en deltaker av gangen (maks 1 forskningsassistent + 1 deltaker tilstede i labben av gangen). Deltakerne skal være mellom 18-40 år og friske.

1. Design (Avstand, kontaktområder og behandling av utstyr)
    - Under hele eksperimentet vil det være 1 meter mellom forskningsassistent og deltaker.
    - Det vil være en deltaker tilstede i labben om gangen. Deltakeren skal sitte på en stol foran en pc skjerm og tastatur mens haken lenes mot en hakestøtte for nøyaktig måling av pupill.
    - Forskningsassistenten vil desinfisere deltakerens hake støtte med desinfiseringsmiddel før eksperimentet begynner. Om bordet som alt utstyret (pc skjerm, tastatur, pupil måler og hakestøtte) må justeres på for nøyaktig høyde vil knappene brukt for dette også bli desinfisert.

Forebyggende tiltak:

- Rengjøring og desinfisering:
    - Bord, stol, dør håndtak og andre kontakt overflater I labben vil bli desinfisert med desinfiseringsmiddel før og etter hver deltaker.
    - ALT av utstyr som pc skjerm, tastatur og hake støtte vil bli desinfisert før og etter bruk.
- Beskyttende utstyr (engangshansker, maske og plastikkpose):
    - Masker og hansker vil bli brukt under rengjøring og desinfisering av utstyr før og etter hver deltaker.
    - Deltakerne vil bli tildelt hansker og maske umiddelbart etter å ha entret labben. De vil bli spurt om å ta i bruk hansker under hele eksperimentet mens masker kun under klargjøringen av den kognitive oppgaven (instruksjoner, spørreskjema, klargjøre dataoppsett med pupil måler). Selve oppgaven vil bli utført i et separat rom i labben og vil vare ca 35 minutter (5x7 minutter per blokk). Under denne oppgaven vil deltakerne være alene i rommet mens forskningsassistenten befinner seg på utsiden i rommet ved siden av. I løpet av disse øktene (5 blokker) vil masken bli tatt av for den grunn at den ikke skal være til bry og forstyrre følelser under den kognitive oppgaven. Etterfulgt av denne oppgaven vil deltakerne bli bedt om å ta I bruk en ny maske under utfylling av nye spørreskjema (vil foregå i rommet ved siden av).
    - Hvis deltakeren ikke har mulighet til å lagre personlige eiendeler utenfor labben vil en plastikkpose for oppbevaring bli tatt I bruk. Denne vil kastes

umiddelbart etter bruk. Deltakerne vil også bli bedt om å slå av mobile og plasseres med sine personlige eiendeler under hele eksperimentet.

- Øvelse av bruk og prosedyrer angående beskyttelses utstyr og vasking av overflater.
    - ❖ Forskere og forskningsassistenter vil utføre øvelser i håndtering og bruk av beskyttelses utstyr samt hvordan labben rengjøres og desinfiseres før o getter testing. Avstand blant forsker/forskningsassistent og deltaker bestående av 1 meter vil opprettholdes under hele eksperimentet
- Symptomer hos deltaker før/under/etter deltakelse av eksperiment:
    - ❖ Om deltakeren skulle oppleve noen form for symptomer før, under eller etter deltakelse av eksperimentet, eller skulle ha noen spørsmål angående tema før eller etter testing er det bare til å ta kontakt med på email: can050@uit.no
    - ❖ Det vil bli skrevet ned kontakt informasjon slik at det vil bli enklere å informere mennesker en har vært I kontakt med eller som har vært I labben de siste to ukene. Denne informasjonen vil bli oppbevart og sikret på en trygg plass. Kontakt informasjonen vil bestå av deltakerens nummer og dato for deltakelse, personlig navn vil ikke bli nedskrevet.
    - ❖ Deltakerne vil bli informert om å forlate eksperimentet om det skulle oppstå symptomer på COVID-10 under deltakelse (feber, tung pust, hoste eller andre symptomer som krever isolasjon eller karantene).

Appendix F

Information Sheet Regarding the Card-Game and its Rules

Velkommen til dette eksperimentet!

I dette eksperimentet skal du spille med en serie av kort og målet dit er å samle så mange poeng som mulig. Avhengig av den totale summen med poeng som du samler, vil du få gavekort (verdi 300 eller 400 kroner) på slutten. Hele eksperimentet består av 5 runder med de samme reglene, men med et nytt sett med kort. Det er ingen sammenheng mellom de forskjellige kortene i hver runde, så i hver runde så starter man på nytt.

I hver runde vil du se 4 forskjellige kort, men alltid bare en om gangen. Din oppgave er å bestemme om du skal «plukke» opp kortet fra «bordet» eller ikke. Du vil se kortet på skjermen i 1 sekund og etter det vil det komme et spørsmålstegn på skjermen i 1 nytt sekund. Hvis du bestemmer deg for å plukke opp kortet så må du trykke på SPACE bar mens du ser spørsmålstegnet. Vennligst ikke trykk på SPACE bar mens kortet er framme. Vent til du ser spørsmålstegnet etterpå. Hvis du ikke vil plukke det opp så trenger du ikke å trykke noe. Etter at spørsmålstegnet forsvinner så vil du få en tilbakemelding på hvor mye poeng du har fått eller tapt på den handlingen du valgte for kortet. Det er tre mulige utfall du kan få: Vinne (10 poeng), ingenting (0 poeng) og å tape (-10 poeng). Det koster derimot 1 poeng å velge å ta opp kortet fra bordet, så hvis du trykker på space for å ta opp et kort så vil de mulige poengsummene du kan få være +9 poeng (vinne), -1 poeng (ingenting) eller -11 poeng (tap).

For hver av de fire kortene så er det en «riktig» respons, som kan enten være å plukke den opp eller å la den ligge på bordet. Så i hver av de 5 seriene så er den beste strategien å finne ut (ved å teste begge responsene for alle de 4 kortene) hvilke av kortene som burde plukkes opp og hvilke som man burde la ligge på bordet. Innen hver serie så endres IKKE reglene for hva som er den «korrekt» handlingen, men når du starter en ny serie med kort så endres reglene. Derimot selv om du velger den «riktige» responsen på et kort så betyr ikke det at du er garantert å få det beste utfallet, om du velger «riktig» eller «feil» respons bestemmer kun hvor stor sannsynlighet du har for å motta det beste eller verste utfallet. Så selv om du har valgt «riktig» respons så kan det være en liten sannsynlighet for at du taper poeng, men det kan også være at du får poeng når du velger «feil» respons, selv om sannsynligheten for det er relativt lav. På flertallet av kort så vil du vinne om du velger den «riktige» responsen og tape hvis du velger «feil» respons.

Av de 4 kortene, så vil det alltid være 2 kort hvor du kan enten vinne (10 eller 9 poeng) eller få ingenting (0 eller -1 poeng). Disse 2 kortene kalles «vinnende kort» siden du aldri taper på de.
De to andre kortene kalles «tapende» kort fordi du kan enten få ingenting (0 eller -1 poeng) eller tape poeng (-10 eller -11). Dette betyr at på de 2 «tapende» kortene så blir det beste utfallet om du får «ingenting» (0 eller -1 poeng, avhengig av om du har trykt på space eller ikke).
For å oppsummere så er din oppgave å lære deg hvilke kort som burde plukkes opp for å vinne og for å unngå å miste poeng, og finne ut hvilke kort som du burde la bli liggende på bordet for å vinne og for å unngå å miste poeng på flest mulig av kortene.

Oppgaven er vanskelig, men du må aldri gi opp. Prøv å finne best mulig strategi for å samle så mange poeng som mulig. Ikke glem at etter hver serie vil det være en liten pause og neste serie vil inneholde 4 nye kort som da betyr at du må begynne å bygge opp en ny strategi på hver serie.

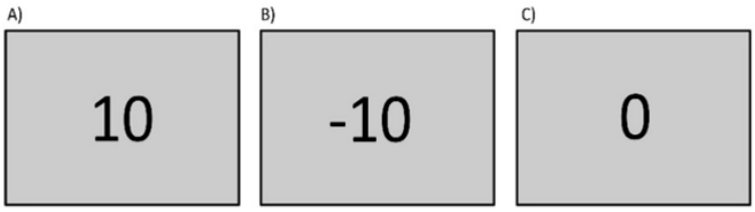
Hvis du har noen spørsmål så er det bare å spørre.

Appendix G

Quiz

QUIZ **CODE**: _____

1. **Sett en ring rundt bokstaven under hvert utsagn som korresponderer med den korrekte tallboksen**



- «Ikke vinne» eller «ikke tape»

  A B C

- Å tape

  A B C

- Å vinne

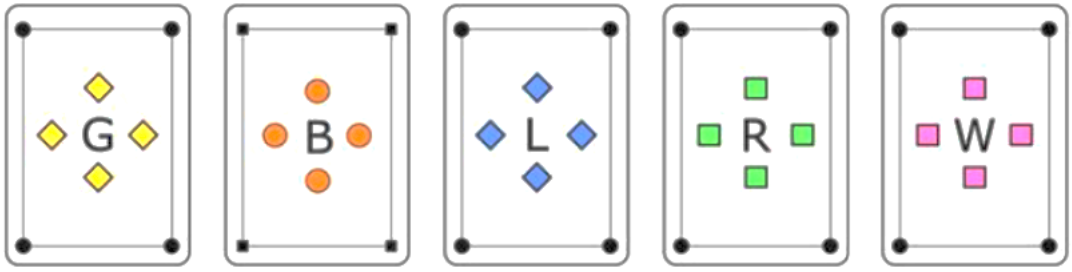
  A B C

2. **Bestem om utsagnet er riktig eller feil**

Hvis jeg svarer riktig vil jeg alltid vinne	☐RIKTIG	☐FEIL
For et «vinn-kort», er et utfall på «0» et dårlig utfall	☐RIKTIG	☐FEIL
Det er alltid verdt å plukke opp et kort	☐RIKTIG	☐FEIL
For et «tap-kort», er et utfall på «0» et dårlig utfall	☐RIKTIG	☐FEIL
Hvis jeg svarer feil vil jeg alltid tape	☐RIKTIG	☐FEIL
Noen ganger kan jeg få «-10» etter et «vinn-kort»	☐RIKTIG	☐FEIL
Hvis jeg svarer feil, har jeg gode sjanser for å oppnå best mulig utfall	☐RIKTIG	☐FEIL
Noen ganger kan jeg få «0» etter et «tap-kort»	☐RIKTIG	☐FEIL
Noen ganger kan jeg få «10» etter et «tap-kort»	☐RIKTIG	☐FEIL
Hvis jeg svarer riktig, har jeg gode sjanser for å oppnå best mulig utfall	☐RIKTIG	☐FEIL
Noen ganger kan jeg få «0» etter et «vinn-kort»	☐RIKTIG	☐FEIL
Det er aldri verdt å plukke opp et kort	☐RIKTIG	☐FEIL

Appendix H

Examples of the Card Stimuli



Appendix I

PANAS (Pre and Post)

PANAS-Nå

Her kommer et spørreskjema med noen ord som beskriver ulike følelser og stemninger. Les hvert ord og skriv det tallet som best viser hvor mye du føler på denne måten *akkurat nå*.

1 = Veldig lite eller ikke i det hele tatt
2 = Litt
3 = Moderat
4 = En god del
5 = Ekstremt

	Følelse/stemning	Svar
1	Interessert/nysgjerrig	
2	I nød	
3	Opprømt	
4	Opprørt	
5	Sterk	
6	Skyldig	
7	Skremt	
8	Fiendtlig	
9	Entusiastisk	
10	Stolt	
11	Irritabel	
12	Våken/energisk	
13	Skamfull	
14	Inspirert	
15	Nervøs	
16	Besluttsom	
17	Oppmerksom	
18	"Skvetten"	
19	Aktiv	
20	Redd	

Appendix J

Post Hoc Comparison Table of Interaction Term Valence * Congruence

Post Hoc Comparisons - Valence ✻ Congruence

		Mean Difference	SE	t	p_{holm}
Win, Incongruent	Avoid, Incongruent	-0.148	0.031	-4.816	< .001
	Win, Congruent	-0.549	0.056	-9.794	< .001
	Avoid, Congruent	-0.459	0.049	-9.389	< .001
Avoid, Incongruent	Win, Congruent	-0.401	0.049	-8.197	< .001
	Avoid, Congruent	-0.311	0.056	-5.550	< .001
Win, Congruent	Avoid, Congruent	0.090	0.031	2.920	0.005

Note. P-value adjusted for comparing a family of 6 (Holm-Bonferroni method). Results are averaged over the levels of Group and Block.

Appendix K

Table From Repeated-Measures ANOVA for Performance Accuracy Using Mean Pain Ratings as Covariates (Within-subjects effects)

Cases	Sphericity correction	Sum of Squares	df	Mean Square	F	p	η_p^2
Valence	None	.003	1, 48	.003	0.13	.722	.003
Valence*MeanPain	None	.047	1, 48	.047	1.94	.17	.039
Congruence	None	14.38	1, 48	14.39	24.57	<.001	.339
Congruence*MeanPain	None	.08	1, 48	.08	0.14	.713	.003
Block	G-G	.052	3.53, 169.4	.015	0.52	.7	.011
Block*MeanPain	G-G	.05	3.53, 169.4	.014	0.5	.713	.01
Valence*Congruence	None	1.47	1, 48	1.47	6.88	.012	.125
Valence*Congruence*MeanPain	None	.072	1, 48	.072	0.34	.563	.007
Valence*Block	G-G	.197	3.11, 149.2	.064	2.01	.101	.042
Valence*Block*MeanPain	G-G	.102	3.11, 149.2	.033	1.08	.359	.022
Congruence*Block	G-G	.076	3.32, 159.4	.023	0.5	.698	.01
Congruence*Block*MeanPain	G-G	.058	3.32, 159.4	.009	0.38	.787	.008
Valence*Congruence*Block	G-G	.029	3.2, 149.1	.009	0.36	.792	.007
Valence*Congruence*Block*MeanPain	G-G	.029	3.2, 149.1	.026	0.36	.791	.007

Note. Sphericity correction Greenhouse-Geisser is denoted by "G-G". Type III Sum of Squares.

Appendix L

Table From Repeated-Measures ANOVA for Pavlovian Performance Bias Using Mean Pain Ratings as Covariates (Within-subjects effects)

Cases	Sphericity correction	Sum of Squares	df	Mean of Squares	F	p	η_p^2
Index	None	.108	1, 48	.108	4.2	.046	.081
Index*MeanPain	None	.002	1, 48	.002	0.07	.79	.002
Block	G-G	.047	3.34, 162.7	.014	0.56	.664	.012
Block*MeanPain	G-G	.037	3.34, 162.7	.011	0.45	.743	.009
Index*Block	G-G	.01	3.24, 155.4	.003	0.9	.447	.018
Index*Block*MeanPain	G-G	.008	3.24, 155.4	.002	0.71	.556	.015

Note. Sphericity correction Greenhouse-Geisser is denoted by "G-G. Type III Sum of Squares.

Appendix M

Post Hoc Comparison Table of Interaction Term IndexRel*Group

Post Hoc Comparisons - Group ✻ IndexRel

		Mean Difference	SE	t	p_{holm}
FALSE, RBI	TRUE, RBI	0.027	0.037	0.737	1.000
	FALSE, PBS	0.040	0.017	2.363	0.133
	TRUE, PBS	0.006	0.037	0.156	1.000
TRUE, RBI	FALSE, PBS	0.013	0.037	0.342	1.000
	TRUE, PBS	-0.021	0.017	-1.272	1.000
FALSE, PBS	TRUE, PBS	-0.034	0.037	-0.923	1.000

Note. P-value adjusted for comparing a family of 6 (Holm-Bonferroni method). Results are averaged over the levels of Block.