COMPETING GOALS ATTENUATE AVOIDANCE BEHAVIOR IN THE CONTEXT OF PAIN

Nathalie Claes[1,2], Kai Karos[1], Ann Meulders[1,3], Geert Crombez[2], Johan W.S. Vlaeyen[1,3,4]

[1]Research Group Health Psychology, University of Leuven, Belgium

[2]Department of Experimental-Clinical and Health Psychology, Ghent University, Belgium

[3]Center for Excellence on Generalization Research in Health and Psychopathology, University of Leuven, Belgium

[4]Department of Clinical Psychological Science, Maastricht University, The Netherlands

The work was conducted at the University of Leuven, Belgium

Key words: Goals, Avoidance, pain-related fear, reward, motivation

Correspondence concerning this article should be addressed to Nathalie Claes, Department of Psychology, University of Leuven, Tiensestraat 102, box 3726, 3000 Leuven, Belgium. E-mail: Nathalie.claes@ppw.kuleuven.be, T: +32 (0)16 32 58 85, F: +32 (0)16 32 61 44.

Abstract

Current fear-avoidance models consider pain-related fear as a crucial factor in the development of chronic pain. Yet, pain-related fear often occurs in a context of multiple, competing goals. This study investigated whether pain-related fear and avoidance behavior are attenuated when individuals are faced with a pain avoidance goal and another valued but competing goal, operationalized as obtaining a monetary reward. Fifty-five healthy participants moved a joystick towards different targets. In the experimental condition, a movement to one target (Conditioned Stimulus; CS+) was followed by a painful unconditioned stimulus (pain-US) and a rewarding unconditioned stimulus on 50% (reward-US) of the trials, whereas the CS- movement was not. In the control condition, the CS+ movement was followed by the pain-US only. Results showed that pain-related fear was elevated in response to the CS+ compared to the CS- movement, but that it was not influenced by the reward-US. Interestingly, participants initiated a CS+ movement slower than a CS- movement in the control condition, but not in the experimental condition. Also, in choice trials, participants performed the CS+ movement more frequently in the experimental than in the control condition. These results suggest that the presence of a valued competing goal can attenuate avoidance behavior.

Perspective: The current study provides experimental evidence that both pain and competing goals impact on behavioral decision making and avoidance behavior. These results provide experimental support for treatments of chronic pain that include valuable daily life goals pursued by an individual, rather than limiting focus to pain reduction only.

Key words: Goals; avoidance; pain-related fear; reward; motivation

1. Introduction

A wealth of evidence endorses the role of pain-related fear in the development and maintenance of (chronic) pain problems.[17,20,29,45,49,53,57] Recently, it has been suggested that pain-related fear should be considered within a motivational context. More specifically, the experience of pain might not only lead to the development of pain-related fear, but may also activate the goal to control or avoid (further) harm. [9,29,47,48] However, the goal to avoid pain does not occur in a motivational vacuum.[9,29,47,48] Indeed, to avoid bodily harm or pain is often only one goal in a context of other, often competing goals.[6,9,23,25,42,47,51,53,58] In a context of multiple goals, the pursuit of one goal may possibly interfere with the pursuit of other goals. This may give rise to goal conflicts during which the same response elicits opposing outcomes.[3] Previous research has shown that individuals with chronic pain often have to weigh the value of pain avoidance against the costs of withdrawal from previously valued activities[16,40,44,49], and experience difficulties selecting which goal to pursue.[11,19,40] Studies investigating the influence of competing goals on pain-related fear, avoidance behavior, and associated decision making behavior are scarce. Most experimental pain research on goals has focused on goal pursuit and attentional processes, indicating that pursuing non-pain goals can inhibit the attentional bias to pain.[24,49,51]

While fear conditioning models are widely accepted as an experimental approach to investigate how fear is acquired, motivational factors have not yet been incorporated into these models. [8] A well-established paradigm to study the acquisition of movement-related fear of pain, is the Voluntary Joystick Movement (VJM) Paradigm [32,34,35], which exemplifies a typical human fear conditioning experiment: a conditioned stimulus (CS+), i.e. arm movements performed with a joystick, is followed by an aversive electrocutaneous stimulus (unconditioned stimulus; pain-US). After repeated pairings with the US, the CS+ becomes a threat signal, and thus starts to elicit fear responses (conditioned response, CR). In a differential fear conditioning paradigm, a control stimulus (CS-) is included, that is never followed by the US, and thus becomes a safety-signal.[10]

In the present study, we adapted the VJM paradigm to experimentally create goal competition by introducing lottery tickets representing a monetary reward as a reinforcing US, to investigate whether pain-related fear and avoidance behavior are attenuated when individuals are confronted with a pain avoidance goal and a competing goal, i.e. obtaining the reward. In the control condition, a movement towards one target (CS+) was followed by a painful stimulus (US), whereas another movement (CS-) was not. In the experimental condition a rewarding conditioned stimulus (reward-US) accompanied the pain-US, thus installing competition between an inclination to avoid pain and an inclination to obtain a reward. We hypothesized that a concurrent reward-US would lead to 1) reduced fear responses, i.e. less self-reported pain-related fear for a painful (CS+) movement, 2) less avoidance tendencies, i.e. lower response latencies for CS+ movements in the experimental condition, and 3) less avoidant decision making behavior, i.e. choosing to perform the painful movement instead of the safe movement. Additionally, we explored whether the importance of both the pain-avoidance and the approach-reward goal was associated with participants' decision making behavior.

2. Methods

2.1 Participants

Fifty-five healthy individuals (28 men, $M_{age} = 21.62$, $SD_{age} = 3.45$) volunteered. Ten participants (18%) were left-handed. Participants were recruited by means of flyers distributed at the University of Leuven, advertisements (both online and on paper), and via the Experiment Management System (EMS) of the Faculty of Psychology and Educational Sciences of the

University of Leuven (Belgium). Participants either received course credits or €10 for their participation. Exclusion criteria were insufficient knowledge of the Dutch language, dyslexia, cardiovascular diseases, lung diseases, neurological diseases (e.g. epilepsy), other serious medical conditions, current diagnosis of psychiatric disorders, chronic or acute pain, being asked to avoid stressful situations by a general practitioner, presence of electronic medical devices (e.g. pace-maker), anxiolytics or antidepressants, pregnancy, and deteriorated vision that is not corrected.

Participants received information, both orally and in writing, that painful electrocutaneous stimuli would be administered, but that the intensity of the stimulus would be individually selected. Participants were given the opportunity to ask for additional information. All participants provided a written informed consent. Ethical approval was obtained through the Ethics Committee of the Faculty of Psychology and Educational Sciences of the University of Leuven (Belgium), registered nr S55216. Because of a technical failure, three participants did not receive any electrocutaneous stimulus during the experiment. Two other participants did not adhere the experimental instructions, and thus their responses were unreliable. These 5 participants were excluded from the statistical analyses. Statistical analyses were conducted on a sample of 50 participants (26 male; M_{age} = 21.36 years, SD_{age} = 3.28; 20% left-handed).

2.2 Apparatus and stimuli

The experiment was run on a Windows XP computer (Dell OptiPlex 755) with 2 GB RAM and an Intel Core2 Duo processor at 2.33 GHz and an ATI Radeon 2400 graphics card with 256 MB of video RAM. The experiment was programmed in Affect, version 4.0.[43] An electrocutaneous stimulus of 20 ms duration served as the pain-US. The pain-US was delivered by an Isolated Bipolar Current Stimulator (DS5; Digitimer ltd, Welwyn Garden City, England) through surface SensorMedics electrodes (1 cm diameter) filled with K-Y gel that were attached to the wrist of the dominant hand. The stimulus intensity was individually determined during a pre-experimental calibration procedure, selecting a stimulus at tolerance level. A monetary reward in the form of lottery tickets (reward-US), was introduced in the experimental condition. A single reward-US always represented two lottery tickets. These lottery tickets represented a chance to win an extra 50€ reimbursement. Movements performed using a Paccus Hawk Joystick (Paccus Interfaces BV, Almere, The Netherlands) in four different directions served as CSs (i.e. towards the left, right, upward or downward). Participants carried out the movements with their dominant hand. Direction of movement was either indicated by a signal (by a purple coloring of a target) or chosen, i.e. the movement to be performed was selected by the participant. The pain-US with or without the reward-US is delivered after completion of a movement in one direction (CS+), but not in another direction (CS-).

2.3 Self-report measures.

2.3.1 Manipulation check. To check whether participants successfully learned the contingencies, participants reported online, prior to the movements to what extent they expected the pain-US to occur ("pain expectancy"). Therefore, a scale ranging from 0 (not at all) to 10 (very much) was used.

2.3.2 Outcome measures. The primary goal of this experiment was to investigate whether a concurrent reward was capable of attenuating pain-related fear. Therefore, we asked participants to indicate to what extent they were afraid that the movement would be painful ("pain-related fear") before performing that movement.

Secondly, the current experiment aimed to explore whether there are any changes in pain intensity, pain unpleasantness, or pain tolerance when adding a concurrent reward to a painful movement. Therefore, participants reported retrospectively to what extent the electrocutaneous stimulus was painful ("pain intensity"), unpleasant ("pain unpleasantness"), and tolerable ("pain tolerance"). Participants answered all these questions using a 11-point Likert-scale, ranging from 0 (not at all) to 10 (very much).

2.3.3 Additional measures. Additional items were included to explore the role of goal importance on avoidance behavior. Participants indicated how important they found the two goals during the experiment using a Likert scale ranging from 0 (not at all important) to 10 (very important). The questions were *"How important was it to avoid the electrocutaneous stimulus?" ("pain-avoidance") and "How important was it to earn tickets?"("approach-reward"), respectively.*

2.3.4 Questionnaires. For descriptive purposes, participants completed several questionnaires: the Dutch version of the Pain Catastrophizing Scale (PCS) [46], which consists of 13 items and measures the frequency of catastrophizing thoughts and feelings generally experienced during painful situations, the Fear of Pain Questionnaire (FPQ-III NL)[50], which measures fear associated with pain in general and consists of 31 items and the trait version of the Positive Affectivity and Negative Affectivity Scale (PANAS), asking participants to indicate how frequently they experience each of 20 adjectives describing both positive and negative emotions[13].

2.4 Behavioural measures

2.4.1 Response latency. For every movement, the response latency was recorded. As in previous studies[32,33,55], response latency is the time before onset/initiation of the joystick movement. More specifically, it was defined as the time from the disappearance of the fixation cross ('+') until participants left the start region, which is a relatively small, invisible circle around the fixation cross in the middle of the computer screen. Response latency is considered a proxy of avoidance tendencies.[5,36]

2.5 Decision making behavior

Participants completed four choice test trials per condition, in which they chose between the CS+ movement and the CS- movement. This measure is taken as an index of approach/avoidance decision making behavior.

2.6 Procedure

The whole experimental session consisted of a calibration, a practice, an experimental and a debriefing phase, and lasted about 75 minutes. A graphical overview of the experiment is presented in Figure 1.

– INSERT FIGURE 1 ABOUT HERE –

2.6.1 Calibration phase. Upon arrival, participants were seated in an armchair (0.6 m screen distance) in a sound-attenuated experimental room, adjacent to the experimenter's room. First, the electrodes for electrocutaneous stimulation were attached. Subsequently, the intensity level of stimulation was determined using a calibration procedure. Participants were informed that they would be repeatedly exposed to electrocutaneous stimuli of increasing intensity and that the aim was to select a painful stimulus that requires some effort to tolerate. At each trial, participants indicated (a) whether the stimulus was painful and required some effort to tolerate, and (b) whether they agreed to receive a stimulus of increased intensity. Participants were also instructed to inform the experimenter when they no longer wished to increase the intensity or that the intensity had to be set back at a lower intensity. When no further increase of stimulus intensity was accepted, the experimenter asked the participant whether s/he agreed upon repeatedly receiving stimuli of maximally the selected intensity during the remainder of the experiment. However, participants always received the same stimulus intensity, that is, at tolerance level. Participants rated the pain intensity of the selected electrocutaneous stimulus right before the start of the experimental phase (*M* = 6.36, *SD* = 1.12).

2.6.2 Practice Phase. In the practice phase, participants learned how to operate the joystick correctly and familiarized themselves with the experimental task. Participants were instructed to move the joystick as fast and accurately as possible towards the signaled target as soon as the fixation cross (start signal, '+') disappeared. The to-be-performed movement was signaled by changing the color of the corresponding target from white to purple. A successful movement resulted in changing the color of the target to yellow. During the practice phase, no pain- and reward-USs were presented. Participants were informed they would receive feedback, both visually on screen and verbally from the experimenter. First, participants were able to monitor their own joystick movements via a cursor shown on the screen. Second, when participants performed a movement in the wrong direction, or left the starting region before the fixation cross disappeared, an error message was displayed (e.g., '*too early, please wait until the fixation cross disappears*'). The experimenter was present in the experimental room and provided tailored feedback if needed. Two blocks of 5 trials were run: the first block consisted of 2 signaled movements in both directions of the horizontal movement plane (left/right), followed by one choice trial in which participants had to choose and perform one of both movements. The second block was identical to the first block, the only difference being that the movements were performed in the vertical movement plane (upward/downward). Each trial started with a 1.5 s-presentation of the fixation cross, and ended when the participant reached the target with his/her movement. A next trial started 10 seconds later (Inter-Trial Interval (ITI) = 10s). For an overview of the trial timing, see Figure 2.

– INSERT FIGURE 2 ABOUT HERE –

2.6.3 Experimental phase. Before the start of the experimental phase, the pain-US was administered once more, and participants rated the pain intensity. We employed a cross-over within-subjects design with all participants completing both the control and the experimental condition. The order in which the conditions were completed was counterbalanced. Participants manipulated a joystick to the left and to the right (horizontal movement plane) in the experimental condition, and upward and downward (vertical movement plane) in the control condition, or vice versa. At the start of each condition, participants were informed that they would have to perform the signaled movements as quickly and accurately as possible as soon as the fixation cross disappeared, and were requested to pay close attention to the fixation cross.

In the Experimental condition participants were informed that a movement in one direction (CS+) would be followed by an electrocutaneous stimulus (pain-US) and lottery tickets (reward-US), whereas a movement (CS-) in another direction would not. The reward-US always represented 2 lottery tickets. The experimenter explicitly stated that on some trials, participants were requested to perform the signaled movement, whereas on other trials, they could choose which of the two movements they performed. Participants were informed that the more tickets they earned during the task, the higher the probability that they would win the extra reimbursement of 50€. The participants first completed 4 acquisition blocks each consisting of 8 trials (4 CS+, 4 CS-). The last acquisition block served as the test phase. Each acquisition block was followed by one choice trial, in which they chose to perform either the CS+ or the CS- movement. Which particular movement served as a CS+ was counterbalanced across participants. There were no breaks between blocks. CS+ movements were immediately followed by the pain-US and the reward-US in half of the trials (50% reinforcement rate), whereas the CS- movement was never reinforced. That is, all participants received a total of eight reward-USs (representing 16 lottery tickets) and eight electrocutaneous stimuli in this phase. In the four choice trials, CS+ movements were always followed by both USs (100% reinforcement rate), whereas the CS- was never followed by either of the USs. Consequently, all participants could earn up to an additional eight lottery tickets in this phase. Trial timing was similar to the practice phase. At the end of each block participants rated pain intensity, pain unpleasantness and pain tolerance. Pain expectancy and pain-related fear were assessed once per block before the start of one CS+ movement and one CS- movement.

The **control condition** was identical to the experimental condition, with the only exception that the CS+ movement was only followed by the pain-US. Participants were informed that in this phase, one movement would be followed by an electrocutaneous stimulus (pain-US), whereas another movement would not.

2.6.4 Debriefing. All participants were informed about the number of tickets that they had won, and were requested to leave their email address to be contacted in case they won the 50€. Second, participants were invited for a debriefing where they were informed about the objectives of the experiment. At the end of the experiment, a winner was randomly selected out of all participants and informed about his prize.

3. Results

3.1 Data preparation

For each condition, we calculated the total number of times the CS+ was chosen, as an index of decision making behavior (range: 0-4). When ratings from multiple time points for self-reported measures were available, mean scores were calculated. For response latency, outlier trials were excluded within each subject from further statistical analysis (<1%). Thus, response latencies < 250 and > 3000 ms were eliminated, as well as trials with response latencies deviating more than 3 SDs from the within-subject-mean calculated for the corresponding movement (CS+/CS-) and condition (control/experimental).[32] Subsequently, mean response latencies for each CS movement per block, per condition were calculated for each participant by averaging the 4 movements of that block.

3.2 Data-analysis

All statistical analyses were run with SPSS 20.0. Repeated measures ANOVAs were run to test for the effects of the reward-US (competing goal; experimental condition) on decision making behavior, as well as on pain-related fear, pain intensity and response latencies during test trials. Greenhouse Geisser corrections are reported where necessary. Effect sizes were calculated using the dependent Cohen's *d*.[7] Power analyses using G* Power 3.1.7[14] indicated that a total of 50 participants would provide 93% statistical power for a medium effect size for repeated measures analysis.

3.3 Descriptive statistics

The average intensity of the painful stimulus was 9.46 mA (*SD* = 4.82). Participants earned on average 20.68 lottery tickets (*SD* = 3.28). The mean score for PCS was 19.16 (*SD* = 8.75), and for FPQ-III-NL 73.9 (*SD* = 14.12). Mean score was 35.69 (*SD* = 4.73) on the positive affectivity scale and 15.94 (*SD* = 5.26) on the negative affectivity scale of PANAS. There were no significant gender differences on either of these independent variables, nor did the current sample differ from other (student) samples of comparable age.[32]

3.4 Self-report measures

A series of 2 [Condition (Control/Experimental)] × 2 [CS type (CS+/CS-)] Repeated Measures (RM) ANOVAs were conducted with self-reported measures (pain-expectancy, pain-related fear, pain-US intensity, unpleasantness and tolerance) as dependent variables (see Table 1). For the pain expectancy measure, there was a significant main effect of CS type, $F(1,49) = 79.02$, $p < .001$, $d = 1.25$ [95% CI: 0.88, 1.62], indicating that participants learned that the CS+ movement was associated with the pain-US, whereas the CS- movement was not. There was no effect of Condition, $F(1,49) = 1.14$, $p = .291$, $d = -0.15$ [95% CI: -0.43, 0.013], nor a CS type × Condition interaction, $F < 1$. For the pain-related fear measure, there was a significant main effect of CS type, $F(1,49) = 51.93$, $p < .001$, $d = 1.02$ [95% CI: 0.68, 1.36], no significant main effect of Condition, $F(1,49) < 1$, p = .360, $d = 0.13$ [95% CI: -0.15, 0.41], nor a significant Condition × CS type interaction, $F(1,49) = 1.126$, $p = .294$, $d = 0.15$ [95% CI: 0.13, 0.43]. This indicates that participants had elevated levels of pain-related fear in response to the CS+ compared to the CS-. For the pain intensity measures statistical analysis revealed that there was no difference between conditions, $F(1,49) < 1$, p = .523, d = -0.09 [95% CI: -0.37, 0.19]. Finally, participants did not experience the pain as significantly less unpleasant when a reward-US was presented concurrently, compared to when only a pain-US was administered, $F(1,49) < 1$, $p = .330$, $d = -0.14$ [95% CI: -0.42, 0.14], nor did they rate the pain-US as less tolerable in the experimental condition compared to the control condition, $F(1,49) = 1.05$, $p = .310$, $d = 0.14$ [95% CI: -0.13, 0.42].

– INSERT TABLE 1 ABOUT HERE –

3.5 Behavioral measures

3.5.1 Response latency. The mean response latencies for CS+ and CS- movements for both the experimental and the control conditions during the test phase are displayed in Figure 3. A 2 [CS type (CS+/CS-)] × 2 [Condition (Experimental/Control)] RM ANOVA showed a marginally significant effect of CS type, $F(1,49) = 3.987$, $p = .05$, $d = 0.28$ [95% CI: -0.09, 0.56], as well as a significant effect of Condition, $F(1,49) = 5.009$, $p = .03$, $d = -0.31$ [95% CI: -0.6, -0.03]. Furthermore, the interaction CS type × Condition was significant, $F(1,49) = 4.60$, $p = .037$, $d = -0.30$ [95% CI: -0.59, -0.02]. Follow-up comparisons revealed that participants are slower initiating a CS+ movement than CS- movements in the control condition, $t(1,49) = -2.878$, $p = .006$, $d = 0.41$ [95% CI: 0.12, 0.70]. In the experimental condition however, no differences in response latencies for both CS movements were found, $t(1,49) = -.038$, $p = .970$ $d = 0.01$ [95% CI: -0.27, 0.28], suggesting that participants were less hesitant to perform the painful movement when a concurrent reward is presented together with it. In other words, these results suggest that a concurrent reward diminished the effects of pain on response latencies, which is considered a proxy for avoidance tendency.

– INSERT FIGURE 3 ABOUT HERE –

3.5.2. Decision making behavior. A one-way ANOVA analysis with Condition (Control/Experimental) as within-subjects factor was run on the number of painful (CS+) movements participants performed in both conditions, yielding a significant main effect of

Condition (Control/Experimental): $F(1,49) = 30.183$, $p < .001$, d = -0.78 [95% CI: -1.09, .-0.46], indicating that participants overall chose to perform the painful movement more often when a concurrent reward was presented (experimental condition), compared to the absence of the reward (control condition). More specifically, 56 % of participants chose to avoid the painful movement completely in the control condition, whereas in the experimental condition only 20% of the participants always chose the safe movement. Only 4% of the participants performed all four painful movements in the control condition, whereas in the experimental condition 28% of the participants perform all painful movements. Figure 4 displays the number of participants choosing to perform the 'painful' CS+ movement, either 0, 1, 2, 3 or 4 times in each condition.

– INSERT FIGURE 4 ABOUT HERE –

3.6.1 Additional Analyses. The correlations between the dependent variable (number of times performing the painful yet rewarding movement) and the predictors (importance of pain avoidance, importance of approach-reward, pain-related fear), as well as the intercorrelations between the predictors are presented in Table 2. The pain-related fear score was the averaged pain-related fear score of the CS+ movements during the test phase in the experimental condition. Both the variables assessing the importance of the pain-avoidance goal as well as the approach-reward goal correlated significantly with the number of times participants performed the painful, yet rewarding movement ($r = -.506$; $r = .549$ respectively), whereas pain-related fear did not (r = -.058).

Backward regression analyses were conducted on the number of times participants chose to perform the painful movement when a concurrent reward was presented (see Table 3). Pain-related fear, the importance of the goal to avoid pain, and the importance of the goal to win as much tickets as possible were introduced into the initial model (see 2.3 Self-report measures). The regression model with all three factors accounted for half of the variance, *adj.* R^2 = .513, *F* (2,46) = 18.17, $p < .001$. After removal of pain-related fear from the equation, the model still significantly explained half of the variance, *adj.* R^2 = *.501, F* (1,47) =25.65, $p < .001$. Both the pain-avoidance goal, β= -.260, t (47) = -4.65, $p < .001$, and the reward goal, β= .238, t (47) = 5.11, $p < .001$, significantly predicted participants' choice behavior.

– INSERT TABLE 2 ABOUT HERE –

– INSERT TABLE 3 ABOUT HERE –

4. Discussion

The present study investigated whether introducing a concurrent reward along with a painful stimulus, would result in a reduction of pain-related fear and less tendencies to avoid using an adapted VJM paradigm. In the experimental condition a reward-US accompanied the pain-US, thus installing competing approach and avoidance tendencies, i.e. avoiding the pain-US and approaching the reward-US. In the control condition, participants were informed that only one CS movement would be followed by a pain-US. On some trials during both conditions, participants were also instructed to choose and perform either the painful or the safe movement.

The results can be readily summarized. *First*, pain-expectancy was higher for painful movements than for safe movements in both conditions, indicating successful differential contingency learning. *Second*, participants were less hesitant to perform the painful movement when a concurrent reward was presented, compared to performing a painful movement alone. *Third*, and most importantly, during the choice trials, participants showed less frequent avoidant decision making behavior when pain was accompanied by a reward than when pain was presented alone. Moreover, the regression analyses revealed that both pain-avoidance and approach-reward goals were significantly associated with avoidance behavior, whereas pain-related fear was not. More specifically, the more important it was for a participant to avoid pain, the less painful movements they performed, even though performing that movement also resulted in a reward. Similarly, the more important it was to earn tickets, the more participants performed the 'rewarding' movement, despite the presence of pain. Indeed, these results suggest that a concurrent reward may attenuate avoidance behavior. *Fourth*, there is no change in pain-related fear when performing a painful movement when a reward was presented compared to performing the painful movement without such reward. This finding is however in line with other studies showing that introducing a monetary incentive does not necessarily result in a decrease in pain-related fear.[29,49]

The current study extends available evidence for the inclusion of a motivational perspective on avoidance tendencies and behavior, wherein the dynamics of several−possibly conflicting−goals should be considered. Avoidance behavior is considered a relatively stable response driven by a fear-based motivation to prevent further injury.[9,18,29,54] However, the results of the current study show that avoidance can be influenced by the presence of concomitant~~,~~ competing goals, such as the goal to retrieve a reward, even without changing pain-related fear itself.[23,40,44,47,49] Thus, avoidance behavior may vary from situation-to-situation, also ~~even~~ within individuals.

Not only did this study investigate avoidance behavior directly by means of choice trials, employing the Voluntary Joystick Movement paradigm enabled us to also examine response latency as an index of avoidance tendencies. As found by Meulders et al.[32], participants were slower initiating the CS+ movement than the CS- movement in the control condition. When adding a monetary reward, this difference disappeared, suggesting that approaching a reward counteracted the avoidance tendency.[37] Previous research has shown that using valuable incentives are capable of increasing pain tolerance[4], and that pain is able to increase motivation to work for a reward, if that reward is valuable enough.[16] Current findings further demonstrate that a valuable incentive is capable of diminishing avoidance tendencies.

Interestingly, not all participants avoided the painful movement in the control condition. When looking at the choices more closely, participants often performed the painful movement just once. This might be due to the partial reinforcement rate of 50% for CS+ movements, which possibly induced exploratory behavior.[2]

These results may have clinical implications, and suggest that both pain-related and competing goals play a role in behavioral decision making and avoidance behavior. As such, this study provides experimental support for interventions that not focus solely on pain reduction goals, but also encourage daily life goals such as returning to work, engaging in sports or family activities. [6,9,42,47,54] Examples of such interventions are cognitive-behavioral treatments (CBT) that incorporate both pain and normal life goals, often explore both advantages and disadvantages of goals, and strive for flexibility in the pursuit to be active despite pain (e.g., Motivational Interviewing[1,21,22], Contextual CBT[31,41,56]), or treatments aimed at enhancing general functioning despite the experience of pain, while simultaneously helping patients to achieve valuable life goals (e.g. graded activity, exposure in vivo).[28,30,41] However, it remains unclear for whom the incorporation of daily life goals results in the reduction of avoidance behavior, and which conditions contribute to recovered activity despite pain. Therefore these questions merit further scientific scrutiny.

There are some limitations that need further consideration. First, the sample size was relatively small ($N = 55$), resulting in relatively broad confidence intervals and the risk of type II errors, although power analyses indicated that the sample size was sufficient to obtain 93% power. Second, we tested our hypotheses in healthy, mostly undergraduate students. That is, the present results are preliminary and we do not claim that they pertain to a clinical population. In this experiment, participants had the choice between pain plus a reward versus neither of the two. For chronic pain patients however, the choice is not so clear-cut. Often they can only choose between 'the lesser of two evils': their usual level of pain or increased pain combined with a valued life goal (e.g. going out with friends). Thus, pain-related goals often compete with other daily life goals[12,48,58] and are likely more salient in a clinical population. Therefore, future research would benefit from testing similar hypotheses in a clinical population, using an adapted experimental design with higher ecological validity. Third, although previous research has shown that a financial reward is effective in increasing motivation, the ecological validity of a monetary incentive as a valued goal may be limited, but is both easy and valuable for students in an experimental sample.[37,44,47,52] Fourth, the use of some self-reported measures may have led to a confound among the measures[38], for example between the measures of pain-related fear and pain expectancy. We asked to indicate to what extent participants were afraid to receive a painful stimulus, which necessarily implies a measurement of pain expectancy. Given the difficulties disentangling pain-related fear and pain expectancy, this confound may explain the absence of a decrease in pain-related fear when presented with a concurrent reward. Furthermore, the self-report measure was only administered once, and did not take perceived harmfulness into account.

Moreover, since fear is usually conceptualized as comprising of three relatively independent response systems, namely verbal responses (e.g., self-reports), behavioral responses (e.g., avoidance), and physiological responses [27], future research would benefit from including psychophysiological markers of pain-related fear (e.g., eye blink startle[26]) and pain (e.g. RIII reflex[39]). Fifth, the importance of both the pain-avoidance goal and the approach-reward goal was assessed post-hoc. Future research should assess this prior to the experiment to avoid participants simply reporting according what they did during the experiment.

In sum, this study provides experimental evidence that inclusion of a valuable competing goal such as obtaining a monetary reward, attenuates avoidance behavior. Therefore, there is some truth in Fordyce's law "*people don't hurt as much if they have something better to do*".[15] At the least, we were able to demonstrate that it has an effect upon avoidance tendencies and behavioral decision making; its putative effect upon the experience of pain awaits further scientific corroboration.

Acknowledgements

The authors thank Liet De Wachter for her help in data acquisition and Jeroen Clarysse for his technical support.

Disclosures

This study was supported by the FWO-grant "Pain-related fear in context: The effects of concomitant non-pain goals and goal conflicts on fear responding in the context of pain" funded by the Research Foundation – Flanders, Belgium (FWO Vlaanderen) granted to GC and JWSV(grant ID: G091812N). The contribution of AM is supported by an EFIC-Grünenthal Research Grant ~~is~~ and a postdoctoral research fellowship of the Research Foundation−Flanders (FWO Vlaanderen), Belgium (grant ID: 12E3714N). The current study was presented as a poster at the 8th Biennial EFIC Congress "Pain in Europe", Florence, Italy, October 2013. The authors report no conflict of interest.

References

1. Ang D, Kesavalu R, Lydon JR, Lane KA, Bigatti S: Exercise-based motivational interviewing for female patients with fibromyalgia: a case series. Clin Rheumatol 26:1843–9, 2007.

2. Berlyne DE: Conflict, arousal and curiosity. New York, NY, US: McGraw-Hill; p. 360, 1960.

3. Boudreaux MJ, Ozer DJ: Goal conflict, goal striving, and psychological well-being. Motiv Emot 37:433–43, 2012.

4. Cabanac M: Money versus pain: experimental study of a conflict in humans. J Exp Anal Behav 46:37–44, 1986.

5. Chen M, Bargh JA: Consequences of Automatic Evaluation: Immediate Behavioral Predispositions to Approach or Avoid the Stimulus. Personal Soc Psychol Bull 25:215–24, 1999.

6. Christiansen S, Oettingen G, Dahme B, Klinger R: A short goal-pursuit intervention to improve physical capacity: a randomized clinical trial in chronic back pain patients. Pain 149:444–52, 2010

7. Cohen J: Statistical Power analysis for the behavioral sciences. San Diego, CA: McGraw-Hill; 1998.

8. Craske M, Hermans D, Vansteenwegen D: Fear and learning: from basic processes to clinical implications. Washington, DC: APA Books; 2006.

9. Crombez G, Eccleston C, Van Damme S, Vlaeyen JWS, Karoly P: Fear-avoidance model of chronic pain: the next generation. Clin J Pain 28:475–83, 2012.

10. Domjan M: Pavlovian Conditioning: Basic Concepts. Essentials Cond Learn 3rd ed. Belmont, CA USA: Thomson Wadsworth; pp. 45–65, 2005

11. Eccles JS, Wigfield A: Motivational beliefs, values, and goals. Annu Rev Psychol 53:109–32, 2002.

12. Eccleston C, Crombez G: Pain demands attention: a cognitive-affective model of the interruptive function of pain. Psychol Bull 125:356–66, 1999.

13. Engelen U, De Peuter S, Victoir A, Van Diest I, Van Den Bergh O: Further validation of the Positive and Negative Affect Schedule (PANAS) and comparison of two Dutch versions. Gedrag en Gezondh 34:61–70, 2006.

14. Faul F, Erdfelder E, Lang A-G, Buchner A: G*Power 3: a flexible statistical power analysis program for the social, behavioral, and biomedical sciences. Behav Res Methods 39:175–91, 2007.

15. Fordyce WE: Pain and suffering. A reappraisal. Am Psychol 43:276–83, 1988.

16. Gandhi W, Becker S, Schweinhardt P: Pain increases motivational drive to obtain reward, but does not affect associated hedonic responses: a behavioural study in healthy volunteers. Eur J Pain 17:1093–103, 2013.

17. Gheldof ELM, Crombez G, Van den Bussche E, Vinck J, Van Nieuwenhuyse A, Moens G, Mairiaux P, Vlaeyen JWS: Pain-related fear predicts disability, but not pain severity: a path analytic approach of the fear-avoidance model. Eur J Pain; 14:870.e1–9, 2010.

18. Hasenbring MI, Verbunt JA: Fear-avoidance and endurance-related responses to pain: new models of behavior and their consequences for clinical practice. Clin J Pain 26:747–53, 2010.

19. Higgins ET: How Self-regulation creates distinct values: the case of promotion and prevention decision making. J Consum Psychol 12:177–91, 2002.

20. Jensen JN, Karpatschof B, Labriola M, Albertsen K: Do fear-avoidance beliefs play a role on the association between low back pain and sickness absence? A prospective cohort study among female health care workers. J Occup Environ Med 52:85–90, 2010.

21. Jensen MP, Nielson WR, Kerns RD: Toward the development of a motivational model of pain self-management. J Pain 4:477–92, 2003.

22. Jones KD, Burckhardt CS, Bennett JA: Motivational interviewing may encourage exercise in persons with fibromyalgia by enhancing self efficacy. Arthritis Rheum 51:864–7, 2004.

23. Karoly P, Okun MA, Ruehlman LS, Pugliese JA: The Impact of Goal Cognition and Pain Severity on Disability and Depression in Adults with Chronic Pain: An Examination of Direct Effects and Mediated Effects via Pain-Induced Fear. Cognit Ther Res 32:418–33, 2007.

24. Karsdorp PA, Nijst SE, Goossens MEJB, Vlaeyen JWS: The role of current mood and stop rules on physical task performance: an experimental investigation in patients with work-related upper extremity pain. Eur J Pain 14:434–40, 2010.

25. Karsdorp PA, Vlaeyen JWS: Goals matter: Both achievement and pain-avoidance goals are associated with pain severity and disability in patients with low back and upper extremity pain. Pain 152:1382–90, 2011.

26. Lang PJ, McTeague LM: The anxiety disorder spectrum: fear imagery, physiological reactivity, and differential diagnosis. Anxiety Stress Coping 22:5–25, 2009.

27. Lang PJ: Fear reduction and fear behavior: Problems in treating a construct. In: Research in Psychotherapy (Shlien J.M., ed.) Washington, DC: American Psychological Association,pp. 90-102, 1968.

28. Leeuw M, Goossens MEJB, van Breukelen GJP, de Jong JR, Heuts PHTG, Smeets RJEM, Köke AJA, Vlaeyen JWS: Exposure in vivo versus operant graded activity in chronic low back pain patients: results of a randomized controlled trial. Pain 138:192–207, 2008.

29. Leeuw M, Goossens MEJB, Linton SJ, Crombez G, Boersma K, Vlaeyen JWS: The fear-avoidance model of musculoskeletal pain: current state of scientific evidence. J Behav Med 30:77–94, 2007.

30. Macedo LG, Smeets RJEM, Maher CG, Latimer J, McAuley JH: Graded activity and graded exposure for persistent nonspecific low back pain: a systematic review. Phys Ther 90:860–79, 2010.

31. McCracken LM, MacKichan F, Eccleston C: Contextual cognitive-behavioral therapy for severely disabled chronic pain sufferers: effectiveness and clinically significant change. Eur J Pain 11:314–22, 2007.

32. Meulders A, Vansteenwegen D, Vlaeyen JWS: The acquisition of fear of movement-related pain and associative learning: a novel pain-relevant human fear conditioning paradigm. Pain 152:2460–9, 2011.

33. Meulders A, Vansteenwegen D, Vlaeyen JWS: Women, but not men, report increasingly more pain during repeated (un)predictable painful electrocutaneous stimulation: Evidence for mediation by fear of pain. Pain 153:1030–41, 2012.

34. Meulders A, Vlaeyen JWS: Mere Intention to Perform Painful Movements Elicits Fear of Movement-Related Pain: An Experimental Study on Fear Acquisition Beyond Actual Movements. J Pain 14:412–23, 2013.

35. Meulders A, Vlaeyen JWS: Reduction of fear of movement-related pain and pain-related anxiety: An associative learning approach using a voluntary movement paradigm. Pain 153:1504–13, 2012.

36. Mineka S, Gino A: Dissociation between conditioned emotional response and extended avoidance performance. Learn Motiv 11:476–502, 1980.

37. Mir P, Trender-Gerhard I, Edwards MJ, Schneider SA, Bhatia KP, Jahanshahi M: Motivation and movement: the effect of monetary incentive on performance speed. Exp Brain Res 209:551–9, 2011.

38. Van Poppel MNM, de Vet HCW, Koes BW, Smid T, Bouter LM: Measuring sick leave: a comparison of self-reported data on sick leave and data from company records. Occup Med (Lond) 52:485–90, 2002.

39. Rhudy JL, France CR: Defining the nociceptive flexion reflex (NFR) threshold in human participants: a comparison of different scoring criteria. Pain 128:244–53, 2007.

40. Roy M: Weighting pain avoidance and reward seeking: a neuroeconomical approach to pain. J Neurosci 30:4185–6, 2010.

41. Schrooten MG, Vlaeyen JW, Morley S: Psychological interventions for chronic pain: reviewed within the context of goal pursuit. Pain Manag 2:141–50, 2012.

42. Schrooten MGS, Vlaeyen JWS: Becoming active again? Further thoughts on goal pursuit in chronic pain. Pain 149:422–3, 2010.

43. Spruyt A, Clarysse J, Vansteenwegen D, Baeyens F, Hermans D: Affect 4.0: a free software package for implementing psychological and psychophysiological experiments. Exp Psychol 57:36–45, 2010.

44. Talmi D, Dayan P, Kiebel SJ, Frith CD, Dolan RJ: How humans integrate the prospects of pain and reward during choice. J Neurosci 29:14617–26, 2009.

45. Turk DC, Wilson HD: Fear of pain as a prognostic factor in chronic pain: conceptual models, assessment, and treatment implications. Curr Pain Headache Rep 14:88–95, 2010.

46. Van Damme S, Crombez G, Bijttebier P, Goubert L, Van Houdenhove B: A confirmatory factor analysis of the Pain Catastrophizing Scale: invariant factor structure across clinical and non-clinical populations. Pain 96:319–24, 2002.

47. Van Damme S, Crombez G, Eccleston C: Coping with pain: a motivational perspective. Pain 139:1–4, 2008.

48. Van Damme S, Legrain V, Vogt J, Crombez G: Keeping pain in mind: a motivational account of attention to pain. Neurosci Biobehav Rev 34:204–13, 2010.

49. Van Damme S, Van Ryckeghem DML, Wyffels F, Van Hulle L, Crombez G: No pain no gain? Pursuing a competing goal inhibits avoidance behavior. Pain 153:800–4, 2012.

50. Van Wijk AJ, Hoogstraten J: Dutch translation of the Fear of Pain Questionnaire: factor structure, reliability and validity. Eur J Pain 10:479–86, 2006.

51. Verhoeven K, Crombez G, Eccleston C, Van Ryckeghem DML, Morley S, Van Damme S: The role of motivation in distracting attention away from pain: an experimental study. Pain 149:229–34, 2010.

52. Vlaev I, Seymour B, Dolan RJ, Chater N: The price of pain and the value of suffering. Psychol Sci 20:309–17, 2009.

53. Vlaeyen JW, Linton SJ: Fear-avoidance and its consequences in chronic musculoskeletal pain: a state of the art. Pain 85:317–32, 2000.

54. Vlaeyen JWS, Crombez G, Linton SJ: The fear-avoidance model of pain: We are not there yet. Comment on Wideman et al. “A prospective sequential analysis of the fear-avoidance model of pain” [Pain, 2009] and Nicholas “First things first: reduction in catastrophizing before fear of movement” . Pain; 146:222; author reply 222–3, 2009.

55. Volders S, Meulders A, De Peuter S, Vervliet B, Vlaeyen JWS: Safety behavior can hamper the extinction of fear of movement-related pain: an experimental investigation in healthy participants. Behav Res Ther 50:735–46, 2012.

56. Vowles KE, McCracken LM: Acceptance and values-based action in chronic pain: a study of treatment effectiveness and process. J Consult Clin Psychol 76:397–407, 2008.

57. Wideman TH, Adams H, Sullivan MJL: A prospective sequential analysis of the fear-avoidance model of pain. Pain 145:45–51, 2009.

58. Wiech K, Tracey I: Pain, decisions, and actions: a motivational perspective. Front Neurosci 7:1–12, 2013.

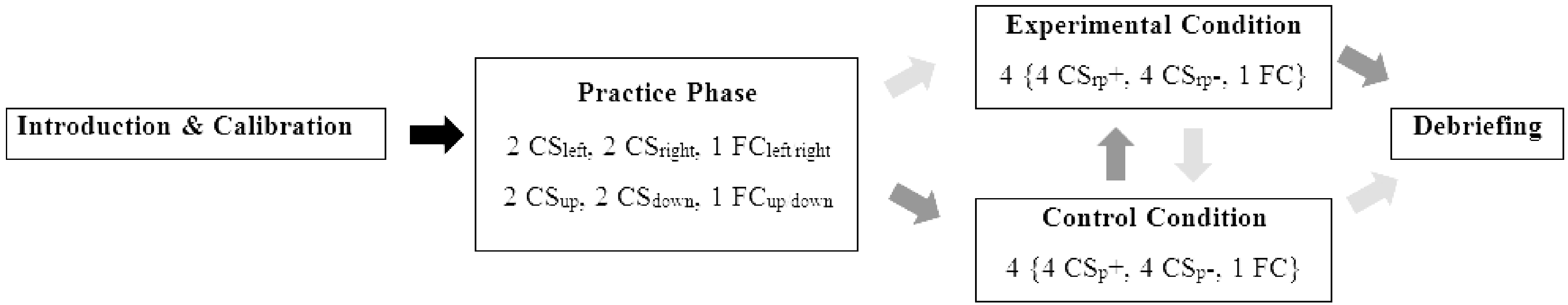
Figure Legends

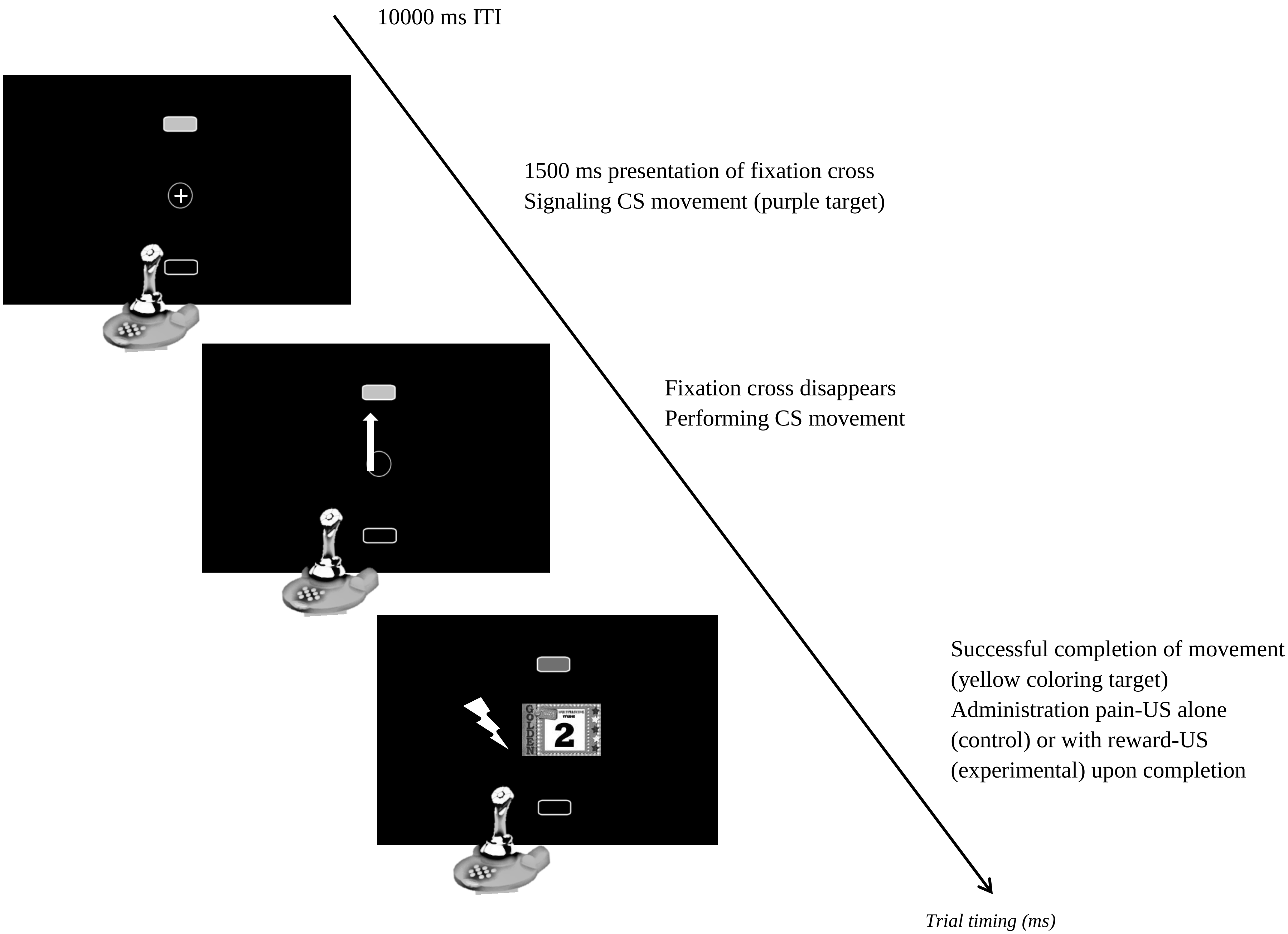
Fig. 1. Experimental Design. CS+ indicates reinforced movements that are either followed by both the pain-US and the reward-US (experimental condition), or by the pain-US alone (control condition) in 50% of the trials. In the practice phase, CS+ movements are never reinforced. CS- indicate non-reinforced trials, which are never followed by either of the USs; CT = choice trials, in which participants chose to perform either one of the movements. These trials always occurred at the end of a block. When choosing for the CS+ movement in these CT, the trials were 100% reinforced. Movements were conducted in two movement planes (vertical and horizontal), and were counterbalanced between conditions. Conditions were run within subject in a counterbalanced order (cf. arrow). Also note that the last block in each condition served as a test block.

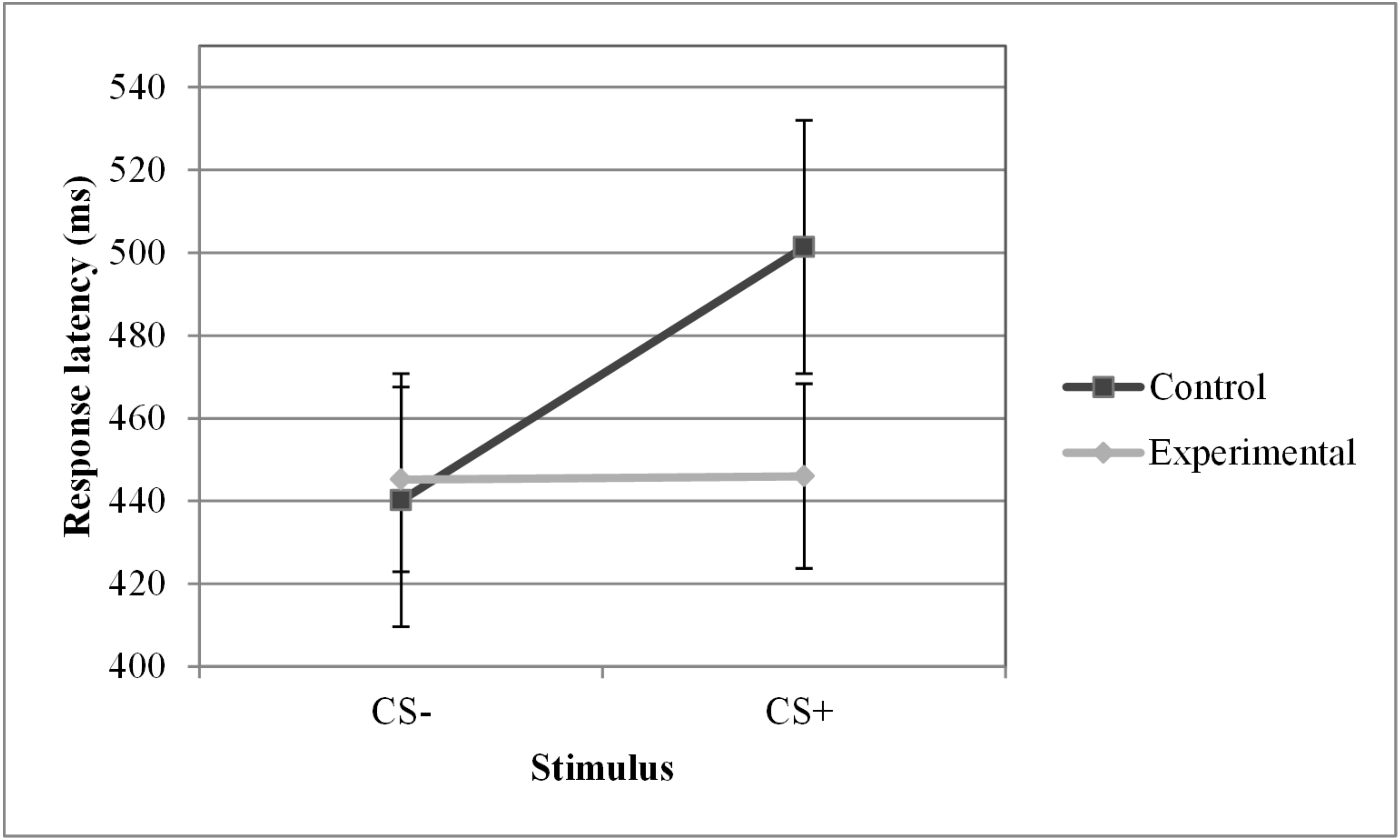
Fig. 2. Overview Trial Timing. Note that the conditions take place in a different movement plane, e.g. the control condition in the horizontal movement plane and the experimental condition in the vertical movement plane. Which movement participants had to perform was signaled by a purple colored target. Thus, the position of the CS+ movement differs between conditions. In the control condition, reinforced CS+ movements are followed by a pain-US in 50% of the trials, represented by a lightning bolt; whereas in the experimental condition CS+ movements are reinforced in half of the trials by a pain-US and a reward-US, as represented by the lottery ticket. In both conditions, CS- movements are never reinforced. An arrow indicates the CS movement. Successful completion of the CS movement resulted in coloring the target yellow.

Fig. 3. Mean response latencies for CS+ and CS- movements for both experimental conditions (control/experimental).

Fig. 4. CS+ Movements during Choice Trials. Number of participants choosing to perform the 'painful' CS+ movement for both the control and experimental conditions for each of the choice trials. Actual numbers are presented above each bar.


Introduction & Calibration
Practice Phase
2 CSleft, 2 CSright, 1 FCleft right
2 CSup, 2 CSdown, 1 FCup down
Experimental Condition
4 {4 CSrp+, 4 CSrp-, 1 FC}
Control Condition
4 {4 CSp+, 4 CSp-, 1 FC}
Debriefing


10000 ms ITI
1500 ms presentation of fixation cross
Signaling CS movement (purple target)
Fixation cross disappears
Performing CS movement
Successful completion of movement
(yellow coloring target)
Administration pain-US alone
(control) or with reward-US
(experimental) upon completion
Trial timing (ms)



Response latency (ms)
540
520
500
480
460
440
420
400
CS-
CS+
Stimulus
Control
Experimental

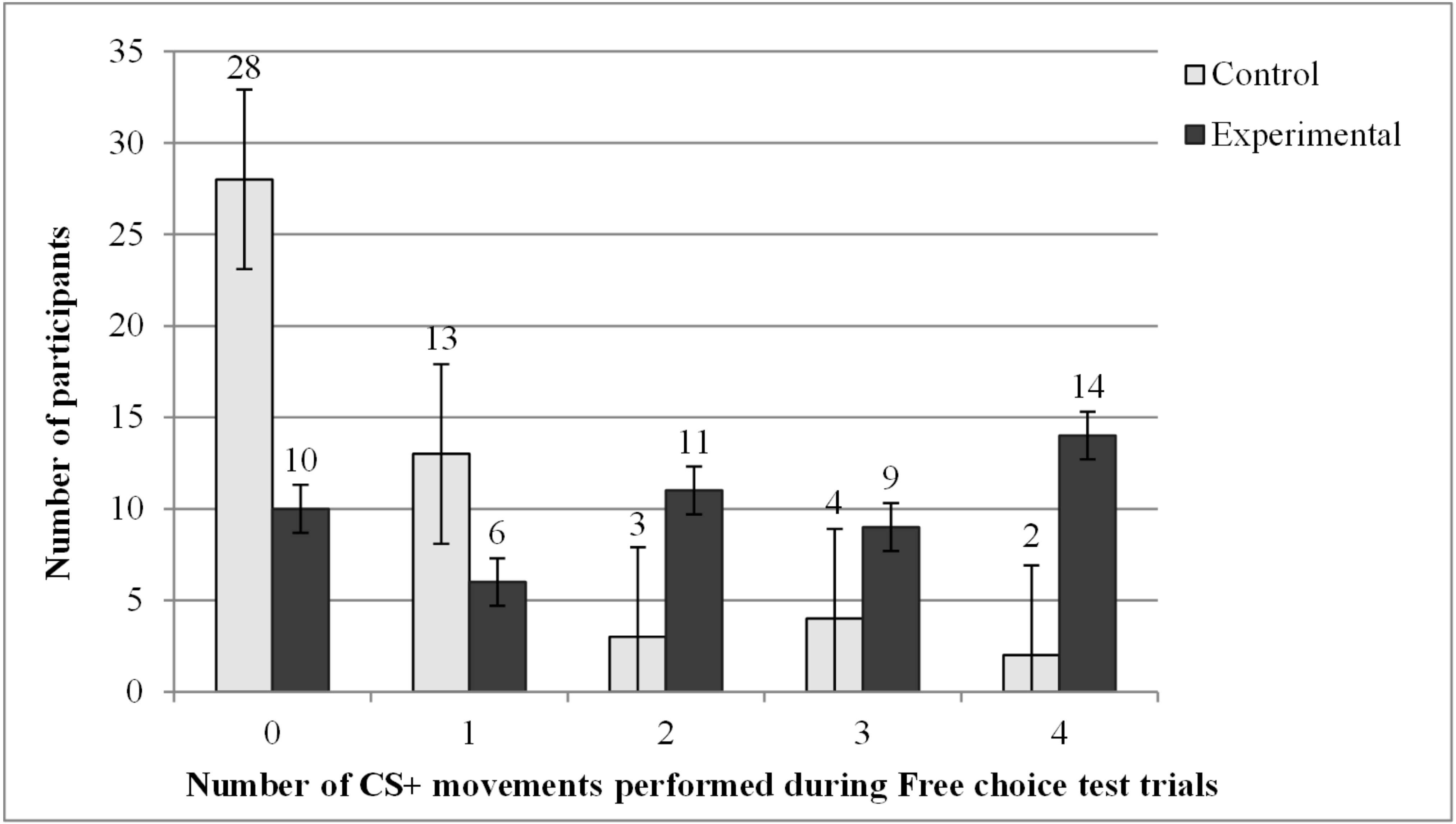

35
30
25
20
15
10
5
0
Number of participants
28
10
13
6
3
11
4
9
2
14
0
1
2
3
4
Control
Experimental
Number of CS+ movements performed during Free choice test trials

Table 1

Mean and SD per CS type and Condition for all self-reported measures and response latency

		Control condition	Experimental condition
Variable	CS type	M(SD)	M(SD)
Expectancy	CS+	6.83(1.79)	6.77(1.79)
	CS-	2.77(2.71)	2.44(2.52)
Pain-related fear	CS+	6.06(1.82)	6.37(1.66)
	CS-	3.13(3)	3.16(2.83)
Pain intensity	CS+	6.36(1.59)	6.24(1.65)
Pain unpleasantness	CS+	7.02(1.6)	6.8(1.68)
Pain tolerance	CS+	5.88(1.75)	6.06(1.87)
Response Latency	CS+	501(177)	445(156)
	CS-	440(139)	446 (127)

Note. CS+ indicates the reinforced conditioned stimulus, and is thus followed by a Pain-US in the control condition and by both a Pain-US and a Reward-US in the experimental condition. CS- indicates the non-reinforced conditioned stimulus and is never followed by an US. Response latency is in ms.

Table 2

Descriptives and correlations of the dependent and predictor variables of the regression analysis

	Variable	*M*	*SD*	2	3	4
1	Number of CS+ movements performed in Experimental condition	2.22	1.49	-.058	-.506[a]	.549[a]
2	Pain-related fear of CS+	6.37	1.66	1		
3	Pain avoidance goal	5.48	2.69	.06	1	
4	Reward goal	4.80	3.23	.212	-.069	1

a $p < .001$

Table 3

Regression of number of painful movements performed during choice trials when a concurrent reward is present (experimental condition) on pain-related fear for the painful movement and self-reported goals

Model	Predictors	β	t (β)	R^2	Adjusted R^2	$F_{adj.\ R2}$	R^2_{change}	$F_{R2\ change}$
Model 1				.542	.513	18.172[a]	.539[a]	18.172[a]
	Pain-related fear of CS+	-.132	-1.437					
	Avoidance goal	-.254	-4.583[a]					
	Reward goal	.253	5.357[a]					
Model 2				.522	.501	25.645[a]	-.021	2.065
	Avoidance goal	-.260	-4.654[a]					
	Reward goal	.238	5.111[a]					

[a] $p < .001$