Cognitive Reappraisal of Exercise Discomfort: The Moderating Role of Experience

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Abstract

Physical inactivity remains a significant public health challenge. Recent studies cite discomfort during exercise as a significant barrier to exercise maintenance. Cognitive reappraisal, a technique that helps individuals reinterpret negative experiences, has been successfully used in emotional regulation, but its potential to reduce discomfort-related barriers in exercise is underexplored. The current study investigated whether cognitive reappraisal could mitigate pain intensity and the negative affective response (pain valence and negative affective valence) associated with a wall-sit exercise, whether this would lead to more favourable affective attitudes, and whether these effects would be moderated by prior exercise experience. Further, the study investigated whether these changes would translate to greater exercise adherence over 14 days. Participants were randomly assigned to a control (n= 30) or reappraisal condition (n = 28), with the manipulation involving a video reframing discomfort as a sign of muscle growth. The results indicated that cognitive reappraisal did not significantly influence pain intensity, pain valence, affective valence, affective attitudes, or exercise adherence (all *p*s > .05). However, the moderation analysis showed a significant interaction effect (p = .048), showing that participants with low prior exercise experience in the cognitive reappraisal condition reported lower pain intensity after the exercise compared to the control group (*p* = .058). While these findings suggest that cognitive reappraisal may reframe discomfort and potentially reduce perceived pain intensity, particularly in individuals who are new to exercise, its impact on broader affective responses and long-term adherence warrants further exploration. intensity, its impact on broader affective responses and long-term adherence warrants further exploration.

Keywords: Cognitive reappraisal, physical inactivity, exercise discomfort, pain intensity, exercise adherence, prior exercise experience, wall-sit.

Cognitive Reappraisal of Exercise Discomfort: The Moderating Role of Experience

Regular exercise is undeniably linked to a myriad of physical and mental health benefits, including a reduced risk of chronic diseases, improved cardiovascular functions, enhanced mood, and an overall improvement of quality of life (Saxena et al., 2005; Warburton, 2006; Reiner et al., 2013). Despite the well-known and established advantages of regular physical activity, an increasing amount of people fail to meet established recommendations on physical activity. In the Netherlands, the share of adults that fail to meet physical activity guidelines increased from 53% in 2017, to 56% in 2022 (CBS, 2023). Globally, one third (31%) of the adults population is physically inactive, and this proportion is projected to rise to 35% by 2030 (World Health Organization: WHO, 2024). In spite of evidence-based recommendations, social marketing campaigns and investment of considerable research funds, physical inactivity can still be characterized as the biggest public health problem of the 21st century (Blair, 2009).

Conventional interventions aimed at increasing exercise adherence commonly focus on cognitive and instrumental outcomes, such as health benefits, with varying success. A growing body of research suggests that these cognitive approaches alone are insufficient to explain exercise behaviour and to promote lasting adherence (Rhodes & Kates, 2015; Brand & Ekkeka-kis, 2017). Recent studies however increasingly point to the potential of affective/experiential factors in predicting exercise behaviour (Stevens et al., 2020). This shift underscores the importance of how individuals interpret and emotionally respond to their exercise experiences, highlighting the need for models that move beyond cognition and incorporate the powerful influence of experience.

One model that integrates these interpretations and responses is the Self-Regulation of Exercise Maintenance Model (Herning et al., 2005). This model, originally adapted from Leventhal's work on illness representations (1983), emphasizes that individuals actively construct meaning from their experiences with exercise, forming interpretations that shape their future behaviour. The reasoning is that each exercise session draws from previous exercise experiences, but also adds new information to pre-existing beliefs and attitudes, such as believing that exercise is inherently unpleasant and exhausting versus seeing it as energizing and rewarding. These interpretations can ultimately influence whether an individual continues or discontinues the activity.

The model differentiates between 2 levels of exercise interpretation: general interpretations and episode-specific interpretations (Herning et al., 2005). General interpretations are more stable and involve long-term beliefs or attitudes drawn from previous exercise experiences as well as other sources like knowledge of health benefits or social norms. Episode-specific interpretations, on the other hand, can change rather quickly and are based on immediate experiences, such as feelings and sensations, experienced during and right after an exercise episode. Furthermore, interpretations at the episode-specific level have the potential to influence future exercise behaviour by updating long-term interpretations at the general level. This influence is particularly relevant in conjunction with a growing amount of literature that points to discomfort, and the resultant affective responses that individuals experience during exercise, as important predictors of exercise maintenance behaviour (Beaumont et al., 2020; Berman et al., 2019; Ekkekakis, 2009; Lee et al., 2016; Parfitt & Hughes, 2009; Stevens et al., 2020).

Discomfort, within the Self-Regulation of Exercise Maintenance Model can be described as an episode-specific interpretation of bodily sensations. These sensations, also termed interoceptive cues, are inherent to many forms of physical exercise and can include muscular pain or burning sensations and are frequently cited as a significant barrier to exercise maintenance behaviour (Ekkekakis & Dafermos, 2012; Rhodes et al., 2015). Understanding how episode-specific sensations, such as pain experienced during the exercise, affect future exercise behaviour, requires a closer examination of the multidimensional nature of bodily sensations.

Pain is a multidimensional experience involving sensory-discriminative, affective-motivational and cognitive-evaluative components (Melzack & Casey, 1968). The sensory-discriminative component, often denoted as pain-intensity, is a physiological representation of sensory information which includes the localization and severity of the sensation (Petersen et al., 2010; Talbot et al., 2019). During exercise, this physiological representation functions as an indicator of the location and strength or severity of potential tissue damage. The affective-motivational component, often denoted as pain-valence, is a psychological representation of how 'bad' or 'unpleasant' the sensation is, motivating an individual to avoid potential tissue damage (Talbot et al., 2019). As pain intensity increases, it often gives rise to a stronger affective response (Melzack & Casey, 1968), where the sensation is experienced as increasingly unpleasant. During an exercise episode, it is precisely this interaction that might be interpreted as a feeling of discomfort. However, a third component is said to have an influential effect on the interaction between the sensory and affective components. The cognitive-evaluative component involves an appraisal process during which sensory inputs are evaluated based on existing interpretations on the general level, such as past experiences, beliefs and expectations (Melzack & Casey, 1968). Crucially, according to Melzack and Casey (1968) these appraisals can directly influence both pain intensity and pain valence, either increasing or reducing the perceived severity of the sensation and its unpleasantness. The potential of pain-appraisals to modulate affective responses to pain becomes especially important when viewed in conjunction with the influence these responses can have on the episode-specific interpretation of exercise as a whole.

The influence of affective responses on episode-specific interpretations of exercise is best described through theories of hedonic motivation and operant conditioning (Kwan & Bryan, 2010; Rhodes & Kates, 2015; Williams et al., 2012). According to this line of research, a behaviours' likelihood of being performed in the future depends on whether it can generate a desirable affective state (i.e., high positive affect, low negative affect) which in turn would reinforce that behaviour on future occasions (Loewenstein, 2000). The experience of negative affect on the other hand, decreases the likelihood of future performance by activating a motivational state of behavioural avoidance (Leone et al., 2005). The significance of these effects has meanwhile been confirmed by a number of studies which concluded that experiencing a greater reward response (e.g., positive affect) and lower aversive response (e.g., negative affect) during bouts of exercise predicts greater current and future physical activity participation behaviour at 6, and even 12 months follow-up measurements (Liao et al., 2016; Magnan et al., 2012; Rhodes & Kates, 2015; Williams et al., 2012). However, the influence of affective responses on future exercise behaviour is likely not of direct nature, but rather facilitated through its critical role in the formation of super-ordinate motivational constructs such as affective attitudes (Rhodes & Kates, 2015).

Research on the role of attitudes within exercise behaviour makes a distinction between two separate attitude constructs, namely the instrumental and affective attitudes. The two constructs are best conceptualized through outcome expectancies with distinct characteristics. While instrumental attitudes concern the perceptions of the costs and benefits of performing a behaviour in the future (e.g., worthless or valuable), affective attitudes represent affect-based expectations of performing a behaviour again. (e.g., dull or enjoyable) (Phipps et al., 2021). Within the Self-Regulation of Exercise Maintenance Model, affective attitudes represent the general interpretations that individuals form about exercise. Just as episode-specific interpretations are influenced by immediate affective responses, these general interpretations are shaped by the accumulation of those responses over time. Studies have shown that affective attitudes, rather than cognitive/instrumental attitudes, indirectly predict physical activity through intention. Additionally, affective attitudes and intention have been found to directly predict physical activity over a 2-week period (Conner et al., 2011; Phipps et al., 2021).

Given the potential of affective responses to influence future exercise behaviour, addressing the sensory-discriminative and affective-motivational dimensions of pain experienced during exercise becomes a critical target for potential interventions. Importantly, these dimensions are not fixed but can be influenced through cognitive processes. Within the cognitive-evaluative dimension of pain, appraisals play a key role in determining the affective evaluation of pain. Thus, changing the appraisal or meaning an individual ascribes to exercise-related discomfort seems imperative. Cognitive reappraisal, an emotion regulation technique, presents a promising avenue to address this gap.

Cognitive reappraisal is an antecedent-focused emotion regulation strategy, meaning it occurs before the emotion response, and targets the meaning of the situation (Gross, 1998). Cognitive reappraisal involves reframing or reinterpreting emotional stimuli to reduce its emotional impact (Gross, 2013) and is generally successful in enhancing of positive and reducing of negative affective experience (Webb et al. 2012).

With regard to exercise, cognitive reappraisal may prove to be a valuable tool for addressing discomfort, through its potential to reframe such exercise-related sensations as pain in a positive light (e.g., as a sign of muscle-growth), and consequently improve an individuals' overall affective response to exercise. The multidimensional nature of pain serves as additional support for this potential. According to Melzack and Casey (1968), pain appraisals are a part of the cognitive-evaluative dimension of pain and include interpreting sensory inputs based on existing beliefs, expectations or prior experiences (Melzack & Casey, 1968). Cognitive reappraisal could alter these appraisals and potentially reduce pain intensity and pain valence which play a crucial role in the formation of episode-specific interpretations. Over time, the accumulation of experiences with these newly formed episode-specific interpretations in mind, may also improve interpretations at the general level, such as affective attitudes. However, affective attitudes towards exercise have already been found to improve right after participants received positively framed affective messages (e.g., regular physical activity often improves the way one feels about their body/appearance) (Conner et al., 2011). This positions cognitive reappraisal as a potentially effective intervention for supporting sustained exercise behaviour by addressing the barriers posed by pain and discomfort.

However, the effectiveness of cognitive reappraisal may depend on an individual's physical activity level. Within the framework of the Self-Regulation of Exercise Maintenance Model, general-level interpretations such as beliefs and attitudes are shaped by previous exercise episodes or may stem from experiences outside of it. As part of the cognitive-evaluative component, beliefs and attitudes play also a central role in pain-appraisal. Given this, individuals with limited or no exercise experience might not have been able to build up general-level interpretations of exercise that could help them cope with discomfort, making them particularly susceptible to experiencing and negatively evaluating exercise-related sensations of pain. Thus, cognitive reappraisal might benefit especially individuals with a low physical activity level, as it might provide them with a coping-mechanism necessary to reframe exercise-related discomfort in a more constructive light.

While cognitive reappraisal has demonstrated benefits in reducing depression, increasing life satisfaction, and lowering negative affect, its application in the context of exercise remains largely unexplored (Berman et al., 2019). Only one study to date, conducted by Berman et al. (2019) has examined the effects of induced cognitive reappraisal of exercise-related pain. The study involved 78 participants performing a bench press as many times as possible to the beat of a metronome using 36 kg and 16 kg weights for men and women respectively. Participants were randomly assigned to either a “helpful” reappraisal condition in which exercise-related pain was framed as sign of muscle-growth, or a or a “harmful” reappraisal condition in which that same pain was framed as a sign of muscle damage. The study found that in the “helpful” condition, cognitive reappraisal significantly reduced pain valence, compared to the “harmful” condition. However, there was no effect of condition on affective valence (the overall feeling associated with the exercise), pain intensity, and task persistence (the number of repetitions completed).

Berman et. al. (2019) suggested that their cognitive reappraisal manipulation did not influence overall affective valence or exercise persistence because of possible ceiling effects that could have occurred due to the high intensity of the exercise task. At higher intensities physiological cues related to fatigue assert a dominant role in shaping affective responses, decreasing the influence of cognitive factors. They argued that cognitive reappraisal might be more successful in influencing affective valence and exercise behaviour when the exercise demands are lower, allowing individuals to dedicate more cognitive resources to the reappraisal process.

Our study builds on the research conducted by Berman et. al. (2019) by incorporating several advancements in design and measurement, allowing for a more nuanced assessment of cognitive reappraisal's effects on exercise-related affect and behaviour.

To avoid possible ceiling effects, the present study utilizes the wall-sit, a sustained isometric exercise that elicits discomfort without requiring maximal exertion, as was the case during the resistance exercise employed by Berman et. al. (2019). While challenging, the wall-sit exercise is of moderate intensity, potentially creating more favourable conditions for cognitive reappraisal to influence not only pain valence but also affective valence. Further, affective valence will be assessed not only during but also immediately after the exercise to capture possible delayed effects of the cognitive reappraisal manipulation. Beyond immediate affective responses, we will assess affective attitudes toward the wall-sit exercise after the intervention to assess whether reducing negative affect during the wall-sit translates to a more positive overall evaluation of the exercise. Crucially, this study will include a 2-week follow-up assessment of exercise adherence outside of the laboratory setting. This provides a valuable measure of whether changes in pain valence, negative affective valence, and affective attitudes translate into actual, real-world exercise behaviour.

Finally, to better understand for whom cognitive reappraisal might be most beneficial, this study investigates prior exercise experience as a potential moderator of the reappraisal effect.

Present Study

This study aims to address the following research question: Can cognitive reappraisal mitigate the negative affective response (pain valence and negative affective valence) associated with a sustained isometric exercise task, and can this lead to more favourable affective attitudes and greater exercise adherence?

To explore this question, we will conduct an experiment using an independent measures design, with participants randomly assigned to either a cognitive reappraisal or a control condition. A follow-up will be conducted to assess the effects of the reappraisal intervention on actual exercise adherence over a 2-week period. The dependent variables will be: (1) pain valence and negative affective valence experienced *during* the wall-sit exercise, (2) affective attitudes toward the wall-sit exercise measured after the intervention, and (3) self-reported exercise adherence (number of wall-sit repetitions) assessed over a two-week follow-up period.

We hypothesize that:

- **Hypothesis 1:** Participants in the cognitive reappraisal condition will report lower levels of discomfort during and immediately after the wall-sit exercise compared to participants in the control condition.
- **Hypothesis 2:** Participants in the cognitive reappraisal condition will report more favourable affective attitudes towards the wall-sit exercise after the intervention compared to participants in the control condition.
- **Hypothesis 3:** Participants in the cognitive reappraisal condition will demonstrate greater adherence to a wall-sit exercise regimen over a 2-week follow-up period compared to participants in the control condition.
- **Hypothesis 4:** Among participants in the cognitive reappraisal condition, those with less exercise experience will report lower levels of discomfort during and immediately after the wall-sit exercise compared to those with more exercise experience.

Method

Recruitment

The recruitment of the participants was conducted via two methods. Of the total of 61 participants, 18 were recruited through the SONA participant pool which is comprised of first year psychology students at the University of Groningen. The remaining 43 participants were approached directly at the Faculty of Behavioural and Social Sciences and were following either a bachelor's, master's or had another educational or professional background. The SONA participants were offered 0.9 SONA credits for participating in the entire study, which was advertised within the internal SONA participant pool. The other participants were informed of a chance of winning one of six cash prizes of 50 euros.

Inclusion criteria required participants to be at least 18 years old. Exclusion criteria included any physical condition that would preclude performing the wall-sit exercise. Recruitment communications invited students to participate in a study on "the perception of physical sensations during a specific physical exercise."

To yield a medium effect size of $f = 0.25$ with a power of 0.8. at an α level of 0.05, a sample size of 128 would have been necessary according to calculations made in G Power (Faul et al., 2009). Due to time constraints and only a total of 2 experimenters a sample size of 61 was feasible, especially considering the novelty of our research question.

Design

A between-subjects design was used, with participants randomly assigned to either a cognitive reappraisal or a control condition in an independent measures design. A follow-up was conducted to assess the effects of the reappraisal intervention on actual exercise adherence over a 2-week period. The dependent variables of pain intensity, pain valence, affective valence and attitude were measured during and immediately after the second wall-sit exercise in the experimental part of the study. Two weeks later, all dependent variables were assessed again via the internet, added to this the behavioural measurement of exercise repetitions in the past two weeks. The study received approval from the Ethical Committee Psychology (ECP) (research code: PSY-2324-S-0107) of the Faculty of Behavioural and Social Sciences.

Procedure

Upon entering the room, participants were informed about the experimental procedure entailing them to answer questions and watch videos (audio fragments with pictorial elements) on a laptop via the Qualtrics platform (https://www.qualtrics.com) and perform a total of two wall-sit exercise. The verbal information about the videos also contained a prompt to use the headphones already connected to the laptop. Upon entering the survey, participants read and signed informed consent after which they filled out pretest measures and were instructed (via Qualtrics) to watch a video about the benefits of doing the wall-sit exercise regularly.

After watching the video, participants were prompted to turn to the researcher who would inform them on the correct execution of the wall-sit. Before the execution of the exercise participants were instructed by the researcher to hold the wall-sit until it ‘starts to feel uncomfortable’, with added examples such as ‘a burning or painful sensation in the leg-muscles’. Further, participants were also informed that the duration of their performance will be recorded (individual baseline measurement) with an additional elaboration that we are not interested in their maximal performance but only until it ‘starts to feel uncomfortable’.

After the wall-sit, participants returned to the laptop and were randomly assigned to one of two experimental conditions: watching a video (containing audio fragments with pictorial elements) that either presented positive interpretations of muscular sensations (manipulation) or neutral information on physical responses (control) during exercise. After the video the participants filled out the manipulation check followed by a prompt to turn to the researcher to get instructed on the procedure of the second wall-sit exercise.

Participants were informed that at a certain point while performing the wall-sit they would be asked to indicate their experience on four verbal scales (printed form) that will be held in front of them. The four scales assessing intensity and unpleasantness of sensations, and positive and negative affective valence towards the experience, were explained to the participants. After the explanation participants performed the second wall-sit again and were asked to indicate their scale-ratings 5 seconds before their recorded baseline measurement. Upon completion the participants were asked to stop the exercise and slowly return to the computer to fill out the rest of the questionnaire (post-measurement).

The post-measurement questionnaire started with a compulsory 30-second rest period timer before automatically proceeding to the next scale. After marking their experience on the final scale, participants can stop the exercise. They then complete the questionnaire, starting with a 30-second rest period tracked by a timer. The final part includes questions about their previous experience, using the same four scales, and their attitude towards future performance of the exercise. Following the completion of the post-measurement questionnaire participants were asked to provide their email address to receive a follow-up questionnaire after 14 days and to have a ‘chance to win one of six cash prizes of 50 euro’.

After 14-day period, participants were requested to complete a follow-up questionnaire assessing their exercise behaviour over the preceding 14 days with the addition of their recall of some affective ratings, after which they were debriefed.

Persuasive message

All participants were exposed to an audio with pictorial elements where the physical benefits of performing the wall-sit exercise regularly were described. For example, enhancement of fitness, increased strength, daily activities becoming easier and a better physique. The purpose of this exposure was to induce positive outcome expectations to ensure that all participants were motivated to perform the behaviour during the follow-up period after the experiment (see Appendix A for the complete text).

Cognitive reappraisal and control condition

Of all 61 participants, 29 randomly assigned individuals were exposed to an audio with pictorial elements containing the positive reappraisal of muscular sensations experienced during the wall-sit exercise. In this audio, the physiological responses occurring from a certain exercise intensity were described and a positive association was repeatedly emphasised between the uncomfortable sensations and muscle growth. The pictorial elements consisted of important keywords from the spoken audio placed in schematic form.

The audio with pictorial elements of the control condition described the physiological responses in a factual manner. No particular emphasis was placed upon the positive association between uncomfortable muscular sensations and muscle growth. Appendix B shows the complete audio texts that were used, and an image of one of the pictorial elements used in the corresponding experimental conditions.

Measures

Pre-test measures

Upon signing the informed consent, participants were asked to provide their gender, age, cultural background and current educational level. They were also asked to indicate their weekly exercise behaviour in the categories of vigorous and moderate exercise and walking (Craig et al., 2017). Examples of activities were provided for the categories, such as “Football” for vigorous exercise and “Bicycling at regular pace” for moderate exercise. Weekly exercise behaviour was assessed by first asking the amount of days they were physically active in these categories for at least 10 consequent minutes. For example: “During the last 7 days, on how many days did you do vigorous physical activities for at least 10 minutes consecutively?” Subsequently, they were asked to indicate the amount of hours and minutes they spend on physical activity in each of the categories on a typical day (on average). For example: “On average, how much time did you spend on vigorous physical activities on one of those days?”

The data collected with IPAQ can be reported as a physical activity score which is a continues measure or used to classify participants as having a low, moderate or high level of physical activity (IPAQ Research Committee, 2005).

Post-test measures

Manipulation check

After watching the video (manipulation) participants from both conditions were asked how they would rate the physiological processes that took place during the wall-sit on a 9-point scale with 3 verbal anchors: 1 = “Not positive at all,” 5 = “Positive,” and 9 = “Extremely positive.”

Measures of intensity of sensations and affective experiences

The intensity of sensations experienced in the muscles, the valence of those sensations, as well as affective valence of the wall-sit exercise as a whole, were measured during the exercise and immediately after. The reasoning behind that was based on previous research on affective responses to exercise which has shown that affective experience measured during exercise was more predictive of future behaviour (exercise maintenance) than the recall of the affective experience measured immediately after the exercise (Rhodes & Kates, 2015). The aim was to test those findings under novel study settings.

Intensity of sensations

The intensity of sensations that participants felt in their muscles while performing the exercise was measured using an 11-point verbal rating scale (Duncan et al., 1989). The participants were asked to indicate the intensity of the sensations in their muscles. The scale contained 1-11 numbers with the following verbal anchors: 1 = “No sensation at all,” 2 = “Barely perceptible,” 3 = “Very mild,” 4 = “Mild,” 5 = “Moderate,” 6 = “Barely strong,” 7 = “Strong,” 8 = “Intense,” 9 = “Very intense,” 10 = “Extremely intense,” and 11 = “Most intense imaginable.” The same scale was used to measure the recall of the intensity of sensations immediately after the wall-sit exercise but with a different instructional text: “What was your experience of the intensity of the sensations in your muscles during the exercise you just performed?”

Valence of sensations

The valence of the sensations was measured using a 9-point numeric rating scale on unpleasantness (Duncan et al., 1989). During the exercise the participants were asked to indicate how unpleasant the sensations in their muscles are. The scale contained 1-9 numbers with two verbal anchors: 1 = “Not unpleasant at all,” and 9 = “Most unpleasant imaginable.” The assessment of the valence of the sensations after the exercise was done with the same scale but this time the participants were asked to indicate how unpleasant the sensations were during the exercise they just performed.

Affective Valence

To assess participants’ affective valence towards the wall-sit exercise, we decided to use separate positive, as well as negative affective valence scales instead of a bipolar scale with a single dimension ranging from negative to positive. Research has shown positive and negative affect to represent distinctive dimensions (Watson et al., 1988), meaning that an individual could experience positive and negative emotions at the same time, which cannot be adequately captured by a bipolar scale. The data on affective valence was collected during the exercise and immediately after the exercise to capture both in-the-moment and reflective affective responses. To measure positive affective valence during the exercise, participants were asked to rate their positive feelings towards the exercise on a scale ranging from 0 to +5. The scale contained the following verbal anchors: 0 = "Neutral," +1 = "Fairly positive," +3 = "Positive," +5 = "Very positive." To measure negative affective valence during the exercise, participants were asked to rate their negative feelings towards the exercise on a scale ranging from 0 to -5. The scale contained the following verbal anchors: 0 = "Neutral," -1 = "Fairly negative," -3 = "Negative," -5 = "Very negative." The affective valence measurement after the wall-sit exercise consisted of the same positive and negative affective valence scale but this time the participants were asked to think back on the exercise experience and then rate their feelings on the corresponding scales.

Affective/ Cognitive Instrumental Attitudes

Affective and cognitive instrumental attitudes towards the adherence of a hypothetical scheme of 2 wall-sit repetitions a day, on 3 different days per week, were measured using semantic differential scales. Four items were used to assess instrumental attitudes (e.g. "For me, adhering to such a scheme would be…": unimportant-important; worthless-valuable; not worthwhile-worthwhile; harmful-beneficial), and four items were used to assess affective attitudes (e.g. "For me, adhering to such a scheme would be…": unsatisfying-satisfying; unpleasant–pleasant; unenjoyable–enjoyable; boring–exciting). Each adjective pair was rated on a 7-point unipolar scale (1–7) and a mean computed (Cronbach's α=0.84 and 0.77 for instrumental and affective, respectively).

Follow-up measure on exercise maintenance

Participants had to indicate the amount of days they have performed the wall-sit on (in the past 14 days) and how many times they have performed the wall-sits during that time, to account for the possibility of performing more than one wall-sit a day. The measure of days had a 0-14 range, while the measure of the total amount of wall-sit had a 0-140 range.

Non-included data

The following measures were not included as they were not part of the hypotheses and analyses of the current study: A post-test measure on self-efficacy, change in exercise routine after follow-up, and whether participants looked up information on the wall-sit exercise during the follow-up period. While not being part of the hypotheses and analyses of the current study, this data could potentially be used for future research purposes.

Results

Preliminary Analyses

Participant Characteristics

A total of 61 participants (29 males, 31 females, and 1 other) were included in the study. Of the 61 participants, 29 were in the experimental condition and 32 in the control condition. Participants ranged in age from 18 to 32 years (*M* = 22.2, *SD* = 2.86) and were all studying or working in higher education, with 70.5% pursuing Bachelor's degrees, 21.3% pursuing Master's degrees, and 8.2% in other educational or professional stages. Most participants were Dutch (52.5%) or German (26.2%).

The data on "minutes spent on vigorous exercise" was missing for four participants. The missing values were imputed with the mean score of 204.30.

After an inspection of participants' total PA-scores (physical activity scores), calculated based on participants' reported frequency, intensity, and duration of physical activity (IPAQ Research Committee, 2005), two participants met the exclusion criteria: The mean total PA-score for the entire sample (*N* = 61) was 3553.82 (*SD* = 3074.57). A box plot of total PA-scores (Figure C1) was generated to screen for potential outliers. A visual inspection revealed two data points lying far outside the typical range. Further examination revealed that these two data points had z-scores of 2.30 and 5.85, exceeding two standard deviations from the mean. Due to their extreme values and potential to influence analyses involving exercise experience, these two participants were excluded from all further analyses. Following the removal of these outliers, the sample size was reduced to 59 with a mean total PA-score of 3128.80 (*SD* = 1774.42). Further, because gender was later included in the moderation analysis, as it was significantly related to the moderator variable total PA-score, and the gender category 'other' contained only one cellcount, one participant who identified as 'other' was excluded from analyses. To simplify interpretation, the decision was made to maintain a consistent sample size across all analyses and exclude these three participants from the entire dataset. Therefore, the final sample size for all analyses was 58.

Randomization check

To assess the comparability of the reappraisal and control groups at baseline, we examined differences on several demographic and exercise-related variables. A Chi-Square test of independence revealed no significant differences between the groups in terms of gender, χ^2 (1, N = 58) = 0.00, p > .99. Since one educational level category had low cell counts, instead of Pearson Chi-Square the Fisher’s exact test was used. The results indicated no statistically significant association between current educational level and condition p = .623. Further, since some cultural background categories had low cell counts, instead of Pearson Chi-Square the Fisher’s exact test was used. The results showed no statistically significant association between cultural background and condition, p = .802. Additionally, an independent samples t-test showed no significant difference in age between the two conditions, $t(56) = -.990$, p = .327. To assess comparability of groups with respect to prior exercise experience, a Mann-Whitney U test was conducted on the total PA-scores. The use of a non-parametric test was based on a Shapiro-Wilk test (p = .007) and a visual inspection of Q-Q plot, conducted prior to the analysis, confirming a non-normal distribution of total PA-score data. The Mann-Whitney U test showed no significant difference in prior exercise experience between the reappraisal and control conditions, U = 385.000, p = .586. These results suggest that the randomization procedure was successful in creating comparable groups at baseline.

Manipulation check

A manipulation check was conducted to verify whether the positive reappraisal condition influenced participants' ratings of the physiological processes during the wall-sit exercise. An independent samples t-test revealed no significant difference ($t(56) = .312$, $p = .756$) between the experimental group ($M = 6.50$, $SD = 1.40$) and the control group ($M = 6.63$, $SD = 1.81$). The effect size, as measured by Cohen's d, was $d = 0.082$, indicating a small effect. These results suggest that the manipulation did not significantly affect participants' perceptions of the physiological processes.

Preparatory analysis

To evaluate the potential need for covariates, we examined the relationships between gender, prior exercise experience (total PA-scores), and the dependent variables, as well as condition assignment (positive reappraisal vs. control).

A Pearson correlation analysis showed no significant association between gender on one hand, and on the other hand, pain intensity, pain valence, positive and negative affective valence (both during and after the wall-sit exercise), and affective attitudes toward the wall-sit exercise (all *p*'s > .3), nor with condition assignment ($p = .857$). For the attitude variables: While gender was not significantly correlated with the affective attitude variable, the negative correlation between gender and instrumental attitude was significant, $r(58) = -.287$, $p = .029$. Given this significant correlation, gender was included as a covariate in the analyses pertaining to the attitude variables.

In contrast, Spearman's rank-order correlations revealed significant negative associations between total PA-scores and pain intensity during ($r(58) = -.261$, $p = .048$), pain valence during ($r(58) = -.332$, $p = .011$) and after ($r(58) = -.367$, $p = .005$), negative affective valence during ($r(58) = -.275$, $p = .037$) and after ($r(58) = -.247$, $p = .062$) and a negative correlation with pain intensity after, approaching significance ($r(58) = -.231$, $p = .081$). The correlation between total PA-score and positive affective valence during ($r(58) = .197$, $p = .139$) as well as after ($r(58) = .071$, $p = .598$) was not significant. Further, total PA-scores were not significantly related to affective and instrumental attitudes (all p's > .2). Prior analyses during the randomization check already showed a non-significant relation between total PA-scores and condition. Given the significant associations with the discomfort variables, total PA-scores were retained as a covariate for subsequent analyses pertaining to pain intensity, pain valence, positive and negative affective valence (both during and after the wall-sit exercise).

To evaluate potential relationships between gender and prior exercise experience, a Spearman's rank-order correlation was conducted. The analysis revealed a significant positive association between gender and total PA-scores ($r(58) = .331$, $p = .011$), indicating that gender may influence prior exercise experience. Given this finding, gender was considered as a potential confounding variable in analyses involving the interaction of total PA-scores with other variables (see Yzerbyt et al., 2004).

Main Effects of Condition on Discomfort

Separate univariate analyses of covariance (ANCOVA) were conducted to assess the effect of condition (positive reappraisal vs. control) on discomfort variables (pain intensity, pain valence, positive affective valence, and negative affective valence) both during and immediately after the wall-sit exercise, while controlling for previous exercise experience (total PA-scores).

The ANCOVA showed no significant effect of condition on any of the discomfort variables (Table 1 displays means, p-values and effect sizes of these 8 variables). This suggests that positive reappraisal did not significantly influence participants' reported discomfort levels compared to the control group.

Effect of Condition on Attitudes

To assess the effect of condition (positive reappraisal vs. control) on affective and instrumental attitudes towards the wall-sit exercise, two separate ANOVAs were conducted. Because of the significant negative correlation with instrumental attitude, gender was included as a covariate. The results showed no significant effect of condition on either affective attitude or instrumental attitude, suggesting that the positive reappraisal condition had no significant influence on participants' attitudes after the wall-sit exercise (Table 1 displays means, p-values and effect sizes of these 2 attitude variables).

Table 1

Means of discomfort and attitude variables by condition, and main effect significance and effect sizes.

Measure	Control		Reappraisal		*p*	η^2_p
	M	*SD*	*M*	SD		
Discomfort During						
Pain intensity	7.13	1.38	6.96	1.35	.504	.008
Pain valence	4.90	1.54	5.18	1.59	.603	.005
Positive affective valence	3.60	1.13	3.54	1.07	.890	.000
Negative affective valence	2.53	1.94	2.82	1.09	.373	.014
Discomfort After						
Pain intensity	7.23	1.65	7.04	1.43	.516	.008
Pain valence	4.40	1.59	4.75	1.91	.552	.006
Positive affective valence	4.03	1.07	3.93	1.02	.725	.002
Negative affective valence	2.00	0.91	2.14	0.98	.659	.004
Attitudes						
Affective attitude	4.33	1,00	4.12	1.10	.455	.010
Instrumental attitude	5.23	1.33	5.09	1.16	.653	.004

Note. Total PA-score was included as a covariate only in the analyses of discomfort-related variables, measured both during and after the wall-sit exercise. Gender was included as a covariate only in the analyses of the attitude variables.

Exercise Adherence (2-Week Follow-Up)

A Mann-Whitney U test was conducted to compare the number of wall-sit repetitions performed by participants in the positive reappraisal condition (n = 28) and those in the control condition (n = 30) during the 2-week follow-up period. The use of a non-parametric test was based on a Shapiro-Wilk test ($p < .001$) and a visual inspection of Q-Q plot, conducted prior to the analysis, confirming a non-normal distribution of reported number of wall-sit repetitions at follow-up. The Mann-Whitney U test showed no significant difference between the groups, U = 352.500, p = .238. This suggests that the positive reappraisal intervention did not significantly influence exercise adherence during the 2-week follow-up period.

Moderating Effect of Previous Exercise Experience

Prior to testing the moderating effect of total PA-score on the relationship between the reappraisal intervention and discomfort variables, we examined the potential influence of gender (see Preparatory Analysis). Given the significant positive correlation between gender and total PA-score, to accurately estimate the moderation effect and control for potential confounding by gender, we followed Yzerbyt et al.'s (2003) recommendation and included gender as another moderator, along with the interaction between gender, total PA-score on one hand, and condition on the other hand, in the subsequent ANCOVAs. Therefore, the resulting ANCOVA models included two moderators, namely, the main effects of gender and total PA-score, as well as their interaction terms (condition × gender, condition × total PA-score).

The interaction of total PA-score with condition was only significant for pain intensity after (p = .048, η_p^2 = .073) and approached significance for pain intensity during (p = .056, η_p^2 = .068). The interaction of total PA-score with condition was not significant for other discomfort variables (see Table 2).

Table 2

Results of the ANCOVA model of the interaction effect (condition × total PA-score) for each dependent variable.

Measure	F(1, 52)	*p*	η^2_p
Discomfort During			
Pain intensity	3.814	.056	.068
Pain valence	1.274	.264	.024
Positive affective valence	0.075	.786	.001
Negative affective valence	2.553	.116	.047
Discomfort After			
Pain intensity	4.096	.048*	.073
Pain valence	0.006	.939	.000
Positive affective valence	0.029	.866	.001
Negative affective valence	1.198	.279	.023

Note. The * mark signifies significance at the α = .05 level.

Our hypothesis suggested that participants with less exercise experience would benefit more from the positive reappraisal intervention, showing more favourable changes in discomfort variables. In the first set of analyses to test this hypothesis, we examined the interaction effect between the reappraisal intervention and total PA-score on discomfort-related variables, identifying two significant interactions effects. However, as our hypothesis targeted a specific level of the total PA-score and a comparison between the conditions, further analyses were focused on examining the main effects at different levels of total PA-score (low and high) for all discomfort variables. This approach allowed us to determine whether, consistent with our hypothesis, the effects of the reappraisal intervention varied according to exercise experience, particularly with regard to the anticipated differences between conditions within a low level.

To capture the full effect of total PA-score on the relationship between conditions and the discomfort variables while controlling for the potential confounding effect of gender, the condition effects for participants with high and low levels of exercise experience were computed. By adjusting individual z-scores by ±1 (following Cohen, 2013; Siero et al., 2009) the dataset ($N = 58$) was modelled to represent two levels of Total PA-score (low and high exercise experience), allowing us to examine the effect of the reappraisal condition under different levels of prior exercise experience. Table 3 displays the estimated means of all discomfort-related variables in the conditions by levels of total PA-score, the correlations between the discomfort variables and total PA-score within each condition, and significance of the main effect within levels of total PA-score between conditions.

Table 3.

Results of analysis on effects of low/high modelled PA-score on discomfort variables within conditions, as well as between conditions.

Measure	Control			Reappraisal				
	Low Mean	*High Mean*	*r*	*Low Mean*	*High Mean*	*r*	*p low* (η^2_p)	*p high* (η^2_p)
Discomfort During								
Pain intensity	8.49	6.79	-.514**	7.26	6.94	-.092	.060 (.066)	.360 (.016)
Pain valence	5.69	4.17	-.513**	5.92	5.32	-.116	.645 (.004)	.244 (.026)
Positive affective valence	3.43	3.85	.208	3.29	3.53	.084	.916 (.000)	.772 (.002)
Negative affective valence	2.92	1.92	-.549**	2.99	2.88	-.022	.603 (.005)	.069 (.065)
Discomfort After								
Pain intensity	8.53	6.76	-.467**	7.13	7.03	-.024	.058 (.068)	.319 (.019)
Pain valence	4.66	3.46	-.476**	6.09	4.82	-.233	.631 (.004)	.714 (.003)
Positive affective valence	4.15	4.22	.089	3.47	3.65	-.004	.718 (.003)	.908 (.000)
Negative affective valence	2.28	1.52	-.483**	2.56	2.33	-.038	.639 (.004)	.272 (.023)

Note. The * mark notes a significant correlation at the α = 0.05 level; The ** mark notes a significant correlation at the α = 0.01 level.

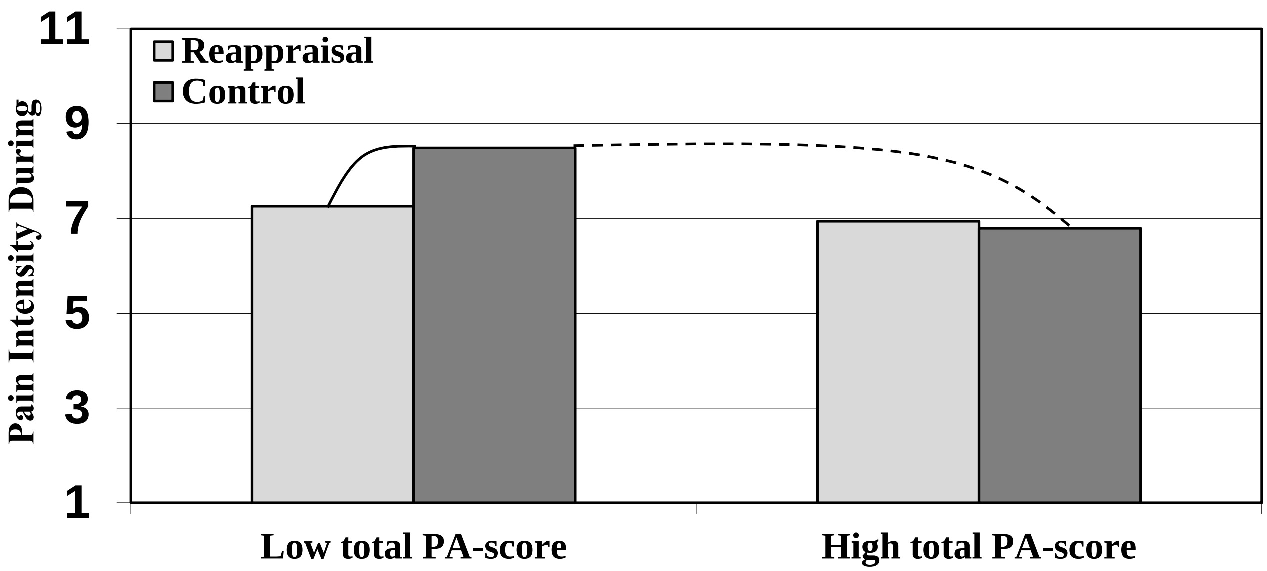
As shown in table 3, in the comparisons within levels of total PA-score between conditions, main effects approaching significance were observed, specifically for pain intensity (during and after) and negative affective valence during (all p's < .069). All three of those comparisons had an effect size of larger than .06, meaning a moderate effect. For pain intensity during, participants with low total PA-score in the reappraisal condition reported lower pain intensity (M = 7.26) than those in the control condition (M = 8.49). For pain intensity after, participants with low total PA-score in the reappraisal condition also reported lower pain intensity (M = 7.03) than those in the control condition (M = 8.23). In contrast, for negative affective valence during, participants with high total PA-score in the reappraisal condition reported higher negative affective valence (M = 2.88) compared to those in the control group (M = 1.92).

Further, 6 out of 8 correlations between total PA-score and discomfort-related variables in the control condition were significant, all indicating a moderate, negative relationship. Thus, for participants in the control condition, higher levels of total PA-score were significantly associated with lower ratings on pain intensity, pain valence, and negative affective valence, both during and after the wall-sit exercise. In contrast, no significant correlations were observed in the reappraisal condition.

Following the results summarized in Table 3, Figures 1 and 2 depict the estimated means of pain intensity rating during and after in the conditions by levels of total PA-score.

Figure 1

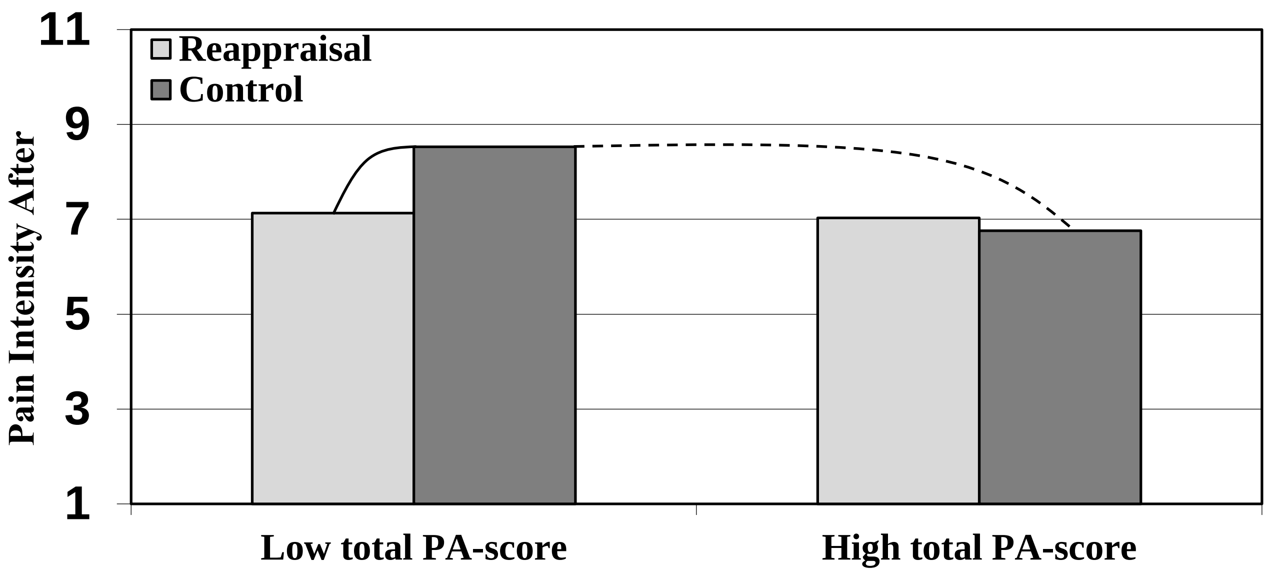
The effects of reappraisal intervention on ratings of pain intensity during the wall sit exercise, moderated by total physical exercise-score.



Note. The dashed lines indicate significant differences (p < .05) and the solid line marks approached significance.

Figure 2

The effects of reappraisal intervention on ratings of pain intensity after the wall sit exercise, moderated by total physical exercise-score.



Note. The dashed lines indicate significant differences ($p < .05$) and the solid line marks approached significance.

Discussion

This study examined the effectiveness of a cognitive reappraisal intervention in influencing exercise-related discomfort variables, affective responses, and adherence to a wall-sit exercise routine. Contrary to initial hypotheses we found no significant differences between the conditions for any of the variables pertaining to discomfort, attitudes and exercise adherence. The possible reasons for these non-significant findings will be discussed in the limitations-section.

However, when prior exercise experience was explored as a possible moderator, one significant interaction effect was observed on pain intensity after the exercise, a core variable of Hypothesis 4, indicating that the reappraisal intervention had a differential impact depending on participants' prior exercise experience. Specifically, participants with low total PA-scores (low exercise experience) in the reappraisal condition reported lower pain intensity ratings compared to those in the control condition. This same pattern emerged for the near-significant interaction effect on pain intensity during the exercise. While these patterns only approached significance, the observed moderate effect sizes ($\eta^2_p > .06$) point to a meaningful trend: cognitive reappraisal may help individuals with low exercise experience to reframe exercise-related pain in a way that reduces its perceived intensity.

These findings are in alignment with the framework proposed by the Self-Regulation of Exercise Maintenance Model, which emphasizes the interplay between episode-specific and general-level interpretations (Herning et al., 2005). Prior to the intervention, participants with lower exercise experience may not have had the necessary, repeated exposure to exercise-related discomfort that is necessary to shape positive general level interpretations (e.g., this pain I feel is a sign of progress) leading to a decreased ability to cope with exercise-related pain. The lower pain intensity ratings after the reappraisal intervention (compared to control) might point to a successful adoption of a coping mechanism that helped the participants to reinterpret pain in a way that reduced its perceived intensity. Furthermore, within the multidimensional account of pain, these results provide evidence that the cognitive-evaluative dimension plays a role in shaping the sensory-discriminative component of pain, reflected by pain intensity ratings (Melzack & Casey, 1968).

Interestingly, a finding approaching significance with a moderate effect size for negative affective valence during the exercise revealed a reversed pattern: participants with high total PA-scores (high exercise experience) in the reappraisal condition reported higher negative affective valence than those in the control condition. This suggests that cognitive reappraisal might have heightened negative affect in more experienced exercisers. However, given the approached significance, caution is warranted in interpreting this result. Future research is needed to replicate and further investigate this effect to determine its reliability and underlying mechanisms.

In addition, correlational analyses revealed that in the control condition, higher total PA-scores were significantly correlated with lower ratings of pain intensity, pain valence, and negative affective valence during and after the wall-sit, while no significant correlations were present in the reappraisal condition. Together these findings might mean that individuals with high exercise experience already possess a coping strategy that seems to be disrupted as soon as cognitive reappraisal is induced. Research shows that habitual exercise is correlated with higher use and success of cognitive reappraisal as an emotional regulation strategy (Giles et al., 2017; Wu et al., 2022). While these studies are correlational and do no imply causation, it is possible that individuals with high exercise experience already developed a tried and tested reappraisal strategy that is different from the one that we have tried to induce during our experiment.

Another possibility is that individuals with high exercise experience tend to use a different coping strategy altogether, for instance distraction. Distraction is a widely used strategy for controlling pain, which involves diverting attention away from painful stimuli (Johnson, 2005). Studies have demonstrated that distraction (e.g., listening to music) can improve ratings on affective responses to exercise (Karageorghis & Priest, 2011; Miller et al., 2016).

Limitations

The study has several limitations that should be considered when interpreting the results. First, the statistical power was limited due to the small sample size, which was roughly half of what we have initially calculated in our Power Analysis (see method section). This limitation might have prevented us from detecting significant results, particularly given the moderate effect sizes observed for key variables such as pain intensity during and negative affective valence during. Furthermore, it might have also hindered the detection of significant effects in the follow-up assessment. Future studies should aim to include a larger sample size to enhance statistical power.

Second, due to the novel nature of the study, the manipulation was newly developed and not tested before. For instance, the length of the manipulation video was 2:22 minutes, but only at around 1:27 the first pictorial association is introduced between “discomfort/pain” and “muscle growth”, while in the audio this association is only completely established at around 1:55. Thus, the actual manipulation was only between 30 seconds and 55 seconds long, which might have been too short to reliably induce cognitive reappraisal. Further, beside the duration, the intensity of the manipulation might have been insufficient, since the pictorial association only consisted of an arrow pointing from “discomfort/pain” to “muscle growth” which might have been too simplistic to support the message effectively. These limitations might have influenced the participants' ability to internalize the reappraisal message and apply it during the second wall-sit exercise, as well as during the follow-up period. Future studies might employ more elements that emphasize the desired association, repeat this association more frequently and increase the duration of the manipulation. Furthermore, studies should also consider testing the manipulation in preliminary studies to ensure its reliability and efficacy before application in larger experiments.

Third, our manipulation check that found no significant difference (p = .756) between the reappraisal and control group, may itself have been flawed. As part of the manipulation check, participants had to rate the physiological processes that took place during the first wall-sit, after watching the manipulation video. That would classify the manipulation check as a retrospective measure of the participants' experience during the first wall-sit exercise. However, the core difference between the manipulation procedure and the control was the provided information that either emphasized a positive association between the uncomfortable sensations and muscle growth or just described the physiological processes. Thus, while, as evidenced by the small effect size (d = 0.082), a larger sample size might have increased the power of the manipulation check and potentially revealed a statistically significant difference, it is the validity of the measure itself that might have been the real issue. A valid alternative manipulation check might have involved questioning the participants about the information provided during the manipulation procedure. Future studies should consider refining and validating manipulation checks in preliminary studies to ensure its reliability and alignment with the experimental goals.

Fourth, the follow-up period posed several challenges. The limitations related to statistical power and the novel nature of the manipulation, as described earlier (see first and second limitation), may have significantly impacted the follow-up assessment. Furthermore, the use of a wall-sit exercise as the follow-up task may have contributed to limited engagement. According to a survey of fitness trends for 2023, strength training with free weights is among the most popular categories (Thompson, 2022). Such training often involves a whole exercise program that targets different muscle categories. The wall-sit alone, might not have been motivating enough for participants to repeat during the 2-week follow-up period. Future studies should consider incorporating exercises or even exercise programs that are more in alignment with popular fitness trends and target diverse muscle categories. Another limitation is that the follow-up relied exclusively on self-reported exercise adherence, which may have introduced recall bias or social desirability effects. Future studies might consider more objective assessment methods (e.g., wearable fitness trackers) to obtain more reliable data on exercise adherence.

Fifth, the persuasive message (that was included at the beginning of the study and meant to support engagement in the exercise during the follow-up, might have influenced participants in ways that biased the experimental manipulation. While the aim of the message was to motivate participants to engage in the wall-sit exercise during the follow-up period, it might also have introduced a positive frame to participants across conditions, thereby weakening the potential effect of the reappraisal intervention. Future studies might consider to leave out a persuasive message and instead formulate a neutral introductory message to better isolate the effects of the manipulation intervention.

Theoretical and Practical Implications

Despite its shortcomings, our study might provide some important theoretical implications. Firstly, our study reaffirms the theoretical framework of the Self-Regulation of Exercise Maintenance Model. In line with the model's premise that episode-specific interpretation are influenced by general-level interpretations we found indications that appraisals of exercise-related sensations such as pain are influenced by prior exercise experiences. This is implied by the significant negative correlations found within the control group, between levels of total PA-score, on the one hand, and pain intensity during ($r = -.514$) and after ($r = -.467$), pain valence during ($r = -.513$) and after ($r = -.476$), and negative affective valence during ($r = -.549$) and after ($r = -.483$), on the other hand. Moreover, our finding that cognitive reappraisal can reduce the perceived pain intensity in less experienced exercisers might constitute an important addition to the model by positioning cognitive reappraisal as a practical mechanism for altering episode-specific interpretations. Future research could explore whether these alterations are confined to the specific episode in which they occur or whether the effects extend to subsequent exercise episodes. Further, our findings also suggest that participants with more extensive exercise experience may rely on well-established general-level strategies (e.g., distraction), which could interfere with the adoption of new episode-specific reappraisal strategies. Secondly, our study reaffirms the multidimensional nature of pain by providing evidence that cognitive reappraisal can influence the cognitive-evaluative component of pain, which in turn shapes sensory-discriminative experiences (pain intensity). Thirdly, our study is an important addition to research on the use of cognitive reappraisal in exercise. Previous research primarily linked cognitive reappraisal to emotional regulation in non-physical contexts. By exploring the effects of induced cognitive reappraisal on exercise-related discomfort, while accounting for the individuals' level of exercise experience, our study represents a valuable addition to the scarce literature available on the application of cognitive reappraisal in exercise settings.

In practice, our study could help practitioners in devising interventions that aim to support individuals in reframing discomfort-related barriers to exercise. This could include coaches or fitness-trainers that work with novice exercisers that might lack the necessary coping mechanisms to appraise exercise-related pain in a constructive way. By learning to reinterpret discomfort through cognitive reappraisal, individuals could, over time, accumulate fewer negative experiences with exercise. It might also be useful for physiotherapist that aim to help patients (e.g., with musculoskeletal conditions) to adopt a training program by addressing discomfort-related barriers early on. However, our study also points to factors that practitioners might need to be attentive to, such as individual differences in exercise experience. Experienced exercisers may not benefit from the same interventions as they already have established coping strategies that align with their exercise routine. Practitioners should therefore carefully assess the individual needs and exercise histories of their clients, tailoring interventions accordingly.

Conclusion

In conclusion, this study highlights the potential of cognitive reappraisal as a strategy for addressing exercise-related discomfort, particularly for individuals with low exercise experience. The findings highlight the significance of recognizing individual differences, such as prior exercise experience, in shaping the effectiveness of interventions aimed at reframing pain and discomfort during exercise. While the results provide initial support of cognitive reappraisal in mitigating discomfort-related barriers to exercise, the novelty of the study calls for replication and further investigation.

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Appendix A

Persuasive Message

Benefits of the wall-sit exercise

In this video several very positive effects of doing the wall sit exercise will be highlighted.

The benefits will be reaped with regular execution. You will already notice a difference in endurance and strength after just a few repetitions. The average beginner starts with 20 to 60 seconds, but you are encouraged to do what suits your fitness level and goals. You will find that you can soon expand your duration.

Now, the positive effects of performing the wall sit will be listed for you.

Firstly, frequently doing the wall-sit exercise will significantly enhance your fitness. It really helps to improve your stamina and condition. This helps you to feel fit during your everyday chores and activities. Such as bending, carrying and walking.

Secondly, doing the wall-sit exercise stimulates your muscle growth and therefore increases your strength. Especially in your back, your butt and your legs. Activities requiring strength will get easier. For example cycling into the wind.

Thirdly, frequent repetition of the wall sit exercise contributes to a better physique.

As explained before, the wall sit exercise enhances fitness and muscle growth, which is great for your physical health. But, just as important for a lot of people: the muscle growth shows in a more toned and muscular body. Your fitness will show in your posture. It may be subtle, but it is something we take into account while evaluating others.

So, frequently doing the wall sit exercise has several attractive benefits you don’t want to miss out on. It enhances your fitness and strength, so that daily activities and chores will become easier for you. This benefits your health, obviously. Besides that, with regular repetition your effort will show in your physical appearance. You will face a more fit and toned body.

Appendix B

Reappraisal text

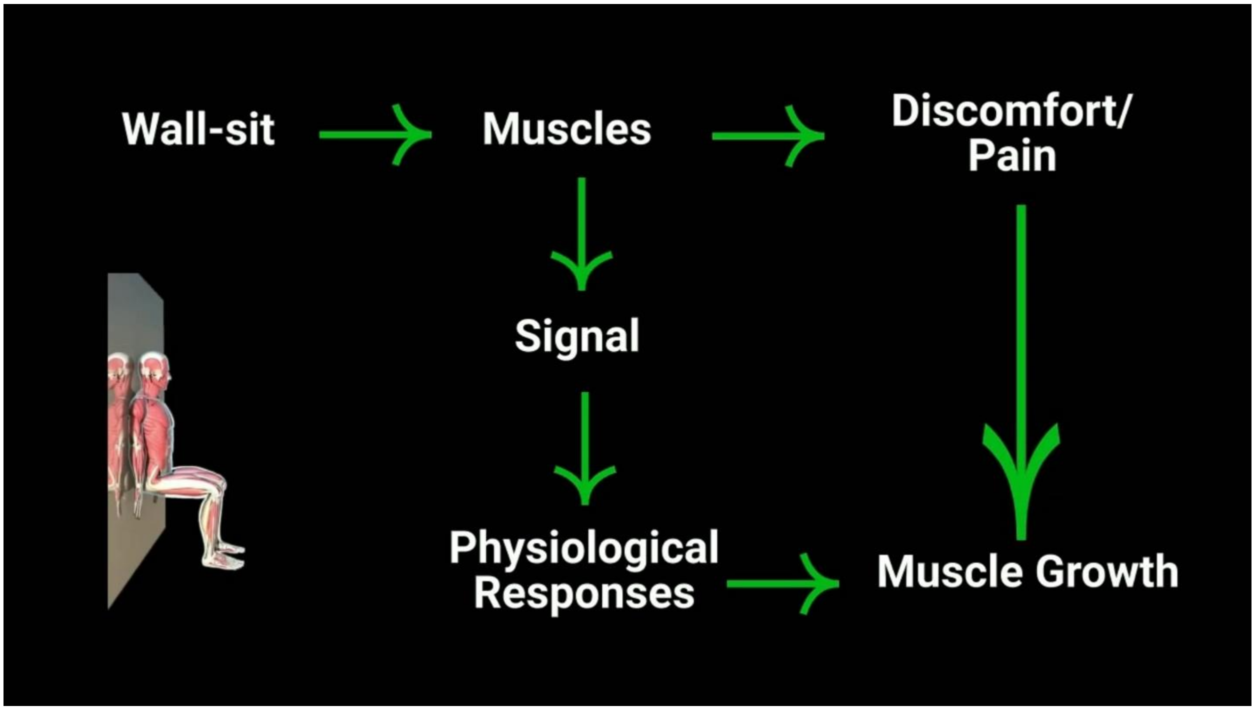
In this video, we will explore the effects of the wall-sit exercise on your physiology. So, you will plant your feet on the ground firmly and put your body into a seated position against the wall. Then something interesting begins to happen within your muscles. With each passing second, your muscles contract and engage. They are working hard to support your body in this challenging position. As the seconds pass, you may start to feel a sensation of discomfort in your legs. This sensation is often referred to as some kind of pain. But it is a very natural response to the intense physical effort your muscles are exerting.

Here is where things get truly fascinating. As you hold the wall-sit position, your muscles are undergoing a process known as hypertrophy. This process involves the enlargement of your muscle fibres, leading to increased muscle strength.

Now, let's break it down further. The discomfort you're feeling is not just random pain. It is a signal from your muscles that they are being challenged and stimulated. Indeed, as you continue to hold the wall sit, your body responds by activating a cascade of physiological responses. These are designed to support muscle growth. The blood flow to your muscles increases to be able to deliver essential nutrients and oxygen needed for maintenance and increased strength. Meanwhile, your muscle physiology triggers the body to rebuild your muscles to make them stronger than before.

So, what does this mean for you? It means that the discomfort you are experiencing while doing the wall-sit is not in vain. It is a sign that your muscles are adapting and growing, becoming more resilient with each passing moment and every time you experience the discomfort. So embrace it. Because the discomfort is a sign that you are on the path to building a stronger, healthier, and more resilient body. The discomfort means that you are becoming a stronger and fitter version of yourself.

Reappraisal Pictorial Element Example



Control text

In this video, we will explore the effects of the wall-sit exercise on your physiology. So, you will plant your feet on the ground firmly, and put your body into a seated position against the wall. It is as if you are sitting on a chair, but you are carrying your weight yourself.

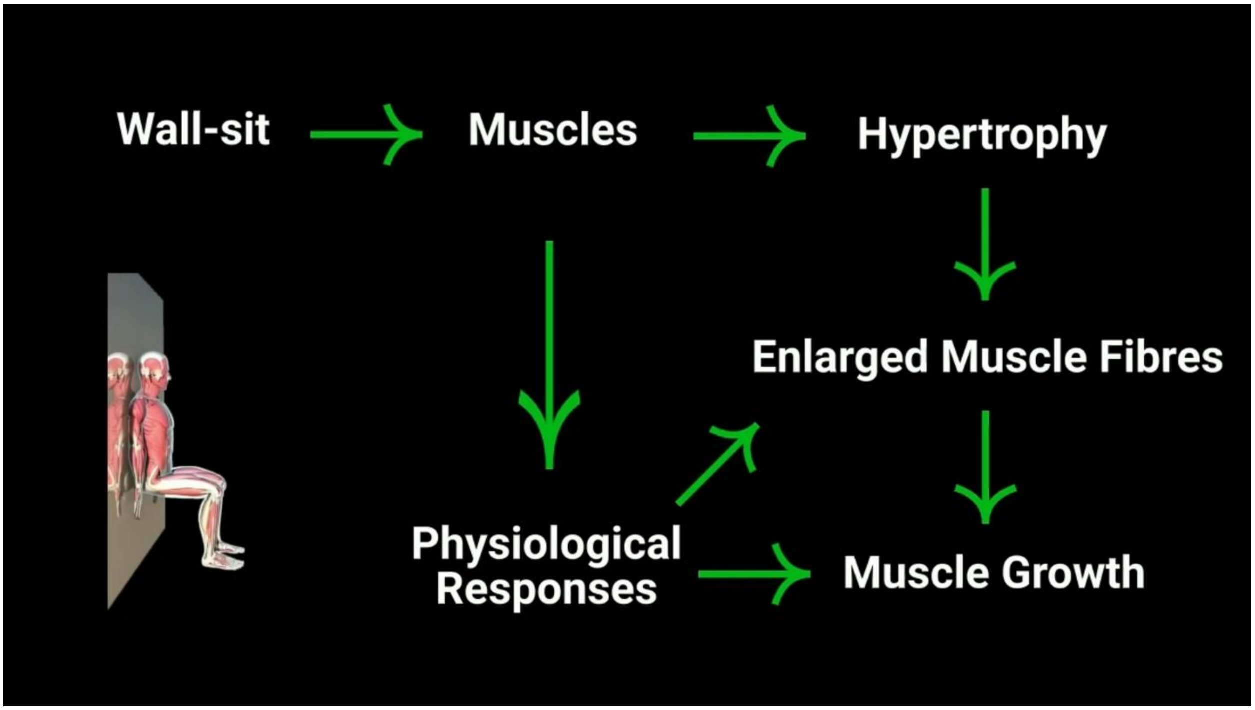
Then something interesting begins to happen within your muscles. With each passing second, your muscles contract and engage, working to support your body in this position. Although the position may not seem very natural, the muscles it activates are used all day.

But here is where things get truly fascinating. As you hold the wall-sit position, your muscles are undergoing a process known as hypertrophy. Your muscles are composed of many muscle fibres, and the process involves the enlargement of these muscle fibres. Which leads to increased muscle mass and muscle strength.

Now, let's break it down further. As you continue to hold the wall-sit, your body responds by activating a cascade of physiological responses designed to support muscle growth. The blood flow to your muscles increases, delivering essential nutrients and oxygen needed for maintenance and growth. So each single muscle fibre will be influenced and will receive more of what it needs to grow. Thus, your muscle physiology triggers the body to build your muscles, to make them stronger than before.

So, what does this all mean for you? by engaging in the wall-sit, your muscles are adapting and growing. They become stronger with each passing moment and every time you engage in the wall-sit. It means that you are becoming a stronger and fitter version of yourself.

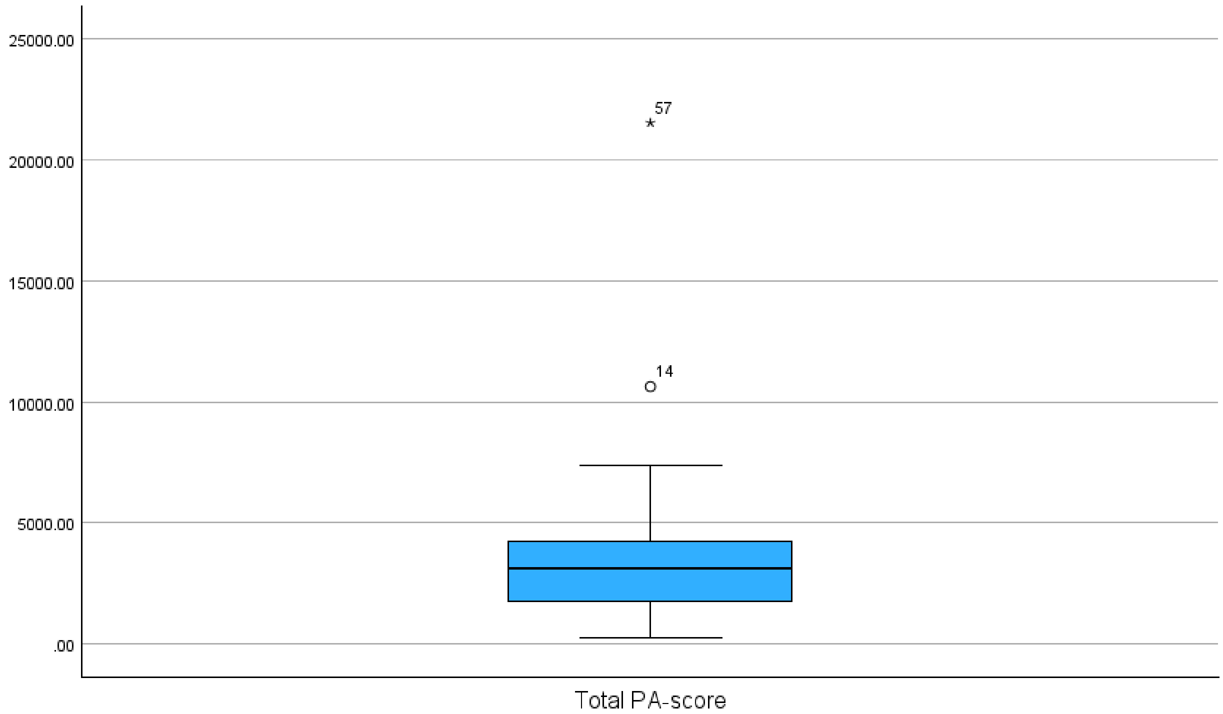
Control Pictorial Element Example



Appendix C

Figure C1.

Box-plot visualization of Total PA-score outliers.



Note. Participant ID's 14 and 57 with a total PA-score of 10638 and 21546 respectively, are identified as outliers.