Reappraisal of Exercise Discomfort: The Moderating Roles of Previous Experience and Gender on Affective Responses and Future Behaviour

Laura Hummel

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Department of Psychology
University of Groningen
Examiner/Daily supervisor:
prof. dr. Arie Dijkstra

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Abstract

Physical inactivity is a significant societal issue, often hindered by practical barriers. Muscular discomfort during exercise negatively affects exercise adherence, underscoring the need for effective regulation strategies. Cognitive reappraisal (CR), a technique for reinterpreting negative experiences, has improved affective responses across various health domains. However, its application to muscular discomfort remains underexplored, with only one study reporting reduced negative affect towards sensations. The current study investigates whether CR can reduce negative affective responses and enhance exercise adherence over 14 days, considering the moderating effects of previous exercise experience (PEE) and gender. Participants were randomly assigned to a reappraisal (N = 29) or neutral condition (N = 32), with the manipulation involving a video linking discomfort with muscle growth. Results indicated that CR significantly reduced perceived intensity for participants with low PEE ($p = .019$) but increased intensity for those with high PEE ($p = .023$). Additionally, women reported reduced negative affect towards sensations, while men experienced an increase ($p = .037$). Although CR did not directly impact exercise adherence ($p = .275$), significant correlations were found between negative affect after exercise and subsequent affective attitude ($p = .008$) and adherence ($p = .020$). While CR may help some individuals navigate discomfort and reduce the negative affective experience, its impact on long-term adherence needs further exploration, particularly regarding individual differences.

*Keywords: c*ognitive reappraisal, physical exercise, discomfort, affective response, exercise maintenance, individual differences

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Despite the well-known long-term benefits of regular physical exercise (PE) for overall health, reality shows an alarming 27% of insufficient activity worldwide which contributes to a growing public health crisis (WHO, 2022). Adequate physical exercise lowers the risk of early death and extends lifespan (de Rezende et al., 2014). More specifically, the risk of the development of diabetes, hypertension and several forms of cancer decreases with regular performance of exercise (Miller et al., 2016). Although mere awareness of such major health benefits may be sufficiently motivating to initiate exercise behaviour, it appears insufficient for sustainment in the long run (Kwashnicka et al. 2016). This is highlighted in interventions that effectively promote exercise initiation but fail in stimulating maintenance (Rhodes et al., 2012). To ultimately stimulate people in lifelong PE, understanding the behaviour change process is essential. As important, insight into barriers to sustained exercise must be gained and strategies to overcome these obstacles should be explored.

Cognitive Framework of Behaviour Change

Behavioural theories have identified outcome expectations as a significant factor in the process of behaviour change (see; Bandura, 1986). Outcome expectations are positive or negative beliefs about the consequences of engaging in a behaviour (Lippke, 2017). Positive outcome expectations, such as health benefits, enhance the likelihood of performing the behaviour by forming positive attitudes (Bandura, 1986; Ajzen, 1991). On the other hand, negative outcome expectations such as perceived risks or barriers, can hinder behavioural performance (Rosenstock, 1974). Given that predominantly positive expectations are essential for sustaining behaviours, balancing both negative and positive expectations is crucial (Rothman, 2000).

Behavioural initiation is often driven by long-term goals and positive outcomes such as improved health and well-being (Michaelsen et al., 2023). However, as engagement in behaviour continues, this future-oriented focus shifts towards immediate experiences (Rothman et al., 2000; Williams et al., 2012). Positive assessments of immediate outcomes play a central role in maintaining adherence, which makes these immediate evaluations critical. For example, Hertel et al. (2008) found that favourable expectations about smoking cessation increased initiation, while positive immediate outcomes predicted maintained cessation. Consequently, satisfaction with the behaviour and outcomes strengthens positive future expectations (Rothman, 2004).

Behavioural satisfaction emerges from an ongoing mental evaluation of experiences, where the perceived benefits and drawbacks of behaviour, referred to as the "pros and cons", are continuously balanced (Bandura, 1986; Bouton, 2000). In this process, current experiences are integrated with memories, forming a cognitive framework that influences decision-making. Satisfaction reflects a favourable mental weighing, where the decision is tilted towards continued engagement.

With experiences, cognitive balancing contributes to the development of an affective attitude toward future behaviour. Affective attitude refers to the emotional response toward performing a specific behaviour (Ajzen, 1991). It significantly influences future engagement by promoting either an approach or avoidance tendency (Elliot, 2001). This way, positive affective attitudes serve as a key motivator for continued participation in PE.

Barrier of Muscular Discomfort in Exercise Behaviour

The shift towards the evaluation of immediate experiences leads to increased visibility of the practical barriers and challenges associated with maintaining the behaviour (Bouma et al., 2024). This is reflected in the balancing of pros and cons, where initial positive evaluations give way to a more critical assessment of the immediate drawbacks of the behaviour (Deci & Ryan, 2000). The result is an increased awareness of factors such as discomfort or external constraints. This can diminish the overall positive perception of the behaviour and impact satisfaction negatively (Rothman, 2004). Addressing barriers early in the behaviour change process can reduce negative expectations and increase the likelihood of sustained behaviour (Glanz et al., 2015).

One major barrier to sustained PE is muscular discomfort felt during intensive exercise. The affective response that follows is an immediate emotional reaction to the sensations felt during exercise (Ekkekakis et al., 2012; Rhodes et al., 2015). Discomfort increases with exercise intensity, shifting the mental balance by making the negative more prominent (Lopes et al., 2022; Berman, 2019). The adverse impact of discomfort on behavioural maintenance shows in high dropout rates observed in supervised exercise (Dishman et al., 1985). Since sensations of discomfort cannot be eliminated as exercise intensity increases, it is crucial to explore ways to cope with this experience.

Cognitive Reappraisal: Lowering Negative Affective Impact

One potential strategy to reduce the negative emotional impact of discomfort felt during exercise is cognitive reappraisal (CR). With CR, the immediate negative response to an affective experience gets re-evaluated to a less negative one (Gross, 1998; Denny et al., 2023). Considering discomfort, a new association will be formed between the aversive sensations and positive outcomes, such as muscle growth. This association gets consolidated in long-term memory (Eysenck & Keane, 2015). With continued engagement in exercise, the long-term memory association, or reappraisal, is activated and integrated with the current experience of discomfort. This repeated activation aligns with the concept of associative learning, where the strength of an association between stimuli and responses increases with repeated exposure (Rescorla & Wagner, 1972). As the positive association of discomfort and muscle growth gets more embedded in memory, the negative impact on the affective experience reduces. Besides altering immediate perceptions, this process also supports the idea that long-term attitudes towards exercise may gradually shift (Kolb, 1984; Hofmann et al., 2008). All in all, by forming a new positive association, CR has the potential to navigate negative affective experiences and stimulate longer-term attitudes.

Previous Research on Cognitive Reappraisal Applied to Exercise Discomfort

Research in other health domains has demonstrated that CR can foster positive changes in negative affect and reduced rates of depression (Khasdan et al., 2006; Garnefski, 2006). However, its application to discomfort in exercise behaviour is relatively understudied. To our knowledge, only one study has explored the effect of CR on muscular discomfort felt during exercise. In this study, Berman (2019) examined the immediate affective experience by measuring the perceived intensity of sensations, affect towards sensations and the overall experience. Participants either received a text emphasising muscle growth as a positive outcome of exercise-related pain (positive reappraisal) or a text emphasising muscle damage (negative reappraisal). The study found that participants exposed to the positive text reported a decreased negative affect towards sensations, which suggests the potential effectiveness of CR in lowering negative affective exercise experiences (Berman, 2019). However, despite this promising finding, the study did not investigate the effects of CR on subsequent affective attitude towards future behaviour and actual exercise maintenance.

Another limitation of Berman's study (2019) is the exclusive focus on retrospective evaluations of the discomfort. Individuals often evaluate their experiences both during and after the activity, and both timings can predict future behaviour (Rhodes et al., 2015). When theorising about learning from experiences and forming outcome expectations, retrospective evaluations are particularly important. These evaluations involve reflective processing and the integration of experiences into long-term memory. This is crucial for developing stable outcome expectations that guide future behaviour (Strack & Deutsch, 2004; Hofmann et al., 2008). Reflective processing is suggested to be harder to engage in during exercise due to the immediate physical demands, which can skew immediate evaluations (Ekkekakis et al., 2011). The differential effects of reappraisal on immediate and retrospective evaluations of the exercise experience remain an understudied area of focus.

Additionally, Berman's study (2019) did not account for individual differences that may moderate the effectiveness of CR strategies. For example, it is indicated that more experienced individuals typically develop greater tolerance and coping mechanisms for discomfort (Dishman et al., 2004; Ekkekakis, 2009). In contrast, less experienced exercisers might find discomfort more daunting and lack adequate coping strategies, which could make them more responsive to CR interventions (Rhodes et al., 2011). In conclusion, it could be valuable to expand the literature on CR applied to affective experiences in the exercise domain by exploring longer-term effects, individual differences in previous experience and timing differences.

The main concepts used in this study are summarised in Table 1 and the relationships between these concepts are illustrated in Figure 1.

Table 1

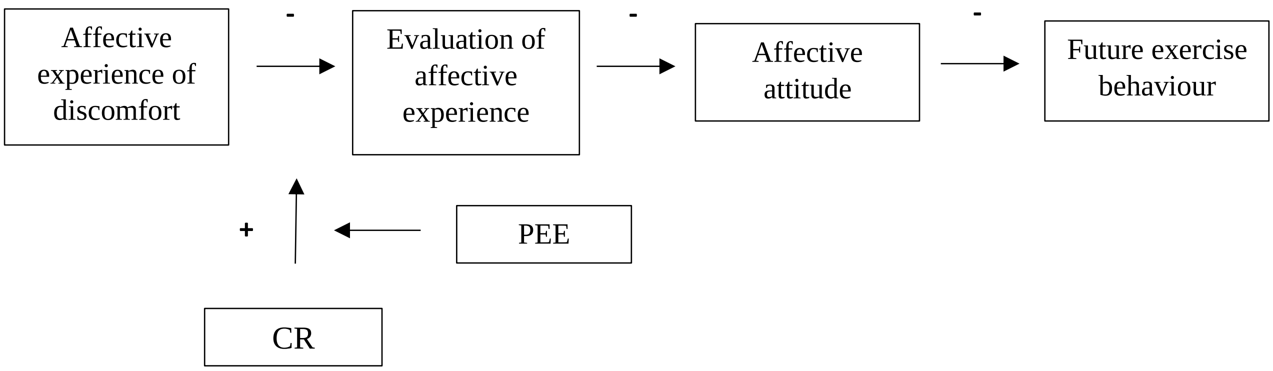
Main Theoretical Concepts

Concept	Explanation
Affective experience	Situation that elicits an immediate emotional reaction, such as discomfort during exercise
Evaluation of the affective experience	Process of assessing the affective experience
Affective attitude	Emotional response towards a specific behaviour, formed by affective experiences
Exercise adherence	Continued engagement in PE, influenced by evaluation of experiences and affective attitude
Cognitive reappraisal (CR)	Emotion-regulation strategy to navigate a negative affective experience, by inducing a positive cognitive interpretation
Previous exercise experience (PEE)	Individual differences based on past engagement in exercise behaviour, possibly moderating the effectiveness of CR

Note. This table presents the main concepts that underlie the current research framework. They provide the theoretical and conceptual basis for the hypotheses and analyses conducted in this study.

Figure 1

Conceptual Framework



Note. This figure shows the theorised relationships between the main concepts presented in Table 1. CR indicates the emotion regulation strategy of cognitive reappraisal. PEE indicates previous exercise experience, which is expected to have a moderating role in the effectiveness of CR.

Current Study: Research Question and Hypotheses

This experimental study builds on Berman's work (2019), by exploring the impact of CR on the affective experience, the affective attitude towards future behaviour, and exercise maintenance. Besides, it addresses the limitations of Berman's study by examining both immediate and retrospective evaluations, and by considering the moderating effect of previous exercise experience (PEE). Furthermore, the current study involves a neutral control condition, as opposed to a negative condition (Berman, 2019).

The research question is: What is the effect of cognitive reappraisal of muscular discomfort felt during exercise on the affective experience, affective attitude and exercise maintenance, and what is the role of previous exercise experience?

CR is used to target the negative affective experience of muscular discomfort by interpreting the sensations as a positive signal of muscle growth. This strategy is hypothesised to lower the perceived intensity of sensations, negative affect towards sensations, and negative affect towards the overall exercise experience (Berman, 2019) (H1).

Research indicates that retrospective evaluations, which involve reflective processing, integrate experiences into long-term memory and significantly influence future behaviour (Hofmann et al., 2008). Given the immediate physical and emotional demands during exercise, there is limited space for reflective processing. Since CR relies on reflective processing, it is suggested to be more effective after exercise (Ekkekakis, 2003; Strack & Deutsch, 2004). Consequently, we hypothesise that CR will have a more substantial effect on the evaluation of the affective experience shortly after exercise compared to during exercise (H2).

The Theory of Planned Behaviour argues that attitudes significantly predict intentions and behaviours, suggesting that more positive affective attitudes will enhance future exercise adherence (Ajzen, 1991; Rhodes & Kates, 2015). Therefore, CR is hypothesised to positively influence the affective attitude towards future exercise experiences (H3).

By reducing the negative evaluation of the affective experience and positively influencing affective attitudes, CR is hypothesised to enhance exercise adherence. (Williams et al., 2008) (H4).

Previous research suggests that less experienced exercisers are more susceptible to negative affective responses and may benefit more from strategies that reframe discomfort positively (Dishman, 2004; Ekkekakis et al., 2011). Following this, it is hypothesised that CR will have a more substantial effect on the evaluation of the affective experience, affective attitude and exercise adherence of inexperienced individuals compared to more experienced individuals (H5).

Method

Recruitment and Criteria

Recruitment and experimental execution took place from mid-April until the first week of May, 2024. A total of 61 participants were recruited in two ways: psychology students at the University of Groningen were offered course credits for participating in the study (N = 18), and students at the Faculty of Behavioural and Social Sciences were approached directly and informed about a chance to win one of six prizes of €50.00 (N = 43). Inclusion criteria required participants to be at least 18 years old. Exclusion criteria included any physical condition that would hinder performing the wall-sit exercise. It was communicated during recruitment that a study was conducted on “the perception of physical sensations during a specific physical exercise". Participant descriptives are included in the results section.

Design

The experimental study with follow-up after two weeks used a mixed design by combining within-subjects and between-subjects elements. A within-subjects analysis was used to explore differences between the evaluation of the affective experience during and shortly after the wall-sit exercise. Between-subjects measurements were included to investigate the impact of CR on the affective experience, affective attitude, and exercise maintenance. Participants were assigned to one of two conditions (positive reappraisal vs. control) using an automated randomisation feature in the Qualtrics questionnaire platform. The affective experience and affective attitude were assessed in the experimental part of the study. Two weeks later, these variables were examined again in an online follow-up questionnaire, as well as a self-report measure of exercise repetitions in the past two weeks. The wall-sit exercise was chosen for this study for several reasons. The exercise is controlled and static, which leaves little room for differences in execution or potential injuries. Besides, not much time or effort is needed to induce a consistent physical strain. The study (PSY-2324-S-0107) received approval from the Ethical Committee Psychology (ECP) of the Faculty of Behavioural and Social Sciences.

Experimental Procedure

The experiment was conducted in various rooms within the faculty building, generally sized to accommodate around six people. Noise and other distractions from outside the room were minimal. During the study, the researcher sat in a chair while participants filled out the questionnaire. To minimize influence, the researcher maintained a comfortable distance, not facing the participants, and focused on other tasks such as using a laptop or writing in a notebook.

Initial Briefing and Consent

Participants were first briefly informed about the experimental procedure. They were told that they were about to answer questions on a laptop via Qualtrics, watch videos, and perform the wall-sit exercise twice. Participants then started the Qualtrics questionnaire, which included sections for informed consent, demographics, exercise routine, and a video on the benefits of the wall-sit exercise.

Video Message on Physical Benefits of the Exercise

After answering questions on demographics and exercise routine, all participants were first exposed to a video describing the physical benefits of regularly performing the wall-sit exercise. For example, the video mentioned enhancement of fitness, increased strength, ease in executing daily activities, and improved physique. This exposure aimed to induce positive outcome expectations before the manipulation and performance of the wall-sit exercise. The purpose was to ensure that all participants had an initial motivation to perform the behaviour, thereby creating a baseline of positive expectations that could influence their engagement in the exercise. This video was shown before the experimental manipulation to standardise the initial motivation level across all participants (see Appendix A for the spoken text).

Baseline Measurement

Subsequently, participants received instructions from the researcher on how to correctly perform the wall-sit exercise. They were instructed to perform the wall-sit until it started to feel uncomfortable, during which their performance time was recorded to establish an individual baseline measurement.

Experimental Manipulation

Participants were then exposed to the core manipulation. This video presented either positive interpretations of muscular sensations (experimental condition) or neutral information on physical responses during exercise (control condition). A detailed description is provided below. A manipulation check was conducted to determine whether the video message effectively communicated the intended positive reappraisal. This involved measuring participants' perceptions of the positivity of the physiological processes described in the video.

Second Wall-Sit and Immediate Experience

Participants were instructed to perform the wall-sit exercise again. Approximately 5 to 10 seconds before their previously recorded baseline time, the researcher held up the scales, and participants verbally indicated their experience. The researcher then circled the indicated responses on the printed scales (Calibri typeface, font size 11).

Post-Exercise Questionnaire

After the second wall-sit, participants sat down and completed another section of the questionnaire, starting with a 30-second rest period tracked by a timer. This section included questions about their retrospective experiences using the same four scales, as well as their affective attitudes towards the future performance of the exercise.

Follow-Up and Debriefing

Participants provided their email addresses to receive a follow-up questionnaire in 14 days and to participate in a cash lottery. After 14 days, participants completed an online follow-up survey, assessing their exercise behaviour since the initial study and reassessed certain variables. Finally, participants were debriefed about the actual purposes of the study and winners of the cash lottery prizes were informed by email.

Positive Reappraisal and Control Condition

Of all 61 participants, 29 randomly assigned individuals were exposed to a video containing the positive reappraisal of muscular sensations experienced during the wall-sit exercise. In this video, the physiological responses occurring from a certain exercise intensity were described and a positive association between the uncomfortable sensations and muscle growth was emphasised five times throughout the text. The visuals consisted of important keywords from the spoken text placed in schematic form. Specifically, “muscles” was linked to “signal”, “physiological responses” and “muscle growth”, as well as to “discomfort/pain” which was also linked to “muscle growth”. See Appendix A for a screenshot of the schema. The link between “discomfort/pain” and “muscle growth” was emphasised with a bold and moving arrow. The video fragment had a duration of two minutes and 22 seconds.

The video of the control condition described the physiological responses occurring from a certain exercise intensity factually. No particular emphasis was placed on the positive association between uncomfortable muscular sensations and muscle growth. The keyword “muscles” was linked to “physiological responses” and “muscle growth”, as well as to “hypertrophy”, “enlarged muscle fibres” and “muscle growth”. The keyword of “discomfort/pain” used in the manipulation video was not added to this schema. The video fragment of the control condition had a duration of two minutes and one second. Appendix A includes the complete spoken texts that were used.

All three spoken texts in the video, on the benefits of the wall-sit exercise and both the experimental and control condition, were created using an online artificial intelligence (AI) programme named Eleven Labs (https://elevenlabs.io/app/speech-synthesis). A male voice with normal intonation and tone was selected and used for the video.

Measures

Demographics

Participants were asked to provide demographic information, including *gender, age, cultural background,* and *current educational level*. Gender was recorded as male, female, or other. Age was reported in years. Participants specified their cultural background by selecting from a list of all existing countries. Educational level options included Bachelor's, Master's, or other.

Participants reported their weekly exercise behaviour using the International Physical Activity Questionnaire (IPAQ) short-form (Craig et al., 2003). Examples of activities provided were “Football” for vigorous exercise and “Bicycling at a regular pace” for moderate exercise.

Exercise Behaviour

Weekly exercise behaviour was assessed using the IPAQ short form (Craig et al., 2003) and the guidelines for scoring provided by the IPAQ Scientific Group (2004). Participants first indicated the number of weekdays they were active in each category for at least 10 consecutive minutes (“During the last 7 days, on how many days did you do vigorous physical activities for at least 10 minutes consecutively?”). Participants then reported the hours and minutes spent on physical activity on a typical day (“On average, how much time did you spend on vigorous physical activities on one of those days?”).

To calculate weekly exercise behaviour, reported daily minutes were converted to total minutes per day for each category. These totals were then multiplied by the number of days active to get weekly minutes per category. Each category's total minutes were multiplied by its MET value (walking = 3.3 METs, moderate exercise = 4.0 METs, vigorous exercise = 8.0 METs). METs are multiples of the resting metabolic rate, accounting for the energy requirements of each exercise category (Sjostrom et al., 2005). These MET scores were summed to create a total MET score, representing the individual's overall physical activity level.

Based on the IPAQ guidelines (IPAQ Scientific Group, 2004), participants were classified into three categories. The inactive category includes participants who engage in minimal or no physical activity. Minimally active participants engage in some physical activity but do not meet the criteria for the HEPA (Health-Enhancing Physical Activity) category. Participants in this category accumulate a high level of physical activity that exceeds the minimum public health recommendations, leading to additional health benefits.

Measures of the (Immediate) Affective Experience

The affective experience was measured during and immediately after the exercise experience (approximately 2 minutes). All four scales used in the study are identical for both the measure during and the measure after the exercise of the affective experience. The only differentiation is that for the measurements afterwards, participants were asked to indicate how they now felt about the exercise experience when thinking back.

Intensity of Sensations. The intensity of muscular sensations during and after the exercise was measured using an 11-point rating scale (Duncan et al., 1989). The question stated for the immediate measurement was "What is the intensity of the sensations in your muscles?" The question for the retrospective measurement was "What was your experience of the intensity of the sensations in your muscles during the exercise you just performed?" The 11-point scale included the following anchors: *No sensation at all* (1), *Barely perceptible* (2), *Very mild* (3), *Mild* (4), *Moderate* (5), *Barely strong* (6), *Strong* (7), *Intense* (8), *Very intense* (9), *Extremely intense* (10) and *Most intense imaginable* (11).

Valence of Sensations. The valence of the sensations was measured using a 9-point numeric rating scale on unpleasantness (Duncan et al., 1989). As the experiment was designed so that all participants experienced self-reported discomfort in their muscles, the experience was inherently unpleasant. The question stated for the immediate measurement was "How unpleasant are the sensations in your muscles?" The question for the retrospective measurement was "How unpleasant were the sensations in your muscles during the exercise you just performed?" The single-item 9-point, unipolar scale ranged from *Not unpleasant at all* (1) to *Most unpleasant imaginable* (9). Numbers two until eight were indicated between both extremes of the scale.

Positive and Negative Valence of Overall Experience. To assess the valence of the overall exercise experience, the Feeling Scale (Russel, 1980) was adjusted. The Feeling Scale, as used in the study of Berman (2019), is a single-item, 11-point, bipolar rating scale ranging from *Very bad* (5) to *Very good* (+5), with *Neutral* (0) serving as a midpoint. The overall exercise experience can be evaluated positively and negatively, as it involves various aspects. Therefore, the Feeling Scale was split into two unipolar rating scales: one assessing negative valence and the other positive valence. The question stated for the immediate experience was "How positive/negative do you value the overall exercise experience?" The question for the immediate experience was "Please think back to the last exercise experience. How positive/negative would you NOW value the overall exercise experience?" The negative valence scale ranges from *Neutral* (0) to *Very negative* (-5), and the positive valence scale ranges from *Neutral* (0) to *Very positive* (+5). Verbal anchors were given to uneven numbers (*Fairly negative* (-1) and *Negative* (-3), *Fairly positive* (+1) and *Positive* (+3)).

Affective Attitude

The affective attitude was assessed towards adherence to a hypothetical scheme of 2 wall-sit repetitions a day, 3 days per week. Semantic differential scales were used for four items to assess affective attitudes ("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 ranging from 1 to 7 (Cronbach's α = .77).

The four subscales were analysed individually for the initial main hypothesis on affective attitude (Hypothesis 3) to understand their unique contributions. Subsequently, a composite mean score of affective attitude was calculated by averaging the scores of the four subscales and used for moderation analyses.

Manipulation Check

All participants were asked to rate the positivity of the physiological processes that took place during the wall-sit after exposure to the video (manipulation or control). A 9-point scale with 3 verbal anchors was used: *Not positive at all* (1), *Positive* (5) and *Extremely positive* (9).

Follow-Up Measure on Exercise Maintenance

Actual future behaviour of the wall-sit exercise was measured as the number of repetitions in the past 14 days. Participants had to indicate the number of days on which they performed the wall-sit (range 0-14) and how many times they had performed the wall-sits in total (range 0-140).

Power Analysis

G*Power software was used to calculate the sample size needed to achieve a statistical power of .80 and an effect size of .25 (Faul et al., 2007). From this power analysis, a sample size of 128 participants was considered sufficient to detect small to medium effect sizes for the planned analyses. However, the final sample size was reduced to 61 participants due to practical constraints and the exploratory nature of the research objectives. This sample size can be considered sufficient for preliminary insights, but may have limited the power to detect more nuanced interaction effects.

Non-Included Data

Several questions in the Qualtrics questionnaires were included as exploratory factors. Self-efficacy, behavioural expectation and instrumental attitude were assessed after the manipulation during the experimental part of the study. Furthermore, retrospective follow-up questions on the affective experience, change in exercise routine after follow-up, and whether participants looked up information on the wall-sit exercise during the follow-up period were assessed in the follow-up questionnaire. While this data could offer valuable insights, it was not included in the current study's analyses as the primary research focus and hypotheses were already substantial. However, this exploratory data may be utilised in future research to further examine related aspects of exercise behaviour and CR.

Results

Participant Characteristics and Exclusion

A total of 61 participants (29 males, 31 females, 1 identifying as other) with a mean age of 22.20 years (*SD* = 2.86) were included. Participants were predominantly Dutch (52.5%) or German (26.2%) and primarily engaged in higher education. The average total MET score was 3553.82 minutes per week (*SD* = 3074.57), with 95.1% of participants considered minimally active and 54.1% HEPA active. One participant who identified as non-binary was excluded from gender-based analyses, leaving 60 participants for those analyses.

Missing Data

Data for minutes spent on vigorous exercise was missing for four participants. These were imputed with values aligning with the mean score of 204.30 minutes.

Preliminary Analyses

Manipulation Check

Participants rated the positivity of physiological processes during the wall-sit to assess the effectiveness of the manipulation. No significant difference was found between the mean score of the CR group (*M* = 6.63, *SD* = 1.76) and the mean score of the control group (*M* = 6.52, *SD* = 1.38), ($t(59) = .27$, $p = .79$, $\eta^2_p = .001$). Therefore, it cannot be concluded that the participants perceived the manipulations as intended.

Inclusion of Previous Exercise Experience and Gender as Covariates

Previous exercise experience (PEE, defined by the total MET minutes per week) was included as a covariate to control for participants' habitual activity levels, as it could influence their familiarity with exercise-related discomfort. Gender was also included due to documented differences between females and males, about both physiology and emotional responses to exercise (Campos-Uscanga et al., 2023; Dominelli et al., 2022). Including both PEE and gender as covariates allows for a more accurate assessment of the intervention by reducing potential confounding effects. Appendix B includes the main analyses without covariates for transparency.

Preliminary analysis revealed that gender and PEE were not significantly correlated ($r = .11$, $p = .41$) (Table B1). This suggests that these factors can be treated as independent in the subsequent analyses in models where both are included as predictors.

Randomisation Check

A chi-square test showed no significant association between gender and condition assignment ($\chi^2(1) = .067$, $p = .80$), and a t-test indicated no significant difference in PEE between conditions ($t(59) = -.16$, $p = .87$). These randomisation checks confirmed that participants were equally distributed across conditions based on gender and PEE.

Normality and Homogeneity Tests

Normality was assessed using the Shapiro-Wilk test, which showed that the data was generally not normally distributed, except for affective attitude ($W(61) = .97$, $p = .14$). Levene's test for homogeneity of variances was non-significant for all variables, indicating equal variances across conditions (see Table B2). Since ANOVA is considered robust with N > 30 per group, we chose to use this type of analysis despite violations of normality (Field, 2013). Results should still be interpreted with caution.

Descriptive Statistics

Descriptive statistics for the evaluation of the affective experience, affective attitude, and exercise adherence are presented in Table 3. Subscales of affective attitude (e.g., enjoyment, pleasantness) are in Appendix B3, though they were not analysed further due to their limited relevance.

Table 3

Descriptive Statistics and Summary of ANCOVA Main Effects

Dependent variables	Condition	Timing	*N*	*M*	*SD*	*F*	*p*	η^2_p
Intensity of sensations	*R*	*D*	29	7.00	1.34	.30	.584	.01
		A		7.07	1.41	.38	.542	.01
	C	*D*	31	7.06	1.41			
		A		7.16	1.68			
Negative valence of sensations	*R*	*D*	29	5.21	1.57	2.62	.112	.05
		A		4.87	1.52	5.33	.025*	.09
	C	*D*	31	4.79	1.90			
		A		4.39	1.56			
Negative valence overall	*R*	*D*	29	2.79	1.08	1.84	.181	.03
		A		2.14	.95	5.07	.028*	.09
	C	*D*	31	2.52	1.03			
		A		1.97	.91			
Positive valence overall	*R*	*D*	29	3.59	1.08	.45	.505	.01
		A		3.97	1.02	2.95	.092	.05
	C	*D*	31	3.61	1.12			
		A		4.06	1.06			
Affective attitude	*R*		29	4.18	1.31	.07	.800	.00
	C		31	4.34	.99			
Exercise adherence	*R*	*F-E*	29	2.31	3.40	1.22	.275	.02
	C		31	2.42	2.16			

Note. This table presents the descriptive statistics for each dependent variable across conditions. The results of the ANOVA (with covariates of gender and PEE) test whether there are statistically significant differences between these two conditions. A significant p-value (*p < .05) indicates a significant difference between the experimental and control groups. Regarding condition, R indicates reappraisal and C indicates control. Regarding timing, D indicates the measurement during exercise, A indicates the measurement after exercise and F-E indicates the follow-up measure.

Hypothesis Testing

Main Effects

The results of the ANCOVA main effects, controlling for PEE and gender, are summarised in Table 3.

Hypothesis 1. CR lowers the negative affective experience, including lower perceived intensity of sensations, less negative valence of sensations, and less negative valence of the overall experience, compared to the control condition.

Affective Experience During Exercise. While the analysis did not show significant results, there was a trend towards more negative evaluations in the control condition compared to the reappraisal condition for both negative valence of sensations (F = 2.62, p = .112, η^2_p = .05) and negative valence of overall experience (F = 1.84, p = .181, η^2_p = .03).

Affective Experience After Exercise. Significant main effects of condition were found for the measurements on the negative valence of sensations (F = 5.33, p = .025, η^2_p = .09) and negative valence of overall experience (F = 5.07, p = .028, η^2_p = .09). Specifically, participants in the control condition reported less negative sensations and overall exercise experience compared to those in the CR condition (see means in Table 3). In conclusion, the hypothesis was not supported, as participants in the control condition reported fewer negative evaluations of the affective experience compared to the experimental condition.

Hypothesis 3. CR has a positive effect on the affective attitude towards future performances of the wall-sit.

No significant main effect of condition was found for the mean score of affective attitude ($F(1, 59)$ = 0.07, p = .800, η^2_p = .00). Additionally, no significant effects were observed for the subscales of affective attitude (enjoyment, satisfaction, pleasantness, and excitement (see Table B3). In conclusion, the hypothesis was not supported.

Hypothesis 4. CR is hypothesised to enhance exercise adherence by reducing the negative evaluation of the affective experience and positively influencing affective attitudes.

Initially, it was hypothesized that CR would have an indirect effect on exercise adherence through its impact on the evaluation of the affective experience and affective attitude. However, the non-significant effects of CR on these variables prevented further mediation analysis. As a consequence, the direct effect of CR on exercise adherence was examined through ANCOVA. Also, we explored the direct relationships between affective experience, affective attitudes, and exercise adherence via correlational analyses.

ANCOVA of Exercise Adherence. No significant effect of condition on exercise adherence was found, with participants in the control condition (M = 2.42) and the CR condition (M = 2.31) showing similar adherence levels, $F(1, 59) = 1.22$, $p = .275$, $\eta^2_p = .02$ (see Table 3).

Correlation Analyses. The results indicated significant positive associations between the positive valence of overall experience (during and after exercise) and affective attitude (during $r = .45$, $p < .001$; after $r = .54$, $p < .001$). Additionally, the negative valence of overall experience (after exercise) was significantly correlated with both affective attitude ($r = -.34$, $p = .008$) and exercise adherence ($r = -.30$, $p = .020$). Correlations between all dependent variables are presented in Table B4. In conclusion, the hypothesis was not supported. However, significant relationships between the evaluation of the affective experience, affective attitude, and exercise adherence were identified.

Repeated Measures of Affective Experience

Hypothesis 2. CR has a more substantial effect on the affective experience after the exercise than on the affective experience during the exercise. Specifically, lower perceived intensity, lower negative valence of sensations and lower negative valence of overall experience are expected at the measurement after exercise compared to during exercise for the reappraisal condition.

A repeated measures ANCOVA was conducted to compare the evaluations of the affective experience during and after the exercise within each condition. The within-subjects factor was time (during vs. after exercise) and the between-subjects factor was condition (reappraisal vs. control). The results, as presented in Table 4, showed no significant interaction effects between condition and time, indicating that the changes in the dependent variables over time were consistent across both conditions. Therefore, the hypothesis was not supported.

Table 4

Repeated Measures ANCOVA on the Evaluation of the Affective Experience

Dependent variable	Source	df	*F*-value	*p*-value	η^2_p
Intensity of sensations	T	1	.93	.339	.02
	T x C	1	.06	.803	.001
	Error	54			
Valence of sensations	T	1	.80	.374	.02
	T x C	1	2.51	.119	.04
	Error	54			
Positive valence overall	T	1	6.17	.016*	.10
	T x C	1	1.96	.167	.04
	Error	54			
Negative valence overall	T	1	7.29	.009*	.12
	T x C	1	.51	.479	.01
	Error	54			

Note. T indicates timing and C indicates condition. *p < .05. The main effect of condition was part of Hypothesis 1, and therefore presented in Table 3. To avoid redundancy, it was not included in Table 5. Means and standard deviations were presented in Table 3 as well.

Despite the lack of a significant interaction, the main effect of time was investigated to determine whether there were significant changes in the dependent variables from the measurement during to after the exercise, irrespective of condition. Significant main effects of time were found for both the positive valence of overall experience (F(1, 59) = 6.17, p = .016, η^2_p = .10) and the negative valence of overall experience (F(1, 59) = 7.29, p = .009, η^2_p = .12), Specifically, positive valence increased from during the exercise (M = 3.61) to after exercise (M = 4.02), while negative valence decreased from during exercise (M = 2.62) to after the exercise (M = 2.03).

Moderation Effect of Previous Exercise Experience

Hypothesis 5. CR has a more substantial effect on the affective experience, affective attitude and exercise adherence for inexperienced people compared to experienced people.

Interaction Analysis. To test this hypothesis, an ANCOVA was conducted to examine the interaction between condition (reappraisal vs. control) and previous exercise experience (PEE) on the dependent variables. Significant interactions were further explored using simple slope analyses to assess the effects of condition at different levels of PEE (low vs. high). In addition to the conventional threshold of $p < .05$ for statistical significance, trends with $p < .10$ were also considered to provide additional insights into potential effects.

The ANCOVA results (Table 6) indicated significant interactions for intensity of sensations during exercise (F(1, 57) = 13.05, $p < .001$, η^2_p = .20) and after exercise (F(1, 57) = 10.49, p = .002, η^2_p = .16), as well as for the negative valence of sensations during exercise (F(1, 57) = 3.91, p = .031, η^2_p = .08). The interaction for negative valence of the overall experience after exercise approached significance (F(1,57) = 3.80, p = .056, η^2_p = .07). These results suggest that the effectiveness of CR varies by PEE level.

Table 6

Moderation of Previous Exercise Experience on the Relationship Between Condition and Dependent Variables

Variable	Time	Condition	*F*-value	*p*-value	η^2_p
Intensity of sensations	During	R C	13.05	<.001**	.20
	After	R C	10.49	.002**	.16
Negative valence of sensations	During	R C	4.91	.031*	.08
	After	R C	1.79	.187	.03
Positive valence overall	During	R C	.03	.858	.001
	After	R C	.019	.892	.00
Negative valence overall	During	R C	2.49	.121	.04
	After	R C	3.80	.056	.07
Affective attitude		R C	.001	.982	.00
Exercise adherence		R C	.04	.851	.001

Note. Interaction effect of Condition and PEE. C indicates control and R indicates reappraisal. * $p < .05$ and ** $p < .01$. Means and standard deviations on conditions are already presented in Table 3 and were therefore not included in this table.

Simple Slopes Analysis. A simple slope analysis was conducted to explore the (nearly) significant interactions between condition and PEE on the intensity of sensations, negative valence of sensations and negative valence of overall experience. This analysis examined the effect of condition at different levels of PEE.

The initial model included the dependent variable, condition as the fixed factor and the z-score of PEE as a covariate. For the simple slopes analysis, the covariate was adjusted to represent simulated low and high groups (one standard deviation below and above the z-score of PEE, respectively). This approach follows the methods outlined by Siero et al. (1996), who provided detailed guidance on applying simple slopes analysis in moderation contexts. Mean scores for the four groups (high and low PEE within both the reappraisal and control conditions) were computed based on parameter estimates from the initial model. This analysis aimed to determine whether the effect of condition differed across these groups. The results are presented in Table 7.

Table 7

Simple Slopes Analysis for High and Low Previous Exercise Experience Groups

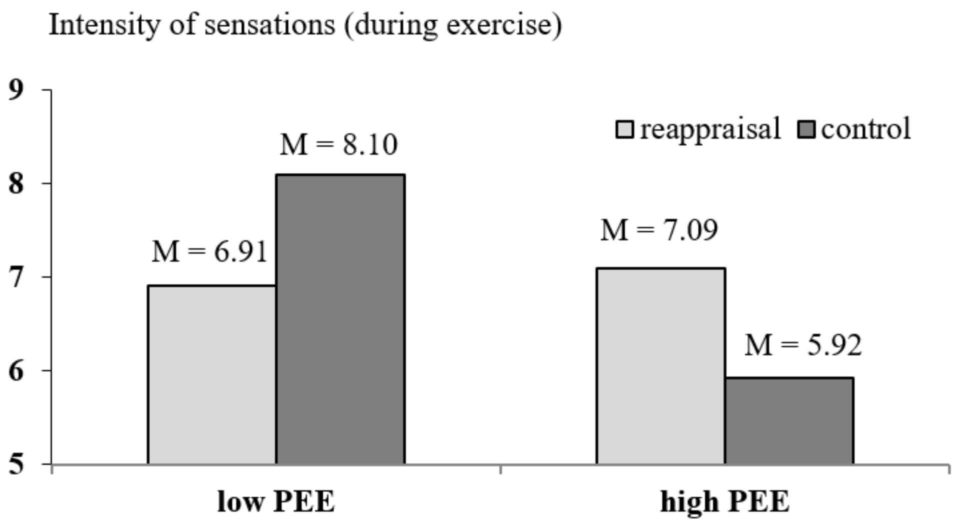
Dependent variable	PEE level	Condition	Estimated Mean	*F*-value	*p*-value	η^2_p
Intensity of sensations (during)	Low	R	6.91	5.95	.021*	.10
		C	8.10			
	High	R	7.09	5.61	.024*	.09
		C	5.92			
Intensity of sensations (after)	Low	R	6.95	6.28	.019*	.10
		C	8.28			
	High	R	7.09	6.28	.023*	.10
		C	5.92			
Negative valence of sensations (during)	Low	R	5.16	1.58	.214	.03
		C	5.89			
	High	R	5.25	4.96	.030*	.08
		C	3.95			
Negative valence of overall experience (after)	Low	R	2.17	1.26	.266	.02
		C	2.56			
	High	R	2.11	5.50	.023*	.09
		C	1.29			

Note. Regarding condition, R indicates reappraisal and C indicates control. *p < .05, **p < .01. Standard deviations do not apply as estimated means are adjusted from the ANCOVA model.

For the intensity of sensations during exercise, a significant effect of condition was observed when PEE was modelled as low (F(1, 57) = 5.95, p = .021, η^2_p = .10). Participants in the reappraisal condition reported lower intensity (M = 6.91) compared to those in the control condition (M = 8.10). Conversely, when PEE was modelled as high, the effect of condition was also significant (F(1, 57) = 5.61, p = .024, η^2_p = .09). Participants in the reappraisal condition reported higher intensity (M = 7.09) compared to the control condition (M = 5.92) (see Figure 2). Figure 2 shows the same pattern for the intensity of sensations after exercise, with slightly different estimated means (see Table 7).

Figure 2

Intensity of Sensations for High and Low Previous Exercise Experience Groups Across Conditions

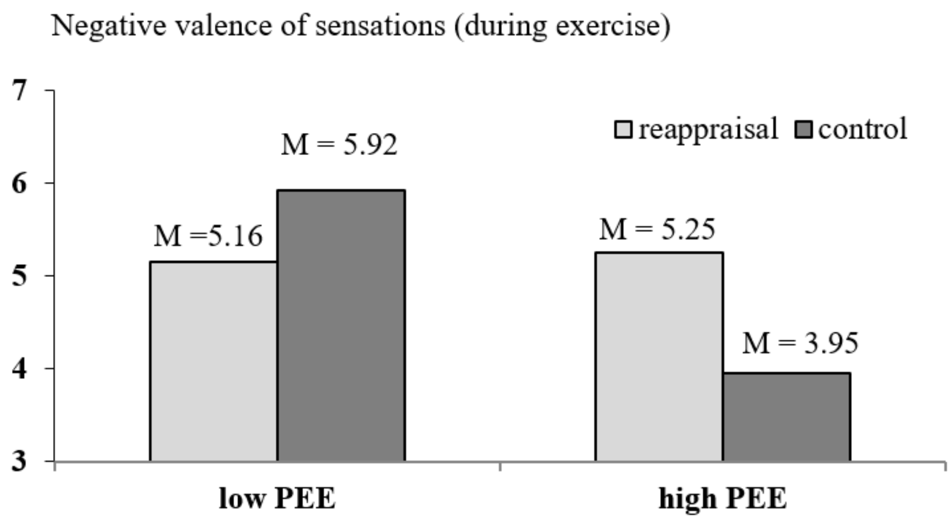


Note. Mean intensity of sensations during exercise for simulated high and low previous exercise experience (PEE) groups across reappraisal and control conditions. M indicates the mean of the group. The full scale is not displayed in the figure to better illustrate the differences between the groups.

For the negative valence of sensations during exercise, no significant effect of condition was found when PEE was simulated as low (F(1, 57) = 1.58, p = .214, η^2_p = .03). Participants in the reappraisal condition (M = 5.16) reported a negative valence similar to those in the control condition (M = 5.92). However, when PEE was modelled as high, condition significantly influenced the negative valence of sensations (F(1, 57) = 4.96, p = .030, η^2_p = .08). Participants in the reappraisal condition reported higher negative valence of sensations (M = 5.25) as compared to the control condition (M = 3.95; see Figure 4). The same pattern showed for the negative valence of the overall experience, but then with different estimated means (see Figure 5).

Figure 4

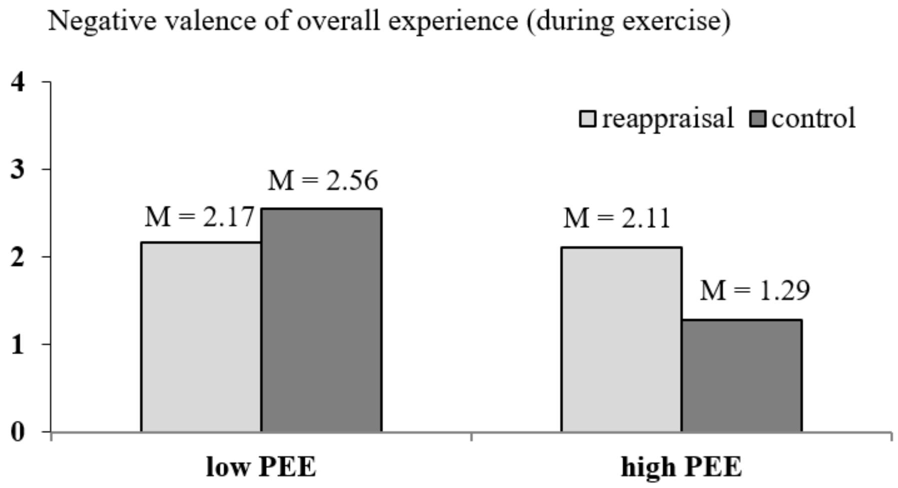
Negative Valence of Sensations for High and Low Previous Exercise Experience Groups Across Conditions



Note. Mean intensity of sensations during exercise for simulated high and low previous exercise experience (PEE) groups across reappraisal and control conditions. M indicates the mean of the group. The full scale is not displayed in the figure to better illustrate the differences between the groups.

Figure 5

Mean Negative Valence of Overall Experience for High and Low Previous Exercise Experience Groups Across Conditions



Note. Mean intensity of sensations during exercise for simulated high and low previous exercise experience (PEE) groups across reappraisal and control conditions. M indicates the mean of the group.

In conclusion, the hypothesis was supported for some dependent variables. CR significantly influenced the intensity of sensations for both inexperienced and experienced individuals. However, the effect of CR on the negative valence of sensations and overall experience was significant only for experienced individuals, suggesting a nuanced moderating effect PEE.

Additional Correlation Analysis. To provide additional context regarding the relationships between previous exercise experience (PEE) and the dependent variables, we also conducted correlation analyses. This aimed to further clarify how PEE interacts with the affective experience, affective attitude, and exercise adherence in the context of CR. Significant interactions were observed only in the control condition. This indicates the nuanced effects of PEE across conditions. The complete correlation analysis can be found in Table B7.

Post-Hoc Analyses

Moderation Effect of Gender

An exploratory analysis using ANCOVA was conducted to examine the moderating effect of gender on the relationship between condition and the dependent variables of affective experience, affective attitude, and exercise adherence. For clarity and to focus on the most pertinent results, only the key findings with $p < .10$ are summarised in Table 8. Detailed results, including those that were not significant or less central to the main findings, are provided in Table B8.

Table 8

Moderation of Gender on the Relationship Between Condition and Dependent Variables

Variable	Condition	Gender	Mean (*SD*)	*F*-value	*p*-value	η^2_p
Negative valence of sensations (after)	R	F	4.27 (1.83)	4.57	.037*	.08
		M	5.36(1.87)			
	C	F	5.00 (1.51)			
		M	3.81 (1.42)			
Positive valence of overall experience (after)	R	F	4.3 (.90)	3.51	.066	.06
		M	3.57 (1.02)			
	C	F	3.87 (.83)			
		M	4.25 (1.24)			
negative valence of overall experience (after)	R	F	1.87 (.64)	3.08	.085	.05
		M	2.43 (1.16)			
	C	F	2.27 (.88)			
		M	1.69 (.87)			

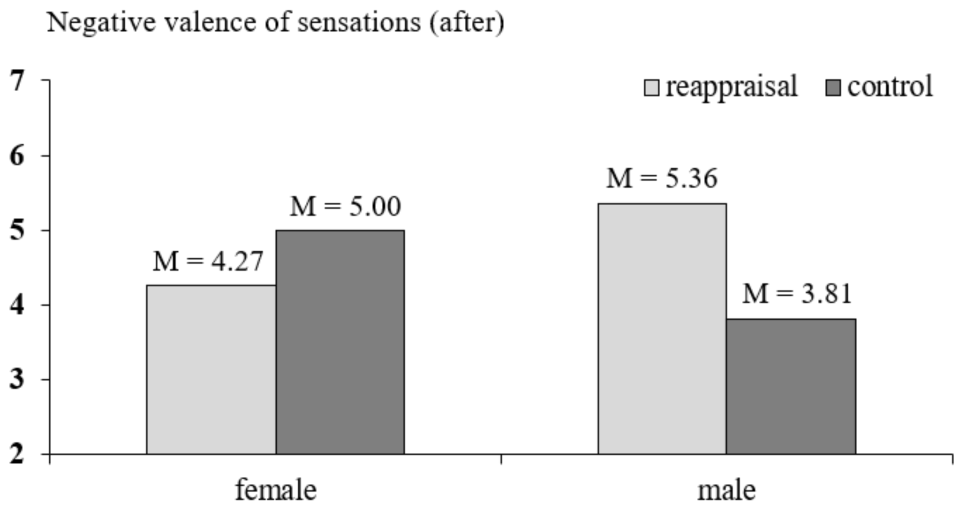
Note. Regarding condition, R indicates reappraisal and C indicates control. Regarding gender, F indicates female and M indicates male. *p < .05.

A significant interaction was found for the negative valence of sensations after exercise (*F* = 4.57, *p* = .037, η^2_p = .08). The results for the positive valence of overall experience after exercise (*F* = 3.51, *p* = .066, η^2_p = .06) and negative valence of overall experience after exercise (*F* = 3.08, *p* = .085, η^2_p = .05) approached significance. These (nearly) significant results suggest that the effectiveness of CR may vary by gender.

Specifically, male participants indicated a more negative valence of sensations and of the overall experience in the reappraisal condition compared to the control condition. In contrast, female participants indicated lower negative valence in the reappraisal condition compared to the control condition. Additionally, male participants indicated a less positive valence of overall experience after reappraisal compared to the control condition, whereas female participants reported a more positive valence of overall experience after reappraisal. Figures 6, 7, and 8 illustrate the directions of the interaction effects between gender and the dependent variables across both conditions.

Figure 6

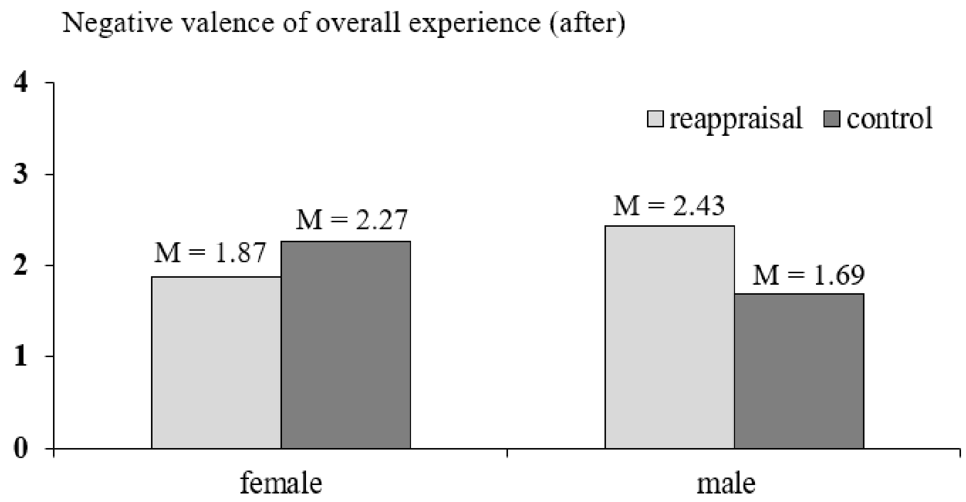
Mean Negative Valence of Sensations for Females and Males Across Conditions



Note. M indicates the mean of a group. The full scale is not displayed in the figure to better illustrate the differences between the groups.

Figure 7

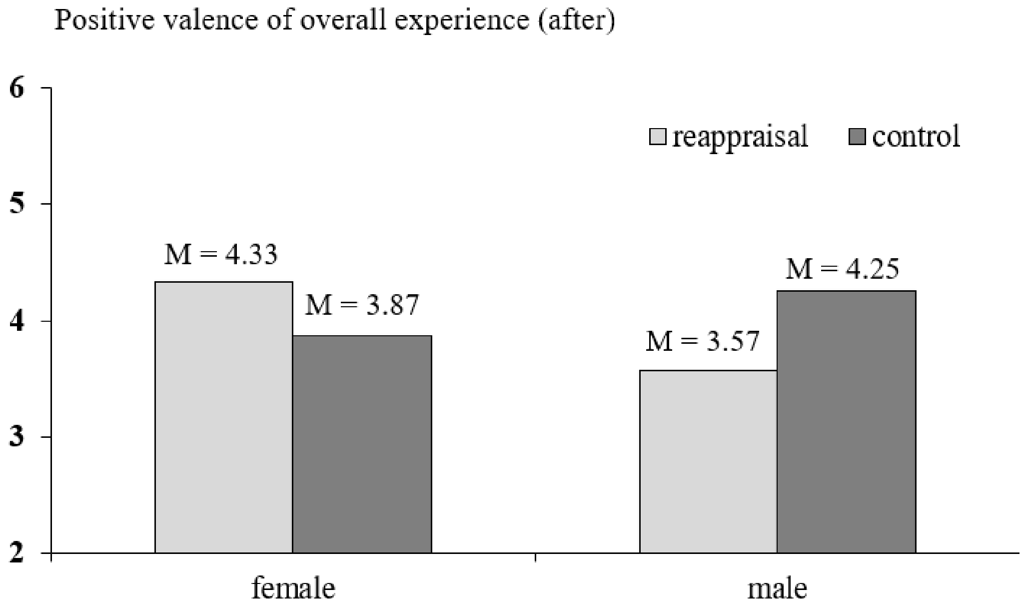
Mean Negative Valence of Overall Experience for Females and Males Across Conditions



Note. M indicates the mean of a group. The full scale is not displayed in the figure to better illustrate the differences between the groups.

Figure 8

Mean Positive Valence of Overall Experience for Females and Males Across Conditions



Note. M indicates the mean of a group. The full scale is not displayed in the figure to better illustrate the differences between the groups.

Three-Way Interaction Analysis

For a final exploration of the combined influence of condition, previous exercise experience (PEE), and gender on the dependent variables, a three-way interaction ANCOVA was conducted. The results indicated a significant three-way interaction for the positive valence of overall experience measured after the exercise ($F(1,54) = 3.73$, $p = .03$, $\eta^2_p = .12$). This suggests that the relationship between PEE and the dependent variable varies across genders and conditions.

Further examination of this significant result revealed that the two-way interaction between PEE and condition approached significance for females ($p = .09$) but was non-significant for males ($p = .80$). This indicates some variation in the interaction effect between genders, although it did not reach significance in either group individually.

Discussion

This study investigated the effects of cognitive reappraisal (CR) on the negative affective experience of muscular discomfort during exercise, and its potential impact on long-term exercise adherence. We hypothesised that CR would reduce negative affect during and shortly after exercise, fostering affective attitudes and improving adherence. Additionally, we explored the moderating roles of previous exercise experience (PEE) and gender, and timing of evaluations (during vs. after exercise).

Main Effects of Cognitive Reappraisal

CR did not directly reduce the negative affective experience or positively impact affective attitude or adherence compared to the control group. This suggests that it may be insufficient independently to drive behavioural change, or that important other factors are in play. Although CR showed no direct and long-term effects, significant correlations indicated that negative affect after exercise was linked to lower attitudes and adherence. This suggests that while CR might not directly influence behaviour, improving immediate emotional responses could indirectly foster long-term adherence. The results underscore the need to understand how moderation effects play a role in the impact of CR.

Moderation Effect of Previous Exercise Experience

Previous exercise experience (PEE) was explored and identified as an important moderating factor in the effectiveness of CR. When analysing low levels of PEE, reappraisal reduced the perceived intensity of sensations during exercise and after exercise. The significant result in combination with large effect sizes supports our hypothesis that inexperienced exercisers may benefit from cognitive strategies that target the emotional regulation of discomfort and negative affect during physical activity (Hall et al., 2002; Ekkekakis & Petruzzello, 1999). Trends indicating reduced negative affect towards sensations and the overall affective experience seem to add to this support. However, the trends in combination with small effect sizes suggest that the effects are modest and should be interpreted with caution. Further research with larger sample sizes is needed to confirm whether these trends reflect genuine effects.

In contrast, when analysing high PEE levels, CR increased perceived intensity and negative affect towards both sensations and the overall experience. In combination with large effect sizes, these findings suggest that reappraisal might disrupt established coping strategies, sin experienced exercisers. This may occur through an increased focus on inward sensations, whereas the habitual strategy of these individuals might be distraction, where they focus on external aspects (Dishman, 2004; Ekkekakis et al., 2005).

The findings highlight the nuanced effects of CR based on previous experience. Further research is needed to understand how CR can reduce negative affect, especially in novice exercisers, and how tailored interventions could improve adherence.

Moderation Effect of Gender

In addition to the hypothesised moderation of PEE, additional analyses revealed gender differences in response to CR. Women experienced a reduction in negative affect towards sensations, in combination with a large effect size. In contrast, men reported an increase in negative affect towards sensations. Additionally, similar trends were observed in positive and negative affect towards the overall experience. Female participants showed an increase in positive affect and a reduction in negative affect, whereas opposite effects were observed for male participants. Although these trends did not reach significance, in combination with moderate effect sizes they highlight noteworthy patterns that should be further explored. Taken together, these gender differences suggest that CR might be beneficial for women, but can even be counterproductive for men.

The observed gender differences in response to CR can be possibly explained by distinct coping strategies and socialisation processes. Research shows that women frequently adopt emotion-focused coping strategies, which can enhance their capacity to manage negative affect (Tamres et al., 2002). In contrast, men often use problem-focused strategies that involve direct efforts to solve stressors. This might increase cognitive load during intensive exercise, thereby diminishing CR's effectiveness (Tamres et al., 2002; Mahalik et al., 2003). Moreover, societal norms often discourage emotional expression among men, which leads to a greater tendency to supress emotions (Mahalik et al., 2007). For men, the combination of emotional suppression and the requirement to focus on discomfort during CR can lead to an amplification of negative feelings. They may struggle to cope with emotions that they typically avoid confronting.

These insights suggest that the effectiveness of cognitive reappraisal may vary according to gender-specific emotional processing and coping mechanisms. First, future research should further explore male and female differences in response to cognitive reappraisal. Additionally, addressing these differences may help optimise interventions aimed at reducing negative affective experiences, ultimately enhancing exercise adherence.

Three-Way Interaction of PEE, Gender, and Condition

Building on both moderating factors, we finally explored the interplay between gender and PEE. The three-way interaction for positive valence showed that the effects of reappraisal varied by PEE and gender, with differences more pronounced in females. This interplay suggests that women's responses to CR might be even more sensitive to their PEE level. This further highlights the need for more tailored interventions that consider both gender and PEE to maximise the benefits of CR as a strategy to stimulate exercise adherence.

The Role of Reflective Processing and Timing of Evaluations

While the analyses revealed interactions between CR and other factors, there was no significant interaction between CR and the timing of affective evaluations. This finding suggests that the timing of evaluations, whether during or shortly after exercise, does not significantly affect the effectiveness of reappraisal.

However, independent of condition, participants reported more positive and less negative affect after exercise compared to during. This finding aligns with dual-process theories (see Kahneman, 2011), where immediate responses dominate during exercise, but reflective evaluation improves perceptions afterward (Gordon et al., 2006). The effect of timing also aligns with the broader concept of experiential learning, where past experiences are re-evaluated more positively over time (Kolb, 1984; Hofmann et al., 2008).

Comparative Analysis with Berman (2019)

Our study builds on Berman's (2019) research, which demonstrated a decrease in negative affect towards sensations following reappraisal. A key difference is that while Berman employed a negative reappraisal group for comparison, we used a neutral condition. Our choice was intended to measure the impact of positive reappraisal in comparison with a more naturalistic and neutral setting. The emotional difference between the negative and positive conditions in Berman's study likely made any changes in negative affect more noticeable. This methodological difference suggests that our findings may provide a more accurate assessment of the effects of positive reappraisal, without the influence of an emotionally charged comparison.

The absence of any main effects of CR could be possibly explained by another methodological difference. Berman employed an objective bench press task, where participants continued until they could no longer maintain the set pace of the metronome. This way, exertion across participants was standardised. In contrast, our study used a subjective wall-sit task, where participants stopped based on their perception of discomfort. This subjective approach is relevant for studying evaluations of experiences since it captures individual differences in emotional and physical responses. It reflects how participants interpret their discomfort in real-world settings. However, this variability in individual perceptions can make it more challenging to observe a consistent effect of cognitive reappraisal across the sample. All in all, the differences in reappraisal conditions and measurement approaches could be important factors in explaining the divergent findings between the two studies.

Limitations and future directions

This study has several limitations that should be considered. First, the small sample size likely constrained statistical power, as described in the method section (see section on Power Analysis). With a limited number of participants, detecting significant effects becomes more challenging. Future studies should aim for larger sample sizes to enhance the power and reliability of the results.

Second, even though the wall-sit exercise was deemed safe and appropriate for this study on discomfort, it may not have been the most effective measure for tracking adherence. Its simplicity and static nature likely made it less appealing to participants. Since many individuals prefer dynamic and varied forms of exercise, they may not have felt motivated to repeat a stationary exercise like the wall sit in their routines. This, together with the short-term follow-up of 14 days, could explain the low adherence rates and limited variance in the data. Future studies could use more engaging, dynamic exercises and extend the follow-up period to better capture real-world adherence patterns over time.

Third, the use of self-report measures to evaluate affective experiences could have introduced potential biases, such as social desirability. This may have led participants to downplay negative emotions, thereby reducing the validity of the findings. To deal with potential biases, future research could combine self-report with more objective or direct measures, such as heart rate variability or facial expression (Hitunen et al., 2019).

Lastly, the study did not account for participants' habitual coping strategies, such as distraction or avoidance. Research indicates that individuals with different coping styles may respond variably to reappraisal techniques (Aldao et al., 2010). This limitation is particularly relevant given our findings that cognitive reappraisal increased negative affect for males. It suggests that men, who may rely more on problem-focused coping strategies, could benefit from tailored interventions that consider their coping styles. Future studies could examine how specific coping strategies interact with cognitive reappraisal to better understand their effectiveness across different populations and contexts.

Theoretical and Practical Implications

Theoretically, this study adds to the small existing body of literature on cognitive reappraisal (CR) applied to exercise behaviour. It highlights the critical role of individual differences in understanding the effectiveness of CR. Our findings indicate that factors such as previous exercise experience (PEE) and gender significantly influence how individuals respond to reappraisal, supporting the notion that emotional regulation strategies are not universally effective but rather dependent on personal characteristics (Tamres et al., 2002; Mahalik et al., 2007). Furthermore, this is the first study to explore the relationship between CR, affective responses, and subsequent exercise adherence. It contributes to the understanding of how immediate emotional evaluations can shape long-term behaviour. The results suggest that negative affective evaluations after exercise may serve as critical predictors of attitude and long-term adherence. This aligns with models of exercise motivation that highlight the role of affective states in influencing behaviour (Ekkekakis, 2008; Williams et al., 2008).

Practically, this study highlights the potential of cognitive reappraisal (CR) to assist novice exercisers and women in managing negative feelings, such as muscular discomfort. By addressing barriers that contribute to physical inactivity, CR can help individuals stick to their exercise routines. However, its effectiveness may vary based on individual differences like previous exercise experience (PEE) and gender. Therefore, fitness professionals should tailor their interventions accordingly. This tailoring should also consider how different coping strategies, such as distraction or avoidance, impact engagement with CR. By helping individuals navigate negative emotional responses, CR can empower them to overcome practical barriers to exercise. This should ultimately add to a more sustainable approach to physical activity and improved overall health.

Conclusion

In conclusion, this study highlights the potential of cognitive reappraisal (CR) as a valuable strategy for managing exercise-related discomfort, particularly for novice exercisers and women. The findings highlight the significance of addressing negative affective experiences to enhance positive attitudes and improve long-term exercise adherence. By recognizing the importance of individual differences, such as previous exercise experience, gender and habitual coping strategies, this research provides a basis for tailored interventions. Ultimately, our findings contribute to the broader goal of promoting sustained physical activity and enhancing public health.

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Appendix A

Screenshots and Spoken Texts of Videos

This appendix consists of the complete spoken texts of the video on the benefits of the wall-sit exercise, the manipulation video including CR and the control video including neutral information on physiological responses during exercise. Additionally, screenshots of keyword schemes as used in the manipulation video on reappraisal and the video for the control condition are presented.

Spoken Text on 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 but 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.

Spoken Text in CR Video

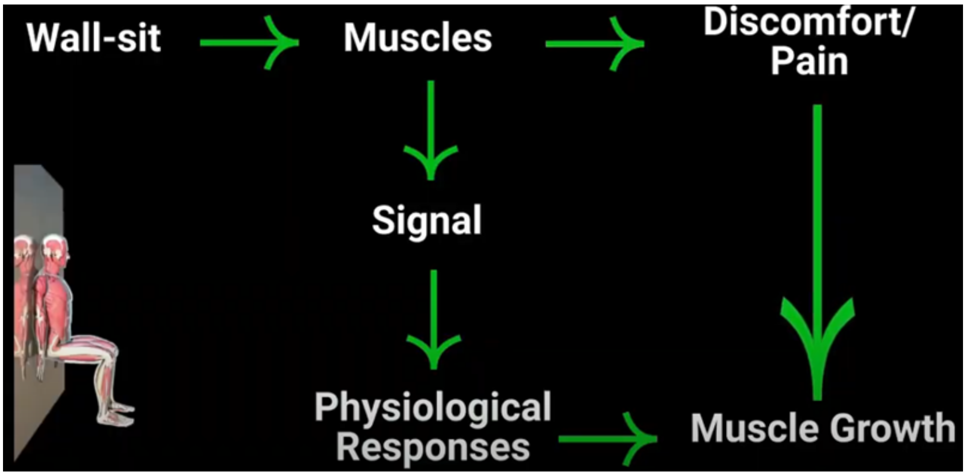
In this video, we will explore the effects of the wall-sit exercise on your physiology. So, you will plant your feet on the ground firmly, and put your body into a seated position against the wall. Then something interesting begins to happen within your muscles. With each passing second, your muscles 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.

Spoken Text in Control Video

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.

Figure A1

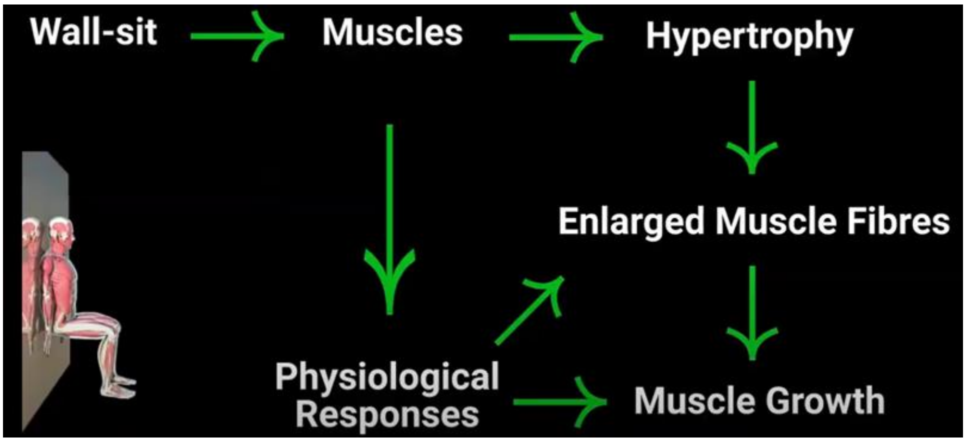
Screenshot of Scheme With Keywords as Used in Reappraisal Video



Note. The arrows indicate a relation between both concepts. This scheme was used as an illustration to the spoken text on cognitive reappraisal, as presented in Appendix A.

Figure A2

Screenshot of Scheme With Keywords as Used in Video of Control condition



Note. The arrows indicate a relation between both concepts. This scheme was used as an illustration to the spoken text for the control condition, as presented in Appendix A.

Appendix B

Table B1

Preliminary Analyses on Relation of PEE and Gender with Dependent Variables

Dependent variable	Gender *M* (*SD*)	PEE *M* (*SD*)	*t*-value Gender	*p*-value Gender	*r*-value PEE	*p*-value PEE
Intensity of sensations (During)	Female: 6.97(1.45) Male: 7.10(1.30)	3553.82 (3074.57)	-.38	.709	-.16	.211
Intensity of sensations (After)	Female: 7.13(1.48) Male: 7.10(1.63)		.08	.934	-.15	.254
Valence of sensations (During)	Female: 5.03(1.63) Male: 5.03(1.47)		.00	1.00	-.14	.269

Valence of sensations (After)	Female: 4.63(1.69) Male: 4.53(1.80)		.22	.825	-.13	.321
Positive valence overall (During)	Female: 3.60(.93) Male: 3.60(1.25)		.00	1.00	.23	.075
Positive valence (After)	Female: 4.10(.89) Male: 3.93(1.17)		.62	.537	.16	.210
Negative valence overall (During)	Female: 2.77(1.07) Male: 2.53(1.04)		.86	.396	-.25	.048*
Negative valence overall (After)	Female: 2.07(.79) Male: 2.03(1.07)		.14	.891	-.20	.117

Variable	Gender *M* (*SD*)	PEE *M* (*SD*)	*t*-value Gender	*p*-value Gender	*r*-value PEE	*p*-value PEE
Affective attitude	Female: 4.28(1.02) Male: 4.26(1.11)		.09	.928	.28	.027*
Exercise adherence	Female: 2.67(3.40) Male: 2.07(2.07)		.83	.412	-.002	.988

Note. This table presents the preliminary analysis of the relationships between covariates and dependent variables. T-tests were used to assess differences in the dependent variables between female and male participants. Pearson correlations were conducted to examine the associations between PEE and dependent variables. Significant p-values ($p < .05$) indicate a statistically significant relationship.

Table B2

Shapiro-Wilk Test for Normal Distribution and Levene's Test for Homogeneity of Variances

Variable	Test	Statistic	df	*p*-value
Intensity of sensations (during)	Shapiro-Wilk Levene	.94 .22	61 1, 59	.03* .639
Intensity of sensations (after)	Shapiro-Wilk Levene	.95 .73	61 1, 59	.005* .396
Negative valence of sensations (during)	Shapiro-Wilk Levene	.93 .06	61 1, 59	.001* .809
Negative valence of sensations (after)	Shapiro-Wilk Levene	.91 .73	61 1, 59	<.001* .166
Positive valence of overall experience (during)	Shapiro-Wilk Levene	.92 .08	61 1, 59	<.001* .783
Positive valence of overall experience (after)	Shapiro-Wilk Levene	.88 .03	61 1,59	<.001* .873

Negative valence of overall experience (during)	Shapiro-Wilk Levene	.90 .05	61 1, 59	<.001* .832
Negative valence of overall experience (after)	Shapiro-Wilk Levene	.85 .02	61 1, 59	<.001* .886
Affective attitude	Shapiro-Wilk Levene	.97 .82	61 1, 59	.139 .370
Exercise adherence	Shapiro-Wilk Levene	.47 .47	61 1, 59	< 001* .497
PEE	Shapiro-Wilk Levene	.68 .50	61 1, 59	<.001* .481

Note. Levene's test was used to assess the assumption of homogeneity of variances across groups. The Shapiro-Wilk test was conducted to evaluate the normality of the distribution for each dependent variable. A significant result (p < .05) indicates a violation of the corresponding assumption.

Table B3

Descriptive Statistics and ANOVA of Dependent Variables Without Covariates of Gender and PEE

Variable	Condition	Timing	*N*	*M*	*SD*	*F*	*p*	η^2_p
Intensity of sensations	*R*	*D*	29	7.00	1.34	.01	.929	.000
		A		7.07	1.41	.02	.888	.000
	C	*D*	32	7.03	1.40			
		A		7.13	1.66			
Negative valence of sensations	*R*	*D*	29	5.21	1.57	..46	.502	.01
		A		4.79	1.90	.77	.384	.01
	C	*D*	32	4.94	1.54			
		A		4.41	1.54			
Negative valence overall	*R*	*D*	29	1.79	1.08	1.42	.239	.02
		A		1.14	.95	.70	.405	.01
	C	*D*	32	1.47	1.05			
		A		.94	.91			

Positive valence overall	*R*	*D*	29	2.59	1.09	.02	.890	.000
		A		2.97	1.02	.13	.715	.002
	C	*D*	32	2.63	1.10			
		A		3.06	1.05			
Affective attitude	*R*		29					
Pleasantness				3.79	1.32			
Satisfaction				5.03	1.30			
Enjoyment				4.31	1.65			
Excitement				3.59	1.59			
Total mean				4.18	1.31	.33	.570	.01
	C		32					
Pleasantness				4.06	1.01			
Satisfaction				5.19	1.49			
Enjoyment				4.28	1.98			
Excitement				3.81	1.35			
Total mean				4.34	.99			
Exercise adherence		*F-E*	29	2.31	3.40	.58	.449	.01
			32	3.06	4.21			

Note. This table presents the descriptive statistics (mean and standard deviation) for each dependent variable across the experimental and control conditions. The results of the ANOVA (without covariates) test whether there are statistically significant differences between these two conditions. A significant p-value (p < .05) indicates a significant difference between the experimental and control groups.

Table B4

Correlation Analyses Between Variables of Affective Experience, Affective Attitude, and Exercise Adherence

Variable 1	Variable 2	Pearson's *r*	*p*-value
Intensity of sensations (D)	AA	-.01	.946
	EA	.02	.878
Intensity of sensations (A)	AA	-.08	.549
	EA	.05	.684
Negative valence of sensations (D)	AA	-.17	.185
	EA	-.06	.670
Negative valence of sensations (A)	AA	-.22	.087
	EA	-.11	.411

Negative valence of overall experience (D)	AA EA	-.16 -.20	.221 .133
Negative valence of overall experience (A)	AA EA	-.34 -.30	.008** .020*
Positive valence of overall experience (D)	AA EA	.45 .23	<.001** .072
Positive valence of overall experience (A)	AA EA	.54 .18	<.001** .157
Affective attitude	EA	.08	.538

Note. D indicates the measure during exercise and A indicates the measure after exercise. AA indicates affective attitude and EA indicates exercise adherence.

Table B5

Repeated Measures ANOVA of the Affective Experience without Covariates of Gender and Previous Exercise Experience

Dependent variable	Source	df	F-value	P-value	η^2_p
Intensity of sensations	T	1	.69	.410	.01
	T x C	1	.02	.900	.000
	Error	59			

Valence of sensations	T	1	15.72	<.001*	.21
	T x C	1	.66	.624	.004
	Error	59			
Positive valence overall	T	1	19.51	<.001*	.25
	T x C	1	.07	.754	.002
	Error	59			
Negative valence overall	T	1	31.18	<.001*	.35
	T x C	1	.34	.562	.01
	Error	59			

Note. T indicates timing and C indicates condition. *p < .05. The main effect of condition was part of Hypothesis 1, and therefore presented in Table 3. To avoid redundancy, it was not included in Table 5. Means and standard deviations were presented in Table 3 as well.

Table B6

Moderation Effect of Previous Exercise Experience on the Relationship Between Condition and Dependent Variables Without Gender as Covariate

Variable	Time	Condition	Source	*F*-value	*p*-value	η^2_p
Intensity of sensations	During	R C	C x PEE	13.05	<.001*	.20
	After	R C	C x PEE	10.49	.002*	.16

Negative valence of sensations	During	R C	C x PEE	4.91	.031*	.08
	After	R C	C x PEE	1.79	.187	.03
Positive valence overall	During	R C	C x PEE	.03	.858	.00
	After	R C	C x PEE	.019	.892	.00
Negative valence overall	During	R C	C x PEE	2.49	.121	.04
	After	R C	C x PEE	3.80	.056	.07
Affective attitude		R C	C x PEE	.001	.982	.00
Exercise adherence		R C	C x PEE	.04	.851	.00

Note. Means and standard deviations on conditions are already presented in Table 3 and therefore not included in this table.

Table B7

Correlations Between Previous Exercise Experience and Dependent Variables in Reappraisal and Control Conditions

Variable	Condition	Time	*r*-value	*p*-value
Intensity of sensations	R	D	.088	.651
		A	.102	.597
	C	D	-.558	< .001**
		A	-.507	.003

Negative valence of sensations	R	D	.035	.857
		A	.005	.978
	C	D	-.451	.010*
		A	-.406	.021*
Negative valence of overall experience	R	D	-.136	.483
		A	-.042	.829
	C	D	-.486	.005**
		A	-.495	.004**
Positive valence of overall experience	R	D	.260	.173
		A	.173	.369
	C	D	.207	.256
		A	.167	.360
Affective attitude	R		.330	.080
	C		.221	.225
Exercise adherence	R		-.007	.970
	C		.010	.959

Table B8

Moderation of Gender on the Relationship Between Condition and Dependent Variables

Variable	Condition	Gender	Mean (SD)	F-value	p-value	η^2_p
Intensity of sensations (during)	R	F	6.93 (1.34)	1.10	.299	.02
		M	7.07 (1.39)			
	C	F	7.00 (1.60)			
		M	7.13 (1.26)			
Intensity of sensations (after)	R	F	7.07 (1.39)	.71	.403	.01
		M	7.07 (1.49)			

	C	F	7.20 (1.61)			
		M	7.13 (1.78)			
Negative valence of sensations (during)	R	F	4.87 (1.51)	1.03	.315	.02
		M	5.57 (1.60)			
	C	F	6.97 (1.45)			
		M	7.20 (1.30)			
Negative valence of sensations (after)	R	F	4.27 (1.83)	4.57	.037*	.08
		M	5.36 (1.87)			
	C	F	5.00 (1.51)			
		M	3.81 (1.42)			
Positive valence of overall experience (during)	R	F	3.73 (.96)	.45	.506	.01
		M	3.43 (1.22)			
	C	F	3.47 (.92)			
		M	3.75 (1.29)			
Positive valence of overall experience (after)	R	F	4.33 (.90)	3.51	.066	.06
		M	3.57 (1.02)			
	C	F	3.87 (.83)			
		M	4.25 (1.24)			
Negative valence of overall experience (during)	R	F	2.67 (1.11)	1.15	.287	.02
		M	2.93 (1.07)			
	C	F	2.87 (1.06)			
		M	2.19 (.91)			
Negative valence of overall experience (after)	R	F	1.87 (.64)	3.08	.085	.05
		M	2.43 (1.16)			
	C	F	2.27 (.88)			
		M	1.69 (.87)			
Affective attitude	R	F	4.32 (1.14)	.23	.632	.004
		M	4.04 (1.14)			
	C	F	4.25 (.92)			
		M	4.45 (1.08)			
Exercise adherence	R	F	3.07 (4.56)	1.67	.202	.03
		M	1.50 (1.09)			
	C	F	2.27 (1.67)			
		M	2.56 (2.58)			

Note. Regarding condition, R indicates reappraisal and C indicates control. Regarding gender, F indicates female and M indicates male. *p < .05.

Table B9

Moderation of Gender on the Relationship Between Condition and Dependent Variables Without PEE as Covariate

Dependent variable	Condition	Gender	Mean (SD)	F-value	p-value	η^2_p
Intensity of sensations (during)	R	Female	6.93 (1.34)	.00	.986	.00
		Male	7.07 (1.39)			
	C	Female	7.00 (1.60)			

		Male	7.13 (1.26)			
Intensity of sensations (after)	R	Female	7.07 (1.39)	.01	.923	.00
		Male	7.07 (1.49)			
	C	Female	7.20 (1.61)			
		Male	7.13 (1.78)			
Negative valence of sensations (during)	R	Female	4.87 (1.51)	2.87	.096	.05
		Male	5.57 (1.60)			
	C	Female	6.97 (1.45)			
		Male	7.20 (1.30)			
Negative valence of sensations (after)	R	Female	4.27 (1.83)	7.03	.010*	.11
		Male	5.36 (1.87)			
	C	Female	5.00 (1.51)			
		Male	3.81 (1.42)			
Positive valence of overall experience (during)	R	Female	3.73 (.96)	1.05	.310	.02
		Male	3.43 (1.22)			
	C	Female	3.47 (.92)			
		Male	3.75 (1.29)			
Positive valence of overall experience (after)	R	Female	4.33 (.90)	4.78	.033*	.08
		Male	3.57 (1.02)			
	C	Female	3.87 (.83)			
		Male	4.25 (1.24)			
Negative valence of overall experience (during)	R	Female	2.67 (1.11)	3.07	.085	.05
		Male	2.93 (1.07)			
	C	Female	2.87 (1.06)			
		Male	2.19 (.91)			
Negative valence of overall experience (after)	R	Female	1.87 (.64)	5.99	.018*	.10
		Male	2.43 (1.16)			
	C	Female	2.27 (.88)			
		Male	1.69 (.87)			
Affective attitude	R	Female	4.32 (1.14)	.76	.388	.01
		Male	4.04 (1.14)			
	C	Female	4.25 (.92)			
		Male	4.45 (1.08)			
Exercise adherence	R	Female	3.07 (4.56)	1.63	.207	.03
		Male	1.50 (1.09)			
	C	Female	2.27 (1.67)			
		Male	2.56 (2.58)			

Note. Regarding condition, R indicates reappraisal and C indicates control. Regarding gender, F indicates female and M indicates male. $^*p < .05$.