PREVENTING NOCEBO SUGGESTIONS THROUGH MINDFULNESS MEDITATION

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ABSTRACT

The nocebo effect is a negative outcome resulting from the belief that a desired treatment has either not been received, or that a received treatment is harmful (Hurst, Foad & Beedie, 2015). This effect has been empirically demonstrated to have negative effects on sporting performance and physical endurance. Expectation has been the foremost mechanism in producing the nocebo response and manipulation through verbal suggestions is arguably the most powerful way to generate expectation (Carlino, Benedetti & Pollo, 2014). The purpose of the study was to investigate whether mindfulness practice can counteract the negative expectations given by potentially harmful nocebo effects, in this case verbal suggestions and a sham electrical stimulation. The majority of the published research on mindfulness has focused on the performance benefits (Gardner & Moore, 2012) and further evaluation is required to establish whether mindfulness can also prevent negative expectations on performance. Research combining the investigation of the nocebo effect and mindfulness is non-existent, both of which are already established topics in the field of sport and exercise psychology. The study hypothesises that mindfulness practice, at a low level of mastery, will combat, or even prevent, nocebo effects. The study contained 70 students from the University of Jyväskylä. The participants were randomly assigned into four groups: a) baseline; b) nocebo group; c) mindfulness intervention control; and d) mindfulness intervention and nocebo effect. Using a leg extension machine (Viveca Biomechanics Laboratory, Jyväskylä), performance was assessed through a combination of a 1-repetition maximum (1-RM) determination and subsequent exhaustion test (Pollo et al, 2012; Carlino et al., 2014). A two-ways mixed ANOVA was used to statistically analyse the data (Hurst, Foad & Beedie, 2015). Results indicated that it was not possible for mindfulness practice to counteract the nocebo effect. There was however further evidence for the efficacy of the nocebo conditioning protocol with nocebo conditions performing significantly worse in comparison the control conditions. The study suggests that combating the nocebo effect may play an important role, for example, in talent development for young athletes that have received negative verbal suggestions or have been rejected from sports academies. The study encourages future researchers to consider the use of single case study designs in the assessment and evaluation of mindfulness’s ability to combat the nocebo effect.

Keywords: Nocebo effect: Expectation: Mindfulness: Verbal suggestions.

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1 INTRODUCTION

From a historical perspective the placebo effect has been a recognised phenomenon in medicine for hundreds of years (Hurst, Foad & Beedie, 2015). However, extensive research has only been evident since the late 18th century when the term "placebo" had became cemented in the medical language (Jütte, 2013). The placebo effect in sports has only become a popular research field in the last 10-15 years (Bottoms, Buscombe & Nicholettos, 2014). Despite the research being in its early stages, multiple studies have found significant increases in endurance (Beedie, Stuart, Coleman & Foad, 2006; Hurst, Board & Roberts, 2013; McClung & Collins, 2007) and strength performance (Kalasountas, Reed, & Fitzpatrick, 2007; Maganaris, Collins, & Sharp, 2000) as a direct result of receiving a placebo (a positive outcome arising from the belief that a beneficial treatment has been received) (Clark, Hopkins, Hawley, & Burke, 2000).

However this effect is not always positive in direction and despite suggestions of its existence in sports science, much less is known about the negative counterpart the ‘nocebo effect’ (Beedie & Foad, 2009). The nocebo effect is essentially the opposite; it is a negative outcome resulting from the administration of a nocebo - an inert pharmacological or procedural treatment, administered with or without deliberate damage intention (Enck Benedetti & Schedlowski, 2008). Based on the research thus far, it is reasonable to suggest that the nocebo effect may be just as relevant to sports performance as the placebo effect (Kalasountas et al. 2007; Maganaris et al. 2000). For example, the above authors found significant deceases in weightlifting performance when the participants were told that their improvements were the result of a sham anabolic steroid. This suggests a reduction in expectation (via verbal suggestion) that effectively had a reverse effect on performance. Verbal suggestions have been shown to be one of the most powerful ways of raising or lowering expectation (Carlino, Benedetti & Pollo, 2014). Pollo, Carlino, Vase & Benedetti, (2012) reported significant nocebo responses as a result from negative expectations (verbal suggestion) on performance during a leg extension exercise to total exhaustion. In this two-part experiment both had the use a nocebo conditioning procedure (a sham electrical stimulation for increased fatigue). The study concluded that it is indeed possible to negatively modulate physical performance of subjects carrying out a muscle exercise to volitional maximum effort by employing the above mentioned protocol (discouraging suggestions and negative conditioning). This protocol will be utilised in the present study. Existing research has not combined nocebo effect research and mindfulness research, both of which are already established topics in the field. The majority of the published research is based around the performance benefits and further evaluation is required to establish whether mindfulness can not only enhance performance but also prevent negative expectations on performance.

1.1 Mechanisms of the Nocebo Effect

Expectations and the nocebo effect have shown to be directly related (Hurst et al., 2015). Fundamentally, a nocebo response is produced because the recipient expects it to be. There are numerous ways to generate expectation, such as verbal suggestions (mentioned above), environmental prompts, emotional arousal, interaction with professional practitioners and previous experiences. When an athlete expects a specific outcome - for example a sports drink to improve performance, the brain may set off a cognitive response and resultant behaviour that fulfills that expectation. If the athletes truly believes that the sports drink is going to benefit his or her performance he/she may have a decrease in anxiety and an increase in self-confidence that may persist during demanding situations. The athletes would then attribute the potential performance increase to the sports drink and not the psychological process that occurred (Michael, Garry & Kirsch, 2012). This is not surprising as the athlete who is given a placebo, believing it to be an ergogenic substance, is expecting a performance benefit. Thus, expectancy manipulation is a key component and mechanism to producing this effect (Stewart-Williams & Podd, 2004). Another key component and underlying mechanism in producing the nocebo effect is Pavlovian conditioning (Benedetti et al., 2011). This is “the process whereby the repeated co-occurrence of an unconditioned response to an unconditioned stimulus (e.g. salivation after the sight of food) with a conditioned stimulus (e.g. a bell ringing) induces a conditioned response (i.e. salivation that is induced by bell ringing alone)” (Pollo, 2012, p. 3893). In sport for example, the sight, smell, touch and taste associated with the previously mentioned sports drink can become the conditioned stimulus through the repeated association of using such substances. Through providing the athletes with the same perceptual characteristics as the real thing, but without the unconditioned stimulus, this may elicit a conditioned response similar to that of a sports performance drink (Hurst et al. 2015).

1.2 The Placebo and Nocebo Effect in Sport

Beedie et al. (2006) did an investigation into the effects of placebos on 10-km cycling performance. Semi-professional level cyclists were told that they would or would not receive a placebo (caffeine), 4.5mg and 9.0mg in a counterbalanced repeated measures design. However, everybody received a placebo in all conditions. The results indicated a dose response relationship; that is depending on the how much of the dose the participants thought they received resulted in how much power they produced during the test respectively. Participants in the placebo condition produced 1.4% less power (arguably a nocebo effect), whereas participants in the 4.5 and 9.0mg conditions produced 1.3% and 3.1% more power respectively. Post-hoc semi-structured interviews revealed that even though five participants believed they had experienced a placebo results still displayed a placebo response. Based on the belief that they would produce more power as the result of ingesting caffeine it is possible that participants deliberately modified their pacing strategy as a result. Overall the study showed that participants may be placebo responsive to the amount of placebo received and that this can indirectly affect performance.

Beedie, Coleman, and Foad (2007) examined this phenomenon further and using a similar protocol explored the effects of positive and negative beliefs on consecutive sprint trials (3 x 30m). The researchers randomly split 42 team sport athletes into two groups and either told them positive information about a hypothetical new ergogenic aid (caffeine) or told them negative information about the same substance. They found that the group who had been told the negative information was significantly slower than baseline (1.7%) suggesting that the negative belief exerted a negative effect on performance. There was a significant linear trend of greater speed with each successive trial in the group that received the positive information. This shows that positive and negative beliefs may have a function to play in interventions, the expectations the athlete has about the intervention and whether the intervention has a successful impact on performance overall. This could be true for psychological interventions also. Theoretically, if the athlete holds some negative beliefs or expectations about the intervention this could potentially compromise some, if not all, of the potential benefits of that intervention (Hurst et al. 2015).

With the majority of studies into the placebo effect being conducted in tightly controlled conditions, it was time to test this phenomenon in the real world and this prompted Hurst et al. (2013) to investigate the placebo effect during a real-life competitive 5km performance time-trials. 15 athletes had to complete four time trials over a two-week period. Unknown to them, two of the four randomised trials were baseline tests and the other two were placebo tests. The participants were informed during the placebo trials that they were given a ‘new’ ergogenic supplement, known to improve endurance performance. Results supported the laboratory research and, compared to the mean baseline, the placebo condition was associated with a mean 1.7% improvement in 5km performance. This finding suggests the laboratory experiments may transfer to real world settings and that athletes' who believe they are taking a beneficial supplement may show improvements in real-life competitions.

Using a more sophisticated design, McClung & Collins (2007) used the balanced placebo design to stringently explore the pharmacological and potential placebo effects of sodium bicarbonate over a 1000m self-paced running time-trial. This design enables the assessment of each possible combination of what the athlete thinks he/she has received and what he/she has actually received. For example, "16 male endurance athletes performed the following conditions in a randomised order: a) informed supplement/received supplement; b) informed supplement/received placebo; c) informed placebo/received supplement; and d) informed placebo/received placebo" (Hurst et al., 2015, p. 327). Results showed that the administration of sodium bicarbonate improved performance by 1.7% compared to baseline. However, merely expecting to receive sodium bicarbonate and not actually receiving the substance improved performance by a not dissimilar 1.5%. Although the resulting variation may seem small, it is the 1 or 2% at the elite level that makes the difference and the authors suggest that such an effect could make a significant difference to athletes in competition. Interestingly, athletes in the informed placebo/received supplement condition did not significantly improve compared to baseline. This finding, or 'biochemical failure' (as termed by the authors), suggests that performance-enhancing substances may be considerably more effective if the athlete knows that they have taken them. This balanced placebo design used here will be replicated and modified in the present study.

Duncan (2010) also used a similar design to further support McClung & Collins (2007) findings. Using the same conditions as above, athletes were given caffeine (5mg) before performing a 30s Wingate fitness test. Results showed again that the administration of caffeine improved peak power output by 12.8% compared to the told placebo/given placebo condition. However, merely expecting to receive caffeine and not actually receiving the substance improved peak power output by 8.9%. In this case, the athletes in the informed placebo/given caffeine condition did improve by a not too dissimilar 7.3%. There are many reasons as to why the McClung & Collins (2007) biochemical failure was not replicated in the Duncan (2010) study, the most important being that not all athletes are placebo responsive. Even in interventions in which researchers expect performance to improve, it is not that straightforward.

For example, Foad, Beedie & Coleman (2008) again used a similar design to stringently explore the pharmacological and potential placebo effects of caffeine on a laboratory 40km cycling time-trial. Results showed that it did not matter whether or not the participants knew that they were receiving caffeine or not, with an average power output increase of 3.5% in both conditions over baseline. Interestingly, when athletes were told that they had not ingested caffeine there was a greater effect on performance in a negative way. There was a 1.9% decrease in performance (nocebo effect) in the told placebo/given placebo condition. Post-hoc semi-structured interviews revealed that only two demonstrated a true placebo response. Seven participants subjectively thought that they were given caffeine when they had actually taken a placebo. However, this did not produce any significant improvements. These findings further evidence that not all athletes are placebo responsive, even if it is not a placebo and they have actually knowingly taken the real substance. It also indicates that expectation alone may not be enough to produce significant performance improvements - a thorough conditioning procedure may also have to be implemented.

Carlino et al. (2014, p. 154) used a double protocol, “with different probabilities of receiving what is believed to be an ergogenic substance (in fact, a caffeine placebo), with or without an associated conditioning procedure”. The protocol used was an adapted replication of the Pollo et al. (2012) study on performance during a leg extension exercise to total exhaustion. The findings suggested that verbal suggestions alone of motor improvement can work. However, when verbal suggestions were reinforced by conditioning, the placebo response was more prevalent over the conditions. The authors added that, by additionally measuring the rate of perceived exertion (RPE), the placebo response was observed more sporadically and RPE proved sensitive to the placebo manipulation. This RPE protocol will be replicated in the present study. Regarding caffeine placebos, many studies have demonstrated reduced RPE during exercise (Duncan, Lyons, Hankey, 2004).

1.3 Mindfulness

One variable, or mental process, which has not been studied in conjunction with the nocebo effect is mindfulness. Mindfulness is a mental state achieved by focusing one's awareness on the present moment non-judgmentally (Kabat-Zinn, 1994). Mindfulness is a popular topic in sport and exercise psychology, increasingly recognised as an effective way to become more aware of external and internal states, values and goals and improved athletic performance (Pineau, Carol, & Keith, 2014). Recent studies have found that mindfulness is connected to present-moment focus, which is essentially the essence of peak performance and flow

(Jackson & Csikszentmihalyi, 1999; Ravizza, 2002). Gardner and Moore (2004; 2006) argue that attempting to control negative internal states may ironically increase their occurrence by priming athletes to become entangled in thought. Such mental routines can adversely impact sport performance by directing conscious awareness to their negative thoughts and feelings, and consequently distracting attention from the sporting task (Bertollo, Saltarelli, & Robazza, 2009). Hence, instead of trying to fight with internal states, it may be more beneficial for athletes to develop skills in present-moment awareness and acceptance (Gardner & Moore, 2006; Kaufman, Glass, & Arnkoff, 2009). Mindfulness in sport is thought to have two main functions: the self-regulation of attention and the present-moment awareness of the sporting situation (Bishop et al., 2004).

Salmon, Hanneman & Harwood (2010) propose a mindfulness-based model that incorporates both awareness and acceptance to further establish how particular attentional processes can enhance sporting performance. For instance, mindfulness has been shown to teach athletes to become more mindful and accepting of their bodily sensations (Bernier, Thienot, Codron & Fournier, 2009). By training these skills athletes can become more accurate at perceiving their level of physical exertion. However, it is the non-judgement attitude taken toward bodily sensations that allows them to make the most of the resources and cues available to them at the time. This can be achieved by avoiding distractions, self-critical thoughts, and subsequent physical consequences which often accompany feelings of fatigue and exhaustion (such as when completing a leg extension exercise to total exhaustion). Hence, by sticking to the task-relevant cues, training the mind to easily accept self-judgements and performance setbacks, psychological flexibility can be achieved.

1.4 Mindfulness-Acceptance Commitment Approach

Mindfulness-Acceptance-Commitment (MAC) approach consists of a number of mindfulness exercises and acceptance techniques designed to enhance sport performance and psychological well-being (Gardner and Moore, 2004). The goals of the techniques are to raise awareness, foster acceptance (of internal states), focus on task relevant stimuli and to maintain a present-moment attention in order to reach performance goals (Gardner and Moore, 2007). The protocol contains seven sessions with 5 pertinent focal points: psycho-education, mindfulness, values identification and commitment, acceptance and, finally, integration and practice. The efficacy of MAC is growing with multiple published case studies - open and randomised trails - all supporting the MAC approach for performance enhancement (Gardner & Moore, 2012).

The early studies into MAC were based on case study material. For example, Gardner and Moore (2004) reported that an elite female power lifter lifted 15% more weight after the intervention and that a male collegiate swimmer scored significantly lower on his perceived sport anxiety questionnaire responses. This was followed up by two open trials, the first by Wolanin (2005) who randomly split 11 collegiate field hockey and volleyball players to take part in either a MAC programme or a control condition. From this intervention design, participants in the intervention group significantly increased in both self and coach ratings of athletic performance, task focused attention, and practice intensity compared to the control group. The second by Hasker (2010) who did a comparison study between MAC and a traditional psychological skills training (PST) programme on 19 collegiate athletes. Participants who were placed in the MAC intervention were shown to significantly improve in their ability to describe their thoughts and emotions, accept present-moment experiences, and commit to value-driven behavior, compared to the psychological skills training group, who did not significantly improve these areas. Although never published, Lutkenhouse, Gardner, & Moore (Cited in Gardner & Moore, 2007) were the first group of researchers to do a randomised controlled trial using MAC. 118 collegiate athletes were recruited from a variety of sporting backgrounds and randomly assigned to either MAC intervention group or a PST intervention group. In this instance, participants in the MAC group were shown to exhibit significantly greater increases in coach ratings of performance when compared to the PST participants. Furthermore, the MAC participants also displayed significant reductions in experiential avoidance and increases in flow experiences.

Doğan (2016) did an action research case study aimed at planning and implementing a seven-session MAC programme (Gardner and Moore, 2007) for a group of regular exercisers and active athletes. The researcher, being a novice instructor himself, designed, completed and reflected on the programme via an elaborate narrative case description. Using a pre-post questionnaire design, participants improved on their perceived performance, thought suppression, acceptance and committed action. The study demonstrated that it was indeed possible for a novice instructor to adapt and apply the MAC programme to a group of regular exercisers and improve their subjective self-report ratings. During the narrative case description, the researcher suggested incorporating more action-oriented exercises within the programme. This will be taken into account when replicating and adapting the seven-session MAC intervention in the present study.

2 PURPOSE OF THE STUDY

The purpose of the study is to investigate whether mindfulness practice can neutralize the negative expectations given by potentially harmful nocebo effects.

Moreover, in the study in question uses an experimental protocol to raise expectation (verbal suggestions) and conditioning (sham electrical stimulation) for the purpose of answering the following research questions;

(1) whether mindfulness can counteract the negative impact on performance given by the potentially harmful nocebo conditioning protocol

(2) whether mindfulness is able to neutralise the negative impact on the RPE given by the potentially harmful nocebo conditioning protocol

It is hypothesised that meditation practice, even at a low level of mastery, will counteract or even prevent nocebo effects.

3 METHODS

3.1 Participants

The study included 70 regular exercisers with an average age of 25.50 years. Their ages ranged between 18-43 years, the sample consisted of 35 males and 35 females, all students of the University of Jyväskylä who considered themselves to be fit and healthy at the time of recruiting. Six participants were discarded: two because they did not attain the necessary attendance needed for testing, two because they misunderstood the instructions from the experimenter (did not attempt maximal efforts) and two due to injury prior to testing. Approximately half of the participants were recruited via an email advertisement for a free mindfulness-based meditation course and the other half were generated via an opportunity sample to take part in a basic motor skill study. Both of these groups were then randomly sub-divided into two test-groups, who either did or did not receive a nocebo conditioning procedure. Group characteristics are summarised in Table 1.

Table 1: Group Averages Of The Participant Characteristics.

	Without Mindfulness		With Mindfulness	
Groups	**Control**	**Nocebo**	**Control**	**Nocebo**
Number Participants	18	15	16	15
Age (Years)	24.94	24.20	27.31	25.53
Weight (KG)	73.78	67.60	72.50	73.87
Height (M)	178.17	169.93	171.06	175.33
1-Rep Max (KG)	129.72	115.67	119.38	110
Weight Lifted (KG)	63.89	57.33	59.06	53.33
Gender (M/F)	15M/3F	4M/11F	9M/7F	6M/9F

In the experiment, the subjects in the control and nocebo groups did not differ for age (p = 0.272), weight (p = 0.430), height (p = 0.430), 1-RM (p = 0.197). There was a significant difference with gender; Pearson's chi-squared test revealed there were significantly more males in the control groups than females (p = 0.003). The subjects who did and did not receive the mindfulness intervention did not differ for age (P = 0.86), weight (P = 0.407), height (P = 0.647), 1-RM (P = 0.363). There was no significant difference with gender (P = 0.462).

3.2 Procedure

All of the participants were involved in weekly sports classes but were all asked not to participate in any rigorous exercise at least 24hrs prior to testing. During the study, a sham sub-threshold electrical stimulation was applied on both quadriceps muscles as a nocebo procedure for the test groups receiving the conditioning protocol (see photo below) (Carlino et al. 2010, cited in Pollo et al., 2012). One electrode was placed on the thigh and another on the lower leg, both of which was connected to a stimulator.

Figure 1: Experimental set-up for the nocebo conditioning protocol, with sham electrical stimulation for increased fatigue.

3.3 Manipulation

This nocebo conditioning procedure involved deception on behalf of the researcher; thus, a standardised form was used as a control for experimenter bias. Adapted from the Pollo et al. (2012, p. 3894) study and clearly stated on the consent form, participants were told “The stimulation delivered during the exercise will be at an intensity level just below your perception threshold, and even though you will not feel it, it will increase your sense of fatigue by adding an external cause of weariness on your muscles, leading to a decrease in motor performance.” To further explain the theory behind this method participants were also told “The impulses are generated by a device and delivered through electrodes on the skin in direct proximity to the muscles to be stimulated. The impulses mimic the action potential coming from the central nervous system, causing the muscles to contract. The electrodes will be attached to your quadriceps through self-adhesive pads that adhere to the skin." This is how the expectation of the electrical muscular stimulation having a negative impact of performance was raised. The form was then read again to the participants' immediately before the trial.

3.4 Experimental Design

Physical performance was measured using a leg extension machine (Viveca Biomechanics Laboratory, Jyväskylä) which assesses the quadriceps in a fixed position (see figure 1) (Pollo et al., 2012). It was important to isolate the muscle to assure we were measuring one singular aspect of performance and to avoid other variables affecting the results. During each condition participants undertook a 5-min sub-maximal warm-up on a cycle ergometer. The adjustable leg extensor device was then fitted to the participants' preferred position and during their first visit to the lab only; the participants' one-repetition maximum (1-RM) was measured. The 1-RM recorded was the maximum amount of force, in this case weight, that was lifted in one maximal contraction. The participants started at 15kg and this steadily went up by 5kg at a time until the participant reached their maximum. The highest single repetition achieved was recorded as the 1-RM and then the participant was asked to rest for 20 minutes while their height and weight was accurately recorded. Following the rest period, the participants performed the total exhaustion test, namely, performing as many leg extensions as possible until they could not lift the weight anymore. The participants always received the same instruction ‘‘go until you cannot lift the weight any longer.’’ The weight to be lifted was individually set at 50% of 1-RM. The 50% of 1-RM value was disclosed to the participants during testing and was kept the same throughout. The participants were instructed to perform the exercise using as constant a pace as possible and full range of motion. The total number of extensions was counted on a tally chart and recorded.

The total work (W) performed was calculated using the following formula:
$W = n \times m \times k^1 \times k^2$. Where n is the number of extensions, m the mass of the load (expressed in kilograms), raised during the lifting phase of the exercise, k^1 is a constant that is represented by the distance the weight was raised, expressed in meters (0.58 m), and k^2 is gravity acceleration (9.81 ms^2) (Pollo et al. 2012). The subjective rate of perceived exertion

(RPE) was assessed verbally every three extensions using an adapted numerical version of the Borg scale ranging from 0 = rest to 10 = maximal exertion (Piedimonte, Benedetti & Carlino, 2015).

In the experiment the participants of both the control groups and nocebo groups were tested in two sessions, 3 days apart (Table 2).

Table 2: Experimental Paradigm

	SESSION 1 ***Baseline***	SESSION 2 ***Test***
GROUP A **(CONTROL)**	50% 1-RM	50% 1-RM
GROUP B **(NOCEBO)**	50% 1-RM	50% 1-RM **+NOCEBO**
GROUP C **(MINDFULNESS/CONTROL)**	50% 1-RM	50% 1-RM
GROUP D **(MINDFULNESS/NOCEBO)**	50% 1-RM	50% 1-RM **+NOCEBO**

In session 1, the control group A's baseline performance was assessed and in session 2 they repeated the same exercise. For the nocebo group B, in session 1 their baseline performance was assessed and in session 2 they repeated the same exercise with the sham sub-threshold stimulation applied on both quadriceps muscles during the whole duration of the exercise, along with the suggestion of decreased performance. The participants in the mindfulness control and nocebo groups (C and D) were also tested in exactly the same way (2 sessions, 3 days apart) with the added nocebo conditioning protocol for group D (Table 2).

3.5 Mindfulness Intervention

The empirically supported MAC protocol (Gardner and Moore, 2007) formed the basis of the intervention. The programme was previously designed and implemented by Doğan (2016) and further adapted by myself based on the feedback collected by the previous researcher. I received support from him in the design and delivery of the course. The course was formed of six sessions (one theory and one practical per week) lasting one hour each session. The students were offered 1 elective (ECTS) credit as an incentive to attend the course and attendance to all six sessions was compulsory, catch up sessions were offered if required. The purpose of the course was to teach the exercisers to be able to accept their internal states and increase their task-related focus in the pursuit of meaningful values and goals. The six sessions consisted of, but was not limited to: psycho-education, mindfulness, values and value driven behavior, commitment, acceptance, and supported with action oriented exercises (integration and applied practice). Homework tasks were set to the exercises after every session and a learning log was collected from each of the participants following the course.

3.6 Ethics

Only after the participants signed informed consent forms were they permitted to take part in the mindfulness course (see appendix 1). On these forms the instructor's experience was disclosed to participants' prior to taking part in the course. Based on this level of experience the instructor would be considered as a novice - consequently a strict following of the protocol was implemented. Different variations of the same consent form were administered for the different experimental groups. Those who participated in the mindfulness intervention and were subjected to the nocebo conditioning protocol were also required to complete an additional consent form (see appendix 2). Following the completion of the trial, participants were later debriefed and questioned as to whether they had any suspicion that a nocebo had been used. Maintaining privacy and confidentiality of both the participants and participant group was of paramount importance to avoid contamination of groups. Debrief numbers were randomly created by the participants' to avoid using their real names during the data analysis. The data was stored on a secure laptop behind an encrypted password. Upon completion of the project all data will be destroyed after four years. Participants were informed they could withdraw from the study at any point without having to justify their decision.

3.7 Statistical Analysis

Using SPSS software, a balanced two-ways mixed ANOVA for repeated measures, followed by the post hoc Bonferroni test for multiple comparisons, was used to statistically analyse the muscle work data. Multiple comparisons via Wilcoxon Signed-ranks Non-parametric T-tests were used for the RPE analysis. Lastly, manipulation checks were considered in relation to the corresponding data in order to strengthen the interpretation of the results.

4 RESULTS

4.1 Performance

Table 3: Mean and Standard Deviations for Work performed/number of extensions

		Work performed (kJ)		*Number of extensions*	
		Session 1 (Baseline)	***Session 2 (Test)***	***Session 1 (Baseline)***	***Session 2 (Test)***
Without	**Control**	7.65 ± 3.08	8.68 ± 3.91	21.06 ± 5.54	23.78 ± 6.72
Mindfulness	**Nocebo**	6.88 ± 2.60	6.46 ± 2.22	21.20 ± 4.23	19.93 ± 3.06
With	**Control**	7.50 ± 3.11	9.00 ± 3.65	22.31 ± 3.68	26.81 ± 4.67
Mindfulness	**Nocebo**	6.84 ± 2.83	7.94 ± 3.36	22.49 ± 5.01	25.93 ± 6.70

In session 1 the mean work performed by the control group increased by 13.46% to session 2. In the nocebo group the mean work performed was decreased by 6.1% to session 2 when expectation of performance worsening was induced.

There was no significant interaction between the nocebo effect, the mindfulness intervention x the session [F(1,60) = 3.242, *p*= 0.077 > 0.05]. However, irrespective of the mindfulness intervention, the two-way mixed ANOVA for repeated measures within subjects showed significant differences when control and nocebo groups were combined x the session [F(1,60) = 9.756, P < 0.001]. Multiple comparisons with the post hoc Bonferroni test showed significant increases from session 1 to session 2 in the combined control groups by 16.46% compared to only 5% the combined nocebo groups.

For the participants who received the mindfulness intervention but did not receive the nocebo effect, in session 1, the mean work performed by the control group increased by 20.00% to session 2. In the mindfulness-nocebo group, the mean work performed increased by 16.8% to session 2, when expectation of performance worsening was induced.

The two-way mixed ANOVA for repeated measures within subjects showed significant differences in mindfulness and no mindfulness groups x the session [F(1,60) = 11.483, P < 0.001]. Multiple comparisons with the post hoc Bonferroni test showed significant increases from session 1 to session 2 for the subjects who received mindfulness by

18.20% compared to only 5.06% for the subjects who did not receive the mindfulness intervention.

4.2 Perceptions

A Wilcoxon Signed-ranks non parametric t-test indicated that regardless of what groups the participants were in, participants' were significantly less exerted in RPE from sessions 1 and 2 at the first six measurements (table 4). Data collected from 3rd repetition was not reported as no meaningful data could be collected so early in the exertion exercise process. Data collected beyond the 21st extension was also not reported, as not enough participants were able to reach the 24th extension data collection point.

When looking at each of the groups individually, there were no significant differences in the mindfulness/nocebo group from session 1 to 2 (table 5). However, the mindfulness control group was significantly less exerted at each of the six measurements (table 6). The same is true for the first five measurements of the control group (table 7) but not for the nocebo group who again did not differ from sessions 1 to 2 at each of the six measurements (table 8).

When looking at participants who did and did not receive the nocebo effect combined, participants who received the nocebo effect did not differ from session 1 to 2 at any of the six measurements, (table 9) however participants who did not receive the nocebo effect were significantly less exerted from session 1 to 2 at all of the six measurements (table 10).

When looking at participants who did and did not receive the mindfulness intervention combined, participants who received the intervention were significantly less exerted from session 1 to 2 at all of the six measurements (table 11), however, participants who did not receive the intervention were also significantly less exerted at 5 of the measurement points (table 12).

Table 4: The rate of perceived exertion (RPE) medians and non-parametric t-test results for all participants.

All participants	***Baseline***	***Test***		
Ext. number	***Mdn***	***Mdn***	***Z=***	***P=***
6	3	3	-3.302	.001

9	5	4	-2.985	.003
12	6.5	6	-3.435	.001
15	8	7	-3.205	.001
18	9	8	-4.251	.000
21	9	9	-2.299	.022

Table 5: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the mindfulness/nocebo group.

Mindfulness+Nocebo	***Baseline***	***Test***		
Ext. number	***Mdn***	***Mdn***	***Z=***	***P=***
6	3	3	-1.328	.184
9	4	4	-.803	.422
12	7	5	-1.344	.179
15	7	7	-1.274	.203
18	8	8	-1.903	.057
21	9	9	-1.000	.317

Table 6: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the mindfulness control group.

Mindfulness Control	***Baseline***	***Test***		
Ext. number	***Mdn***	***Mdn***	***Z=***	***P=***
6	3	3	-2.000	.046
9	5	4	-1.833	.067
12	7	5	-1.991	.047
15	8	7	-2.437	.015
18	9	8	-3.307	.001
21	9	9	-2.264	.024

Table 7: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the control group.

Control Group Ext. number	***Baseline*** ***Mdn***	***Test*** ***Mdn***	***Z=***	***P=***
6	4	2	-2.170	.030
9	5	4	-2.360	.018
12	6.5	5.5	-2.708	.007
15	7.5	7	-2.539	.011
18	9	8	-2.859	.004
21	9	9	-1.414	.157

Table 8: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the nocebo group.

Nocebo Group Ext. number	***Baseline*** ***Mdn***	***Test*** ***Mdn***	***Z=***	***P=***
6	3	3	-1.026	.305
9	5	4	-.967	.334
12	7	6	-.710	.478
15	8	8	-.081	.935
18	9	9	-.707	.480
21	9	9	-1.414	.157

Table 9: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the combined nocebo group.

Combined Nocebo Ext. number	***Baseline*** ***Mdn***	***Test*** ***Mdn***	***Z=***	***P=***
6	3	3	-1.708	.088
9	5	4	-1.228	.219
12	7	6	-1.478	.139
15	8	7	-.916	.360
18	9	9	-1.182	.237
21	9	9	-.649	.516

Table 10: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the combined control group.

Combined Control	***Baseline***	***Test***		
Ext. number	***Mdn***	***Mdn***	***Z=***	***P=***
6	3	2.5	-2.967	.003
9	5	4	-2.923	.003
12	6	5	-3.270	.001
15	8	7	-3.497	.000
18	9	8	-4.327	.000
21	9	9	-2.347	.019

Table 11: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the combined mindfulness group.

Combined Mindfulness	***Baseline***	***Test***		
Ext. number	***Mdn***	***Mdn***	***Z=***	***P=***
6	3	3	-2.326	.020
9	5	4	-1.836	.062
12	6	5	-2.367	.018
15	8	7	-2.651	.008
18	9	8	-3.737	.000
21	9	9	-2.131	.033

Table 12: The rate of perceived exertion (RPE) medians and non-parametric t-test results for the combined no mindfulness group.

Combined no-Mindfulness	***Baseline***	***Test***		
Ext. number	***Mdn***	***Mdn***	***Z=***	***P=***
6	4	3	-2.379	.017
9	5	4	-2.409	.016

12	7	6	-2.532	.011
15	8	7.5	-1.834	.067
18	9	9	-2.222	.026
21	9	9	-1.121	.262

4.3 Manipulation Checks

Lastly, manipulation checks for the nocebo and mindfulness/nocebo groups are as follows. Over 90% of the total participants who received the nocebo conditioning procedure had no suspicion that any deception had been used. During the debriefings, 2 out of 15 participants from the nocebo group said they had a suspicion that a placebo had been used. Interestingly, both of these participants still performed worse on their second visit to the laboratory. Again, 2 out of 15 participants from the mindfulness/nocebo group said they had a suspicion that a placebo had been used. However, when both were asked if they could think of any reason why they performed better on the second occasion, neither of them attributed this to a suspected placebo. On the contrary, when participants were asked how they were feeling several commented on how much 'more fatigued' they were feeling in comparison to baseline. Moreover, when participants were asked why they believed they had performed better second time round several commented on external factors such as their 'sleep quality', 'diet' or 'energy levels'. Interestingly, many of the participants had still thought they had performed worse second time round despite actually performing better. It was only until the final result was revealed to the participant that they had any idea that their performance had actually improved. In conclusion, the overall observation of participant behaviour over the testing period and post hoc debriefings supported the effectiveness of the manipulation.

5 DISCUSSION

The purpose of the study was to investigate whether mindfulness practice could prevent the negative expectations given by potentially harmful nocebo effects. In line with previous research the study was able to successfully replicate the Pollo et al. (2012) protocol showing that performance was significantly negatively moderated in participants performing a leg extension exercise to maximum effort through employing negative suggestions and negative conditioning, irrespective of the mindfulness intervention. However, when the mindfulness variable was introduced the study was unable to show a significant interaction between the nocebo effect and the mindfulness intervention across both sessions, despite the direction of change in the means being in accordance to the hypothesis.

Namely, the study observed a decrease in performance in the nocebo group of 6.1% from sessions 1 to 2, verses an increase of 13.46% in the control group. Interestingly, the same was not found in the mindfulness conditions. The study observed performance increases in both of the groups from sessions 1 to 2, with the mindfulness-nocebo group reporting an increase of 16.8% and the mindfulness-control group reporting an increase of 20%. Firstly, when interpreting these results it is important to consider that a training effect of around 15% is expected based on the findings of the replicated study (Pollo et al., 2012). This is attributed to both the familiarisation of the equipment/environment and specific changes in muscular endurance from sessions 1 to 2. The reason the training effect evident in the control group was not only prevented, but also reversed in the nocebo group but not in the mindfulness-nocebo group is to be discussed.

Due to the stringency and sophisticated nature of the balanced placebo design (McClung & Collins, 2007), (also used in clinical settings), a high number of participants is required in order to achieve the statistical power necessary to take forward the proposed hypothesis. Although the sample size (64) taken forward for testing in the present study could be interpreted as high, it is highly likely that additional participants spread evenly across the experimental groups would have increased the statistical power beyond the significance level set. Nevertheless, there are a host of reasons in isolation (or combination) that could account for the findings, all of which will be addressed in relation to research presented in the introduction.

Gardner and Moore (2004) presented case material to suggest MAC could conceivably improve strength-training performance. Following a mindfulness intervention similar to the one implemented in the present study an elite power lifter was able to improve her baseline performance by 15% following the intervention. However, this was relatively early in the overall research of MAC and there is not the breadth of studies about the effect of MAC on strength training to empirically support this finding. In terms of the nocebo effect, there is evidence displaying that weight lifting can be significantly negatively impacted through verbal suggestion and reduction in expectation (Maganaris et al., 2000; Kalasountas et al. 2007) and the same is true for the study in question. In this instance the participants were informed that their weight lifting improvements was due to the implementation of an sham anabolic steroid - subsequently performance decreased significantly. Although in the current study the verbal suggestions were not in combination with an administered nocebo drug, it still shows the susceptibility of lowered expectation in relation to weight lifting specifically.

Alongside the concrete performance measurement (work performed), the subjective measurement (RPE) was also recorded throughout the leg extension exercise in order to obtain the perceptions of the participants (after every 3 repetitions). This provided the study with perceptive information at each of the first 7 seven time points. The main finding from the RPE analysis is that it is not possible for meditation practice to neutralize the negative effect of the nocebo conditioning protocol on RPE. Both of the groups that received the nocebo conditioning protocol were shown to be non-significant, whereas the control group and mindfulness control group was shown to be significantly less exerted from sessions 1 to 2. In the replicated study by Pollo et al. (2012), the nocebo manipulation was shown not to affect the RPE. In both of their experiments, the participants failed to show any significant changes in their RPE from sessions 1 to 2. The significant findings in the control groups of the present study can therefore be viewed in two contrasting ways. It could be viewed that, as both of these groups were significantly less exerted in comparison to the nocebo testing groups who showed no change, that the nocebo conditioning procedure prevented the nocebo testing groups from seeing this positive difference in exertion. Juxtaposition, it could also be deduced that the nocebo conditioning procedure was ineffective at manipulating fatigue and the positive differences in the control groups were a result of other confounding variables. For example, the training effect counteracting the decrease in performance could potentially be responsible for the lack in fatigue increase. Regardless of how the findings relate to previous research, one factor which is apparent is the intrinsic low accuracy of this measure. Due to the speed of the exercise and relatively short duration of the activity it is difficult to record accurately the RPE without an assistant experimenter to hand. Despite this ambiguity and similarly to the results of the performance measure, the study cannot categorically say that mindfulness is not beneficial for RPE. For the most part, it seems mindfulness does have a positive effect on RPE in general. However, the nocebo conditioning procedure was too robust to make the effect of mindfulness significant. Both empirically and in real world settings the evidence to suggest mindfulness is beneficial to combating fatigue and exhaustion is known (Salmon, Hanneman & Harwood, 2010). However, under the parameters of the experimental procedure and again due to speed and duration of the activity, the transferability is uncertain.

4.1 Limitations and Future Direction

Some limitations into the design and methodology of this investigation must be recognised. Due to the high requirement of participants both genders were recruited in this study and gender imbalances were found in 2 of the 4 groups. In previous work on the nocebo effect and in sports particularly, female participants have generally been excluded in order to avoid possible gender differences (Carlino et al. 2014). In hindsight, controlling for gender would be recommended for future studies which have access to large populations. Secondly, for the people who were in the MAC intervention it is possible that participants could have benefited from being specially treated. Although a standardised form was used to control for experimenter bias, it is still possible that the increased contact time and attention could have resulted in the participants working harder and performing better (Hawthorne effect) (Hurst et al., 2015). On the other hand, with the instructor of the mindfulness course being a novice instructor it is equally likely that the participants may have benefited more from being taught by a qualified instructor. To what extent motivation or instructor experience played a part is ambiguous; despite this, controlling for motivation by implementing an intervention from an experienced practitioner for participants in the intervention groups is suggested. Furthermore, due to the limited resources of the experimenter, both the intervention and the data collection of all participants had to be conducted by one person. Adopting a double-blind design, with access to multiple experimenters or laboratory assistants would help to eliminate any implicit biases the experimenter may possess. Lastly, the non-parametric tests used in the RPE analysis pose less statistic power than their counterparts. As with the performance measure, an increased sample size would allow for greater certainly across the board.

One clear strength of the study was the implementation of the post performance manipulation checks. This allowed the study to test the effectiveness of the deception and a 90% success rate was found. One new finding from the study is that it is possible for the nocebo effect to make a large proportion of the participants perceive they have performed worse, despite actually performing better. It was only when the final result was revealed to the participant that they had any idea that their performance had actually improved. Perhaps a better way of aligning the methodology to the research question would be to implement a single case study method (McDougall, 2013). Due to the individuality of nocebo responsiveness (Duncan, 2010) and the difficulty of generalising across populations (Foad, Beedie & Coleman, 2008), a single case study design may be able to apply the nocebo principles to sport and exercise psychology more neatly.

Conclusively, the findings from this research can make a valuable contribution to the realm of talent identification and development. For young athletes that have received negative verbal suggestions in relation to their potential ability or have been rejected from youth academies, combating nocebo effects may play an important role in their future development. Research has shown that talented athletes need a wide array of psychological skills and characteristics in order to develop their full potential (Moesch, Hauge, Wikman & Elbe, 2013). Here, the study has displayed how potentially harmful nocebo effects can have significant implications on training. For instance, the training effect shown in the control group was significantly adversely affected by the nocbeo conditioning procedure. The study has also shown that not everybody is nocebo responsive and it is unlikely a stable characteristic.

Future studies should consider the recommendations made concerning the limitations and investigate these effects using a single case study design, which may allow for greater application in the evaluation of mindfulness's ability to combat the nocebo effect.

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APPENDIX

Appendix 1- Mindfulness Course

PARTICIPANT CONSENT FORM

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

Faculty of Sport and Health Sciences
Department of Sports Sciences

Mindfulness Meditation

Brief Description of Research Project: This free elective course is formed of a 6-session programme based on the practical application of mindfulness. Through the sessions and exercises we aim to make you focus in present moment (the task in hand), accept your internal states and pursue your meaningful values and goals.

The instructor holds a BSc in Sport psychology and is currently doing his master's in sport and exercise psychology in JYU. This course is part of his Master's thesis, so participants would automatically be participating in the study if they would like to attend the course. The instructor has attended regular mindfulness practice in the United Kingdom and has also attended 2 elective courses worth a total of 6 ects at the University of Jyväskylä.

Brief Description of what will be required of Participants: Participants will be required to actively participate in 6 mindfulness meditation based sessions and complete a learning log about their experiences on the course. At the end of the course participants will be asked to complete a basic motor task via a simple exertion exercise. More information will be given to the participants at a later date and an additional consent form will be required to be completed.

Credits: 1, Pass/Fail Fail (Attendance to all 6 sessions is required, with the possibility of 1 or 2 extra sessions being organised if needs must).

You will be given a number on your Debrief Form that you should retain; everything the participants say will be kept confidential. You can withdraw from participation from the whole experiment or any part of it at any point without needing to justify your decision. You can also request for your data to be withdrawn at any time after participation in the study. In order to do this, please contact the investigator with your participant number, which you will find on the Debrief Form. Please return your signed Consent Form to the investigator and retain your Debrief for future reference. Consent Forms and any other data will be stored separately, and securely.

You can contact the researcher and the supervisor if necessary of the study anytime via information provided below:

Investigator Contact Details:

Jonne Tryphonos
+357449881408
jonne.a.tryphonos@gmail.com

Consent Statement:

I agree to take part in this research, and am aware that I am free to withdraw at any point. I am aware that my participation in this program and study is voluntary. I understand that the information I provide will be treated in confidence by the investigator within the limits described and that my identity will be protected in the publication of any findings. The researcher has reviewed the individual and social benefits and risks of this project with me.

I have read the above form, and, with the understanding that I can withdraw at any time, and for whatever reason, I consent to participate in the Mindfulness Meditation Study.

Name …………………………………..

Signature ………………………………

Date ……………………………………

Please note: if you have a concern about any aspect of your participation or any other queries please raise this with the investigator. However if you would like to contact an independent party please contact the Project Supervisor:

Project Supervisor Contact Details:
Taru Lintunen
Department of Sports Psychology
University of Jyväskylä
taru.lintunen@jyu.fi

Appendix 2- Additional Consent Form

ADDITIONAL CONSENT FORM

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

Faculty of Sport and Health Sciences
Department of Sports Sciences

Electrical muscle stimulation (EMS)

Brief Description of Research Project and what will be required of Participants:

During the mindfulness course you have been taught to focus on present moment (the task in hand), accept your internal states and pursue your meaningful values and goals. You will now be required to complete a leg extention exercise assessing work performed, and rate of perceived exertion undergoing electrical muscle stimulation (EMS).

EMS is the elicitation of muscle contraction using electric impulses and will be used during todays testing. This stimulation will be delivered during the exercise at an intensity level just below your perception threshold, and even though you will not feel it, it will increase your sense of fatigue by adding an external cause of weariness on your muscles, leading to a decrease in motor performance.

The impulses are generated by a device and delivered through electrodes on the skin in direct proximity to the muscles to be stimulated. The impulses mimic the action potential coming from the central nervous system, causing the muscles to contract. The electrodes will be attached to your quadriceps through self-adhesive pads that adhere to the skin.

Credits: 1, Pass/Fail Fail (Attendance to all 6 sessions is required, with the possibility of 1 or 2 extra sessions being organised if needs must).

You will be given a number on your Debrief Form that you should retain, everything the participants say will be kept confidential. You can withdraw from participation from the whole experiment or any part of it at any point without needing to justify your decision. You can also request for your data to be withdrawn at any time after participation in the study. In order to do this, please contact the investigator with your participant number, which you will find on the Debrief Form. Please return your signed Consent Form to the investigator and retain your Debrief for future reference. Consent Forms and any other data will be stored separately, and securely.

You can contact the researcher and the supervisor if nessersary of the study anytime via information provided below:

Investigator Contact Details:

Jonne Tryphonos
+357449881408
jonne.a.tryphonos@gmail.com

Consent Statement:

I agree to take part in this research, and am aware that I am free to withdraw at any point. I am aware that my participation in this program and study is voluntary. I understand that the information I provide will be treated in confidence by the investigator within the limits described and that my identity will be protected in the publication of any findings. I agree not to discuss what I have experienced today with any other person. The researcher has reviewed the individual and social benefits and risks of this project with me.

I have read the above form, and, with the understanding that I can withdraw at any time, and for whatever reason, I consent to participate in the Mindfulness Meditation Study.

Name …………………………………..

Signature ………………………………

Date ……………………………………

Please note: if you have a concern about any aspect of your participation or any other queries please raise this with the investigator. However if you would like to contact an independent party please contact the Project Supervisor:

Project Supervisor Contact Details:
Taru Lintunen
Department of Sports Psychology
University of Jyväskylä
taru.lintunen@jyu.fi

Appendix 3- Electrical muscle stimulation (EMS) Consent Form

PARTICIPANT CONSENT FORM

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

Faculty of Sport and Health Sciences
Department of Sports Sciences

Electrical muscle stimulation (EMS)

Brief Description of what will be required of Participants: You will be required to complete a leg extention exercise assessing work performed, and rate of perceived exertion undergoing electrical muscle stimulation (EMS).

EMS is the elicitation of muscle contraction using electric impulses and will be used during the second day of testing. Participants will be required to attend 2x 20 minutes sessions. The stimulation delivered during the exercise will be at an intensity level just below your perception threshold, and even though you will not feel it, it will increase your sense of fatigue by adding an external cause of weariness on your muscles, leading to a decrease in motor performance.

The impulses are generated by a device and delivered through electrodes on the skin in direct proximity to the muscles to be stimulated. The impulses mimic the action potential coming from the central nervous system, causing the muscles to contract. The electrodes will be attached to your quadriceps through self-adhesive pads that adhere to the skin.

You will be given a number on your Debrief Form that you should retain, everything the participants say will be kept confidential. You can withdraw from participation from the whole experiment or any part of it at any point without needing to justify your decision. You can also request for your data to be withdrawn at any time after participation in the study. In order to do this, please contact the investigator with your participant number, which you will find on the Debrief Form. Please return your signed Consent Form to the investigator and retain your Debrief for future reference. Consent Forms and any other data will be stored separately, and securely.

You can contact the researcher and the supervisor if necessary of the study anytime via information provided below:

Investigator Contact Details:

Jonne Tryphonos
+357449881408
jonne.a.tryphonos@gmail.com

Consent Statement:

I agree to take part in this research, and am aware that I am free to withdraw at any point. I am aware that my participation in this program and study is voluntary. I understand that the information I provide will be treated in confidence by the investigator within the limits described and that my identity will be protected in the publication of any findings. The researcher has reviewed the individual and social benefits and risks of this project with me.

I have read the above form, and, with the understanding that I can withdraw at any time, and for whatever reason, I consent to participate in the study.

Name …………………………………..

Signature ………………………………

Date ……………………………………

Please note: if you have a concern about any aspect of your participation or any other queries please raise this with the investigator. However if you would like to contact an independent party please contact the Project Supervisor:

Project Supervisor Contact Details:
Taru Lintunen
Department of Sport Sciences
University of Jyväskylä
taru.lintunen@jyu.fi