Cardiff School of Sport

DISSERTATION ASSESSMENT PROFORMA:

Student name:	Chloe Louise Taylor	***Student ID:***	ST20007329
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Dissertation title:	The effects of a 'performance enhancing' (placebo) on the performance and the rating of perceived exertion on incremental arm crank ergometry		
Supervisor:	Paul Smith		

Comments	Section
	Title and Abstract (5%) Title to include: A concise indication of the research question/problem. Abstract to include: A concise summary of the empirical study undertaken.
	Introduction and literature review (25%) To include: outline of context (theoretical/conceptual/applied) for the question; analysis of findings of previous related research including gaps in the literature and relevant contributions; logical flow to, and clear presentation of the research problem/ question; an indication of any research expectations, (i.e., hypotheses if applicable).
	Methods and Research Design (15%) To include: details of the research design and justification for the methods applied; participant details; comprehensive replicable protocol.
	Results and Analysis (15%) [2] To include: description and justification of data treatment/ data analysis procedures; appropriate presentation of analysed data within text and in tables or figures; description of critical findings.
	Discussion and Conclusions (30%) [1] To include: collation of information and ideas and evaluation of those ideas relative to the extant literature/concept/theory and research question/problem; adoption of a personal position on the study by linking and combining different elements of the data reported; discussion of the real-life impact of your research findings for coaches and/or practitioners (i.e. practical implications); discussion of the limitations and a critical reflection of the approach/process adopted; and indication of potential improvements and future developments building on the study; and a conclusion which summarises the relationship between the research question and the major findings.
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CARDIFF SCHOOL OF SPORT

DEGREE OF BACHELOR OF SCIENCE (HONOURS)

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2013-4

The effects of a 'sport enhancing' (placebo) on the performance and the rating of perceived exertion during incremental arm crank ergometry

(Dissertation submitted under the discipline of Physiology and Health)

Chloe Louise Taylor

[2] This form should be used for both quantitative and qualitative dissertations. The descriptors associated with both quantitative and qualitative dissertations should be referred to by both students and markers.

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The researcher would like to thank Dr Paul Smith, discipline director for Physiology and Health at the Cardiff Metropolitan School of Sport, for his support and guidance. Also, the researcher would like to thank the participants, friends and family for all the help and support they have given throughout the process.

ABSTRACT

Previous research has looked into the effects of a placebo as an ergogenic aid, the aim of the current study was to expand on the available research. The investigation was designed to discover the effect of an inert sugar free drink described as ‘performance enhancing’ (placebo) on peak minute power (PMP;W), during incremental arm crank ergometry (ACE). Seven healthy male rugby players, whom are non-specifically trained in the upper body volunteered to take part. Their mean age height and mass were 20.9±0.9 =years, 183.3± 6.8cm and 90.0±8.3kg, respectively. A control trial with repeated measures was used to assess the difference the introduction of the placebo caused on the following; Peak minute power (PMP;W) Oxygen uptake, Heart rate (HR), minute ventilation, respiratory exchange ratio (RER) Subjective reports of local ratings of perceived exertion (LRPE) and central rating of perceived exertion (CRPE), between two separate but identical ACE tests. The participants were asked to maintain a constant crank rate of 70 rev·min-1 whilst the wattage increased in a rank protocol of 10 (W) every minute, until the participant reached exhaustion, terminating the test. Fifteen minutes prior to the exercise the participants were required to drink 500ml of a ‘sports performance’ drink (placebo) or control (water). The placebo caused a statistical significant increase in PMP;W ($P<0.05$). However, a non-significant statistical difference ($P>0.05$) was revealed with physiological measurements between trials. It is thought that the belief and expectation of the participants had a potential impact on individual effort. The results show a positive impact with the ingestion of a placebo ergogenic aid on sports performance. There is much more to be researched into the placebo effect in order to broaden understanding, finding use for the placebo in the sporting world in the near future.
This research can be beneficial for coaches looking to improve the motivation of athletes who have hit a performance slump. The coach can help to improve the athlete’s psychological status without having to introduce performance enhancing supplements, avoiding the accidental use of illegal substances or any possible negative side effects of the drugs.

CHAPER ONE - INTRODUCTION

For many years Sport and Exercise Scientists have rigorously been testing different substances to evaluate their effects on performance. This has been done in an attempt to find the best solutions to enhance performance. The idea of a drink or a tablet that can drastically improve performance is appealing to a large party, including coaches and athletes. However, over the last 10-15 years research focusing upon performance enhancing substances has speculated that benefits may simply be down to a psychological factor, commonly known as the 'placebo effect' (Beedie and Foad, 2009). The placebo effect is attributed to an individual's belief and expectations of a specific outcome rather than a pharmaceutical drug or remedy (Crum and Langer, 2007).The placebo effect has a central role in many clinical trials and is an acknowledged factor in sports medicine (Benedett, Mayberg, Wager, Stohler and Zubieta, 2005; Kallmes, Comstock, Heagerty, Turner, Wilson and Diamond., 2009) There is relatively little known about the placebo effect in sport-specific, performance research settings (Beedie and Foad, 2009); leaving clear room for further research on the phenomenon of the placebo. The placebo effect is psychological and, therefore, once understood has the possibility to expand on many of the already successful psychological methods used to improve and control performance. Work published 14 years ago by Maganaris, Collins and Shar. (2000) suggested evidence that the placebo effect works as an ergogenic aid is slowly increasing. Recent research has suggested that the magnitude of the placebo effect appears to be associated with an individual's expectation of outcome (Bottoms, Buscombe and Nicholettos., in press).

1.1 Purpose of the study

The purpose of the current study was to expand and improve the understanding of the placebo effect. The study will be predominantly focusing on the comparison in peak performance, physiological measures and ratings on perception using the likert scale, between the placebo trail and the control trial. The results from current study will further the knowledge of the placebo effect, expanding available research.

1.2 - Aims and objectives

The current investigation aims to explore the effects of a placebo as an ergogenic aid on one mode of exercise. Evaluating the effects on performance, comparing the peak minute power (PMP; W) and comparing physiological changes between a placebo and a control (plain water) trial. The comparison of both the physiological variable and the performance PMP allows a full investigation on the placebo effect. To comply with much of the research

discussed in the literature review regarding the importance of belief and perception, the participants will be asked to rate their perception of both the control and placebo trail. Allowing for more understanding of the reasons for results found. The main focus of the literature review will not only consider, but also compare research from the medical field and many different sporting situations; from endurance cycling to weight lifting. In doing this possible mechanisms underpinning the placebo effect will be explored in detail.

1.3 Hypotheses

- 1. The null hypothesis states that the ingestion of the ‘sports performance’ will have no significant effect on the peak power output (PMP) in comparison to the control (water) trial during a VO_{2peak} test on the arm crank ergometer.
- 2. It is also hypothesized that participants will stop exercising at the point of volitional exhaustion due to the onset of acute, localized muscular (peripheral) fatigue, rather than cardio respiratory fatigue. Therefore, it is anticipated that a differentiated rating of perceived exertion will be higher in association with the local muscular rate of perceived exertion (LRPE) than the central rate of perceived exertion (CRPE).

CHAPER TWO - LITERATURE REVIEW

2.1 - Placebo effect

The placebo effect is when an individual has strong belief or high expectations that what they are doing will have a positive outcome. Therefore, having a positive psychological effect holds the potential to positively (or negatively) influence results (Foad, Beedie and Coleman., 2008). Many of the testimonials for nutritional products and training aids cited by manufacturers are consistent with the placebo effect, especially products and aids that have no reasonable underlying mechanism for the expected enhancement of performance (Clarke, Hopkins, Hawley and Burke., 2000). A number of studies have explored the placebo effect in sporting situations and have reported substantial and statistically significant increases in endurance capacity (Clarke *et al.*, 2000) as well as improvements in strength performance (Kalasoun, Reed and Fitzpatrick,. 2007; Marganaris *et al*., 2000). Ariel and Savile (1972) noted that a placebo influenced a group of male athletes; by encouraging them into thinking that they were taking anabolic steroids, significant improvements in their strength were observed during the placebo trail. Although a considerable amount of the research reported improvement in performance, underpinning, physiological responses often appear to remain unchanged compared to a control trial (Bottoms *et al.,* in press*;* Foster, Felker and Porcari.,2004).

2.2 - Placebo in the Medical Field

Numerous studies have shown that there may be more to a placebo effect than first thought. As well as being used in sport, the placebo effect has been acknowledged and has been controlled for in clinical trials for over 50 years (Beedie and Foad, 2009).The placebo effect has even been used in situations as drastic as sham surgery (Kallmes, Comstock and Heagerty., 2009). A doctor from America who specializes in fixing broken vertebrae; by injecting a cement like mixture into the fractured areas, began to question the theory of a placebo. Finding that some of his patients had been treated in the wrong area and still experienced a decrease in pain. Therefore, a trail was carried out where 68 patients received the vertebrae surgery and 63 received a simulated procedure. Astonishingly, a month after the surgery there was no significant difference between the groups; both groups had experienced immediate improvement in disability and pain scores post-intervention (Kallmes *et al*., 2009).

Over recent years the placebo effect has also been used to provide treatment for individuals with Parkinson's disease. A study published by De la Fuente-Fernandez, Sossi,

Schulzer, Calre and Stoessi. (2001) found that administration of a placebo in the form of a pill, induced the expectations of motor improvement, with an ingested pill being shown to activate the release of endogenous dopamine in the striatum region of the patients' forebrain. In addition Pollo, Torre, Lopiano, Rizzone, Lanotte and Cavanna. (2002) found that when patients with Parkinson's diseases expected improvements in motor performance, the changes occurred within minutes, suggesting that subjective expectations prompted almost immediate neural changes.

2.3 - Mechanisms of the Placebo Effect

There is little known about the mechanisms of action underpinning the placebo effect (Pollo, Carlino, Vase and Benedetti., 2012) and they are likely to be situation-specific as the placebo effect is a psychological phenomenon. It is speculated that the main mechanisms associated with the placebo effect are conditioning and expectation (Montogomery and Kirsch, 1997; Benedetti *et al*., 2011). Pollo *et al*. (2012) discussed the possibility of a link with the placebo effect and Pavlovian conditioning. Pavlovian conditioning is the process of mentally linking an unconditioned response to an unconditioned stimulus, with a conditioned stimulus. It is thought that the placebo response is the coupling of a perception of a stimulus (*e.g*. sport drink) with the positive side effects of generating improvements in the potential to perform. It is also thought that taste alone (*e.g*. the ingestion of a sweet sports drink) can be perceived positively, causing subsequent improvements (Schedlowki and Pacheco-Lo'pez., 2010). Research has been carried out to look at the role of conditioning in the placebo effect.

In order to gather a better understanding of the placebo effect, Wager, Riling, Smith, Sokolik, Davidson and Kosslyn.,(2004) conducted a study that investigated the expectations of placebo analgesia in a thermal pain model. The model was used to asses if the application of a placebo treatment in anticipation of pain can change the pain process in any way. In considering the temporal patterning in the brain, findings reported that the introduction of a placebo decreased both the reported pain, as well as pain-evoked activity in the brain. It is, therefore, possible that the placebo may reduce anxiety and reduce anticipatory responses, which when taken together might result in less pain being experienced. It has been thought that the effects of expectation may be linked to opioid activity in the brain, causing a reduction in pain (Benedetti *et al*.,2005).

Petrovic, Kalson and Petersson. (2002) hypothesised that the placebo effect is driven by executive attention; self-distraction strategies may be increased with appraisals of safety. Numerous studies have considered the possibility of the placebo providing a distraction

from pain. Other literature supported the link between the placebo and mechanisms underlying pain and analgesia (Colloca and Benedetti., 2005; Finniss and Benedetti., 2005).

2.4 - Perception of placebo

Pollo, Carlino and Benedetti. (2008) discovered that when a placebo was offered as an ergogenic aid, (as found in his study of caffeine,) it had an effect on perceived fatigue, resulting in the individual having an expectation of improvement; thereby the resulting effect was noticeable. The study showed that a placebo ergogenic aid had an effect on both muscle work and perceived fatigue in participants performing leg extensor exercise to the point of volitional exhaustion. This finding lead to the understanding that the combination of conditioning and expectation added to the strength of argument associated with the placebo effect.

Tracey (2010) reported that the placebo effect can be brought on by expectation; verbal suggestions can induce cognitive engagement, improving the perception of a placebo. The perception of a placebo plays an important role in the context of positive impact when a patient has high expectations of a perceived benefit (Kamper., 2013).

Research undertaken by Foad, Beedie and Coleman (2008) showed that the achievements did not correspond with the placebo effect. However, it was speculated that during her study the participants were aware of the protocol and the possibility of a placebo, causing individuals to question what they have received - this possibly contradicted the anticipated outcome. Although there has been proof of a link between participants' expectation and the placebo effect, with results that support this from Bottoms *et al*. (in press). There a still fewer studies that have investigated this in the sports science domain (Pollo *et al*., 2008).

2.5 - Mental perceptions of fatigue

When performing a protocol testing Vo_{2peak}, the demands on the body are extremely high. Maximal tests are designed to push the body until it reaches fatigue, testing its ability to remove lactate and regenerate PCr stores (Tomlin and Wenger, 2002). When blood lactate accumulates at a rate in excess of its removal, intracellular acidity increases, which may cause enzyme disruptions and muscle contraction impairment, and ultimately fatigue (Billat, Sirvent, Koralsztein and Mercier., 2003). The enzyme disruptions linked with

intercellular acidity is likely to cause pain and discomfort for the participant. The production of lactic acid is a consequence of anaerobic glycolysis (Fits, 1994). Karlsson and Saltin (1970) reported consistent associations between high muscle lactate concentrations and exhaustion.

Fatigue during prolonged exercise is described as the inability to sustain a certain level of expected force leading to a loss of performance in a given task (Edwards, 1981). It is thought that one of the main factors contributing to peripheral fatigue is the depletion of muscle glycogen. Bergstrom, Hermansen and Hultman. (1967), thus believed to limit the rate of adenosine diphosphate rephosphoration, alongside the progressive loss of body fluids resulting in increased cardiovascular, metabolic and themoregulary strain (Meeusen, Watson, Hasegawa and Roelands*.,* 2006).

Bottoms et al. (in press) noted that even though factors such as the physiological changes stated above may cause fatigue, the brain will still orchestrate the final decision. Even though the body is feeing extreme discomfort a belief that the 'sport enhancing' placebo drink is having a positive effect can help drive an individual to continue. This was observed in a recent study by Bottoms et al (in press) where improvements in time to fatigue and increases in peak power output were observed. Interestingly, however, no significant physiological differences were observed between trials, there was a significant difference between peak power, indicating that the ingestion of the placebo had a positive effect.

2.6 - VO_{2peak}

Maximal oxygen uptake (VO_{2max}) is considered as the benchmark indicator of cardiorespiratory fitness (McArdle and Katch., 1996). Individuals with higher VO_{2max} have a more efficient cardiorespiratory system, with increased ability to remove lactate, resynthesise ATP and regenerate PCr stores (Tomlin and Wenger, 2002). However, in relation to the current study where arm crank ergometry (ACE) will be employed, at relative exercise intensities above the anaerobic threshold there is a change in the anticipated VO_2 response causing it to plateau, peak or even decrease during the final stages of a progressive VO_2 test (Shrieks and Pacheco-Lopez*.,* 2011). This is due to the energy requirements of adenosine triphosphate levels no longer being met with equivalent increases in oxidative phosphorylation. The energy required to continue is supplemented through anaerobic glycolysis, causing the formation of lactate. Therefore, as a plateau is

not likely to be evident, the test is referred to as a VO_{2peak} test instead of VO_{2max}. The highest measurement of VO_2 over a 30-s continuous period through the duration of a test is typically used.

2.7 - Arm Crank Ergometry

Arm crank ergometry (ACE) is an effective method of investigating physiological responses in athletes from upper body specific sports (Smith, Price and Doherty*.,* 2001). Arm crank ergometry is not a correct indicator on VO_{2max} in an individual untrained in the upper body, as they will experience local fatigue prior to central fatigue (Smith, Amaral, Doherty, Price and Jones., 2006). During ACE a small amount of muscle mass is used, therefore Brooks, Fahey and White.(1996) also suggested values associated with physiological responses be classified as VO_{2peak}. Sawaka, Foley, Pimental, Tonerm and Pandolf(1986) and Sanada, Kearns and Kojima. (2005) reported that during a VO_{2peak} test on the ACE, the amount of skeletal muscle mass in the arms, shoulders and back plays a major role in influencing the peak power output attained. Subsequently, corresponding with Miles, Cox, Bomze, Davidson, Scott and Balmer (1989), non-specifically trained athletes not only have a smaller muscle mass, but their muscles are likely to be less aerobically conditioned and this will result in peripheral fatigue before a true value of VO_{2max} is achieved. Research published by Shrieks*,* Barnes and Hodges (2011) supported this; their findings demonstrated that many of the participants who took the test stopped arm cranking because of local muscle fatigue rather than cardiopulmonary endpoints. Sawka *et al*. (1983) suggested that during cycling movements, a small amount of active muscle mass is in use, resulting in a large percentage of its maximum being needed in order to produce a given output. Also proposing that during ACE, an athlete is likely to switch to anaerobic processes earlier. This is due to the constant isometric contraction of the forearm in order to grip the handles, which results in a pseudo-occlusion, preventing blood flow both to and away from the arm.

2.8- Purpose of the study

Collective previous research has indicated that there is room for further research into the placebo effect in sporting situations. Therefore, the aims of the current study was to focus upon the perception of a sports inducing drink (placebo) on athletes. Trained athletes are likely to have skeletal muscles that are physiologically adapted to cope with demands of exercise more efficiently, resulting in a decrease in lactate accumulation (Hollszy 1973)

and an increase in muscle buffering (Sahlin and Henriksson 1984). Due to this, athletes who are untrained in the upper body have been chosen for the following study. The untrained athletes are likely to experience negative effects of peripheral fatigue earlier during the ACE. With previous research showing that the introduction of a placebo can have an effect on the pain experienced (Colloca and Benedetti., 2005; Finniss and Benedetti., 2005; Wager *et al*., 2004).

Therefore, the current study aimed to expand and improve the understanding of the placebo effect. Focusing on the comparison in peak performance, physiological measures and ratings on perception using the likert scale, between the placebo trail and the control trial. Expanding on the available research.

2.8 Hypotheses

- 1. The null hypothesis states that the ingestion of the 'sports performance' will have no significant effect on the peak power output (PMP) in comparison to the control (water) trial during a VO_{2peak} test on the arm crank ergometer.
- 2. It is also hypothesized that participants will stop exercising at the point of volitional exhaustion due to the onset of acute, localized muscular (peripheral) fatigue, rather than cardio respiratory fatigue. Therefore, it is anticipated that a differentiated rating of perceived exertion will be higher in association with the local muscular rate of perceived exertion (LRPE) than the central rate of perceived exertion (CRPE).

CHAPER THREE - METHOD

3.1 Participants

Seven, healthy males volunteered to partake in the study, all of which are able-bodied and play rugby on a regular basis (mean ± SD age: 20.9±0.9 years; weight: 90.0±8.3kg; height: 183.3± 6.8cm). All participants were non-specifically trained in the upper body and free of injury. Participants were fully informed of the procedures and asked to sign full written consent to participate within the study. All information collected will remain anonymous, although the participants will have full access to their own results. During each testing session, participants were required to perform a standardized warm-up and cool-down, minimising any risk of injury. Ahead of any testing, all methods and procedures were considered and gained ethical approval from the School of Sport Research Ethics Committee, Cardiff Metropolitan University.

3.2 Study Design

The testing required participants to perform two incremental $VO_{2\ peak}$ tests using an electrically-braked arm crank ergometer (Lode Angio, Lode, Groningen, Netherlands). Participants were required to ingest 500ml of a 'sport enhacing' placebo drink or 500ml of water (control) 15-min prior to testing. The trial order was randomized. Participants were informed that the 'sport enhancing' placebo drink should act in such a way to improve performance and slow down fatigue, thus instigating a placebo effect. The sweet tasting drink was formulated using sugar free, double concentrate orange cordial. For the benefit of the reader, it should be noted that the placebo drink contained nothing that would have any meaningful impact on either physiological responses or functional capacity. However, the participants were informed that the drink would improve their performance and, therefore, are likely to expect a positive effect of their performance capacity.

Participants were informed that the 'sports enhancing' drink was provided from a manufacturer who wanted their product to be trialled in different modes of exercise, assessing the effects it has on performance. This maximised the authenticity of the drink and improved the belief the participants had in the 'sports enhancing' drink. It was highlighted to the participants that the control trial (water) was being used as a comparison.

3.3 Testing procedures

Each participant's body mass and height were recorded using digital scales (Model 770, SECA: Vogel & Halke, Hamburg, Germany) and a stadiometer (Holtain Ltd, Croswell,

Crymych, Wales), respectively. Participants were fitted with a heart rate monitor and linked directly to a previously calibrated breath-by-breath gas analysis system (Jaeger, Oxycon CPX, Warwick, UK). In order to take correct measurements the participants were briefed on rating their perceived exertion (RPE) using a 6-20 Borg scale that was placed on the wall directly in front of the ergometer. Measurements were taken for both central rating of perceived exertion (CRPE) and local ratings of perceived exertion (LRPE). To warm up, participants were required to perform a 3-min warm-up which consisted of rotating the arm crank handles at 70 rev·min^{-1} at watts (W). Once complete, the exhaustive protocol could begin. The participants were required to keep a constant rotation of the handles on the arm crank ergometer of 70 rev·min^{-1}. Every minute the external power output increased by 10W, participants were required to keep cranking until the point of volitional exhaustion. Fatigue was deemed to have occurred when they were unable to maintain a crank rate at or above 70 rev·min^{-1} (Smith, Price and Doherty., 2007). Once the participants' reached exhaustion they performed standardised cool-down at 30W using a self-selected crank rate. Time to exhaustion was recorded to the nearest second, which allowed the calculation of peak (final minute) aerobic power (PMP;W) to be implemented accurately.

3.4 General Procedures

A step protocol was applied whereby the power output was increased by 10W every minute. Bottoms *et al.,* (in press) used a similar in the sense step protocol whereby power output was increased, however, unlike the current study the power output was increased every 2-min. Once the participants had performed their 3-min active warm up at 40 W, the workload was increased by 10W every minute. Participants were required to maintain a constant speed of 70 rev·min^{-1} throughout the test until volitional exhaustion. Research suggests that during standard physiological testing, crank rates between 70-80 rev·min^{-1} permit a more valid assessment of peak physiological responses than slower crank rates (Smith *et al.,* 2007)

In order to determine the peak minute power in watts (PMP;W) a calculation proposed by Smith *at el.,* (2004) was used. The PMP;W is obtained by using the value (s) of the workload participants' went through during the last minute of the test. Should a participant execute the final minute of the test at 140 W for 60-s, their PMP was calculated at 140 W. However, if, for example, the participant exercised for 11-min and 30-s, they would have completed exercise at 160 W for 30-s and 140 W for 30-s. Therefore, the PMP;W would be 150W.

A number of measurements were obtained during testing and the results were compared against the control trial to evaluate the performance effect of consuming the placebo drink. Participants' were required to wear a gas mask attached a calibrated Oxycon CPX gas analysis system collecting respiratory data; Oxygen consumption (VO_2) carbon dioxide production (VCO_2), respiratory exchange ratio (RER) and minute ventilation volume (VE) were measured. The particpants were also required to wear a wireless heart rate monitor (Polar Electro, RS4000, Kemple, Finland) in order to measure heart rate. Participants' respiratory values were each collected from a 30-s screen report produced by the Oxycon system. All the data was then organised into tables in Microsoft Excel (2010).

Differentiated ratings of perceived exertion for the local muscles (LRPE) and central system (CRPE) components of effort were collected for each test, through the use of the Borg scale (1982). The rating of perceived exertion was measured during the final 15-s of each bout of exercise and at the point of volitional exhaustion similar to a protocol used by Price *et al*., (2011.)

Once participants' had finished the testing and were fully cooled down, participants' were asked to identify the extent by which they believed the placebo drink had adversely affected their overall performance (using a Likert scale from -10 to 10) the degree to which they expected the sports performance drink would positively impact their performance (-10 being a decrease in performance, 0 none at all, 10 being very much so), similar to the protocol from Bottoms *et al.,* (in press). In addition the participants were asked to provide subjective comments regarding their perceived effects of the placebo drink. After completion of the testing the participants were informed of the deception of the study and the use of a placebo. It was explained why the deception was a fundamental component.

3.5 Statistical Analyses

All graphical representations of data were formed through the use of Microsoft Excel (Microsoft, USA) and statistics were performed using the Statistical Package for the Social Sciences (SPSS 17.0 for Windows, SPSS, Inc, Chicago, IL . Separate, two-tailed, paired T-test were used to determine if differences in PMP as well as peak values of heart rate, VO_2, VCO_2, RER and VE existed between tests. Additionally, differences in peripheral and central ratings of perceived exertion were explored using a non-parametric Wilcoxon matched-pairs signed-ranks. Statistical significance was accepted at a conventional

probability level of 95% ($P<0.05$) or higher. All subsequent data are presented as mean and standard deviations in tables and figures.

A Spearman's rank correlation coefficient was used to determine the correlation and to explore the link between the degree to which participants expected (Likert score) that the placebo would increase their performance and the subsequent difference between the participants PMP in comparison to the control water trial.

CHAPER FOUR - RESULTS

4.1 Mean Peak Power (Watts)

Peak power (watts) achieved was measured for both the control and placebo trail. A significant difference in PMP;W was observed between the two conditions ($p < 0.05$), with the highest PMP;W occurring in the placebo trail. Six out of seven participants improved in with the placebo in comparison to the control trial. Table 1 summarises the mean (SD) for PMP (W)achieved during both trials.

Table 1. Individual peak minute power values for the two trials.

Participant	Water PMP;W (watts)	Placebo PMP;W (watts)	% increase in performance PMP;W between trials
1	126.0	140.8	11.70
2	109.0	120.0	10.10
3	110.8	130.0	17.00
4	138.3	140.0	1.20
5	150.8	147.5	-0.03
6	125.0	140.0	12.00
7	137.0	140.0	2.00
Mean (±SD)	**128 (15)**	**137 (9)**	**7.71 (7)**

4.2 Physiological measures and rate of perceived exertion

Table 2, shows the mean (SD) values of all peak physiological variables measures along with differentiated ratings of perceived exertion for local muscular (LRPE) and central cardio-respiratory (CRPE) systems. Mean (±SD) values of peak oxygen consumption (VO_2), respiratory exchange ratio (RER), carbon dioxide production (VCO_2), minute ventilation (VE), tidal volume (Vtex) and heart rate (HR) are summarised below in Table 2. Two tailed, paired t-test were used to compare variables from both trials. Results observed no significant difference between any of the variables. On average none of the results were significantly different between each trail ($p>0.05$).

Table 2. Mean (±SD) values of the peak physiological variables. A Decrease between performance is presented as a minus (e.g. -1 represents a decrease of 1%), increases are presented as positive figures (e.g. 1 represents an increase of 1%).

Participant	Water	Placebo	% difference (Water & placebo)	T-test score
VCO_2 ($ml \cdot min^{-1}$)	2788(±449)	3027(±179)	8.5(± -60)	0.19
VO_2 ($ml \cdot kg^{-1} \cdot min^{-1}$)	28.2(±5.6)	30.14(±4.2)	6.8(±-0.3)	0.17
RER	1.14(±0.06)	1.15(±0.04)	6.9(±-33)	0.58
VE (l•min-1)	100(±27)	112(±17)	12(±-37)	0.32
Vtex (L^{-1})	2.6±(0.45)	2.6(±0.32)	0(±-28)	0.88
HR (beats•min-1)	169 (± 29)	174(±21)	3.3(±-27)	0.38
LRPE (Borg Scale)	19.3 (± 1.1)	19.86(±0.37)	2(±-66)	0.28
CRPE (Borg scale)	18(±0.8)	18±(1.2)	0(± 50)	0.17

Figure 1; demonstrates the relationship between PMP (W) (placebo drink compared to the water trial) and the participants' expectation of experiencing a placebo effect (Spearman's r_s value= 0.38).

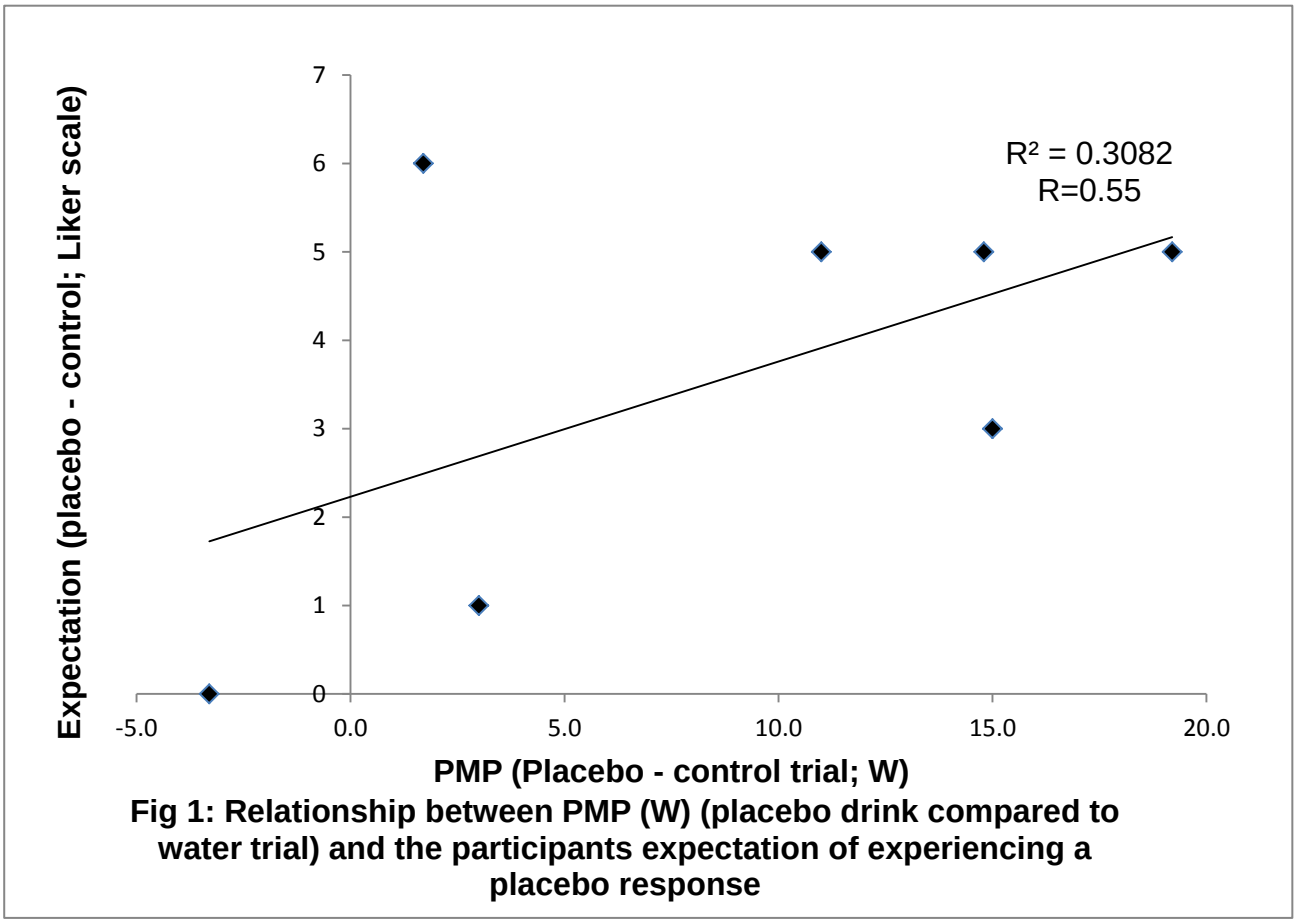
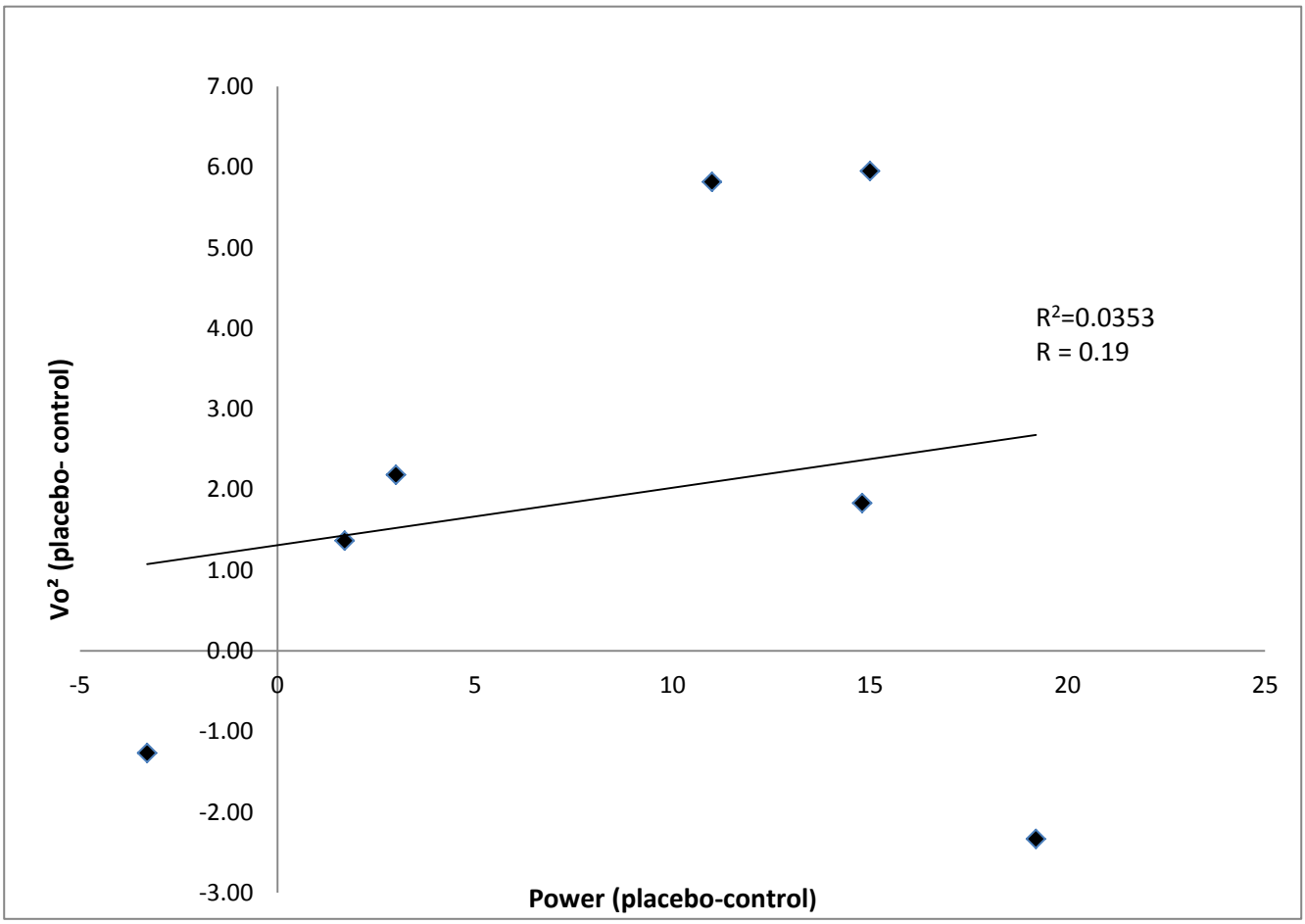


Fig 1: Relationship between PMP (W) (placebo drink compared to water trial) and the participants expectation of experiencing a placebo response

Spearman's rank correlation coefficients revealed a positive correlation (r=0.38) between individuals who had the greatest increase in PMP (W) compared to the control trail and those who had the highest expectation of the placebo drink (Likert), a non-parametric Wilcoxon matched-pairs signed-ranks test revealed a statistical difference ($P<0.05$) between the participants' expectations for each drink to improve performance during the VO_{2peak} test.

Figure 2 demonstrates the relationship between the increase in PMP (W) and the $VO_{2\ peak}$ achieved during the (placebo and water trial).



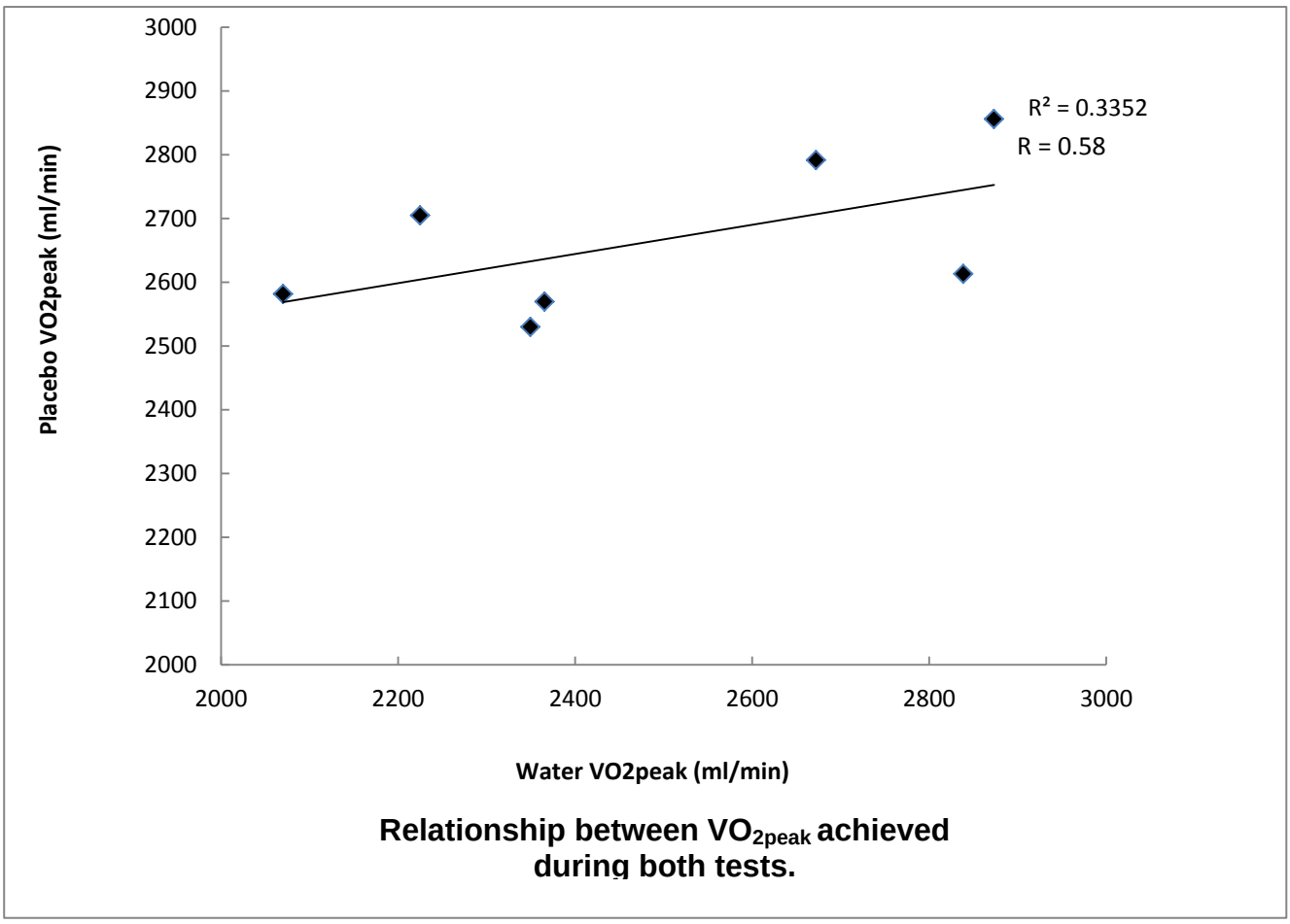
Spearman's rank correlation coefficients revealed a positive correlation (r=0.14) between PMP;P observed and VO_{2peak} attained. A t-test revealed non-significant difference ($p>0.05$).

4.3 - Difference between CRPE and LRPE

A non-parametric , Wilcoxon matched-pairs, signed-ranks test was performed to compare the peak central rate of perceived exertion (CRPE) and peak local peripheral rate of perceived exertion (LRPE) for both the water (control) and placebo trail. The test revealed a significant difference between the CRPE and LRPE measurements for both trials ($p=<0.05$). Another test was carried out comparing the difference found in CRPE and LRPE between the placebo and water trial, determining a non-significant difference ($p>0.05$).

4.4 - $VO_{2\ peak}$ achieved during placebo and water (control) trials

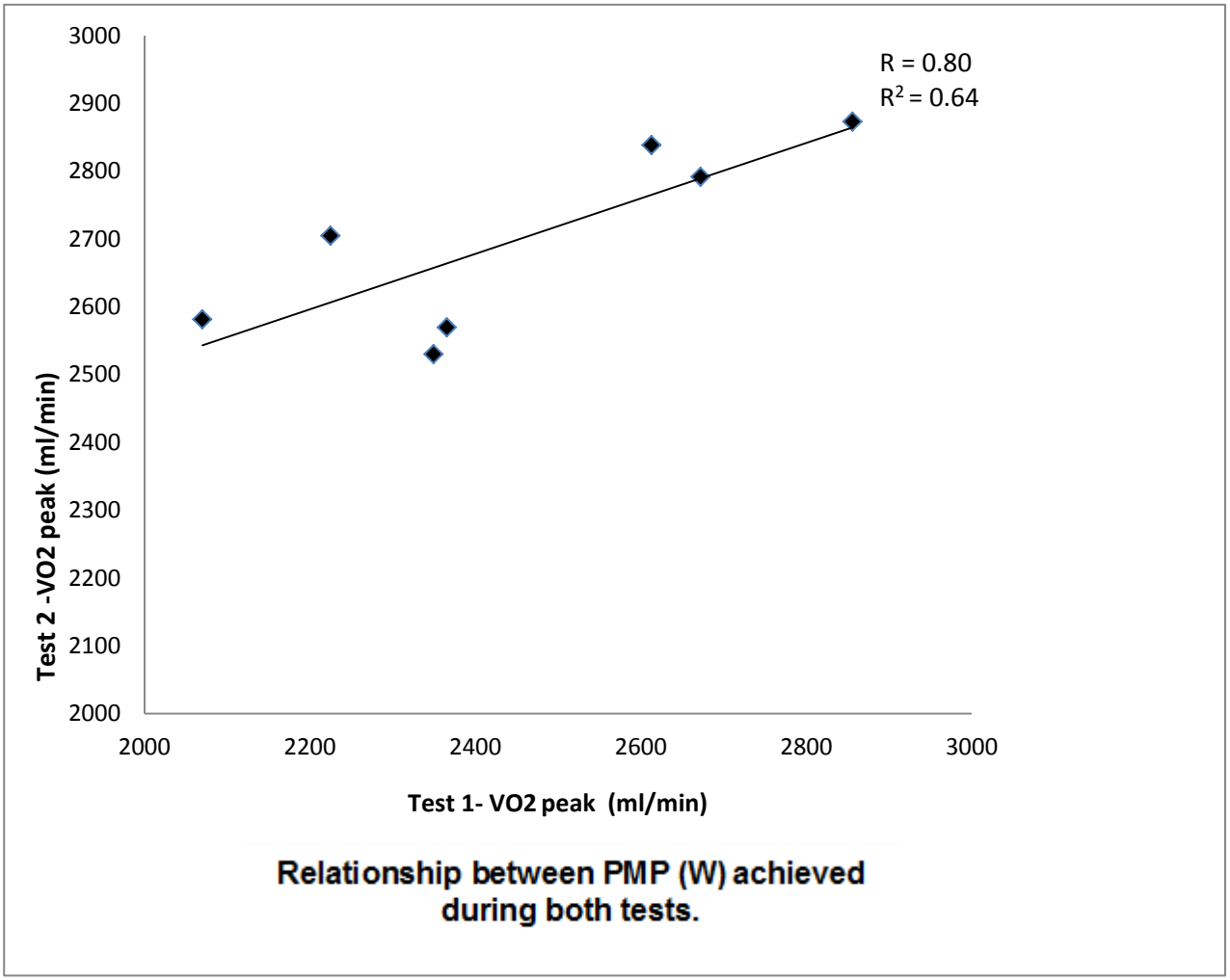
Figure 3 demonstrates the relationship between VO2peak achieved in the placebo and water (control) trail. Pearson's rank correlation coefficients displays a positive correlation between the placebo and water trial of (R=0.58) in figure 3.



Relationship between VO_{2peak} achieved during both tests.

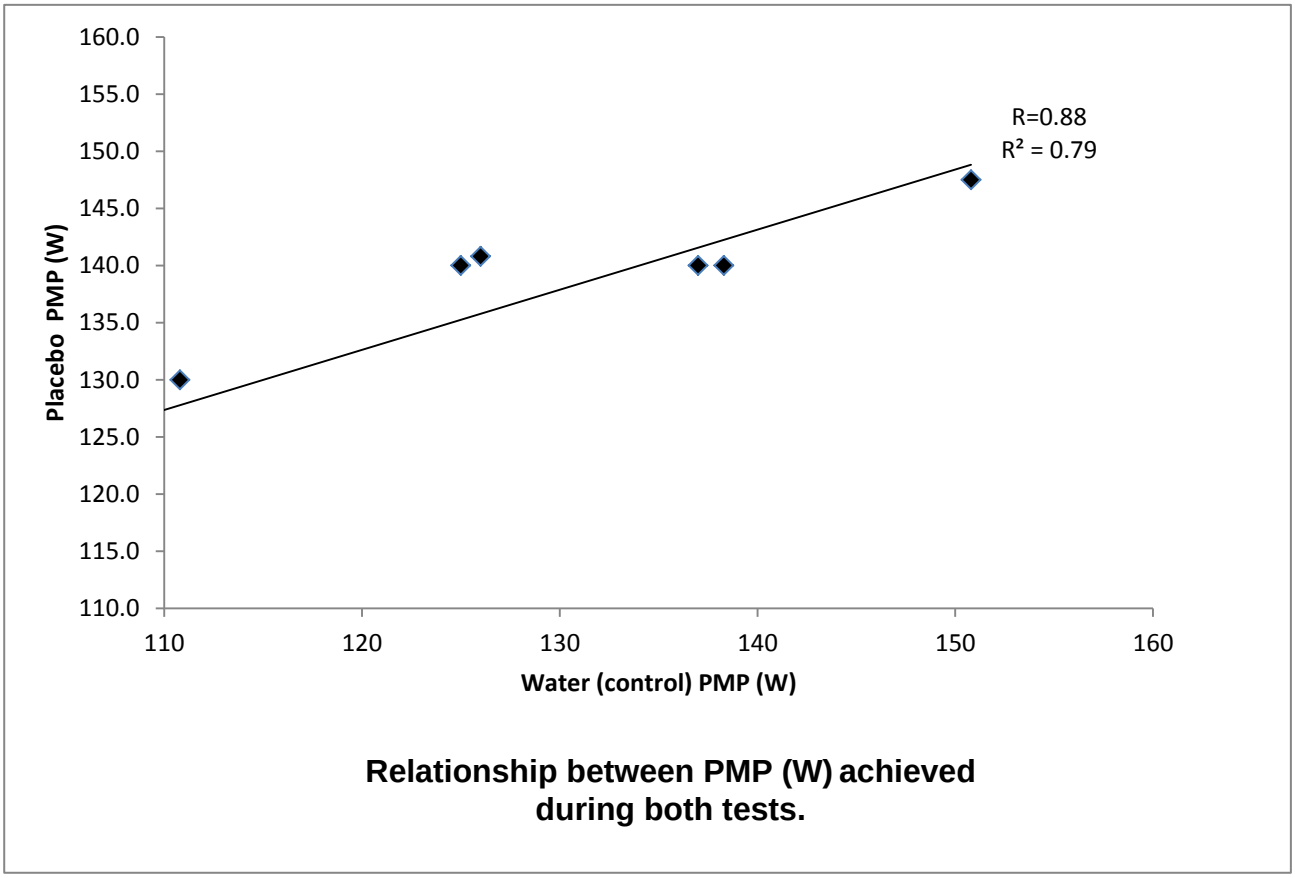
A paired T-test indicated there was no significant difference between the VO_{2peak} achieved in both tests ($p>0.05$).

Figure 4 demonstrates the relationship in VO_{2peak} between the first and second test taken by participants. Pearson's rank correlation coefficients displays a positive correlation between the placebo and water trial (r=0.80).



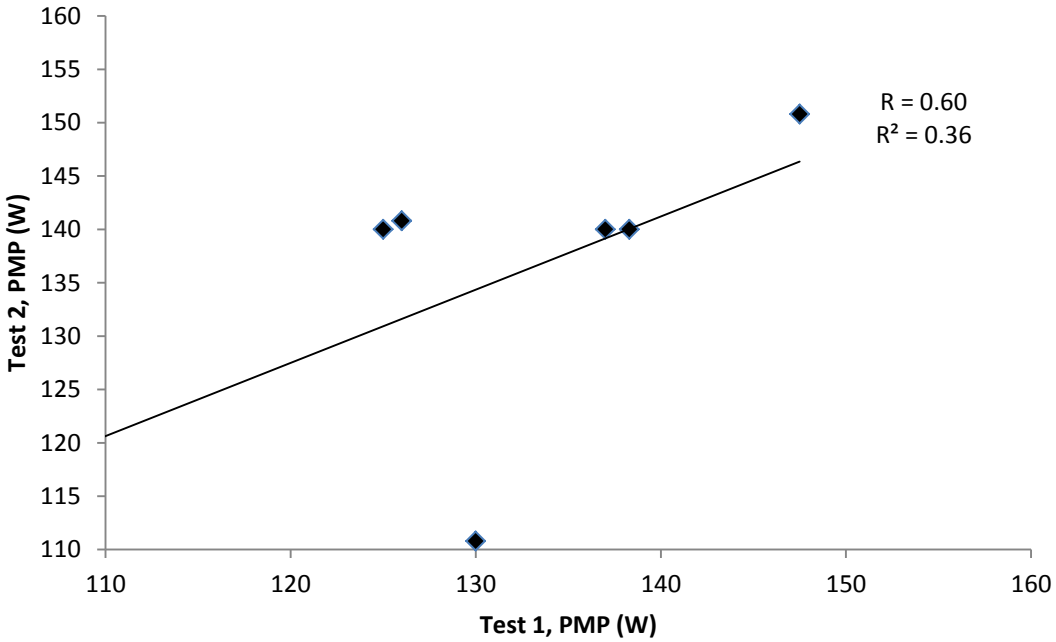
Relationship between PMP (W) achieved during both tests.

Figure 5 demonstrates the relationship between PMP (W) achieved in the placebo and water (control) trail. Pearson's rank correlation coefficients displays a positive correlation between the placebo and water trial (r=0.88).



Relationship between PMP (W) achieved during both tests.

Figure 6 demonstrates the relationship in PMP (W) between the first and second visit to the laboratory by participants. Pearson's rank correlation coefficients displays a positive correlation between test 1 and test 2 (r=0.60).



Relationship between PMP (W) achieved during both tests.

CHAPER FIVE - DISSCUSION

The following chapter will be interpreting the findings of the study, highlighting strengths and critiquing limitations. Previous research will be used to compare the results of the study, looking into the placebo effect more in depth.

5.1 Interpretation of findings

The hypothesis set for the current investigation is inconsistent with the findings. It was hypothesised that the placebo would not have an impact on PMP due to the limited sport specific research available. However, findings in the current study resulted in a significant increase ($p<0.05$) in PMP during the placebo trial compared to the water trail. Consequently, results show that the consumption of the 'sport performance' drink (placebo) had a positive impact on the participants' performance.

Previous sport related studies have found results supporting the current findings on the placebo. Some research has found less of an increase with a placebo (Ariel & Saville, 1972; Clarke *et al*.,2001; Kalasountas *et al*., 2007; Pollo et al., 2008), nevertheless, an increase with the ingestion of a placebo was evident. Recently, research with a similar protocol to that of the current study was conducted by Bottoms et al. (in press), similarly looking at the effects of the placebo on ACM. Corresponding with the current study, a significant difference was found between the placebo and control trial, with a slightly lower average increase in PMP (6.7%) in comparison to 7.7% reported here. The authors of the study also used a likert scale to assess the participants' perception of the 'sports drink' (placebo), however, the authors noted that using the scale alone was not enough to determine how the participants perceived the placebo. Consequently, prior to testing in the current study, the participants were asked to rate their perception in the likert scale as well as writing comments on how they felt. The current study noted a variety of perceptions from the participants. One participant did not believe the 'sports drink' had a positive effect and in turn did not improve their PMP. However, over half of the participants felt that consuming the drink had a substantial effect on their performance, reporting '…higher energy levels...' and '…feeling less pain peripherally…', compared to the control trial. The belief that the placebo had a positive effect was the possible reason for an increased PMP of up to 17% for one participant. The reports of perception in the current study resemble those of participants in other research, an investigation into the placebo effect on 5-km running; participants reported the placebo made them feel 'lighter on their feet' and asked where they could purchase the product (Porcari *et al*., 2006).

There was no significant difference observed between peak physiological responses between the placebo and control trail, although notable increases were evident. For

example, there were slight increase of between 6-7 % for VCO_2, VO_2 and RER. An increase in peak average for VE by 11% and increase in HR by 3.3%. The slight rise in physiological variables along with the significant increase in PMP indicate the participants worked harder in the placebo trail, none of the variables increased enough to result in a significant difference. Research from Foster, et al. (2004) reported similar findings; the physiological results in their testing had no statistical significant difference, while their participants did experience an increase in speed. The authors concluded their physiological results were not statistically different, but the pattern observed warranted future research.

During testing the participants were asked to rate how they felt using subjective reports of local ratings of perceived exertion (LRPE) and central ratings of perceived exertion (CRPE) using the Borg 6-20 scale (1982). The rate of perceived exertion is a participants' perception of physical exertion, integrating the internal and external environment of the body, reflecting the interaction between body and mind during physical activity (ACSM). The intensity of a participant's perception of effort can be influenced by numerous factors; an increase in cardiovascular function, oxygen uptake, increased metabolic activity, it is even possible that changes in the diet prior to testing may have an influence (Noble, et al 1973). Increased uptake of carbohydrate prior to testing can influence glycogen stores, manipulating the participants perception of the testing (Noble *et al.*, 1973). in an attempt to optimise the reliability and validity of the current study particiapants were asked to eat the same before each session, in hope of avoiding nutritional influences during testing. Findings in the current study correspond with the hypothesis that participants would reach peripheral fatigue, prior to carido respiratory endpoints causing termination of testing. A significant difference ($p<0.05$) was found between the peak CRPE and LRPE ratings; the average peak value for LRPE (19.8) was higher than that peak average for CRPE (18.1), supporting a previous report by Bottoms *et al*. (in press). There was no statistical significant difference ($p>0.05$) in LRPE or CRPE found between the water (control) and the placebo trail, indicating that the application of the placebo drink had no effect on the participants perception at the peak of each test. However, on average the participants managed to keep going for a longer period of time on the placebo trail, with an average increase of 54 (0.03) s. In conjunction with the collective answers post testing, it is clear that some of the participants felt the placebo had an effect on their performance.

5.2 Strengths

A strength of the current study was the specific selection of the participants and mode of exercise chosen (ACE). Previous research suggested that the placebo effect on inhibiting pain works better with males than females (Pud, Granvsky and Varnisky 2009; Staud, Robinson, Vierck and price, 2003). One theory is that the pain perception pathway is activated more so in males, resulting in less pain perceived (Eippert , Bingel, Schoell, Yacunion, Klinget and Lorenz., 2009). However, other research has reported no differences in gender (Lautenbacher , Kunz, Lorenz and Burkhardts ,2008). In view of collective previous literature, the decision was made to test males rather than females.

Research was found to indicate that untrained participants (in upper body modes of exercise) are likely to find ACE demanding peripherally, experiencing discomfort, including acute metabolic fatigue and pain within the muscles of the torso, shoulders, arms and hands. Untrained skeletal muscles are likely to produce more metabolic by-products, such as lactate, lowering oxidative capacity of the recruited muscles in ACE (Schrieks., 2011). As a result, it was hypothesised that participants were likely to stop exercising due to acute, localised fatigue prior to central fatigue (Smith *et al* ., 2006; Miles *et al*., 1989). Due to this, seven participants whom were all physically active, but not considered as being specifically upper body trained volunteered to take part in the study. In doing this we augmented the chances of the participants discontinuing the test due to peripheral pain, allowing opportunity for the placebo to take effect.

Scientists in the medical field have hypothesised that the introduction of a placebo can alter the pain threshold, allowing participants to continue working whilst in pain (David et al., 2009; Wager et al.,2004; Benedetti et al.,2005; Colloca & Benedetti., 2005; Finniss & Benedetti .,2005). If the hypothesis that a placebo can slow down pain threshold works in medical cases, in theory, the same should apply to sporting situations.

Linking the research from the two different spectrums suggested that when the participants experienced considerable localised fatigue, the pain experienced may be slowed down by the perception of the placebo. This would therefore cause the participants to continue cranking for longer, achieving a higher PMP. Due to relatively limited research linking the hypothesis to pain and placebo during sporting situations, this was not hypothesised for the current study. However, it was evident with the results found, the placebo did have an effect,, causing a significant increase of 7.7% in PMP. In conjunction with the performance increase, a significant correlation ($r = 0.37$) was found using Spearman's rank correlation coefficients between PMP and the Likert score given by individuals. This indicated a

positive, although relatively weak link between expectation of the placebo and peak performance achieved. The Likert score was taken for both the placebo mean 5.1(±2.4) and control trial mean 1.6(±2.1), a significant difference was found ($p<0.05$). Proving an increase in perception between the placebo trial and control trial.

To limit the prospective suggestion that the placebo effect was simply down to the participants trying harder, the current study used distinct physiological measures to identify maximal effort (Kalasountas et al., 2007). These authors suggested that studies should use a water trial as a no treatment group to increase accuracy in testing, allowing the extent of the placebo effect to be more accurately assessed (Be´rdi , Koteles, Szabo and Bardos, 2011; Bottoms et al., in press).

5.3 Limitations

The current study was done by an undergraduate student with limited resources, thus many foreseen issues were evident. One of the most obvious limitations was the number of participants tested; a substantially larger sample size would have improved the statistical power of the research design.

The decision was made to select physically active, though non-specifically trained participants because of the increased possibility of the early onset of peripheral fatigue. However, the use of the untrained athletes may have also caused a limitation in the current study. It has been speculated that participants whom are untrained may experience slight neurobiological alterations in the second test (Kaiasountas et al., 2007). Previous research from (Lee *et al.,* 2012) supports this, finding the use of a baseline (familiarisation) trial is important to examine the impact of the scientific intervention when using an unfamiliar exercise mode. In order to work out if this had any effect on the results in the current study, a Pearson's correlation coefficient was calculated to compare the extent of similarity between VO_{2peak} and PMP achieved during the placebo and control trial, as well as for trial order. The first and second were compared in order to see if the participants improved due to familiarisation rather than the ingestion of a placebo. The Pearson's correlation between the placebo and control trial for VO_{2peak} achieved was ($r=0.58$) whereas the correlation between trails was ($r = 0.80$). The higher correlation between the first and second trail indicate a possibility that the improvement observed in the present study was more likely to be due to familiarisation rather than participants experiencing a placebo effect. The same approach was then used to compare the PMP (W). The correlation between the placebo and the control trail was high ($r = 0.88$), whereas the comparison between the first and the second was lower ($r = 0.60$). This indicated that

the participants more likely improved their PMP (W) due to the placebo rather than the order of the trials. Therefore, there are two contrasting set of results. Results show that the VO_{2peak} was effected by familiarisation rather than the placebo, whereas the PMP (W) demonstrated the opposite. It can, therefore, be speculated that the meaningfulness and overall design of the current study would have been improved if a familiarisation trial had been used. There is research to suggest that anxiety can have an impact on VO_2 max testing (Hunn, Lapuma and Holt., 2002). The participants had never performed ACE before and, therefore, it is possible that they were apprehensive about the testing during the first trail in comparison to the second. This could be a possible reason for the participants experiencing a rise in the second test in comparison to the first for VO^2_{peak} testing and not for PMP (W). A study from Lee, Nokes and Smith (2011) also using ACE eliminated the possibility of testing being affected by familiarisation by using a pilot study beforehand. It is clear in the results they gathered that the familiarisation trail had an impact on improving the reliability of their results, with lower PMP (W) in the first trail to the subsequent testing trials.

Another limitation to the current study was the participants' belief in the placebo. Bjørkedal. (2011) noted low expectancies of pain relief down to the participants not being entirely convinced by verbal information provided. In the present study, testing was performed on sports students who are very aware and knowledgeable of sports supplements and, although the 'sports drink' was provided in plain 500ml bottles, the bottles had no labels convincing them that the solution formulations were legitimate. It has been proven that the use of a brand can have an effect on an individual's perception, a complex phenomenon comprised of what the participant is actually consuming in comparison to what they expect to experience (Halson 2013). Therefore, the use of a well-known sports brand may have been beneficial to the current study. Enhancing the possible involvement of Pavlovian conditioning; linking the perception of the placebo with positive possible side effects, generating improvement.

Literature has suggested that any uncertainty about a treatment is likely to reduce the degree of perceived effect, it has also been suggested that a degree of uncertainty may also elicit the placebo effect (Kirsch,1988). The current study reflected this in its results; the participant who scored low on the Likert scale and did not believe the placebo drink would improve his capacity performed worse (-0.03 %) during the placebo compared to the water trial . To further improve the belief from the participants it is proposed that administration of a more persuasive substance such as a capsule or injection may induce

a stronger placebo response (Bjørkedal et al., 2011). To further improve on the current study, the open ended questioning, where participants were allowed to, expanded upon their thoughts that underpinned their Likert score could have been extended and made more of. For example, a questionnaire could have been used to gather additional information on the perception of the ingestion of the placebo, allowing a greater richness and understanding of view provided.

CHAPER SIX - CONCLUSION

6.1 Conclusion

The null hypotheses stated at the end of the literature review cannot be accepted as significant differences (P>0.05) were observed between the placebo and control groups for PMP (W) and time to exhaustion. Peak physiological responses from both tests were similar (P>0.05), suggesting the ingestion of a placebo aid did not bring about physiological changes. Interestingly a Spearman's rank correlation coefficients revealed a positive though relatively weak correlation (R=0.38) between increase in PMP (W) and expectation (Likert). A non-parametric Wilcoxon matched-pairs signed-ranks test revealed a statistical difference (P<0.05) between the participants' subsequent perceptions for each drink to improve performance during the exhaustive VO_2peak test. This evidence taken together suggests that the ingestion of the placebo drink did indeed have a positive influence on the participants' expectation between trails and in turn improved performance on the test.

6.2 Future research

The placebo has been widely used in the medical field and scientists are continually finding new inroads, treating diseases such as Parkinson's disease, including hoax operations on vertebrae conditions (Pollo *et al*., 2002; David *et al*., 2009). The opportunity to treat a patients without the use of any drugs will not only save the NHS money, but reduce the risks of side effects from medicines. The increasing testing of the placebo in the sporting world has increased over the last few years. Authors such as Maganaris *et al*. (2000) suggested that the collective, slowly increasing evidence that a placebo as an ergogenic treatment works, raises a strong argument against the use of performance enhancing drugs. Hopefully in the future, this will contribute to educational anti- doping strategies. Research by Kalasountas *et al.* (2007) demonstrated that the placebo effect can even bring about increases in strength, mimicking steroid use. The widespread hope of the knowledge that physiological aspects can be just as effective as nutritional supplements in enhancing performance, will allow a starting point for coaches and teachers to educate young athletes. Avoiding young athletes jeopardising their career by resorting to illegal supplements whilst experiencing a performance slump (Beedie and foad, 2009).

In addition to educating young athletes about the importance of psychological effects before resorting to illegal and potentially health damaging supplement use. Benedetti

(2001) mentioned the use of eliciting a placebo response using pharmacological or non-pharmacological conditioning procedures. This work suggested that coaches could possibly pre-condition athletes with a performance boosting drug and then replacing it with placebo close to competition, therefore avoiding the competitor from being accused of illegal performance enhancing drug use. The limitations of future rese arch with using a placebo as an ergogenic aid is the effects on trust between coach and athlete. Research has shown that in order for a placebo to work the participant has to believe what they are taking is going to have an effect. As seen in the current study, when participants were told that what they have taken was a placebo, they can feel deceived and lied too. This can have a drastic effect on the relationship between a coach and athlete, causing the athlete to question what the coach says or does.

Therefore, the conclusion can be drawn that the ingestion of a placebo as an ergogenic aid did result in a positive effect on performance. The counterpart of the placebo, is the nocebo. The nocebo is the application of a substance that causes a negative effect on performance (Pollo et al., 2012). The following study could be emulated for future research in two main ways; a pilot study could be used to eliminate the chances of familiarisation effecting results. It would also be interesting to look upon both the placebo and nocebo, in order to compare both spectrums; and their effect on performance.

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Appendix A
Ethics Approval

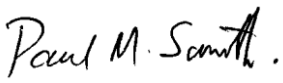
When undertaking a research or enterprise project, Cardiff Met staff and students are obliged to complete this form in order that the ethics implications of that project may be considered.
If the project requires ethics approval from an external agency such as the NHS or MoD, you will not need to seek additional ethics approval from Cardiff Met. You should however complete Part One of this form and attach a copy of your NHS application in order that your School is aware of the project.
The document ***Guidelines for obtaining ethics approval*** will help you complete this form. It is available from the Cardiff Met website.
Once you have completed the form, sign the declaration and forward to your School Research Ethics Committee.
PLEASE NOTE:
Participant recruitment or data collection must not commence until ethics approval has been obtained.
PART ONE

Name of applicant:	Chloe Louise Taylor
Supervisor (if student project):	Paul Smith
School:	School of Sport
Student number (if applicable):	ST20007329
Programme enrolled on (if applicable):	SPE
Project Title:	The effects of a 'sport performance' (placebo) on the performance and the rating of perceived exertion during arm crank ergometry.
Expected Start Date:	01/10/2013
Approximate Duration:	6 months
Funding Body (if applicable):	Click here to enter text.
Other researcher(s) working on the project:	If your collaborators are external to Cardiff Met, include details of the organisation they represent.
Will the study involve NHS patients or staff?	If yes, attach a copy of your NHS application to this form
Will the study involve taking samples of human origin from participants?	No

In no more than 150 words, give a non technical summary of the project
Over the last 10-15 years an interest into the placebo effect on exercise has become a regular research enquiry, allowing the topic to be intensively researched. Numerous studies have observed increases in endurance and strength performance (Clark et al, 2000). Bottoms et al (2013) investigated the effects of a placebo and nocebo on peak minute power during incremental arm crank ergometry. This study was only based upon upper-body exercise where peripheral mechanisms of fatigue are apparent. However, the proposed study will expand on this, exploring the

placebo effect during arm ergometry and treadmill running, mode of exercise that are typically associated with predominantly either peripheral of central mechanisms of fatigue, respectively.

Does your project fall entirely within one of the following categories:	
Paper based, involving only documents in the public domain	No
Laboratory based, not involving human participants or human tissue samples	No
Practice based not involving human participants (eg curatorial, practice audit)	No
Compulsory projects in professional practice (eg Initial Teacher Education)	No
If you have answered YES to any of these questions, no further information regarding your project is required. If you have answered NO to all of these questions, you must complete Part 2 of this form	

DECLARATION: Michael David Jenkins **I confirm that this project conforms with the Cardiff Met Research Governance Framework**	
Signature of the applicant: Chloe Louise Taylor	Date: 01/10/2013
FOR STUDENT PROJECTS ONLY	
Name of supervisor: Paul Smith	Date: 01/10/2013
Signature of supervisor: 	

Research Ethics Committee use only	
Decision reached:	Project approved ☑ Project approved in principle ☐ Decision deferred ☐ Project not approved ☐ Project rejected ☐
Project reference number: Click here to enter text.	

PARTICIPANT INFORMATION SHEET

Participant Information Sheet

Student Reference number:

Title of Project: The effects of a 'sport performance' (placebo) on the performance and the rating of perceived exertion on two modes of exercise.

As you are the aware, the purpose of this study is to explore the effects of a brand new sports drink on peripheral fatigue (fatigue of the arms) and central fatigue (fatigue of the respiratory system) and subsequently how this affects performance during maximal tests on an arm crank ergometer and a treadmill running test.

Background

A brand new sports drink company have recently developed a sugar free sports drink which is designed to slow down the process of acute fatigue. The aim of the project is to explore the effects of sugar free drinks described as 'sport performance' on two tests that will effectively test VO2max and peak minute power in an incremental arm crank ergometry test. As a researcher I am interested in exploring how this formulation works and in particular the impact it has on two modes of exercise.

Participant's role in the investigation

Within the study, you will fulfil the role as a research participant. This means that the data gathered from the investigation will be based upon your results.

Pre Procedure

You must then complete a Physical Activity Readiness Questionnaire. This will screen for any health problems that may hinder the results of the experiment.

Procedure

This study will be laboratory based and will use eight physically able volunteers from Cardiff Metropolitan University. Participants will be tested over a two week period.

As the participant you will perform a standard incremental arm crank ergometry test and a VO2max test on the treadmill; these tests will represent a control trial. These tests will subsequently be repeated after the consumption of 500 ml of a 'sport performance' drink.

A number of measurements will be obtained during testing; the results will be compared against the control trial to demonstrate the effect of the sport performance drink on performance. During both tests an online oxicon analysis will be used to measure the participants' respiratory data. This procedure will require the participants to wear a face mask collecting the air they exhale for analysis. Heart rate monitors will be used to collect the heart rates throughout the testing; this will require the participants to wear a monitor just below their sternum and will have no impact on participant's performance. During the testing the participants will be asked to rate their perceived exertions using the BORG scale. The BORG scale has been derived to assess participants' perceived intensity. During the treadmill protocol, velocity at VO2max (vVO2max) will be monitored just before the point of exhaustion. The participants Peak aerobic power (Wpeak) will be measured during the arm crank ergometry protocol in order to monitor the rates at which the upper limbs fatigue.

The drink will be administered 15 minutes prior to the testing. Post testing the participants will be administered a questionnaire devised to assess their perceived effect of the application of the sport performance drink. Data obtained from the testing will be statistically analysed and compared between the control trial and the sport performance drink trial.

Are there any risks involved?

You must complete the Physical Activity Readiness Questionnaire which will identify and screen you for any health problems prior performing the experiment. You may feel light headed post exercise due to the intensity of which the nature of performing a maximum intensity $VO_{2\,max}$ test.

What are the benefits to me?

Through participating within this study, you will receive information regarding your results of the test. This will identify the rate at which you metabolise substrates when exercising and whether or not the substrate metabolism increases or decreases after consuming sugar free energy drinks.

How do we protect your privacy?

As the administrator or the study, I will personally respect your privacy and any decision you may make regarding the study. All your data will be stored in a secure, electronic database away from your consent forms, and backed up to prevent accidental loss. All information regarding you will be destroyed post evaluation of the study, although your consent forms will be stored for ten years to suit the requirements of Cardiff Metropolitan University.

You're Rights

It must be made clear that you have the right to withdraw from this study at any point. You also have the right to view any data we may have on yourself on request.

Thank You for your time reading this.

Should you require any further information regarding any part of the study, please do not hesitate to contact me at:

Chloe Taylor- ST20007329

- 07807764747
- st20007329@outlook.cardiffmet.ac.uk