THE PLACEBO AND NOCEBO EFFECT IN SPORT: INTENTIONS, ATTITUDES AND BELIEFS TOWARDS SPORT SUPPLEMENTS AND BANNED PERFORMANCE ENHANCING SUBSTANCES

by

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Abstract

The focus of this research is to determine the magnitude and moderators of placebo and nocebo effects on sport performance and to explore the impact of a placebo intervention on athletes' beliefs and intentions towards sport supplements. Recent research suggests that supplement users may be more likely to use banned substances (i.e. doping) and that beliefs and intentions towards supplements may influence future supplement use. As such, this research also explores the effects of a placebo intervention on athletes' attitudes to doping. Study 1 focuses on the development and validation of the Sports Supplements Beliefs Scale. This measure is used to assess athletes' beliefs about sport supplements and the impact of the placebo intervention conducted in Study 2 on these beliefs. Study 2 uses a placebo intervention to examine the magnitude and moderators of the placebo and nocebo effect on repeat sprint performance, and Study 3 examines the impact of this intervention on participants' beliefs and intentions to use sport supplements and attitudes to doping. In Study 2, no significant mean placebo effect on sport performance was evident, however, a significant mean nocebo effect compared to no-treatment controls was observed. Further analyses indicated that participants' intentions to use sport supplements influenced the direction and magnitude of the placebo effect. Study 3 showed that participants' beliefs and intentions towards sport supplements and attitudes to doping changed after the intervention. Although it appeared to reduce the likelihood of athletes using sport supplements and banned substances overall, participants that were not intending to use sport supplements before the intervention were more likely to use them after. In conclusion, data from this research suggest that an athlete's intention to use sport supplements moderates the direction and magnitude of placebo effects on sport performance and that a placebo intervention significantly influences athletes' beliefs and intentions towards sport supplements and attitudes to doping. These

results have important implications for how international and national anti-doping organisations develop their anti-doping education interventions. Interventions aimed at educating athletes about the placebo effect and targeting their use of sport supplements, may prevent future doping behaviours.

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Authors declarations

The author conceived the rationale and procedures for each part of this research. The author was responsible for the construction of all the testing procedures used in the research programme. The author carried out all recruitment, tests, data input, and statistical analyses.

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In all cases of work that has been published, presented and submitted for publication, the work has been directly attributed to the Ph.D. candidate. All research, analyses and reporting have been solely undertaken by the researcher in keeping with the requirements of a Ph.D. candidature. However, those acknowledged have assisted with the formulation of research ideas and reviewed manuscripts.

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List of Abbreviations

AIC = Akaike Information Criterion

AIS = Australian Institute of Sport

ASADA = Australian Sports Anti-doping Authority

BOA = British Olympic Association

CFA = Confirmatory Factor Analysis

CFI = Comparative Fit Index

CVI = Content Validity Index

d = Cohens *d*

df = Degrees of Freedom

EFA = Exploratory Factor Analysis

ECVI = Expected Cross-Validation Index

FIFA = Fédération Internationale de Football Association

fMRI = Functional Magnetic Resonance Imaging

IAAF = International Association of Athletics Federations

IADA = International Anti-Doping Arrangement

ICC = Intraclass correlation

IOC = International Olympic Committee

LSD = Least Significant Difference

PEAS = Performance Enhancement Attitude Scale

PET = Positron Emission Tomography

RCT = Randomised Controlled Trial

RMSEA = Root Mean Square Error of Approximation

SEM = Standard Error of the Mean

SRMR = Standardized Root Mean Squared Residual

SSBS = Sports Supplements Beliefs Scale

TLI = Tucker-Lewis Index

TPB = Theory of Planned Behaviour

TRA = Theory of Reasoned Action

UCI = Union Cycliste Internationale

UNESCO = United Nations Education, Scientific and Cultural Organization

UKAD = United Kingdom Anti-Doping

USADA = United States Anti-Doping Agency

WADA = World Anti-Doping Agency

WADC = World Anti-Doping Code

Chapter One

INTRODUCTION

1.1 Introduction to the research programme

Historically, the placebo effect has been regarded as a nuisance and methodological artefact that should be controlled using the placebo control trial. However, recent studies in clinical medicine, neuroscience and psychology suggest that this effect is a biological response to psychosocial cues surrounding the administration of a treatment (Benedetti, 2013; Hall, Loscalzo and Kaptchuk, 2015). Studies have shown that the placebo effect can mimic effects associated with actual drugs (Benedetti, 2013, 2014; Benedetti & Dogue, 2015; Kessner et al., 2014; Weimer, Colloca, & Enck, 2015). Research has also shown that these effects are not always positive in direction. Negative responses are often referred to as nocebo effects, which can offset some or all of the benefits of a treatment.

An extensive body of evidence now suggests that placebo and nocebo effects can significantly influence sports performance (Beedie & Foad, 2009; Broatch, Petersen, & Bishop, 2014; de la Vega, Alberti, Ruiz-Barquin, Soos, & Szabo, 2017; Ross, Gray, & Gill, 2015; Saunders et al., 2017). This research has presented interesting data relating to the direction and magnitude of placebo and nocebo effects, with implications for both research and practice. However, investigations into placebo effects on sports performance often lack a no-treatment control, which make it difficult to accurately estimate the relative magnitude. Similarly, the sample size in the majority of placebo effect studies in sport is too small to facilitate identification of variables that moderate this effect. If knowledge of placebo and nocebo effects is to develop, an understanding of the relevant moderators and mechanisms is needed through larger sample sizes and robust methodologies that include a no-treatment control.

Data from sports science suggest that athletes using sport supplements may be more likely to progress to banned substances (i.e. doping; Backhouse, Whitaker, & Petroczi, 2013; Barkoukis, Lazuras, Lucidi, & Tsorbatzoudis, 2015; Hildebrandt, Harty, & Langenbucher,

2012; Ntoumanis, Ng, Barkoukis, & Backhouse, 2014; Petróczi, 2013), a phenomena often termed the gateway hypothesis (Kandel, 1975). Researchers have suggested that anti-doping organisations could inform athletes about the placebo effect and in doing so, support them to make more informed choices about the use of sport supplements and banned substances (Beedie & Foad, 2009; Kalasountas, Reed, & Fitzpatrick, 2007; Maganaris, Collins, & Sharp, 2000; McClung & Collins, 2007). Maganarais et al. (2007) reported anecdotal evidence in which athletes were less inclined to use banned substances after experiencing a placebo effect. Similarly, data from Beedie (2007) suggest that if athletes are informed about the placebo effect, they might realise that a proportion of the benefit of banned substances comes from their belief in it and as a result may be less likely to use banned substances. Hypothetically, therefore, if it is demonstrated to athletes that placebo effects can affect their performance to a similar degree to a sport supplement, it is reasonable to suggest that athletes with this experience and/or knowledge may be less likely to use sport supplements in the future. While this link has been made by several authors anecdotally (Kalasountas et al., 2007; Maganaris et al., 2000; McClung & Collins, 2007), the idea remains untested.

In light of this context, the aim of this research programme is to extend the current body of knowledge in placebo effect research using a large sample to investigate the magnitude and moderators of placebo and nocebo effects in sports performance. In addition, this research aims to assess the effect of a placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping.

1.2 Definition of key terms

Despite an extensive body of placebo effect literature, the term ‘placebo effect’ often causes considerable confusion among researchers. For example, by searching *placebo* in the online resource PubMed, approximately 200,000 papers can be found, the word placebo frequently associated with the term *response* or *effect* (Benedetti, 2008). Many of these papers use the term *placebo effect* inappropriately, suggesting that it is, for example, an “outcome that is found in a group of participants who receive a placebo.” It is also common to discover titles of studies such as “High rate of placebo effects in clinical trials on…” or “Analysis of the placebo effect in clinical trials on…” These papers do not analyse the placebo effect per se, but the time course of symptoms in placebo control groups, which could be due to factors unrelated to the placebo effect such as regression to the mean, natural history of the condition or spontaneous improvements in symptoms. Further, and given that this research aims to distinguish what moderates the placebo effect of sport supplements, definitions surrounding sport supplements are often inaccurate and researchers often confuse moderation with mediation. For these reasons, and to add clarity to the terminology used throughout this research, sport supplements, moderation and mediation are defined.

Placebo

Historically, placebos are often used as a control treatment that is indistinguishable from the experimental treatment, but without the essential component. From a medical perspective, the term placebo is referred to as an inert substance devoid of any specific properties (Colloca & Miller, 2011b; Kirsch, Wampold, & Kelley, 2016). However, placebos are not all equal. Placebos can be, for example, a sugar pill, saline injection or fake surgery. A placebo must match the experimental treatment in terms of its name, description, appearance and mode of administration. A placebo is therefore identical to an active treatment but differs only with respect to the essential component.

The placebo effect

In its broadest sense, the placebo effect is an improvement in a person's symptoms following the administration of a placebo, which cannot be attributed to the properties of the placebo itself (Arnold, Finniss, & Kerridge, 2014). However, the placebo effect is a misnomer because in some cases there is no need to use a placebo to induce a placebo effect. Placebo effects can be induced after administration of an actual treatment and can be induced by factors that include the treatment context, expectations on behalf of the person receiving the treatment and the person administering it, previous experiences and symbols (Carlino, Piedimonte, & Benedetti, 2016). Thus, researchers examining the placebo effect are studying the psychosocial context surrounding the person and the effect that this context has on the persons experience, brain and body (Price, Finniss, & Benedetti, 2008).

The nocebo effect

The nocebo effect is a negative response following the administration of a placebo. It is essentially the opposite of the placebo effect and relates to the negative aspects of the psychosocial environment (Benedetti, Carlino, & Piedimonte, 2016).

Sport supplements

Although there have been many attempts, there is no universal definition of what constitutes a sport supplement (Maughan et al., 2018). Where definitions are attempted, they are largely unhelpful and confusing. The Oxford English Dictionary (2017) defines a supplement as "something added to supply a deficiency." However, this definition is inconsistent with the use of such products, with many supplements including nutrients and food chemicals for which the body does not have an estimated or theoretical requirement (Castell, Stear, & Burke, 2015). The US congress defines dietary supplements as a "product, other than tobacco, which is used in conjunction with a healthy diet" (Maughan, Depiesse, & Geyer, 2007, p. 104). Based on this definition, a product is a sport supplement if it is

consumed by an athlete who has a “healthy diet,” whereas that same product is not a sport supplement if it is consumed by an athlete who has an “unhealthy diet.” The Dietary Supplement Health and Education Act of 1994 provides a more comprehensive definition of non-banned substances. However, this document includes 13 separate sections and is over 4,000 words. In terms of practical application, the Australian Institute of Sport (AIS) define sport supplements as products comprising one or more of the following categories:

- **Sports foods:** Specialised products used to provide a practical source of nutrients when it is impractical to consume everyday foods (e.g. beetroot juice, sport drinks and sport gels)
- **Medical supplements:** Used to treat clinical issues, including diagnosed nutrient deficiencies (e.g. calcium, iron and vitamin D)
- **Performance supplements:** Used to directly contribute to optimal performance (e.g. caffeine, sodium bicarbonate, and creatine)

In line with the AIS definition, the term *sport supplement* is presented throughout this research programme as relating to sport foods, medical supplements and performance supplements.

Moderation

A moderator affects the direction and/or strength of the relationship between an independent variable and dependent variable (Baron & Kenny, 1986). Therefore, moderation implies that relationships of interest differ significantly in two or more subpopulations. Specifically, in a correlational analysis, moderation affects the zero-order correlation between two other variables. In placebo effect research, Holroyd, Labus, and Carlson (2009) reported that anxiety moderated the relationship between a placebo pill and chronic headaches. That is, participants who reported low scores of anxiety, were more likely to report a reduction in headache pain following the administration of a placebo pill than those who reported high

scores of anxiety. Moderation is also reported when the direction of the correlation changes (Hayes, 2009). Such an effect would have occurred in the Holroyd et al. study if those with higher anxiety levels reported an increase in headaches following the administration of the placebo pill.

Mediation

Similar to moderation, mediation involves detecting an interaction between an independent and dependent variable. However, while moderation affects the direction and/or strength of the relationship between two variables, mediation *explains* the relationship between the two. Thus, researchers examining mediation are interested in determining under which conditions an independent variable can be considered a possible cause of the dependent variable (MacKinnon, Fairchild, & Fritz, 2007). For example, Benedetti, Amanzio, Rosato, and Blanchard (2011) reported that placebo analgesia was reversed following the administration of the cannabinoid receptor antagonist rimonabant. This indicates that placebo analgesia is mediated by the release of endogenous cannabinoids.

Chapter Two

REVIEW OF THE LITERATURE

This research programme examines the magnitude and moderators of the placebo and nocebo effect in repeat sprint performance. It also examines the impact of a placebo intervention on an athlete's beliefs and intentions towards sport supplements and attitudes to doping. The first part of this review aims to familiarise the reader with literature around the placebo effect, the associated psychological and neuropsychological mechanisms, and empirical studies that have addressed this phenomenon in sport. The second part of the review aims to provide an overview of doping in sport. The literature concerning the history of doping is briefly addressed, the policy and methods in place to prevent doping in sport are explained, and the psychosocial predictors of current and future doping behaviours are reviewed.

2.1.1 Introduction to the placebo effect

While use of the term *placebo* dates back to biblical periods (Psalm 114:9), use of the term *placebo effect* gained significant scientific interest and attention since Beecher's (1955) seminal paper which reported that around one third of people respond to a placebo. Beecher's paper marked a new era for placebo effect research, whereby new concepts and ideas were put forward. Although his methods and conclusions have been heavily criticised (Hróbjartsson & Gøtzsche, 2001; Kienle & Kiene, 1997), Beecher's paper paved the way for researchers investigating the placebo effect across a range of medical conditions (e.g. blood pressure, depression, Parkinson's disease; Benedetti, 2016), ultimately leading to a neurobiological understanding of the phenomenon twenty years later (Levine, Gordon, & Fields, 1978).

As far back as the 18th century, researchers have acknowledged that placebo effects (although not explicitly labelled as such) can have significant effects on a range of conditions. In 1784, Louis XVI instructed Benjamin Franklin to perform a series of

experiments to see if the psychic force of mesmerism had “any real force” or whether it was the result of “imagination” (Lopez, 1993, p. 329). After World War II, placebos were widely adopted as concurrent controls in randomised control trials. From these trials, scientific interest into the placebo effect emerged out of the observation that patients in the placebo control would often demonstrate significant improvement (Finniss, Kaptchuk, Miller, & Benedetti, 2010). Shortly after, Beecher’s seminal 1955 paper “The Powerful Placebo” suggested that 35% of participants respond positively to a placebo. Two decades after this publication, Levine et al. (1978) provided the first mechanistic explanation of the placebo effect, reporting that it could be blocked by naloxone (i.e. an opioid antagonist), thus implicating a role for the endogenous opioid system.

Psychological theories posit that learning and classical conditioning play key roles in the formation of placebo effects (Benedetti et al., 2003; Montgomery & Kirsch, 1997; Voudouris, Peck, & Coleman, 1990), alongside a variety of cognitive and psychosocial variables (e.g. expectations, beliefs and desires; Amanzio et al., 2001; Kirsch, 1985; Kirsch & Weixel, 1988). Various neurobiological mechanisms of the placebo effect have been reported, most notably the endogenous opioids (Levine et al., 1978; Zubieta et al., 2005) and neurotransmitter pathways (e.g. dopamine; de la Fuente-Fernández et al., 2001; Fulda & Wetter, 2007).

While placebo effects are generally reported to be beneficial for the recipient, they can also be harmful. Negative effects of a placebo treatment are usually labelled nocebo effects and are essentially the opposite of placebo effects. They were first observed in clinical trials whereby participants in the placebo control reported similar side effects to those of the actual drug (Mitsikostas, Mantonakis, & Chalarakis, 2011). In fact, participants assigned to the placebo control may discontinue because of the adverse side effects attributed to the treatment (Enck et al., 2013; Rief, Bingel, Schedlowski, & Enck, 2011). Beecher (1955) was

one of the first to report that placebos can lead to side effects such as headaches, fatigue and nausea (i.e. nocebo effects). More recently, investigations have reported that just one occasion of a nocebo effect can induce long-lasting effects that influence the efficacy of a future treatment (Colloca & Miller, 2011a). For these reasons it has been suggested that if a placebo treatment were submitted to the Food and Drug Agency for approval, although the agency might be impressed with its efficacy, it would probably be rejected based on the high incidence of side effects (Glasser & Frishman, 2008).

With increasing advancements in scientific methodology (e.g. balanced placebo design; Rohsenow & Marlatt, 1981) and technology (e.g. positron emission technology), researchers now have the tools to identify several of the psychological (e.g. expectations) and neurobiological (e.g. dopamine) mechanisms of placebo effects. This research has enabled the identification of not one but many placebo effects operating across different pathways and receptors of the brain and driven by different psychological and neurobiological mechanisms depending on the context in which a placebo is administered (Price et al., 2008). However, while knowledge and understanding of placebo effects have progressed significantly in the last 15 years, further research is required to foster a better understanding of its mechanisms and the ability to control and capitalise on these in clinical and applied practice.

2.1.2 Psychological mechanisms

Theoretical and experimental research over the past 30 years has centred upon two psychological mechanisms of the placebo effect phenomenon: expectancy and classical conditioning. Expectancy theory is underpinned by a person’s belief that an effect will occur (Shaibani, Frisaldi, & Benedetti, 2017). Expectations can be generated by verbal instructions/suggestions (Michael, Garry, & Kirsch, 2012), environmental cues (Christiansen, Townsend, Knibb, & Field, 2017), emotional arousal (Zhang, Guo, Zhang, & Luo, 2013),

previous experiences (Reicherts, Gerdes, Pauli, & Wieser, 2013) and interaction with others (Benedetti, Durando, & Vighetti, 2014). Positive expectations about a treatment can result in positive feelings that increase reward mechanisms in the brain (e.g. dopamine) and negative expectations about a treatment can create negative feelings that increase threat related areas of the brain (e.g. Cholecystokinin; Benedetti, 2013). In short, when a person expects a particular outcome, a chain of cognitions is set in motion that can influence psychological and neurobiological pathways.

Classical conditioning theory posits that a conditioned stimulus (e.g. placebo pill) elicits a conditioned response (e.g. placebo effect) by virtue of its previous coupling with an unconditioned stimulus (e.g. the drug purported to be inside the pill). When an active treatment (e.g. anti-depressants, caffeine, paracetamol) is administered repeatedly and replaced with a placebo, similar neurobiological drug effects can occur (Meissner, Kohls, & Colloca, 2011). For example, repeat coupling of a placebo capsule with caffeine can lead to a conditioned response (e.g. increase in heart rate), whereby the placebo on its own can create a response that is similar to caffeine. The placebo is thus the conditioned stimulus and the placebo effect is the conditioned response (Stewart-Williams & Podd, 2004). This is often framed as a learning phenomenon, where previous experiences of a treatment can lead to placebo responses.

Expectancy and classical conditioning are often pitted against one another as the main theory to explain the placebo effect (e.g. Colloca & Miller, 2011b; Kirsch et al., 2014; Montgomery & Kirsch, 1997; Price et al., 1999). While authors have noted that the focus on only two mechanisms is limiting (Geers & Miller, 2014), placebo experiments often share a basic framework in which variations of these two psychological mechanisms are manipulated and many of the findings reported in the placebo effect literature can be explained by both expectations and conditioning. Take for example the finding that placebo injections are more

effective than placebo capsules (Kaptchuk, Goldman, Stone, & Stason, 2000). Depending on the stance of the researcher, these findings can be interpreted differently. Within the classical conditioning framework, the researcher may argue that injections often contain a more potent dose than capsules, so the placebo effects elicited are based on prior learning and experience. However, an expectancy theorist may suggest that people expect injections to have stronger effects than capsules, and that it is this expectation that produces the enhanced effect.

An alternative suggestion is that classical conditioning results in the formation of a generalised expectation. In fact, it is worth noting that some authors argue that classical conditioning is an expectation of the occurrence or non-occurrence of an unconditioned stimulus (Benedetti et al., 2003; Kirsch, 2004). For example, expectations created by verbal information, social observation and learning, are hypothesised to mediate conditioning and ultimately the placebo effect (Kirsch et al., 2014). Studies have shown that expectations induced by verbal suggestions can reverse the placebo effect of pharmacological preconditioning (Benedetti et al., 2003; Carlino & Benedetti, 2016) suggesting that placebo effects might be induced by expectations and not conditioning. However, further evidence has shown that expectations about hormonal increases and decreases after the administration of a placebo had no effect on growth hormone plasma concentrations, whereas preconditioning mimicked the effect of a hormonal drug in the absence of expectations (Benedetti et al., 2003). Thus, expectations did not influence hormonal levels, but conditioning did. This suggests that learning and previous experiences can contribute to the placebo effect even in the absence of conscious awareness. While placebo effects are often the result of beliefs and expectations, these beliefs and expectations are complex and only partially dependent on conscious cognitive processes.

2.1.3 Neurobiological mechanisms

In a landmark study, Levine et al. (1978) demonstrated that the placebo effect could be reversed by administration of the opiate antagonist naloxone. Amanzio and Benedetti (1999) reported that this paper marked the date that “the neurobiology of placebo was born” (p. 484). Since this publication, an extensive body of research has shown how expectations and conditioning mediate specific mechanisms of the placebo effect. In fact, this research has shown that there is not just one mechanism of the placebo effect but several operating across different neurobiological pathways. While many mechanisms are posited, a significant number of studies have investigated the mediating role of the endogenous opioid and dopaminergic pathways.

Since Levine and colleagues’ (1978) study, research investigating placebo analgesia (i.e. the placebo effect of pain) has been corroborated by functional magnetic resonance imaging (fMRI) and positron emission tomography (PET) technology. Using ischemic arm pain as the main outcome measure, a series of experiments between 1999 and 2003 identified the role of the endogenous opioid system as a mediator of placebo analgesia. In one study, participants exposed to a conditioning procedure of the opioid drug buprenorphine, reported placebo analgesia when the drug was surreptitiously replaced with saline. However, when replaced with naloxone, placebo analgesia was reversed, highlighting the mediating role of the endogenous opioid system (Amanzio & Benedetti, 1999). In a follow up study, Benedetti et al. (2003) provided further evidence that placebo analgesia could be induced via preconditioning, but could also be reversed by the nocebo effect. After a conditioning procedure similar to Amanzio and Benedetti (1999), participants were administered a placebo but informed that it was a hyperalgesic agent (i.e. would increase pain). Authors reported that verbal instructions blocked placebo analgesia and induced hyperalgesia (i.e. an increase in pain). These findings demonstrate that nocebo effects can act on the endogenous opioid

system through negative expectations and block placebo analgesia induced via preconditioning procedures.

Mechanisms of placebo analgesia are also suggested to be mediated by cannabinoid receptors. Amanzio and Benedetti (1999) demonstrated that placebo analgesia is mediated by expectations and conditioning, with the latter activating the opioid system and the former activating cannabinoid receptors. These authors reported that naloxone blocked placebo analgesia induced by means of expectations of morphine, whereas placebo analgesia induced by means of prior conditioning with the cannabinoid receptor agonist ketorolac, was insensitive to naloxone. Similarly, the cannabinoid receptor antagonist rimonabant had no effect on opioid-induced placebo analgesia of morphine, but completely reversed placebo analgesia following nonopioid conditioning of ketorolac (Benedetti et al., 2011). Further, specific placebo analgesic responses can be obtained on different parts of the body, and can be further reversed by naloxone (Benedetti, Arduino, & Amanzio, 1999). Benedetti et al. (1999) reported that after applying a harmful cream to participants' hands and feet and applying a placebo cream on one hand, placebo analgesia was only reported on the hand receiving the placebo cream. This effect was further blocked by naloxone, suggesting that the placebo activated opioid systems can involve highly specific areas of the central nervous system. The results of these studies, and elsewhere (Lee et al., 2015; Petrovic, Kalso, Petersson, & Ingvar, 2002; Price et al., 1999; Rütgen et al., 2015), suggest that placebo analgesia can be mediated by both opioid and cannabinoid receptors that often depend on participants' previous exposure to pharmacological drugs (Benedetti, 2013).

Several dopaminergic pathways have also shown to be influenced via expectancy and conditioning procedures. Using PET imaging, de la Fuente-Fernández et al. (2001) demonstrated that administration of a placebo, described as an active drug, increased dopamine in the striatum for Parkinson disease patients who expected the drug to be

effective. The increase in dopamine concentration corresponded to a change of 200%, which is comparable to the response of amphetamines in people with an intact dopamine system (Benedetti, 2014). In a further study with Parkinson disease patients (Pollo et al., 2002), electrodes were implanted to the basal ganglia (an area of the brain highly modulated by dopamine) and patients were administered deep brain stimulation. Hand movement was monitored via a movement analyser and each patient was tested twice on different days under two different treatments. In the first treatment, patients were informed that the stimulation would impair motor performance, whereas in the second they were informed that it would improve motor performance. However, unbeknown to patients, the stimulation was identical for each treatment. Authors reported that patients' hand movement was faster when they expected good hand movement and slower when they expected impaired movement. Scott et al. (2008) also demonstrated that while placebo effects increased activation of dopamine neurotransmitters, nocebo effects significantly decreased it. These findings demonstrate the significant influence placebo and nocebo effects can have on motor performance and the dopaminergic system.

Neurobiological mechanisms of placebo effects are evident in pain (Amanzio & Benedetti, 1999; Petrovic et al., 2002), Parkinson's disease (de la Fuente-Fernández et al., 2001; Jarcho et al., 2016), immune diseases (Albring et al., 2014; Vits et al., 2011), anxiety (Furmark et al., 2008) and depression (Kong et al., 2006; Kong et al., 2009). These responses are often induced by prior conditioning of a treatment and/or the expectation of treatment outcome. Placebo effects often share similar neurobiological pathways to those activated by pharmacologically active treatments. Expectations of analgesia for example, can activate the same receptors and pathways, and elicit similar biological effects as those produced by verum treatments (Benedetti, 2013). Furthermore, Amanzio et al. (2001) have shown that even when a verum treatment is administered, the placebo effect component of that treatment can have a

significant influence on its outcome. Authors demonstrated that administering a drug (i.e. tramadol, buprenorphine and ketorolac) openly to the participant is far more effective than when participants are unaware of its administration (closed administration). These data suggest that the expectation of drug administration is a crucial component of its effectiveness.

2.1.4 Responders and non-responders

As noted in previous sections, the administration of a placebo treatment can influence a wide variety of conditions. Nevertheless, the proportion of people responding to a placebo treatment varies considerably from study to study. Administration of a placebo treatment will not always elicit a placebo effect, and identifying those who respond (i.e. placebo responders) and those who do not (i.e. placebo non-responders) has been a focus of placebo effect research for over 60 years.

Historically, authors have identified placebo responders through self-report instruments. For example, Knowles and Lucas (1960) reported that participants identified as extroverted on the Maudsley Personality Inventory (Eysenck, 1959) were significantly more likely to report placebo analgesia ($r = .89$, $p < .01$). More recently, Geers, Wellman, Fowler, Helfer, and France (2010) reported that participants identified as optimistic on the Life Orientation Test-Revised psychometric scale (Scheier, Carver, & Bridges, 1994) were more likely to report placebo analgesia than pessimists ($p = .007$). De Pascalis, Chiaradia, and Carotenuto (2002) suggested that participants with high scores on the sensory suggestibility scale (Gheorghiu & Reyher, 1982) were more likely to report placebo analgesia than those scoring lower on the scale ($p = .039$).

Personality traits have also been shown to influence activity in the brain after administration of a placebo. In a review of mechanisms associated with placebo analgesia, Medoff and Colloca (2015) reported that ego-resiliency, altruism, straightforwardness and

low angry hostility predicted 25% of placebo analgesia and 27% of endogenous opioid system activation. Additionally, Huber, Lui, and Porro (2013) reported that for participants with high suggestibility, placebo analgesia was associated with increased activity of the dorsolateral prefrontal cortex. These results suggest that certain personality traits may be linked with placebo analgesia and the ability to release endogenous opioids after administration of a placebo.

Researchers have also suggested that certain genetic traits moderate responses to a placebo. Participants with catechol-O-methyltransferase (COMT) polymorphism Met/Met alleles have been shown to demonstrate larger placebo analgesic effects than those with Val/Val and Val/Met alleles (Hall et al., 2012), whereas those with the Val/Val alleles are associated with higher frequency of nocebo effects (Wendt et al., 2014). Similarly, Pecina, Stohler, and Zubieta (2014) reported that gene variants in the fatty acid amide hydrolase predicted placebo analgesia and regulated the release of endogenous cannabinoids. While it is unlikely that a single genetic trait will predict who will respond to a placebo treatment, a small body of data provide evidence that certain genetic traits may moderate a person's response to a placebo.

Placebo effects are also suggested to be triggered by situational determinants generated from outside (e.g. context in which the treatment is administered) or inside the person (e.g. mood of the participant). Accumulated evidence suggests placebo effects are often created within a psychosocial context that influences a person's response to a placebo. These include the interaction between the person receiving the treatment and the person administering it (e.g. patient and doctor), the environment in which the treatment is delivered (e.g. laboratory) and the sensory processes involved (e.g. colours, shapes, tastes and smells). For instance, coloured pills have shown to be more effective than white pills (de Craen, Tijssen, de Gans, & Kleijnen, 2000), injections are reported to be more effective than capsules (Moerman &

Jonas, 2002) and branded drugs are suggested to be more effective than generics (Kam-Hansen et al., 2014). In the context of medical practice, placebo effects are more likely to be induced if the doctor administers the treatment with empathy, attention and confidence (Kaptchuk, Kelley, Conboy, et al., 2008). These findings emphasise the importance of context in the generation of placebo effects and suggest that even when a legitimate treatment is administered, its effectiveness can be mediated and moderated within the context in which it is delivered.

To illustrate the previous point, Amanzio et al. (2001) examined the effect of four widely used painkilling drugs (buprenorphine, tramadol, ketorolac and metamizol) and their effectiveness on the analgesic dose needed to obtain a 50% pain reduction in open and hidden administration settings. The open setting consisted of a doctor administering the drug in full view of the patient coupled with the information that it was a powerful analgesic. The hidden setting consisted of an automatic infusion machine delivering an injection of the same drug unknowingly to the patient. Authors reported that the analgesic dose needed to reduce pain by 50% was much higher in hidden settings compared to open settings (Figure 2.1). Similar results have been shown in Parkinson's disease symptoms, where brain stimulation is shown to be more effective when participants are aware they are receiving the treatment than when they are not (Pollo et al., 2002). These studies highlight that the overall effectiveness of a treatment is heavily influenced via the psychosocial context in which it is delivered. If a placebo treatment is administered and the psychosocial context is absent, it is less likely that a placebo effect will be induced.

Given the available evidence, placebo effects appear to be manifest in an interaction between individual traits and the social context in which the placebo is delivered. Individual characteristics (e.g. learning, personality and genotype), the type of placebo treatment (e.g. pills, capsules and injections) and the verbal instructions used (e.g. "the treatment is a potent

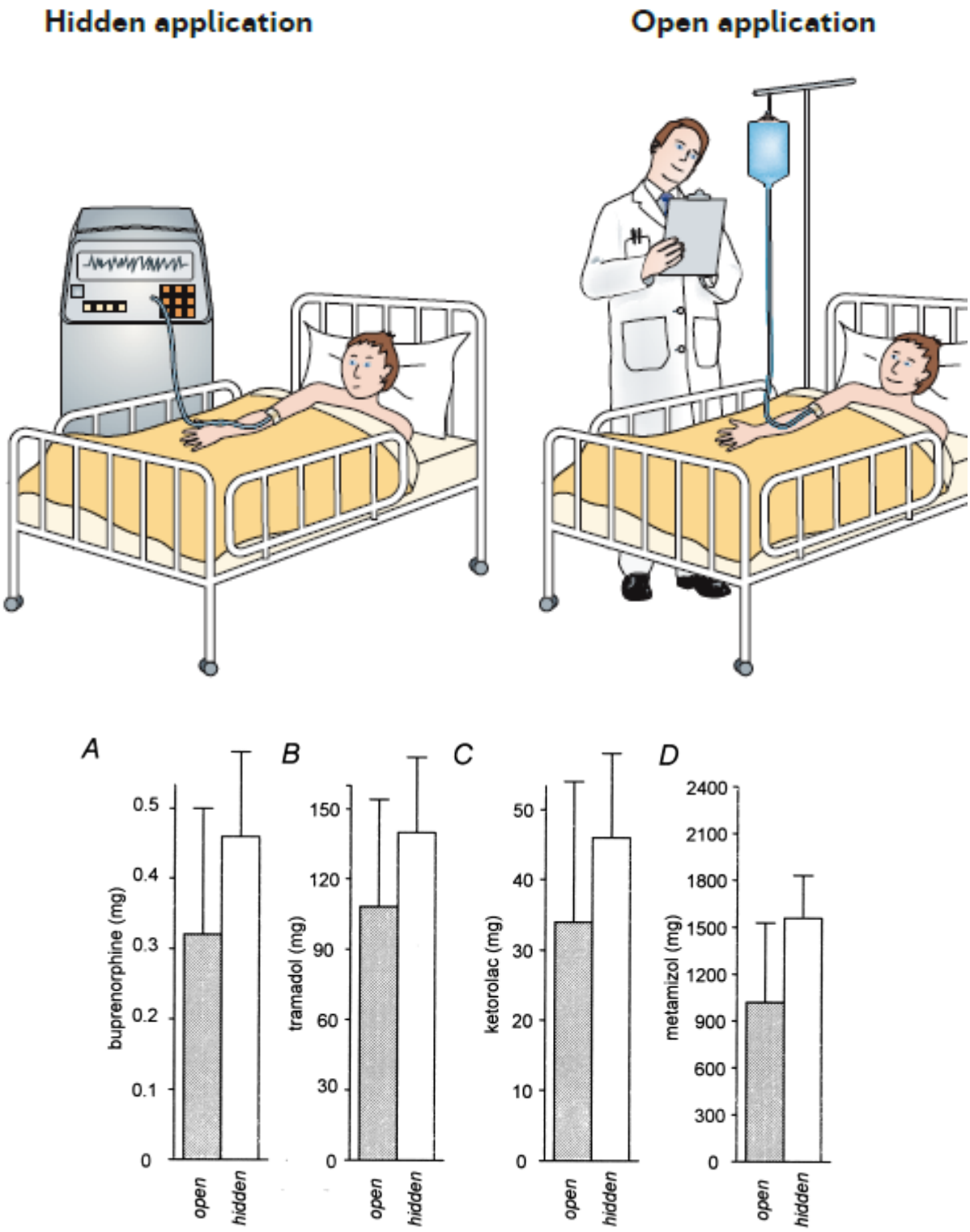

Figure 2.1. Hidden vs. open administration of treatments. *Note.* Differences in the analgesic dose needed to obtain a pain reduction of 50% between open and hidden settings (Amanzio, Pollo, Maggi, & Benedetti, 2001).

analgesic”) are just some of the mediators and moderators of the placebo effect. In light of this understanding, it is emphasised that people will respond differently to treatments administered in different situations. A participant does not arrive to a study as a “blank slate” but with a history of experiences and memories that are evoked by signals related to the idiosyncrasies of the treatment and the environment. In other words, a treatment is not administered in a vacuum, but rather in a complex set of psychological states that varies from person to person and from situation to situation (Benedetti, 2013). Arguably, therefore, almost every aspect of the administration of a treatment, placebo or verum, moderates the placebo components of that treatment. While there may not be a single setting that everyone will respond to or in, this does suggest that under the correct circumstances, everybody has the potential to be a placebo responder. In this model, the placebo responder is ubiquitous and activated by an interaction of individual traits and the situational determinants in which a placebo is administered.

2.1.5 No-treatment controls in placebo effect research

While there is extensive evidence to suggest that placebo effects are influenced by individual and situational variables, there are a number of methodological problems associated with a large proportion of these studies. Aside from basic problems such as self-report instruments with poor validity and reliability and a lack of randomisation of participants to treatments (Geers, Helfer, Kosbab, Weiland, & Landry, 2005), mechanisms associated with the placebo effect are often observed in studies that are not designed to investigate individual differences in responses to a placebo. Instead, they are often designed to investigate a medical treatment within a randomised controlled trial. During this trial, the placebo treatment is often relegated to a passive baseline against which to control the effectiveness of the active treatment. Rarely do researchers include a no-treatment control to

compare both the placebo and the verum treatment (Benedetti, 2013). If researchers use this type of design, any attempt to analyse the mechanisms influencing the response to the placebo treatment is limited.

To highlight this point, take for example a randomised controlled trial investigating the efficacy of a drug for chronic lower back pain. Participants with chronic lower back pain are sampled and randomised to either drug or placebo. Results demonstrate that both the drug and placebo significantly improved lower back pain after one hour of administration. From these results, it could be inferred that the placebo improved lower back pain and is indicative of a placebo effect. However, without a no-treatment control, we are unable to truly assess if changes in lower back pain are due to the psychosocial context in which the treatment was administered or the natural course of the condition. Symptoms may fluctuate on a daily, even hourly basis and what may be identified as a placebo effect may be fluctuation of symptoms. Likewise, if the participants sampled report extremely high pain scores at the onset of the study, any follow up trial would tend to show lower scores. In this instance, changes in symptoms are often interpreted as placebo effects, but are instead the result of a statistical phenomenon referred to as regression to the mean. Furthermore, participants in a study may change aspects of their lifestyle over the course of a trial (e.g. diet, sleep and exercise) that can go unnoticed and affect the outcome of treatment. For these reasons, without a no-treatment control in study design, natural history, fluctuation of symptoms, regression to the mean and lifestyle changes cannot be discounted. For future research investigating the placebo effect and its mechanisms, researchers must include a no-treatment control, or control for potential confounders, to ensure changes observed in the placebo treatment are in fact due to the psychosocial environment surrounding the administration of treatment and not non-specific factors associated with methodological and/or statistical artefacts.

2.1.6 The placebo effect: control or capitalise?

Researchers often aim to control for the placebo effect using the randomised controlled trial. Participants in these trials are often administered a placebo that is, in theory, indistinguishable from the treatment under examination. The ultimate aim of these trials is to measure the magnitude of the placebo effect in order to make an accurate estimation of the "true" effect of a treatment and hence prevent overestimation of the treatment by accounting for the contribution of placebo effects or non-specific effects that may occur during administration (Garcia, 2015). However, in applied practice it is reasonable to suggest that the placebo effect is something that could be capitalised on and enhanced. Once a treatment has shown efficacy in randomised controlled trials, the ultimate aim is to maximise a person's response to the treatment. It is therefore important for researchers to understand that controlling for the placebo effect in randomised controlled trials can optimise placebo-treatment differences and that capitalising on it in applied practice can augment the benefits of a treatment.

Randomised controlled trials are recognised as the gold standard for assessing the efficacy of a treatment (Kaptchuk, Kelley, Conboy, et al., 2008) and are intended to prevent overestimation of a treatment under examination due to other effects that can occur during administration (e.g. placebo effects; Enck et al., 2013). Many variants of the randomised controlled trial have developed since its inception. For example, researchers have used treatment-naive participants to control for expectations (la Fuente-Fernández, 2012), replaced inert placebos with active placebos to mimic the side effects of a treatment (Jensen, Bielefeldt, & Hróbjartsson, 2017), and extended trial duration to decrease the occurrence of placebo effects (Potkin et al., 2011). One of the most controversial variations of the randomised controlled trial is the placebo run-in trial, where researchers identify and exclude placebo responders at an early stage in the trial (e.g. Lavalle-González et al., 2013). Although

some evidence suggests this does not prevent the occurrence of placebo effects in the latter stages of a trial (Quigley et al., 2013), it is generally accepted that placebo run-in trials are more effective at controlling for the placebo effect and optimising placebo-treatment differences than standard randomised controlled trials (Enck et al., 2013).

While researchers attempt to control for the placebo effect in randomised controlled trials, a basic assumption during these trials is that placebo effects shown in the placebo arm are identical to placebo effects shown in the treatment arm (Colloca, Klinger, Flor, & Bingel, 2013; Kirsch, 2013; Meissner, Bingel, et al., 2011). However, recent studies have shown that this may not be true under all conditions (Lund, Vase, Petersen, Jensen, & Finnerup, 2014; Muthén & Brown, 2009) and that placebo effects may fluctuate between participants and contexts (Benedetti, 2013). A consideration for future research is therefore to explore whether placebo effects are additive or interactive during the administration of a verum treatment (Figure 2.2). If the latter is correct, then caution should be applied by researchers using the standard randomised controlled trial to estimate the difference between placebo and treatment effects

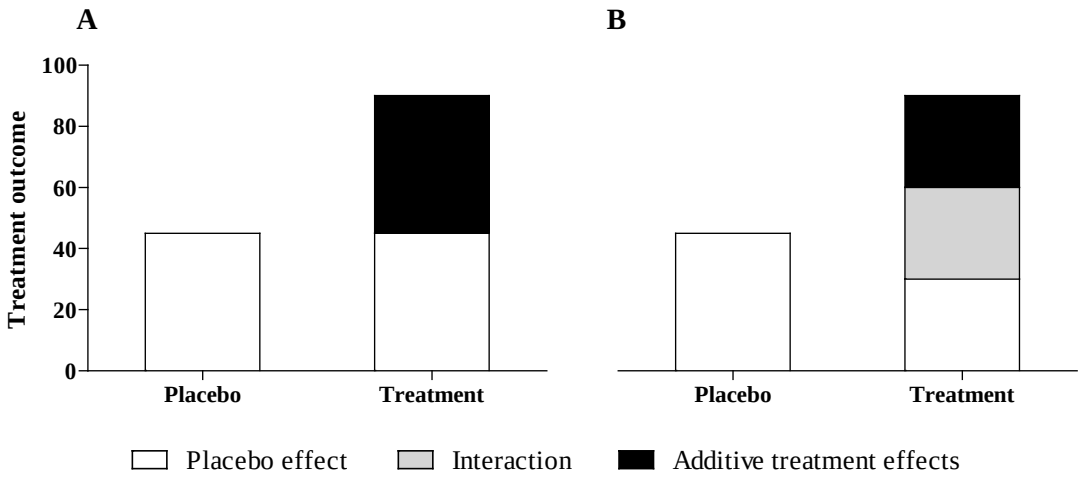

Figure 2.2. Additive vs. interactive effects of treatments. *Note.* A: Additive model, which assumes placebo effects are equal in the placebo and treatment groups. **B:** Interactive model, which assumes that treatment effects may interact with placebo effects (adapted from; Enck, Bingel, Schedlowski, & Rief, 2013).

On the other hand, if the placebo effect interacts positively with the pharmacological effects of a treatment, applied practitioners could theoretically be able to augment the pharmacological effects of a treatment by manipulating a person's belief about that treatment (Foad, Beedie, & Coleman, 2008). It is reasonable to suggest that the ultimate aim of an applied practitioner should be to enhance the pharmacological effect of a treatment irrespective of whether the effects are attributed to the treatment, the placebo, or a combination of both (Figure 2.2; Enck et al., 2013). For practitioners to capitalise on the placebo effect of a treatment, expectations prior to its administration should be monitored to ensure that the person receiving the treatment expects that it will benefit them. If the person does not expect the treatment to be beneficial, then they may not fully benefit from it. Research has shown that patients' expectations about the severity of illness significantly influence recovery from a surgical treatment (Barefoot et al., 2011) and that expectations about the effectiveness of an analgesic influence how well it works (Ružić, Ivanec, & Stanke, 2017). Thus, the words a practitioner uses and the information provided to the participants can significantly affect the outcome of treatment. Influencing a participant's expectations by the careful use of words and provision of appropriate information about the expected effects of the treatment are important characteristics of administration (Enck et al., 2013).

To address whether researchers or practitioners should control or capitalise on the placebo effect is, however, difficult. Placebo research is still in an embryonic stage and although research in disciplines such as medicine, neuroscience and psychology has shed light on potential mechanisms, a major challenge still exists in both controlling, and capitalising on the placebo effect. Current evidence suggests that we can "tap into" certain mechanisms when a certain set of trait and situational variables are met, but we are still far from fully predicting and controlling these mechanisms and associated responses. Future research is therefore needed to provide greater understanding of the placebo effect and its

underlying mechanisms. Doing so has the potential to not only enhance our understanding of the placebo effect, but also to improve how researchers and applied practitioners can control and capitalise it.

2.1.7 Placebo effects on sports performance

In recent years, numerous studies have examined the placebo effect in sport and exercise science. While placebo effects have been shown to influence sports performance for a variety of ergogenic aids (e.g. ice baths, respiratory training devices and shoes), the aim of this review is to focus on sport supplements and banned performance enhancing substances. Empirical evidence has demonstrated that placebo effects can influence performance by on average 6.5% (range = -7.8% to 22.1%; see Table 2.1), with qualitative data suggesting that effects may be associated with pain sensation, arousal regulation (Beedie, Stuart, Coleman, & Foad, 2006) and increases in motivation (Ross et al., 2015). Others have suggested that personality traits, specifically extroversion, agreeableness, openness and neuroticism, may also influence the response to a placebo (Beedie, Foad, & Coleman, 2008). While research continues to explore this phenomenon, the extant literature suggests that placebo effects can have a significant impact on sports performance.

The first published study to investigate the placebo effect in sport was by Ariel and Saville (1972). After baseline strength testing for bench press, military press, sitting press and squat, six sub-elite weightlifters were deceptively administered placebo pills described as Dianabol (i.e. an anabolic steroid). Participants received the pills each day for four weeks, before strength data were collected once more. Participants improved by 9.6, 8.5, 6.2 and 13.8% for bench press, military press, sitting press and squat, respectively. The authors concluded that the strength improvements shown were the result of participants believing

Tale 2.1

Research studies investigating placebo effects on sports performance

#	Author	Year	*n*	Sample characteristics	Design	Performance Measure	Treatment		% Change
							Informed	Received	
1	Ariel and Saville	1972	6	Sub-elite weightlifters	Within-participants design	Strength (bench press, military press, seated press, squat)	Anabolic steroids	Placebo	9.5
2	Maganaris et al.	2000	11	Sub-elite weightlifters	Between-participants design	Strength (Bench press, dead life, squat)	Anabolic steroids Anabolic steroid then placebo	Placebo Placebo	3.8 1.7
3	Clark, Hopkins, Hawley, and Burke	2000	42	Sub-elite endurance cyclists	Between participants Latin square design	Endurance (40 km cycling power)	Carbohydrate	Placebo (50% of participants) Carbohydrate (50% of participants)	1.7
							Placebo	Placebo (50% of participants) Carbohydrate (50% of participants)	4.3
							50/50 chance of receiving carbohydrate	Placebo (50% of participants) Carbohydrate (50% of participants)	-1.1
							Overall placebo effect		3.8
4	Beedie et al.	2006	6	Sub-elite cyclists	Within-participants design	Endurance (10 km cycling power)	0 $mg \cdot kg^{-1}$ caffeine 4.5 $mg \cdot kg^{-1}$ caffeine 9.0 $mg \cdot kg^{-1}$ caffeine	Placebo Placebo Placebo	-1.4 1.3 3.1

Continued on next page

Table 2.1 cont.

#	Author	Year	*n*	Sample characteristics	Design	Performance Measure	Treatment		% Change
							Informed	Received	
5	McClung and Collins	2007	16	Sub-elite endurance athletes	Within-participants Balanced placebo design	Endurance (1000 m running time)	Sodium bicarbonate	Sodium Bicarbonate	1.7
							Sodium bicarbonate	Placebo	1.5
							No treatment	Sodium bicarbonate	-0.3
6	Beedie et al.	2007	42	Sub-elite athletes	Between-participants design	Anaerobic (30 m running speed)	Positive supplement	Placebo	0.0
							Negative supplement	Placebo	-1.6
7	Kalasountas et al.	2007	42	Untrained students	Between-participants design	Strength (Bench press, seated leg press)	Amino acids	Placebo	19.6
							Amino acids then placebo	Placebo	6.3
8	Pollo, Carlino, & Benedetti	2008	44	Sub-elite athletes	Mixed design	Strength (leg extension)	Caffeine	Placebo	11.8
							Caffeine (after conditioning procedure)	Placebo	22.1
						Perceived fatigue	Caffeine	Placebo	-0.3
							Caffeine (after conditioning procedure)	Placebo	-7.8
9	Foad et al.	2008	14	Sub-elite cyclists	Within-participants Balanced placebo design	Endurance (40km cycling power)	Caffeine	Caffeine	2.3
							Caffeine	Placebo	0.1
							No treatment	Caffeine	2.9
							No treatment	No treatment	-1.9

Continued on next page

Table 2.1 cont.

#	Author	Year	*n*	Sample characteristics	Design	Performance Measure	Treatment		% Change
							Informed	Received	
10	Duncan, Lyons, and Hawkey	2009	12	Untrained athletes	Within-participants design	Total weight lifted (Leg extension)	Caffeine	Placebo	19.0
							Placebo	Placebo	12.0
11	Hulston and Jeukendrup	2009	10	Sub-elite athletes	Within-participants design	Endurance (60 minute cycling power)	Carbohydrate	Placebo	0.4
12	Wright et al.	2009	32	Sub-elite runners	Within-participants design	Endurance (5 km running time)	superoxygenated water	Placebo	6.5
13	Wright et al.	2009	18	Untrained students	Within-participants design	Anaerobic (Wingate power)	Alpha-hydroxydreatine	Placebo	0.6
14	Wright et al.	2009	10	Cardiovascular disease patients	Within-participants design	Endurance (6 minute walk distance)	Pellegrino Spa Water	Placebo	1.4
15	Duncan	2010	14	University athletes	Within-participants design	Anaerobic (Wingate power output)	Caffeine	Placebo	9.7
							Placebo	Placebo	7.1
16	Bottoms, Buscombe, and Nicholettos	2014	12	Untrained athletes	Within-participants design	Endurance (incremental arm crank peak power)	Positive supplement	Placebo	5.4
							Negative supplement	Placebo	-0.8

Continued on next page

Table 2.1 cont.

#	Author	Year	*n*	Sample characteristics	Design	Performance measure	Treatment		% Change
							Informed	Received	
17	Carlino, Piedimonte, and Frisaldi	2014	110	Untrained students	Between-participants design	Endurance (Work performed KJ)	Caffeine (100% chance)	Placebo	11.4
							Caffeine (50% chance)	Placebo	13.7
							Caffeine (25% chance)	Placebo	9.7
							Caffeine (0% chance)	Placebo	6.3
							Caffeine (100% chance after conditioning procedure)	Placebo	22.0
							Caffeine (50% chance after conditioning procedure)	Placebo	19.5
							Caffeine (25% chance after conditioning procedure)	Placebo	21.3
							Caffeine (0% chance after conditioning procedure)	Placebo	12.6
18	Bellinger and Minahan	2015	8	Sub-elite athletes	Within-participants Balanced placebo design	Anaerobic (1 km cycling power)	β-alanine	β-alanine	2.4
							β-alanine	Placebo	0.6
							Placebo	β-alanine	1.8
							No treatment	No treatment	-1.0

Continued on next page

Table 2.1 cont.

#	Author	Year	*n*	Sample characteristics	Design	Performance Measure	Treatment		% Change
							Informed	Received	
19	Tolusso, Laurent, Fullenkamp, and Tobar	2015	10	Untrained athletes	Within participants design	Anaerobic (Running sprint power)	New sport supplement	Placebo	6.7
20	Ross et al.	2015	15	Sub-elite athletes	Between-participants design	Endurance (3 km running time)	OxyRBX	Placebo	1.5
21	Tallis, Muhammad, Islam, and Duncan	2016	14	Untrained athletes	Within-participants Balanced placebo design	Strength (leg extension)	Caffeine	Caffeine	15.8
							Caffeine	Placebo	9.8
							Placebo	Caffeine	12.8
22	Saunders et al.	2017	42	Sub-elite athletes	Within-subject design	Endurance (25 min time-trial)	50/50 chance of receiving caffeine	Placebo	1.5
23	de la Vega, Alberti, Ruiz-Barquin, Soos, and Szabo	2017	60	Sub-elite athletes	Between-participants design	Anaerobic (200 m running speed)	100% change of supplement	Placebo	5.9
							50% chance of supplement	Placebo	2.2
							Placebo	Placebo	1.9

they were ingesting an anabolic steroid. These results were the first to suggest that the placebo effect can significantly improve sports performance among sub-elite athletes.

Maganaris et al. (2000) investigated the deceptive administration of a placebo tablet on weightlifting performance. One week after baseline testing for bench press, deadlift and squat, eleven elite weightlifters were administered a tablet and informed they had received a potent anabolic steroid. Participants performed experimental trials and showed improvements of 3.5, 4.2 and 5.2%, for bench press, deadlift and squat, respectively. One week later, participants received a further tablet but this time, six participants were informed that the tablets were in fact a placebo while the other five were given no new information. Compared to the first experimental trial, performance was maintained for those who believed they had received anabolic steroids (3.2, 4.0 and 4.4%, respectively). However, the performance of participants informed they were receiving a placebo reduced significantly (1.7, -0.4 and 0.4%, respectively). Maganaris et al. concluded that the expectation of receiving a potent anabolic steroid significantly improved participants' performance. Authors also highlighted that almost all participants would have achieved international level status as a result of the intervention. The results of both Ariel and Saville and Maganaris et al. suggest that certain drugs expected to improve performance may in part be influenced by the placebo effect.

While the results of Ariel and Saville (1972) and Maganaris et al. (2000) provide evidence of the magnitude of placebo effects in sports performance, they do little to elucidate the potential psychological mechanisms underpinning the phenomenon. Beedie et al. (2006) used quantitative and qualitative methods to explore the possibility of a dose-response relationship to placebos and the mechanisms underpinning changes in performance. Six sub-elite cyclists performed two baseline and three experimental 10 km time-trials. In experimental trials, participants were administered placebo capsules and informed that they would receive a placebo, 4.5 $mg \cdot kg^{-1}$ caffeine and 9.0 $mg \cdot kg^{-1}$ caffeine randomly assigned.

Compared to baseline, performance in experimental trials showed a dose-response relationship, with participants producing -1.4% less power when they believed they had received a placebo, 1.3% more power when they believed they had received 4.5 $mg \cdot kg^{-1}$ caffeine and 3.1% more power when they believed they had received 9.0 $mg \cdot kg^{-1}$ caffeine. To further explore these changes in performance, semi-structured interviews were conducted after the intervention. Participants reported heightened arousal, pain reduction and a change in pacing strategy when they believed they had ingested caffeine. One participant however, believed that caffeine would have a negative effect on his performance and reported that he "felt terrible" during the caffeine trials (i.e. a nocebo effect). The results of this study suggested a dose-response relationship between expectation and effect.

Having observed a potential nocebo effect (Beedie et al., 2006), Beedie et al. (2007) designed a study to investigate the impact of positive *and* negative expectations on sports performance. After baseline 3 x 30 m repeat sprints, 42 sub-elite team-sport athletes were randomised to one of two treatments. In the first treatment, participants were given a red and white capsule and informed that it would have a *positive* effect on speed and endurance, whereas in the second treatment, participants were given the same capsules and informed that it would have a positive effect on endurance but a *negative* effect on speed. Participants performed the experimental condition in an identical manner to baseline 20 minutes later. Authors reported that speed decreased significantly during baseline for both treatments. However, during the experimental condition, while speed continued to decrease in the negative treatment, speed in the positive treatment increased. No differences in speed were shown between baseline and the positive treatment (p = .96), demonstrating that expectation of receipt of a beneficial supplement offset fatigue and facilitated performance (Figure 2.3). However, the expectation of receiving a negative supplement appears to have impaired performance and influenced the ability to maintain speed over consecutive sprints. Results

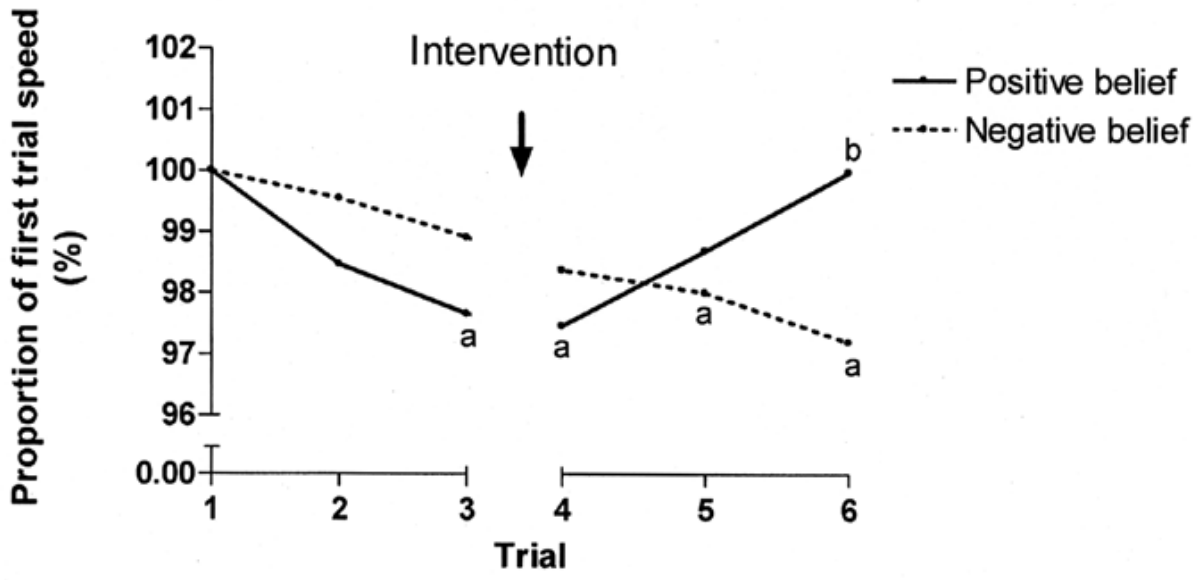

Figure 2.3. Results from Beedie, Coleman and Foad (2007). Mean times for trials 1-6 expressed as percentages of Trial 1. *Note:* a denotes significant difference from Trial 1 ($p < .05$), and b denotes significant difference from Trials 3 and 4 in the positive belief trials ($p < .05$).

demonstrate that negative expectation could offset the effectiveness and potential benefits of an intervention. Although it is unlikely that an athlete would ever knowingly ingest a supplement they expect was harmful to their performance, the results suggest that if athletes do not expect that the treatment is beneficial, they may not fully realise the benefits of that treatment.

In a further study, Foad et al. (2008) investigated the placebo effect of caffeine on sport performance using the balanced placebo design (Rohsenow & Marlatt, 1981). Fourteen sub-elite cyclists performed 14 x 40 km time-trials consisting of eight experimental trials interspersed with six baseline trials. Experimental trials consisted of: 1) informed caffeine/given caffeine; 2) informed caffeine/given placebo; 3) informed placebo/given caffeine; 4) informed placebo/given placebo. Caffeine was found to improve performance compared to baseline whether participants expected to receive it or not (informed caffeine/given caffeine = 2.9 ± 3.4%; informed placebo/given caffeine = 2.3 ± 3.3%). In

contrast to previous research, no mean placebo effect was observed compared to baseline when participants were informed caffeine/given placebo (0.1 ± 3.2%). In summarising the findings of their study, the authors suggested that placebo effects may operate differently depending on whether a verum treatment is present. Arguably, when participants receive a verum treatment (e.g. caffeine), they are consciously or unconsciously responding to the subtle cues of its presence (e.g. heightened arousal, increase in heart rate or increase in alertness). Thus, in a study when no active treatment is administered, no comparison of the presence or cues of that substance can be made and researchers cannot be confident that the participant's expectation about the treatment is the significant factor in performance improvement.

Other studies exploring the impact of placebo effects on sports performance include McClung and Collins (2007), who reported that expectation of receipt of sodium bicarbonate improved performance to the same magnitude as actually receiving sodium bicarbonate, and Ross et al. (2015), who reported that participants self-injecting saline water believed to be a new performance enhancing substance significantly improved their time to run 3000 m. Collectively, 23 published investigations in sport and exercise science have shown that the belief that a treatment has been received can influence performance by on average 6.5% (Table 2.1). However, the idea that placebo effects are reliable and predictable is questioned by the results of Foad et al. (2008). The placebo effect is a complex psychosocial phenomenon consisting of an interaction between cognition, previous experiences and the context in which the treatment is administered. Accordingly, people will respond differently to different placebo interventions. Understanding and determining potential moderators is required to help explain why some people respond to a placebo intervention and others do not. Furthermore, while the body of research suggests that receiving a placebo is beneficial to performance, a handful of researchers (e.g. Beedie et al., 2007; Bottoms, Buscombe, &

Nicholettos, 2014) suggest that the performance outcome may not always be positive. Pre-existing beliefs and/or experiences about a treatment can offset some, or all of the therapeutic benefits of that treatment. Further research is required to understand the nocebo effect on sports performance and the implications this could have in the effectiveness of a treatment.

2.1.8 Limitations of placebo effect studies in sport

The available research suggests that placebo effects can have a significant impact on sports performance. However, the sample size is small in almost all studies investigating the placebo effect of performance enhancing substances. In studies conducted between 1972 and 2013, samples sizes ranged from 6 to 44, with only 319 participants sampled in total. While these studies may be sufficiently powered to reject a false null hypothesis, the sample sizes are too small to facilitate the reliable identification of variables that may moderate the placebo effect. The variance of the performance measure in most studies is often greater in experimental trials than baseline, suggesting that even if a placebo effect is observed, there is considerable inter-individual variability in the response to placebo.

Placebo effect studies often fail to demonstrate unequivocally that observed changes in performance are placebo effects, and not the result of methodological and/or statistical artefacts. For example, Beedie et al. (2007) reported both placebo and nocebo effects during repeat sprint performance, but did not include a no-treatment control alongside experimental treatments. What was labelled a placebo or nocebo effect could have been regression to the mean and/or spontaneous changes in performance. The studies by McClung and Collins (2007) and Foad et al. (2008) for example, used participant's own baseline as a no-treatment comparison. Without a separate no-treatment control, observed placebo effects could be attributed to methodological artefacts such as carry-over effects and/or behavioural conditioning (Horing, Weimer, Muth, & Enck, 2014). In fact, 19 of the 23 studies (83%)

outlined in Table 2.1 do not include a no-treatment control in study design. Without a natural history control treatment, authors cannot be confident that simple measurement repetition would result in the same changes in performance. In light of the above, research investigating placebo effects should include a large enough sample size to facilitate the reliable identification of the mechanisms of the placebo effect. In addition, the inclusion of a natural history control treatment ensures that observed changes in performance are the result of placebo effects and not the result of methodological artefacts.

2.1.9 Translating placebo effect research into applied practice

In laboratory studies, the aim of the research is usually to explore the biological basis of the placebo effect. However, it is also important to develop knowledge that can support applied practice. To achieve this, translational placebo effect research emphasising the real world impact of the placebo effect on sports performance is required.

Over the last 40 years, empirical research into the placebo effect in sport and exercise has remained relatively static, with focus placed on examining the existence of the placebo effect in controlled environments. Seldom have authors attempted to translate the knowledge gained from placebo effect research into applied settings. This is important, as translating the results from empirical research can enhance best practices in the community (Rubio et al., 2010). For example, in *vitro* and in *vivo* empirical biomedicine research develops knowledge that helps improve the diagnosis, treatment and prevention of human diseases (Barbieri et al., 2015) and data from controlled experimental trials of physical activity help to shape national and international policy guidelines (Estabrooks, 2017). In light of this, researchers in sport and exercise science should aim to translate knowledge gained from empirical placebo effect research into applied practice.

Translating placebo effect research into applied practice is, however, fraught with ethical dilemmas. Typically, placebo effect research involves deception, with a placebo presented as a potent performance enhancing substance. While this type of research can, for example, generate knowledge about the impact of beliefs on performance, applying this in practice is arguably unethical (Beedie, Foad, & Hurst, 2015; Beedie et al., 2017). The benevolent and paternalistic use of a deceptive treatment is arguably contrary to the respect of individual autonomy. Pre-existing beliefs or experiences of a treatment may also result in nocebo effects that could eliminate or negate the therapeutic benefits. Therefore any attempts to translate placebo effect research should be done in accordance with professional norms and ethical principles (Beedie et al., 2017).

With this in mind, using a deceptive placebo treatment in isolation in applied practice is perhaps unethical. However, research has suggested that a significant proportion of the efficacy of a performance enhancing substance may be due to the placebo effect. This suggests that athletes using sport supplements may not benefit *entirely* from the pharmacological properties of that substance, but from their beliefs (e.g. it will be effective for improving performance). Athletes that are aware of this, and that their beliefs about the effectiveness of a substance could make as much difference to their performance as the actual pharmacological properties, may be less likely to use these substances in the future. Anecdotal evidence by Maganaris et al. (2000) suggests that participants were less likely to use anabolic steroids once they were informed about the placebo effect. McClung and Collins (2007) also highlighted the importance of educating athletes about the placebo effect as an educational intervention and suggested that athletes aware of this phenomenon could make more informed decisions about their use of sport supplements. Other researchers have made this explicit link (Kalasountas et al., 2007) but this suggestion remains untested. It is reasonable to conclude that translating the findings of placebo effect research into applied

practice and emphasising the significant impact the placebo phenomenon may have on sports performance could help athletes make more informed decisions about their use of sport supplements and banned performance enhancing substances. This has the potential to reduce the potential health risks of athletes using performance enhancing substances.

2.1.10 Summary of placebo effect research in sport

Since Ariel and Saville's (1972) study, a plethora of researchers have presented data relating to the magnitude of the placebo effect on sports performance. Despite methodological limitations (e.g. sample size and no-treatment controls), there is evidence that the placebo effect has a significant influence on sports performance. Although not everyone will respond to a placebo under the same conditions, numerous questions arise as to how sport practitioners and researchers capitalise and control for this response in sport and exercise scenarios. This is even more important when considering that an athlete's pre-existing beliefs and experiences of a treatment may be negative. Only a handful of authors (Beedie et al., 2007; Bottoms et al., 2014) have investigated the nocebo effect on sports performance, and further research addressing the magnitude and moderators of this effect is required. In addition, a lack of translational placebo effect research is evident, with authors seldom utilising knowledge gained from placebo effect research in applied settings. While careful consideration of ethical guidelines is of paramount importance, applying and utilising the placebo effect could act as a vehicle to educate athletes and provide them with the information to make better more informed decisions regarding supplement and banned substance use. Extant evidence suggests that a significant proportion of the efficacy of a substance could be the result of the participant's beliefs and expectations about it. However, data supporting this is anecdotal. A hypothesis therefore remains untested that aims to

determine how awareness of placebo effects influences an athlete's decision to use sport supplements and banned performance enhancing substances.

2.2 Anti-Doping Literature Review

The second aim of this literature review is to describe and explain the anti-doping literature. The origins of doping are reviewed in order to establish the context in which anti-doping policy was shaped. While it is not the purpose of this research programme to examine the structures in place aimed at preventing doping, it is impossible to discuss the use of sport supplements and performance enhancement in sport without doping policy being a significant feature. Debates about whether doping should be banned or not are outside the scope of this research, the focus of which is the *athletes'* use of sport supplements and doping substances. The social science literature is mostly referred to, which consists of the psychosocial variables associated with doping behaviours.

It has been suggested that researcher bias can influence interpretation of the literature and methodological design (Finlay & Gough, 2008). In the anti-doping literature this is no different. For these reasons, some authors have suggested that the researcher acknowledges their position on doping to provide the context by which implicit biases may have shaped the research design and outcomes (Mazanov, 2016). In this research programme, the researcher holds the position that values preventative approaches as opposed to post-hoc detection and sanctioning, one that provides athletes with education, information, strategies and tools that inform and support their decisions. The aim of this research is to understand the impact of a placebo intervention on an athlete's beliefs and intentions towards sport supplements and their attitudes to banned substances.

Anti-doping policy is necessary to both protect the integrity of sports, which are defined by their rules, and even more importantly, to ensure the health and wellbeing of

athletes. Yet, while anti-doping policy is essential, it can be draconian, unfair and ineffective (Dimeo, 2016). Anti-doping policy was created in the early 20th century within a context of distorted and inaccurate information (about both the drugs it was trying to control and the user; Coomber, 2014; Dimeo, 2016; Henne, 2015). Linked to immorality and to prejudice, anti-doping policy was shaped to "protect" the values of sport (Dimeo, 2008), which included, for example, ethics, health and courage. Dimeo (2016) argues that anti-doping policy emerged with the vision to separate the virtuous "self" from the "dirty" other. The implication arising from this is the judgement about the moral status of an athlete. In the media, for example, athletes are often stigmatised and ostracised for doping and are often judged as "clean" or "dirty." To label athletes this way can invoke stereotyping and prejudice, equivalent to "good *vs.* evil" or "hero *vs*. villain." For example, in response to Usain Bolt winning the Olympic 100 metres against Justin Gatlin (who has failed two drug tests), the Guardian newspaper printed the headline "Usain Bolt stars in old-fashioned battle between 'good and evil' at Rio 2016" (i.e. Bolt being "good" and Gatlin "evil"; The Guardian, 2016). Such language may be common within the media, but within academia, such prejudice can distract the reader from potentially important messages underpinning the researcher's aims. Mazanov (2016) argued that using such language could invoke a sense of racism that suggests athletes described as dirty need to be rehabilitated and modified and are not as valuable as those labelled clean. Although researchers using such words may simply be reflecting the language of the layperson, labelling and judging athletes this way only serves to reinforce prejudice. For this reason, moralistic language, such as labelling athletes as clean or dirty, is avoided throughout this research.

2.2.1 Introduction to doping in sport

The use of substances to improve performance has permeated sport since the beginning of competition. Athletes in the ancient Olympics (776 – 394 AD) ate raw animal testicles to improve performance, hearts to increase bravery and brains to enhance intelligence (Willick, Miller, & Eichner, 2016; Yesalis & Bahrke, 2002). In the late 1800's, swimmers and runners combined alcohol, strychnine, heroin and cocaine to improve performance and cyclists drank coffee spiked with cocaine and strychnine during races. Likewise, ultramarathon runners experimented with dosages of morphine, brandy and strychnine during events lasting six days (Hoberman, 2001; Yesalis & Bahrke, 2002). The first death associated with substance use in sport was attributed to the English cyclist, Arthur Linton, who reportedly overdosed on trimethyl during the Bordeaux-Paris race in 1886 (López, 2014). While the actual cause of his death is debated (Dimeo, 2008), the apparent use of substances at this time represents the significant health risks athletes exposed themselves to.

Prior to the inter-war period, substance use in sport was arguably viewed as standard practice (Hoberman, 2001; Waddington, 2001). However, in the late 1920's debates on "natural athleticism" and what could be perceived as "normal" in sport ensued (de Hon, 2016). Such debates led to the term "doping," which was first described as an artificial means to improve performance (Yesalis & Bahrke, 2002). In 1928 the International Association of Athletics Federations (IAAF) made an official statement banning doping substances in competition (Gleaves & Hunt, 2016). After the amphetamine-related death of Dutch cyclist Knut Jenson in 1960, the Medical Commission of the IOC voted to adopt a policy banning doping in sport. In doing so, the IOC published a list of prohibited substances and methods outlining what athletes cannot use in competition, while enforcing punishments for those found violating these prohibitions (de Hon, 2016). This early anti-doping policy aimed to: 1)

uphold and preserve the ethics of sport; 2) safeguard the physical health and mental integrity of athletes; and 3) ensure that all competitors have an equal chance of winning (Dvorak, Saugy, & Pitsiladis, 2014). To achieve these aims and discourage doping, the IOC introduced drug testing and sanctioning at the 1966 FIFA World Cup and 1968 Olympic Games.

Up until the latter part of the twentieth century, sporting organisations independently conducted their own drug tests and sanctioning (Houlihan, 2002). After the 1998 "Festina scandal" in which the Festina cycling team were found to have an organised and systematic doping regime, stakeholders in sport met at the first World Conference on Doping in Sport and agreed on the creation of a separate, independent agency to head efforts in this field. This agency is called the World Anti-Doping Agency (WADA; Henne, Koh, & McDermott, 2013). Today, WADA standardises anti-doping policies across all Olympic sports, which include universally applicable sanctions, a list of prohibited substances and management of doping controls.

Half of WADA's funding comes from public authorities with the remainder coming from the IOC. The funding given to WADA has increased from US$18 million in 2002 to $30 million in 2016 (WADA, 2003, 2017a). A considerable proportion of this funding is spent on implementing the WADC, which includes costs associated with organising, conducting and analysing drug testing. In 2002, the United States Anti-Doping Agency (USADA) spent approximately US$4 million on drug testing (USADA, 2003), while in 2016, it spent over $9 million (USADA., 2017). Likewise, the Australian Sports Anti-Doping Authority (ASADA) spent approximately US$0.6 million in 2006 and $3.5 million in 2016 (ASADA, 2017). The financial costs for WADA analysing drug tests has increased by 50% from 2003 to 2016 (WADA, 2004, 2017a). Despite greater emphasis and financial resources aimed at preventing doping and the technology to detect more types of banned substances, there has not been a statistical increase in the number of tests returning positive since 1985

(Pound, Ayotte, Parkinson, Pengilly, & Ryan, 2013). In fact, if the substances marijuana, asthma medications and glucocorticosteroids were removed from the analysis, all of which can be used with therapeutic use exemption, less than 1% of tests would return positive (Pound et al., 2013). While this could suggest that increases in drug testing have discouraged athletes from doping, the prevalence of doping is estimated to be far greater than the number of positive tests. Recent reports suggest between 14 and 39% of elite athletes are doping (de Hon, Kuipers, & van Bottenburg, 2015), which is significantly higher than the 1 to 2% of athletes identified with banned substances in their system.

2.2.2 Anti-doping education

Preventing a behaviour from occurring is recognised to be more effective than discouraging one that is already established (Backhouse, Patterson, & McKenna, 2012). When implemented properly, education can provide athletes with the information to make more informed decisions about their doping behaviours. For this reason, educational interventions have been a key element in WADA's policy since the publication of the 2009 WADC. Article 18 of the latest WADC states:

> The basic principle for information and education programs for doping-free sport is to preserve the spirit of sport…from being undermined by doping. The primary goal of such programs is prevention. The objective shall be to prevent the intentional or unintentional *Use by Athletes of Prohibited Substances and Prohibited Methods*
>
> (WADC, 2015, p. 96)

Anti-doping educational interventions are implemented all over the world to athletes and the general public. Traditionally, these interventions comprise of value laden "moral

education" that aims to instil a commitment to ideological sporting principles such as integrity, respect and honesty (e.g. UKAD's "100% me," USADA's "play clean" and the IOC's "Olympic Values Education Programme"). WADA includes copious material on their website about the "spirit of sport," including online games such as "the Play True Quiz" and "Youth Quiz" (WADA, 2017b). International federations (e.g. IAAF, IOC and UCI) and National Anti-Doping Organisations (e.g. ASADA, UKAD and USADA) also organise campaigns to educate athletes and the general public about the values of sport in an effort to deter doping behaviours. The British Olympic Association's (BOA) "Get Set for the Spirit of Sport" campaign which "encourages young people to develop a core set of sporting values" has engaged over 4.5 million children and young people since 2012 (BOA, 2017). The Federation Internationale de Football Association (FIFA) implemented the "11 rules to prevent doping in football" campaign to raise awareness among young athletes about the "dangers and consequences of doping" in over 20 countries across Africa, Asia, Europe, Oceania and South America (FIFA, 2017). UNESCO sponsor a series of projects that deliver anti-doping education to "raise awareness of the risks associated with doping" to people all over the world, including Lithuania, Botswana, Ethiopia, Malawi and the Philippines (UNESCO, 2015).

While the reach of anti-doping educational interventions is impressive, limited evidence is available to support the effectiveness of these interventions. In this context, effectiveness refers to the degree in which educational interventions contribute to WADA's objective of preventing doping in sport (WADC, 2015, p. 98). Although it is argued that this goal will never be achieved, doping-free sport is what WADA aims to achieve (de Hon, 2016). Typically, WADA and other anti-doping organisations evaluate the effectiveness of anti-doping educational interventions on the outputs delivered (i.e. how many athletes received education, how many interventions were delivered; Petróczi & Naughton, 2011),

rather than the impact they are having on an athlete's decision to dope. Hoberman (2013) argued that such an approach could "signify a tacit agreement to do nothing beyond issuing proclamations, promulgating slogans, and putting online anti-doping games on the Web" (p. 139). Without any evidence of effectiveness, WADA cannot guarantee that anti-doping educational interventions are meeting their objectives of preventing doping.

A similar paucity of evidence for the effectiveness of interventions characterises the scientific literature. In a systematic review funded by WADA that included over 100 studies of the social science anti-doping literature, Backhouse, McKenna, Robinson, and Atkin (2007) reported that there is little evidence to indicate the effectiveness of anti-doping education. This conclusion is similar to a follow up review in 2016 (Backhouse, Whitaker, Patterson, Erickson, & McKenna, 2016). In fact, the available evidence suggests that interventions have little impact on doping behaviour. For example, the ATLAS (Athletes Training and Learning to Avoid Steroids; Goldberg et al., 1996) and ATHENA (Athletes Targeting Healthy Exercise and Nutrition Alternatives; Elliot et al., 2004) interventions, which both involve conveying knowledge about a range of unhealthy behaviours, including doping, showed only a small reduction in doping intentions and no changes in actual reported cases of doping (Ntoumanis et al., 2014).

More recently, Barkoukis, Kartali, Lazuras, and Tsorbatzoudis (2016) educated athletes on the health, moral, social and psychological aspects of sports supplements and doping and Sagoe et al. (2016) provided athletes with information on fundamental principles of exercise and strength training, use of supplements, and resisting peer pressure to dope. In both studies, authors reported no differences in doping attitudes pre and post-test. Similar results were shown for Lucidi et al. (2017) who educated athletes about the role of media messages in promoting dysfunctional beliefs, the side effects of doping substances, nutrition

and lifestyle, the way the media may disregard or minimize the moral implications of doping, and reframing sport goals to resist doping temptations.

There is also the risk of interventions increasing doping by intervening to prevent it. For example, a knowledge-based information intervention, which provided facts on the comparable physiological effects of nitrate rich foods and synthetic EPO, increased the reported likelihood of athletes using EPO (James, Naughton, & Petroczi, 2010) and a training programme aimed at enhancing athletes' ethical decision making ability was reported to elicit more favourable attitudes to doping (Elbe & Brand, 2016).

A number of explanations could account for the limited effectiveness of these interventions (Box 2.1). Firstly, interventions are often aimed at overall health-related behaviours and are not sufficiently focused on doping behaviours. The ATLAS (Goldberg et al., 1996) intervention sought to improve participants' knowledge of a range of variables such as nutrition, optimal training, communication skills and anabolic steroids, and the ATHENA (Elliot et al., 2004) intervention comprised of eating disorder behaviours, driving without a seatbelt, media advertisements and anabolic steroid use. Secondly, questionnaires used to detect changes in, for example, attitudes towards doping, are often bespoke instruments with questionable validity (Backhouse et al., 2007; Backhouse et al., 2016). These measures may not be sufficiently reliable and valid to detect changes in doping intentions and behaviours. Thirdly, participants sampled in anti-doping education intervention studies often report low initial intentions to dope. Ntoumanis et al. (2014) posited that initial low intentions, or "floor effects," may explain the limited effectiveness of current education interventions. If, for example, a research study recruits participants with no prior intention to use doping substances, establishing the effectiveness of the intervention is extremely difficult. Finally, if an athlete admits to doping, they could be banned from competition for up to four years. Even an athlete that is not currently doping but who is

Box 2.1. Limitations of anti-doping education interventions

1. Intervention focus
Interventions aiming to improve overall health-related behaviours do not sufficiently focus on doping behaviours

2. Ad hoc instruments
Interventions using bespoke and ad hoc instruments to identify changes in the behaviour may not be valid or reliable

3. Floor effects
Recruiting participants with low doping intentions make it difficult to identify any changes following the intervention

4. Admitting to doping
Athletes may be reluctant to admit their doping behaviours and/or intention

tempted to do so might understandably experience some reluctance in disclosing this.

In light of the above, evaluating the effectiveness of an anti-doping educational intervention is challenging. However, over the past ten years a growing body of literature has identified a number of psychosocial variables that influence doping behaviours. In a recent meta-analysis, Ntoumanis et al. (2014) identified 34 predictors of doping behaviours, including task and ego orientation, moral disengagement, perfectionism, sport confidence and anticipated regret. The authors also reported that the use of sport supplements was one of the strongest predictor of doping behaviours. As such, targeting an athlete's use of sport supplements as opposed to banned substances might therefore be not only a legitimate anti-doping intervention, but also one that facilitates less problematic evaluation of its effectiveness, given that it is predicated on the use of supplements and not banned substances.

2.2.3 Sport supplements as a risk factor to doping

Sports supplements are reported to be widely used by athletes of all ages and abilities (Knapik et al., 2016), with the aim of enhancing performance, recovery, and/or other sport related factors (Lun, Erdman, Fung, & Reimer, 2012; Maughan, King, & Lea, 2004; Nieper,

2005). Prevalence is suggested to be anywhere between 40 and 70% (Outram & Stewart, 2015) with estimates dependent on gender (Nieper, 2005), age (Desbrow et al., 2014; Lieberman et al., 2015) sport played (Heikkinen, Alaranta, Helenius, & Vasankari, 2011), time of the season (Tscholl, Alonso, Dolle, Junge, & Dvorak, 2010) and the definition of supplement used in the study survey (Outram & Stewart, 2015). It should also be noted that sport supplement use is reported to be widespread not only among athletes, but among the general population. Reasons for use by the general population are attributed to enhancing health (Bailey, Gahche, Miller, Thomas, & Dwyer, 2013), diet (Dickinson, Blatman, El-Dash, & Franco, 2014) and physical appearance (Pezdirc et al., 2015). While prevalence is high among both athletes and the general population, this research programme will focus only on athletes.

Use of sport supplements is suggested to be a risk factor for an athlete's health and to future doping behaviours. A number of recent anecdotal reports and scientific evidence suggest that sport supplements can be contaminated with banned substances (Geyer et al., 2004; Geyer et al., 2008), and that they may act as a "gateway" to doping substances (Backhouse et al., 2013; Ntoumanis et al., 2014).

Cross-contamination of a sport supplement occurs as a result of insufficient surveillance and quality control by the sport supplement industry (Geyer et al., 2004). Many supplements by-pass the most rudimentary pharmaceutical safeguards and banned substances can often be added to the supplement accidentally or deliberately. Geyer et al. (2008) analysed 634 sport supplements in 13 countries and reported that 15% of sport supplements were contaminated with anabolic steroids and testosterone. Cohen, Bloszies, Yee, and Gerona (2016) also reported that of 21 supplements sampled, 52.4% contained stimulants. Thus, for athletes using sport supplements, the probability of contamination and potentially failing a drug test is high.

Contamination of substances can also have serious health implications. A review of 24 commercially available protein drinks indicated that 31% failed quality assurance tests, with 6 to 18 mg of lead discovered in some of the products (Maughan, 2013). Another study reported that products sold online did not include any of the active ingredients displayed on the label, with low-cost substitutes such as melamine used instead of protein ingredients (Champagne & Emmel, 2011). More seriously, the use of a weight-loss supplement containing hidden quantities of an untested drug (n-nitrsoso-fenfluramine) resulted in four deaths and 800 people falling seriously ill (McVeigh, Evans-Brown, & Bellis, 2012), while use of a similar weight-loss supplement (ephedra) has been linked to multiple deaths and cardiovascular incidences (McVeigh et al., 2012).

In addition to the health risks posed by the use of sports supplements, it has been proposed that habitual consumption of these supplements can lead athletes to use banned performance enhancing substances. Several hypotheses have been put forward to explain this association. Thorndike's (1911) "law of effect" suggests that the probability of a response is increased when followed by a reward and decreased when followed by discomfort. Accordingly, an athlete using a sport supplement for the first time may attribute any improvements (or decrements) in performance to the supplement, with improvements in the athlete's performance increasing the likelihood of future supplement use and decrements decreasing the likelihood of future supplement use. Further positive experiences of supplementation reinforce the belief that the supplement is effective, while negative experiences reinforce the belief that the supplement is ineffective. The response to the supplement is thus reinforced by the performance outcome. This is underpinned by classical conditioning, where a stimulus (i.e. sport supplement) is associated with a response (i.e. improvement in performance), which can reinforce belief in the substance's effectiveness (Everitt & Robbins, 2013). These experiences can also create cues that strengthen the

association between the response and the stimuli (Stewart, De Wit, & Eikelboom, 1984). The conditioned effects of a substance can activate neural mechanisms that mimic the neural activity of the substance, and it is the activation of these states by conditioned stimuli that may initiate further substance use behaviour (Everitt & Robbins, 2005; Everitt & Robbins, 2013). However, with repeated exposure of a substance, the pharmacological effects are often markedly reduced over time and the brain systems that are normally involved become desensitised to the physiological effects, but more significantly, become hypersensitive to the associated stimuli (Hyman & Malenka, 2001). Sensitisation of substances may lead to an increased use of the same substance or use of another, stronger, substance; a process termed "cross-sensitisation" (Robinson & Berridge, 1993).

While it is clear that numerous hypotheses might explain the progression to strong drugs through the use of weaker ones, the term "gateway hypothesis" has been used as a coverall. Originally credited to Kandel (1975), the gateway hypothesis posits that individuals become increasingly involved in drugs in stages and in sequences. Kandel (1975) reported that if adolescents use marijuana, the likelihood of them using harder drugs, such as cocaine and heroin, increases significantly from 2 and 3% to between 16 and 23%. More recent epidemiological data report that 56.3% and 84.5% of high school students smoke tobacco or drink alcohol before progressing to marijuana and cocaine respectively (Johnston et al., 2013). Further evidence from the Substance Abuse and Mental Health Services Administration (2013) revealed that 65% of marijuana users started smoking or drinking before they started using marijuana, while 97% of cocaine users started smoking or drinking before progressing to cocaine. Fergusson and Horwood (2000) reported that over 99% of illicit drug users in New Zealand used cannabis first before progressing to other illicit drugs and Prince van Leeuwen et al. (2014) reported that tobacco use in the Netherlands was associated with a higher likelihood of developing a marijuana use disorder.

Although the epidemiological evidence presented above has arguably established a "weak drug-strong drug" sequence in which different substances are used progressively, it has not identified what causes the progression from one drug to the next. For this reason, many authors have criticised the validity of the gateway hypothesis and its causal mechanisms (Kleinig, 2015; Vanyukov et al., 2012). However, animal studies have shown that the intake of a "softer" drug can increase the intake of a "harder" drug; for example, animals sensitised to amphetamines have shown an increased intake of cocaine (Ferrario & Robinson, 2007), while animals given sugar increase their intake of alcohol (Avena, Carrillo, Needham, Leibowitz, & Hoebel, 2004) and cross-sensitise to cocaine (Gosnell, 2005). Levine et al. (2011) proposed a molecular explanation for the gateway hypothesis and the sequence of drug use, suggesting that exposure to nicotine caused specific changes in the brain that made it more vulnerable to cocaine addiction. It was also shown that pre-treatment with nicotine altered the response to cocaine in terms of addicted related behaviour and changes in brain regions critical for addiction related rewards. Furthermore, and at a molecular level, nicotine was found to enhance the effect of cocaine when administered for several days prior to the use of cocaine. These results stimulated further analysis of epidemiological data, where Kandel and Kandel (2014) reported that cocaine users would often start using cocaine only after prolonged smoking of tobacco. Collectively, data suggest that in the general population in Western societies, there is a well-defined sequence of progression of drug use. That is, hard drug use often starts with a softer drug. The idea of the gateway hypothesis has influenced US drug policy since the 1950's (Morral, McCaffrey, & Paddock, 2002).

For anti-doping educational interventions, targeting an athlete's use of sport supplements may therefore prevent unintentional (i.e. via cross-contamination) and future (i.e. via the gateway hypothesis) use of banned performance enhancing substances.

2.2.4 Theories of substance use behaviour in sport

Research on sport supplement and banned substance use often frames the behaviour as one of decision-making (Hauw & McNamee, 2015). Based on this, doping is the outcome of a process determined by numerous factors such as an athlete's beliefs, hopes, attitudes, intentions, expectations and perceptions of others. Therefore, researchers using this framework often study the explicit or implicit processes involved in the decision to dope (e.g. Backhouse et al., 2013; Petróczi, 2013; Ring & Hurst, 2019). Given this, there are several existing models posited to explain the reasons why athletes might dope. Social Cognitive Theory (SCT; Bandura, 1986), Self-Determination Theory (SDT; Deci & Ryan, 1985), the Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1975) and the Theory Planned Behaviour (TPB; Ajzen, 1985) have been used extensively in the past decade. In this research programme, the TRA and TPB are referred to. However, to provide an insight into the evolving anti-doping field and position the theoretical underpinning of this research programme more clearly, SCT and SDT will be briefly addressed first.

Bandura's (1986, 1989, 1991) SCT of moral thought and action describes how moral conduct is influenced by external (e.g. other athletes) and internal (e.g. cognitions) factors. This theory posits that behaviour is guided by moral standards and people are responsible for their own actions. When behaviour is not in line with moral standards, negative emotions are experienced. Thus, for an athlete using a banned performance enhancing substance, it is suggested athletes with high moral standards will feel a greater sense of regret and guilt than those with lower moral standards. Numerous studies have supported the notion that morality influences an athlete's decision to use performance-enhancing substances (Kavussanu & Ring, 2017; Ring & Hurst, 2019; Ring, Kavussanu, Lucidi, & Hurst, 2019).

Other authors (e.g. Barkoukis, Lazuras, Tsorbatzoudis, & Rodafinos, 2013; Chan, Dimmock, et al., 2015; Chan, Donovan, et al., 2015) have applied the constructs of SDT

(Deci & Ryan, 1985; Deci & Ryan, 2008) to account for athletes' motivation to use performance enhancing substances. According to SDT, motivation exists along a continuum anchored by two broad types: autonomous and controlled. Autonomous motivation represents behaviour that is driven by intrinsic interest or because of the value attached to the activity, whereas controlled motivation represents behaviour that is driven by extrinsic interest, ego enhancement and fame. It has been reported that athletes high in controlled motivational are more likely to dope than those with high autonomous motivation (Chan, Dimmock, et al., 2015; Gucciardi, Jalleh, & Donovan, 2010; Lucidi et al., 2008).

Several authors have used the TRA (Ajzen & Fishbein, 1975) and TPB (Ajzen, 1985, 1991) to examine intentions, attitudes and beliefs around doping behaviours. Both theories have shown to accurately predict a number of different health behaviours such as physical activity participation (Bélanger-Gravel, Godin, & Amireault, 2013), smoking (Cooke, Dahdah, Norman, & French, 2016), sexually transmitted disease prevention (Andrew et al., 2016), nutritional choices (McDermott et al., 2015) and driving while under the influence of alcohol (Lheureux, Auzoult, Charlois, Hardy-Massard, & Minary, 2016).

The TRA and TPB both assume that a person's intention is the most proximal and immediate predictor of behaviour (Chan, Hardcastle, et al., 2015). Intention is the extent to which a person plans to engage in the behaviour in the future (Ajzen, 1991). Barkoukis et al. (2013) reported that participants who self-reported using banned substances showed significantly stronger intentions to use these substances in the future than self-reported non-users. These results are supported by Dodge and Jaccard (2007) and Goulet, Valois, Buist, and Cote (2010), who report significant relationships between banned substance intention and actual use. This relationship is also reported in relation to sport supplement use (Tsochas, Lazuras, & Barkoukis, 2013).

The TRA and TPB suggest that intention is determined by attitudes (i.e. how a person favours the behaviour) and subjective norms (i.e. how a person perceived the social appropriateness of the behaviour). The TPB, which is an extension of the TRA, suggests that a person's perceived behavioural control also influences decision making (i.e. how a person perceives the controllability of their behaviour). Since athletes admitting to the actual use of doping is problematic (see Box 2.1, p. 46), attitudes, subjective norms and perceived behavioural control are often used as a proxy for doping behaviours and intentions. Lucidi, Grano, Leone, Lombardo, and Pesce (2004) and Lucidi et al. (2008) reported that the Theory of Planned Behaviour constructs (i.e. attitudes, subjective norms and perceived behavioural control) significantly predict doping intentions and behaviour.

Attitudes, subjective norms and perceived behavioural control are also suggested to be determined by behavioural, normative and control beliefs, respectively (Figure 2.4). For instance, attitudes are determined by a person's beliefs about the outcomes of performing the behaviour (i.e. behavioural beliefs). A person who holds strong positive beliefs about the effectiveness of anabolic steroids, for example, is proposed to have positive attitudes towards them. Similarly, a person who believes it is socially acceptable to use anabolic steroids (i.e. normative beliefs), often holds positive subjective norms about the use of anabolic steroids. This is then suggested to influence the person's intention to use anabolic steroids, which ultimately influences a person's likelihood of using them.

Most empirical research in the doping literature has focused on doping attitudes. Typically, attitudes are assessed via open-ended questionnaires or surveys that people from the target population are asked to complete. One of the most widely used attitude questionnaires in the doping literature is the Performance Enhancement Attitude Scale (PEAS; Petróczi, 2006; Petróczi & Aidman, 2009), which represents people's general attitudes to doping. The questionnaire contains 17 items such as "doping is necessary to be

competitive" and "doping is not cheating since everyone does it," which are evaluated on a 6-point Likert type scale ranging from strongly disagree (1) to strongly agree (6). PEAS scores have been shown to be significantly associated with self-reported banned substance use

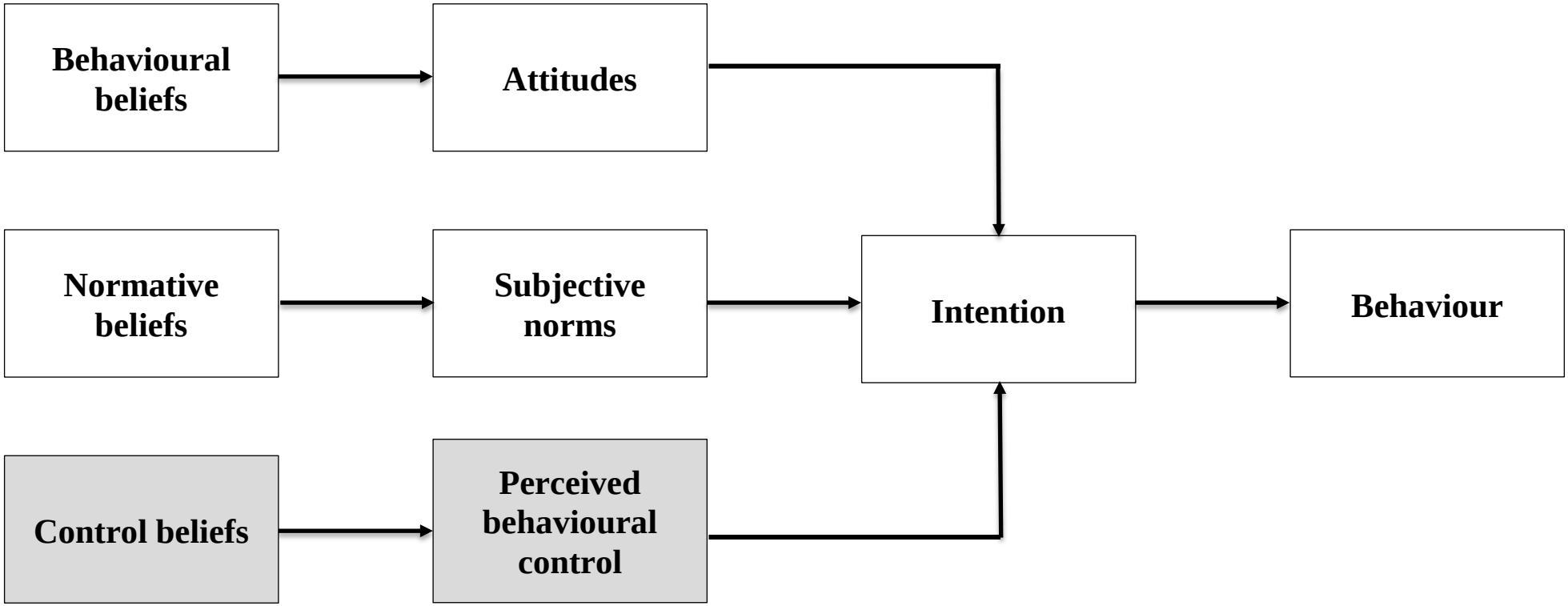

Figure 2.4. Theory of Reasoned Action and Theory of Planned Behaviour. *Note.* Areas shaded in grey show the Theory of Planned Behaviour constructs.

(Whitaker, Long, Petróczi, & Backhouse, 2014; Zabala, Morente-Sánchez, Mateo-March, & Sanabria, 2016) and intention to use banned substances (Chan, Dimmock, et al., 2015; Lazuras, Barkoukis, Mallia, Lucidi, & Brand, 2017) whereas, users of sports supplements have shown to be and intention to use banned substances. However, there is no published evidence of a theoretical or conceptual framework underpinning the PEAS. After assessing the factor structure of the PEAS amongst 1,054 adults, Nicholls, Madigan, and Levy (2017) reported that the 17 item PEAS displays poor model fit. Authors reported that modifications of the scale used elsewhere (e.g. Elbe & Brand, 2016; Gucciardi et al., 2010; Gucciardi, Jalleh, & Donovan, 2011; Vargo et al., 2014) with fewer items provide better model fit than the original. Future research using the PEAS should therefore examine the factor structure and model fit before assessing athletes' attitudes towards doping.

While doping attitudes are related to other psychosocial predictors of doping (e.g. perfectionism, motivational climate, willingness to dope and achievement goal orientations; Nicholls et al., 2017), recent meta-analytical data suggest that attitudes have only a small effect on actual banned substance use (effect size = 0.08; Ntoumanis et al., 2014). In a relatively early study in this field, Petróczi (2007) reported that attitudes were not significantly associated with actual banned substance use, but that beliefs about doping were. While the Theory of Reasoned Action and Theory of Planned Behaviour suggest that beliefs determine attitudes before they affect behaviour, Petróczi's (2007) findings suggest that beliefs might directly influence doping behaviours. Chan, Hardcastle et al. (2015) showed that beliefs about the advantages of using banned substances predicted doping attitudes (β =0.43, p <.01), subjective norms (β = 0.29, p <.01), perceived behavioural control (β = 0.25, p <.01) and intention (β = 0.29, p <.01). Research conducted by Backhouse et al. (2013) and Dascombe, Karunaratna, Cartoon, Fergie, and Goodman (2010) suggests that athletes who use sport supplements express more favourable beliefs about these types of substances than

non-users. Research examining the belief-based constructs of doping is limited, but there is sufficient evidence to suggest that future interventions targeting athletes' beliefs in the interests of preventing doping are warranted.

2.2.5 Summary of anti-doping literature

Over the past 50 years, sport organisations have attempted to prevent doping via drug testing and sanctioning. In recent years, sport organisations have encouraged a more preventive approach that focuses on educating and informing athletes about doping. While challenges exist in evaluating the effectiveness of these interventions (Box 2.1, p. 46), targeting predictors of doping and the underlying psychological processes might facilitate less problematic evaluations. However, any attempt to measure and understand the psychological process should use valid and reliable measures to ensure accurate estimations of athletes' actual doping related behaviours. Recent evidence suggests that athletes using sport supplements are more likely to use banned performance enhancing substances, and that their beliefs, attitudes and intentions about sport supplements influence future behaviours. Anti-doping education targeting sport supplements as opposed to doping could be a more pragmatic alternative to evaluating the effectiveness of interventions. This type of intervention could enable athletes to make more informed decisions about their use of supplements and subsequently, banned substances.

2.3 Summary

This review aimed to familiarise the reader with the placebo effect and anti-doping literatures. These literatures have informed the rationale and aims of this research programme, the research questions posed and the methodological choices made. The research questions and aims of this research are presented in Chapter Three.

Chapter Three

RESEARCH PROGRAMME QUESTIONS AND AIMS

3.1 Questions and aims

The placebo effect has been extensively studied in sport. The nocebo effect has received less attention, with a paucity of evidence suggesting that negative beliefs can significantly impair performance. In one of the first studies investigating both placebo and nocebo effects in sport, Beedie et al. (2007) reported significant improvements and decrements in repeat sprint performance when participants ingested a placebo believed to be a supplement likely to have either a positive or negative effect, respectively. However, the study in question did not include a no-treatment control in study design and, although relatively large for a study in sport and exercise science, the number of participants recruited was not sufficiently large enough to examine factors that might moderate the placebo effect (n = 42). Small sample size and lack of a no-treatment control are common features in placebo effect studies on sports performance making it difficult to accurately ascertain the magnitude and moderators of observed placebo and/or nocebo effects. Using a similar repeat sprint design to Beedie et al. (2007), a major aim of this research programme was to explore the magnitude and moderators of the placebo and nocebo effect using a large sample of athletes in a fully controlled experimental design (Study 2).

It has been proposed that athletes aware of the placebo effect, or who have direct experience of it, may be less likely to use supplements and banned substances (Kalasountas et al., 2007; Maganaris et al., 2000; McClung & Collins, 2007). The idea underpinning this proposal is that an athlete aware of the placebo effect might also recognise that this significant psychological contribution to the effectiveness of a supplement is something that they may be able to achieve through other means, such as mental preparation and psychological skills training. If such an athlete is less likely to use supplements, the gateway hypothesis also predicts that the athlete is theoretically less likely to progress to banned substance use. Therefore, a second aim of this programme was to measure the outcomes of a

placebo intervention on athletes' intentions to use sport supplements and banned substances (Study 3)

Data suggest that beliefs about sport supplements influence future doping behaviours (Backhouse et al., 2013; Petróczi, 2007). If a placebo intervention is designed to target athletes' beliefs about the effectiveness of sport supplements, a measure facilitating the reliable and valid assessment of beliefs about supplements could represent a useful tool in understanding the effectiveness of this type of intervention. To the author's knowledge, no validated measure of athletes' beliefs about sport supplements has been published. A third aim of this programme was to develop and validate a psychometric instrument that could be used to help verify the impact of the placebo intervention used in study 3 (Study 1).

3.2 Summary of aims and research questions

Aims

1. Develop and validate a psychometric instrument that can be used to measure the outcomes of a deceptive placebo intervention
2. Assess the magnitude of resultant placebo and nocebo effects on a large sample of athletes
3. Examine potential moderators associated with observed placebo and nocebo effects
4. Measure the impact of a deceptive placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping

Research questions

1. What is the magnitude of placebo and nocebo effects on the repeat sprint performance of a large sample of athletes associated with the administration of a purported sport supplement?
2. What factors moderate observed placebo and nocebo effects in repeat sprint performance?
3. What is the impact of a placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping?

This research programme will be conducted in three sequential chapters:

Study 1 – DEVELOPMENT AND VALIDATION OF THE SPORTS SUPPLEMENTS BELIEFS SCALE

Aim: To develop and validate a psychometric instrument that measures athletes' beliefs about sport supplements. Development and validation of the measure was conducted in five parts using both qualitative and quantitative methods to develop and validate a list of items that could be used to evaluate the impact of the placebo intervention used in Study 2.

Study 2 – INVESTIGATING THE MAGNITUDE AND MODERATORS OF THE PLACEBO AND NOCEBO EFFECT ON REPEAT SPRINT PERFORMANCE

Aim: To assess the magnitude and moderators of placebo and nocebo effects on a large sample of athletes. This experimental study used a randomised controlled design to assess the effects of placebo and nocebo treatments on repeat sprint performance.

Study 3 – EFFECT OF A POSIITVE AND NEGATIVE BELIEF INTERVENITON ON ATHLETES' BELIEFS AND INTENTION TOWARDS SPORT SUPPLEMENTS AND ATTITUDES TOWARDS DOPING

Aim: To test whether a deceptive placebo and nocebo intervention influences athletes' beliefs and intentions towards sport supplements and attitudes to doping. Participants completed a series of psychometric measures including the Performance Enhancement Attitude Scale (PEAS; Petróczi, 2006), and the Sports Supplements Beliefs Scale (SSBS), developed and validated in Study 1. Pre-post intervention scores were calculated and corroborated with post-intervention qualitative responses.

Chapter Four

DEVELOPMENT AND VALIDATION OF THE SPORTS SUPPLEMENTS BELIEFS SCALE

4.1 Introduction

The development of anti-doping educational interventions requires robust and valid methods in order to establish effectiveness. However, obtaining reliable self-report information about explicit doping behaviours is associated with several ethical and practical challenges, including the considerable problem that admission of use of a banned substance can result in the athlete losing their right to participate in sport (Box 2.1, p 46). For this reason, researchers generally use one or more psychological constructs as a proxy to doping behaviour. The use of sport supplements and beliefs about their effectiveness has been reported to increase the likelihood of an athlete doping (Backhouse et al., 2013; Boardley, Grix, & Harkin, 2015). A psychometric measure that can "tap in" to this psychological construct may help identify athletes at risk of doping and facilitate understanding of an intervention aimed at preventing supplement use. Therefore, the focus of this study is the development and validation of a psychometric measure of beliefs about sport supplements.

Several authors have employed self-report instruments in the measurement of psychological variables related to supplement use and doping (Backhouse et al., 2013; Barkoukis et al., 2015; Dodge & Jaccard, 2008; Petróczi, 2007). Petróczi and Aidman (2009) used the Performance Enhancement Attitude Scale (PEAS) and reported that athletes with significantly more favourable attitudes towards doping substances were more likely to dope. Similarly, Ring and Kavussanu (2017) used the moral disengagement in doping scale and reported that athletes scoring higher on the scale were more likely to use banned substances. Barkoukis, Lazuras, Tsorbatzoudis, and Rodafinos (2011) used the Sport Motivation Scale and reported that athletes categorised as "amotivated" were more likely to dope than those categorised as "intrinsically motivated."

While a number of measures have been used to analyse predictors of doping behaviour, recent data suggest that athletes who use sport supplements are also more likely to

progress to doping (Backhouse et al., 2013; Barkoukis et al., 2015; Hildebrandt et al., 2012; Ntoumanis et al., 2014; Petróczi, 2013). This is underpinned by the gateway hypothesis, which posits that softer drugs can lead to harder drugs (Kandel, 1975). In sport, authors have reported that the prevalence of banned substance use is more than three times higher in athletes using sport supplements than non-users (Backhouse et al., 2013). Qualitative evidence presented by Boardley, Grix, and Dewar (2014) suggested that bodybuilders believed that once the benefits of sport supplements plateau, they would look to use banned substances to facilitate further performance enhancements. Given the difficulties in assessing actual doping behaviours in anti-doping educational interventions, targeting athletes' sport supplement use may be fruitful.

Recent research has suggested that athletes using sport supplements tend to express more favourable beliefs about the effectiveness of these types of substances than non-users (Backhouse et al., 2013). Furthermore, athletes' beliefs about sport supplements are reported to influence future behaviours and intentions (Bell, Dorsch, McCreary, & Hovey, 2004). Hypothetically therefore, if athletes' beliefs about sports supplements influence current and future supplement use, and if current/future supplement use predicts future doping, it is reasonable to suggest a relationship between current beliefs about supplements and future doping. Thus, an instrument facilitating the reliable and valid assessment of beliefs about supplements could represent a useful tool in the development and evaluation of anti-doping interventions. To the author's knowledge, no validated measure of athletes' beliefs about sport supplements has been published.

The validation of any questionnaire requires multiple procedures, which are employed sequentially at different stages of its development. Thus, the validation of a test never ends and validity is built into the test at the outset rather than being limited to the last stages of test development, as in traditional criterion-related validation (Terry, Lane, & Fogarty, 2003).

Each of these procedures/stages can be seen as fundamental to demonstrating the two sources of information described by Murphy and Davidshofer (1988) as representing strong evidence for the validity of measurement, that is, content and construct validity. Murphy and Davidshofer (1988) proposed that the empirical and theoretical basis for the construct, the interpretability of that construct, the generalisability of the construct definition, and the applicability of the initial item pool to that definition, all jointly determine the content validity of the questionnaire. Similarly, the results of empirical item analyses, factor analyses, and criterion analyses jointly indicate construct validity.

In line with the proposals above, this study aimed to report the multi-stage validation of a belief measure that could support evaluation of the effectiveness of anti-doping education interventions. This study reports the results of semi-structured interviews exploring athletes' beliefs about sport supplements (phase 1), initial instrument development and content validity procedures (phase 2), exploratory and confirmatory factor analyses of responses to the questionnaire from 171 and 412 athletes respectively (phases 3 and 4), and relationships between questionnaire scores and supplement use (phase 5). Institutional research ethics committee approved all studies. Informed consent was obtained from each participant in each of the studies prior to their involvement (Appendix 1).

4.2 Phase 1

4.2.1 Aims

Phase 1 aimed to explore and demonstrate the empirical basis for the questionnaire through the identification of themes and dimensions relating to the use of sports supplements by athletes.

4.2.2 Method

DeVellis (2016) and (Lynn, 1986) recommend that in questionnaire development, core concepts are identified using qualitative interviews. Semi-structured interviews were therefore used to explore athletes' beliefs about sports supplements.

Participants

Sixteen athletes (6 females and 10 males; age = 24 ± 3; years training = 10 ± 4; hours per week training = 13 ± 4), were recruited via social media (Appendix 2). To ensure that responses were not affected by specific sport cultures and practices, athletes of varying abilities were recruited from various sports including football, gymnastics, mixed martial arts, rowing, Rugby union, track and field, and weightlifting. Participants had a range of athletic experience, with 13% competing at club level, 19% at county, 19% at regional, 25% at national and 25% at international.

Procedure

Each athlete was interviewed individually either face-to-face or via Skype. Initially adopting a deductive approach, an interview guide based upon the available literature was developed. However, the semi-structured interview schedule (Appendix 3) was developed to be sufficiently flexible to allow new concepts to surface inductively (Ntoumanis, Pensgaard, Martin, & Pipe, 2004).

Athletes were asked to describe their decisions for using or not using sport supplements, the factors that influenced these decisions, and any experiences of using sport supplements. The semi-structured interviews consisted of a series of questions within four interrelated sections: 1) what is a sport supplement? 2) experiences of sport supplements 3) beliefs about sport supplements and 4) influences to use sport supplements. Interview times ranged from 36 to 91 minutes (mean ± SD = 56 ± 21 minutes). All participants had the right

to stop the interview and/or participation at any time. All participants were emailed a copy of the transcript to enable them to revise responses. Data analysis began after the athlete accepted the final version of the transcript.

4.2.3 Data analysis.

Audio recordings were transferred onto the software QSR NVivo 10. Each transcript was read several times, which allowed ordinate and sub-ordinate themes to emerge. Both deductive and inductive approaches to thematic analysis were used. Data analysis followed a three-stage coding process adapted from Smith et al. (2010): first, a summary report of the individual interviews to highlight the most pertinent issues; second, a pool of narratives centred on specific ordinate themes; and third, a thematic grouping structure around sub-ordinate themes.

4.2.4 Results

A summary of the main findings is presented in Table 4.1. Four ordinate themes emerged from the data. The first related to the performance enhancing effects of sport supplements and contained three sub-ordinate themes: improved performance, higher chance of winning, and competitive edge. A second ordinate theme related to athletes' perceptions that sport supplements could help improve recovery and health, which also contained three sub-ordinate themes: improved recovery, overcoming illness, and reduced chance of injury. A third ordinate theme related to athletes' perceptions that sport supplements were necessary for performance and contained two sub-ordinate themes: performance advantage and the similarity between the use of supplements and the use of up-to-date equipment. A final ordinate theme related to the psychological effects associated with sport supplement use contained two sub-ordinate themes: confidence and anxiety.

Table 4.1

Ordinate and subordinate themes derived through interview data

Ordinate theme	Sub-ordinate theme	Transcript example
Performance effects	Improved performance	"Supplements help me improve my performance. Whether pre, during or post competition"
	Higher chance of winning	"It's really pushing you beyond what you could normally achieve"
	Competitive edge	"I'm going to take full advantage of anything that is out there"
Recovery and health effects	Improve recovery	"I know that I need to like recover as quickly as possible and therefore... a protein shake is ideal"
	Overcome illness	"... a bit of supplementation wouldn't go a miss… I think in terms of illness"
	Reduce injury	"I tend to just have it, because... I don't want to have another injury"
Necessary for performance	Necessary to improve	"They were necessary... I felt a lot better after taking them and I felt that after a match where you feel beaten up… they were necessary"
	Same as equipment	"We are always looking for the fastest gear and the fastest kit. Supplements are just part of that"
Psychological effects	Increase in confidence	"I think it's as much confidence as well… you are maximising… you know, because recovery and preparation are as much part of the training and competitions as anything else"
	Decrease in anxiety	"I was shit scared to be honest… The preparation became a very much part of that, nutrition became definitely a safety blanket in that sense"

4.3 Phase 2

4.3.1 Aims

Following the guidelines of Terry, Lane, Lane, and Keohane (1999), phase 2 aimed to assess the content validity of a pool of items derived from responses in phase 1 and reduce the number of items following subsequent analysis.

4.3.2 Method

Based on responses reported in phase 1, a pool of 26 items was developed. A panel of experts and athletes subsequently assessed the content validity of the resultant measure.

Participants.

Participants were a sample of six experts on anti-doping and 23 British athletes. Experts had all published in the anti-doping literature and were situated in Australia (n = 2), the United Kingdom (n = 1), the United States (n = 1), Italy (n = 1) and Canada (n = 1). Athletes (57% male, years training = 11 ± 6, hours per week training = 9 ± 6) were of a variety of ages, the majority between 18 and 24 years (48%). Athletes competed at various levels, with county being most common (48%), followed by national (35%), international (13%) and club (4%). Athletes were drawn from a variety of sports including athletics, weightlifting, triathlon, Rugby union, field hockey, and badminton. No participants from phase 1 were recruited to phase 2.

Procedures.

An online survey to enable academic experts to assess content validity was developed and emailed to a number of experts worldwide requesting their participation (Appendix 4). Experts were provided with the 26 items and asked to respond on a 4-point Likert-type scale

(1 = not relevant to 4 = highly relevant) as to how they believed each item related to athletes' beliefs about sport supplements. Free-text boxes for each item facilitated comments (Appendix 5). An additional online survey was developed for athletes to provide feedback on each item and the structure of the questionnaire. Athletes were asked to complete the 26 item questionnaire by specifying their level of agreement with each statement on a six-point Likert-type Scale (1 = Strongly disagree to 6 = Strongly agree). A Likert-type scale was used following Comrey's (1988) recommendations that multiple choice scales are more reliable and produce better scales than other formats (e.g., visual analogue scales, checklists). Athletes were also asked to evaluate and provide feedback on the questionnaire at the end of the survey (Appendix 6).

4.3.3 Results

Expert ratings of content validity were summarised by dividing the number of experts who provided a rating of 3 or 4 by the total number of experts (Lynn, 1986). Lynn proposed that when six or more experts review the content validity index (CVI) of a scale, values equal to or greater than .8 are acceptable (see also Polit, Beck, & Owen, 2007). CVI values of less than .8 were evident for seven items and these were removed from further analysis.

Athletes reported that the items adequately represented their beliefs about sport supplements. However, athletes reported that certain types of sport supplements do not elicit specific performance effects and suggested that the type of supplement they used influences their belief about its effects. For example, athletes who used protein drinks did not believe that this type of supplement would influence performance, but did believe that it would improve recovery. Based upon these comments, eight items relating to specific performance enhancing effects of sport supplements (e.g., fatigue, pain, and recovery) were deleted. A final pool of 11 items remained.

4.4 Phase 3

4.4.1 Aims

Following content validity procedures, the factor structure of the 11 item measure was examined. Factor analysis is a statistical procedure applied to a single set of variables where the researcher is interested in discovering which variables in the set form coherent subsets that are relatively independent of each other. Essentially, the aim of factor analysis is to reduce a large number of variables to a smaller number of factors (Tabachnick, Fidell, & Osterlind, 2001), and to indicate how many factors are needed to describe the data.

Researchers have often relied on exploratory factor analysis (EFA) to identify and distinguish between key psychological constructs (Marsh, Morin, Parker, & Kaur, 2014). EFA is an inductive process that in essence "explores" the data and results in a set of latent variables that explain correlations among the measured, or manifest, variables (Osborne, 2015). Marsh and Yeung (1997) argued that "a long history of factor analytic research has demonstrated that this purely exploratory approach to factor analysis is typically ineffective" (p. 33), and Hendrickson and Jones (1987) suggested that EFA is no more than "an undisciplined romp through a correlation matrix" (p. 105). As a consequence of its limitations, it has been proposed that EFA is appropriate only when the analyst does not know what the underlying factor structure of a set of data should be (Biddle, Markland, Gilbourne, Chatzisarantis, & Sparkes, 2001). Several authors (Anastasi & Urbina, 1997; Bollen, 2002; Marsh & Yeung, 1997; Schutz, 1994; Schutz & Gessaroli, 1993; Strauss & Smith, 2009; Tabachnick et al., 2001) proposed that confirmatory factor analysis (CFA), which permits the analyst to test an *a priori* model of relationships between the manifest and latent variables, should be used in preference to EFA.

However, in phases 1 and 2 above, an empirical and largely atheoretical approach in deriving items was adopted. Thus, *a priori* theory as to any potential inter-correlations between items was posited. It has been suggested that CFAs fail to provide clear support for factor structure and are more restrictive than EFAs, in which cross-loadings between items are assumed to be exactly zero (Marsh et al., 2014; Morin, Arens, & Marsh, 2016). On this basis, the optimal approach to demonstrating factorial validity was considered to be to report the results of EFA first and then confirm the factor structure using CFA on a separate sample (Marsh et al., 2014). Phase 3 therefore used EFA on a first sample of athletes and subsequently interrogated, modified and confirmed the resultant factor structure using CFA on a different sample in phase 4.

4.4.2 Method

Participants

Participants were 171 athletes (67% male; years training = 12 ± 9; hours per week training = 11 ± 7). Over 25 different sports were represented, with the highest proportions of athletes from athletics (43%), triathlon (18%), cycling (13%), and weightlifting (5%). Athletes were between the ages of 18 and 24 (24%), 25 and 34 (26%), 35 and 44 (25%) and 45 or older (25%) and were of differing competitive levels with 30% competing at club level, 19% county, 27% national, and 24% international. Athletes were recruited via social media, and asked to complete the questionnaire via a secure online survey platform (www.surveymonkey.com).

Procedure

Athletes completed the newly developed 11 item instrument (Appendix 7), which was labelled the “Sports Supplements Belief Scale” (SSBS). The SSBS required athletes to

respond on a 6-point Likert-type scale with scores ranging from strongly disagree (1) to strongly agree (6).

Data analysis

Data were inputted into SPSS v22.0. A missing values analysis indicated that of a possible 1,881 data points only 15 (0.7%) were missing from 12 respondents (8%). No respondents had less than 5% of missing data and Little's MCAR test revealed that data were missing completely at random (χ^2 =146.093, *df* = 50, *p* = .957). Missing values were replaced using a multiple imputation model that generated five data sets with a maximum number of parameters set at 100. The average value of the missing data sets was used for subsequent analysis.

Exploratory factor analysis with the Maximum Likelihood method was used to examine the dimensionality of responses to items. Sample size recommendations for EFA vary, but given that 5-10 participants per item are considered acceptable (Bentler & Chou, 1987), the sample size of 171 for the 11 items is adequate. Oblique (promax) rotation was used as it anticipates correlation among factors. Factors with eigenvalue greater than 1 were extracted, primary loadings of .3 or above were considered interpretable, and loadings 0.4 or above considered important (Hair, Black, Babin, Anderson, & Tatham, 2006). Any item associated with a loading below .3 was excluded. Cronbach's alpha is reported to indicate the internal consistency of the scale, with adequate reliability demonstrated at levels above .7 (Nunnally, 1978).

4.4.3 Results

A two-factor model emerged. Item 10 "Using supplements makes me optimistic about my performance" cross-loaded, so this item was removed and the analysis with 10 items was repeated. Once again a two-factor model emerged with an explained variance of 48.83%.

Factor 1 (7 items) appeared to describe the beliefs of athletes regarding the outcomes of using supplements themselves, while Factor 2 (3 items), although less clear, could be interpreted as normative beliefs of athletes about supplements, that is, athletes' perceptions that supplements are an accepted means of performance enhancement. Bartlett's test of sphericity was significant ($\chi^2 = 490.963$, $df = 15$, $p < .001$) and the Kaiser-Meyer-Olkin statistic was considered good (.884). The 10 items and their respective factor loadings are presented in Table 4.2.

4.5 Phase 4

4.5.1 Aims

The penultimate stage of the development and validation process was to assess the factor structure of the instrument using confirmatory factor analysis (CFA).

4.5.2 Method

Confirmatory factor analysis is a statistical procedure for testing theory. As such, it contrasts with EFA in that in CFA, the test developer specifies the item-to-factor loadings in advance and assesses the "goodness of fit" between this model and the reported data. The principal indicator of good model fit is a small and non-significant χ^2 (Biddle et al., 2001). However, it is often unclear whether a significant χ^2 is the result of poor fit or large sample size (larger samples tend to produce larger values of χ^2 that are also more likely to be significant, i.e. a Type I error, whereas small samples may accept poor models, i.e. a Type II error). To moderate the effects of sample size on model fit, several authors have recommended that the χ^2 to degrees of freedom ratio be used in preference to χ^2 alone (e.g. Heene, Hilbert, Draxler, Ziegler, & Bühner, 2011; Marsh, Balla, & McDonald, 1988) while

Table 4.2

Factor structure matrix of the 10 item scale derived from exploratory factor analysis

Item no.	Items	Factor loadings	
		Factor 1	Factor 2
1	Supplements improve my performance	.800	
2	Supplements are necessary for me to be competitive	.695	
3	Supplements improve my confidence	.540	
4	My chances of winning improve when I use supplements	.810	
5	Supplements help me realise my potential	.725	
6	Supplements improve the quality of my training	.830	
7	Athletes using supplements are usually the ones who medal at major championships		.394
8	Supplements provide a greater improvement compared to a healthy diet		.496
9	Supplements are the same as having the best equipment		.772
10	Training increases the need for supplements	.487	

others have suggested that authors rely on other types of fit indices (Byrne, 2013; Hu & Bentler, 1999). These include Comparative Fit Index (CFI); Root Mean Square Error of Approximation (RMSEA); Standardized Root Mean Squared Residual (SRMR); Tucker-Lewis Index (TLI), Akaike Information Criterion (AIC) and the Expected Cross-Validation Index (ECVI).

Participants.

Four hundred and sixty-eight competitive male and female athletes (81% male, years training = 10 ± 6, hours per week training = 6 ± 4) were recruited from sports clubs and volunteered to participate in the study. Over 12 different sports were represented, with the highest proportions of athletes from Rugby union (54%), football (23%), hockey (5%), and American football (4%). Athletes were between the ages of 18 and 24 (64%), 25 and 34 (24%), 35 and 44 (4%) and undisclosed (8%) and were of differing competitive levels with 23% competing at club level, 32% county, 26% national, 10% international and 9% undisclosed.

Procedure.

Athletes were asked to complete the 10 item SSBS reported in phase 3. Athletes were required to read and respond to each statement on a 6-point Likert-type scale ranging from strongly disagree (1) to strongly agree (6). All statements were scored in the same direction and total scores ranged from 10 to 60.

Data analysis.

Data were inputted into SPSS v22.0 and AMOS v22.0. Examination of data revealed that 16 respondents did not respond to any of the items on the scale and were thus deleted. A further 40 respondents were removed after examination of the data revealed they were disengaged (i.e. responses were coded identically for each item). A missing values analysis

indicated that, of a possible 2,652 data points, only 8 (0.17%) were missing from 8 respondents (1.8%). Little's MCAR test revealed data were missing completely at random (χ^2 = 25.775, *df* = 24, *p* = .365). Missing values were replaced using a multiple imputation model that generated five data sets with a maximum number of parameters set at 100. The average value of the missing data sets was used for subsequent analysis.

Measurement model fit using CFA and the Maximum Likelihood procedure was examined using AMOS v22.0. Model fit was expressed as acceptable when the ratio between the χ^2/df ranged between 1 and 3 (Kline, 2011). The overall fit of the model was also assessed with the RMSEA, SRMR, CFI, and TLI. Model fit was considered acceptable with values of RMSEA close to or less than .06, of SRMR close to or less than .08, and of CFI and TLI close to or greater than .95 (Hu & Bentler, 1999). The AIC and ECVI do not have a specified acceptable value, but the lower the value amongst competing models is considered to be the most parsimonious and most likely to be replicated by other samples. Finally, to determine the significant parameter estimates, *t*-values were calculated by dividing the factor loading by the standard error. *t*-values were classified by 1.96 and 2.56 as significant at the .05 and .01 level respectively (Suhr, 2006).

As per published recommendations (Bentler, 2006), each hypothesised relationship between the latent factor and factor loadings was a free parameter, with the exception of a single item that was randomly assigned to unity to define the scale of the factor.

4.5.3 Results

Mean scores on the 10 item SSBS were 31.69 ± 9.59. Scores ranged from 11 to 59, with increasingly higher scores representing increasingly favourable beliefs relating to sports supplements.

Confirmatory factor analysis of a two-factor, 10 item model revealed inadequate fit (χ^2/df = 3.832, RMSEA = .083; 90% CI = .068 to .098, p < .001, SRMR = .0731, CFI = .950, TLI = .934, AIC = 172.304, ECVI = 0.419). After examination of the scale it was suspected that a single-factor, unidimensional scale, might improve model fit. The second factor of three items was therefore removed and the CFA was performed once more.

Confirmatory factor analysis of a single-factor seven item model indicated improved model fit (χ^2/df = 3.239, RMSEA = .074; 90% CI = .05 to .098, p = .047, SRMR = .0309, CFI = .978, TLI = .968, ACI = 73.349, ECVI = 0.178). However, modification indices revealed large overlap between item 1 (‘Supplements improve my training’) and item 7 (‘Training increases the need for supplements’). As the items related to similar theoretical constructs, item 7 was removed.

Confirmatory factor analysis on a single-factor six item scale indicated acceptable loadings for all indices (χ^2/df = 2.894, RMSEA = .068; 90% CI = .038 to .099, p = .146, SRMR = .0246, CFI = .987, TLI = .978, AIC = 50.045, ECVI = 0.122). The results of the final model are summarised in Table 4.3 and factor loadings with standard errors are shown in Figure 4.1.

4.6 Phase 5

4.6.1 Aim

The aim of phase 5 was to demonstrate the construct validity of the SSBS by examining the relationships between SSBS scores and self-reported supplement use.

4.6.2 Method

Murphy and Davidshofer (1988) argue that, while in the past validation strategies were distinct, that is information relating to predictive, discriminant, concurrent, and

Table 4.3

Factor structure matrix of the 10 item scale derived from confirmatory factor analysis

Item no.	Items	Factor loading	*t*-value
1	Supplements improve my performance	.652	13.306
2	Supplements are necessary for me to be competitive	.966	12.880
3	Supplements improve my confidence	.755	11.615
4	My chances of winning improve when I use supplements	.463	10.289
5	Supplements help me realise my potential	.581	11.173
6	Supplements improve the quality of my training	.868	12.400

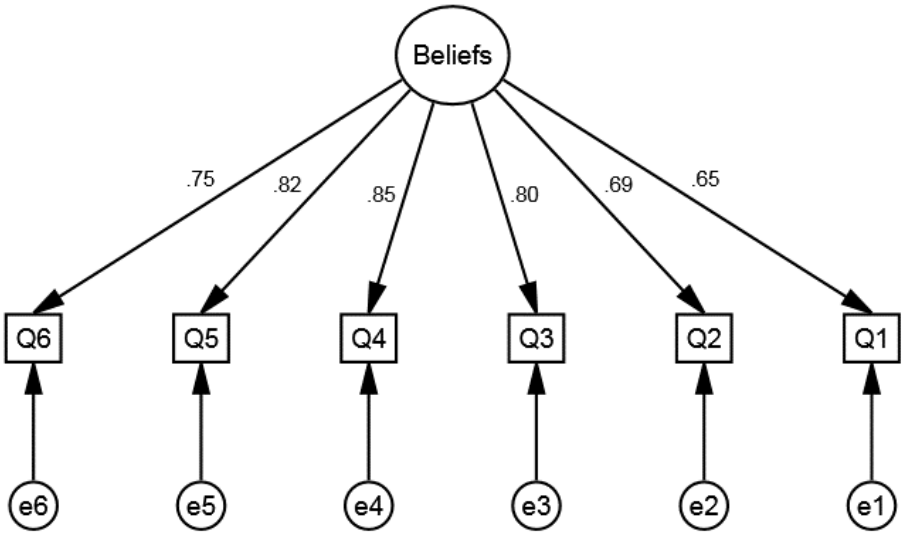

Figure 4.1. Single-factor model. *Note.* All parameters standardised and significant ($p < .001$)

construct validity would be presented separately, researchers increasingly recognise that all validation procedures can be grouped under the heading of construct validity.

Participants

Sport Supplements Beliefs Scale scores collected from participants (n = 468) in phase 4 were used in this phase of the study. Participants were also asked to respond to a series of questions relating to the range of supplements they used and to the frequency of use.

Data analysis

Linear regression examined relationships between SSBS scores and both the total number of sport supplements used and the frequency of use (i.e. daily, weekly, monthly and never). Mann-Whitney U tests compared total SSBS scores of users and non-users of sport supplements followed by discriminant function analysis to determine the degree to which SSBS scores might predict which athletes fell into one of two groups; users of supplements and non-users of supplements. Finally, Cronbach's alpha was calculated to provide an indication of internal consistency.

4.6.3 Results

A Kolmogorov Smirnov test indicated that data violated normality ($p < .05$). Linear regression indicated significant relationships between SSBS scores and supplement use. Specifically, higher SSBS scores were significantly associated with the use of a greater variety of supplements ($\beta = 0.534$, $p < .001$, $r^2 = .285$). Likewise, higher SSBS scores were significantly related to higher frequency of supplement use ($\beta = -0.517$, $p < .001$, $r^2 = .267$).

Differences in SSBS scores between users and non-users were analysed using a Mann-Whitney U test. Users reported significantly higher SSBS scores than non-users (mean differences = 6.37 ± 0.5, U = 8,357, $p < .001$; Figure 4.2). Discriminant function analysis

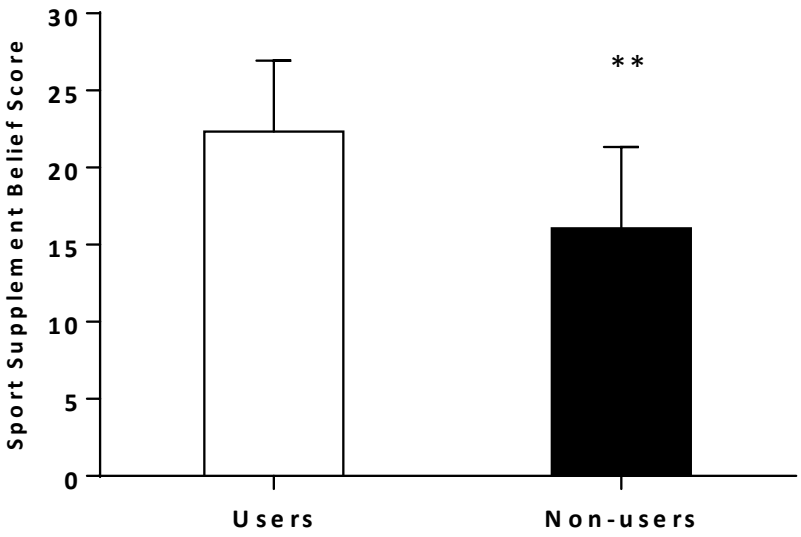

Figure 4.2. Differences in Sports Supplements Beliefs Scale (SSBS) scores between users and non-users. *Note.* $^{**}p = .001$

indicated that SSBS scores correctly predicted 76% of sport supplement users and 66% of non-users (Wilks Lambda = 0.760 $\chi^2 = 110.988$, $p < .001$). Tests of equality between groups were significant ($p < .001$). Cronbach's alpha of .891 indicated good internal consistency of the six item scale.

4.7 Discussion

The gateway hypothesis posits that athletes who use supplements are more likely to use banned substances. Given the demand characteristics inherent in any attempt to assess beliefs about banned substances, a measure of beliefs relating to supplements might have utility in both predicting at-risk athletes and in verifying the effectiveness of anti-doping interventions.

This chapter reported the empirical five-stage development of the Sports Supplements Beliefs Scale (SSBS; Appendix 8), in which multiple methods were used to generate, synthesise, evaluate and test increasingly more parsimonious versions of the instrument.

From this, a brief, single-factor measure with six items emerged: “Supplements improve my performance,” “Supplements are necessary for me to be competitive,” “Supplements improve my confidence,” “My chances of winning improve when I use supplements,” “Supplements help me realise my potential,” and “Supplements improve the quality of my training.” These six items formed a theoretically and statistically coherent scale relating to athletes’ beliefs about the effects of supplements on their own performance and performance related constructs. One item was eliminated in phase 4 (“training increases the need for supplements”) to help improve model fit. Some authors have recommended that rather than deleting an item it should be covaried with overlapping items (Terry et al., 2003), however, it was decided that it should be dropped because of its close similarity with another item on the scale (“supplements improve the quality of my training”). Overall, the resultant six-item scale appears to tap into athletes’ personal perspective on the effects of supplements on themselves.

The SSBS includes six, positively worded items. It has previously been suggested that the validity of a questionnaire is improved when both positive and negative worded items are included (Burke, 1999; Kam, 2017; Worcester & Burns, 1975). Some authors have suggested that without negatively worded items, respondents may act acquiescently and generally agree, rather than disagree with items (Barnette, 2001; Roszkowski & Soven, 2010). However, previous research has reported that negative worded items often perform poorly in single-factor (Roszkowski & Soven, 2010; Woods, 2006) and multi-factor models (Lane et al., 2009). Lane et al. (2009) suggested that poor factor loading is often demonstrated for negative worded items, which can be attributed to carelessness on the respondent’s behalf and not reading the item correctly. Van Sonderen, Sanderman, and Coyne (2013) argued that including negative worded items can lead to increased difficulty in answering the questionnaire and introduces further bias. Lane et al. (2009) also argued that negative worded items often perform poorly on athletic samples. Lane, Sewell, Terry, Bartram, and Nesti (1999) and Lane et al. (2009) both reported weak factor-loadings for reverse scoring items in

the Competitive State Anxiety Intevorty-2 (Martens, Vealey, & Burton, 1990) and the Emotional Intelligence Scale (Schutte et al., 1998), respectively. For these reasons, and given that the target audience in this research programme is athletes, no negative wording items were included in the SSBS.

Scores on the SSBS were associated with both frequency and volume of supplement use among 412 athletes. Given that sport supplement use is reported to be associated with an increased likelihood of doping, it is reasonable to suggest that high scores on the SSBS might predict athletes at risk of doping. This has several implications for intervention and educational efforts targeting the use of sport supplements and doping behaviours. For example, National Anti-Doping Organisations (NADO) typically pursue a multifaceted approach in their education methods, where the aim is to cover a range of topics such as the values of sport, the testing procedures, medications and therapeutic use exemption forms (e.g. WADA's Athlete Learning Program about Health and Anti-Doping, UKAD's 100% me programme and USADA's true sport community-based movement). This often leaves only a small portion of the intervention to the discussion of sport supplements. For an athlete that scores high on the SSBS, a greater proportion of time may be needed to discuss issues related to sport supplement use. To improve the effectiveness and efficiency of the educational interventions delivered, the NADO could instead target athletes who score high on the SSBS and provide a more bespoke and in-depth intervention. Targeting the behaviour at this stage could also improve the effectiveness of anti-doping education. As the consumption of sport supplements arguably creates a psychological and physiological need for further, stronger substances of the same type, athletes experimenting with chemically active supplements may experience no ill effects. This would appear to contradict and undermine the strong negative publicity directed at doping. The advice and education athletes receive in the future may then become less persuasive and could increase rather than reduce the number of athletes moving onto doping substances, undermining the interventions in place by WADA, International

Federations (IF) and NADOs. Educating athletes about sport supplementation may therefore help to prevent athletes from progressing to doping substances and improve the interventions WADA, IF's and NADO's implement.

The SSBS could be used within the battery of self-report instruments researchers use to understand athletes' doping behaviours. Doping is often viewed as a complex and multifaceted psychological phenomenon, where beliefs, desires, intentions, attitudes and perceptions of others, for example, intertwine and determine whether an athlete will decide to use banned substances or not (Hauw & McNamee, 2015). Researchers generally agree that there is no single factor that predisposes a person to use banned substances and the gateway hypothesis is just one factor to consider within the realm of anti-doping interventions. For future research aiming to understand and unravel the influences of doping behaviours, the SSBS could be used alongside other instruments to generate a more complete picture of doping behaviours. Future work will need to evaluate the predictive validity of the SSBS by reporting the degree to which scores relate to future supplement use by athletes not currently using supplements, and while problematic, to doping behaviours. Future work should also aim to demonstrate the construct validity of the measure by assessing pre-post changes in SSBS scores following interventions designed to reduce athletes' reliance on and confidence in sports supplements. Interestingly, the SSBS will also have utility in research investigating the effectiveness of sport supplements. Specifically it has been reported that the performance of athletes with strong beliefs in the effectiveness of sports supplements were more likely to improve following the administration of both supplements and placebos than the performances of those with weaker beliefs (Beedie & Foad, 2009).

In conclusion, the SSBS is a valid and reliable measure for understanding athletes' beliefs about sport supplements. In the context of this research programme, this measure is

used in the studies presented in subsequent chapters to allow the researcher to assess the influence of a placebo intervention on athletes' beliefs towards sport supplements.

Chapter Five

INVESTIGATING THE MAGNITUDE AND MODERATORS OF THE PLACEBO AND NOCEBO EFFECT ON REPEAT SPRINT PERFORMANCE

5.1 Introduction

Placebo effects have been extensively studied in sport, with a systematic review (Beedie & Foad, 2009) reporting that placebo treatments can exert a significant effect on sports performance. Recently, Ross et al. (2015) reported a 1.2% improvement in 3 km running time-trial performance when participants self-administered saline injections believing it to be a performance enhancing substance. Likewise, Saunders et al. (2017) reported that mean power output improved by 3.7% among cyclists deceptively administered a placebo when they believed they had ingested caffeine.

While there is empirical support for the potential role of the placebo effect in sports performance, there is less evidence for the nocebo effect. Arguably the first study of the nocebo effect in sport was conducted by Beedie et al. (2007). These authors reported that 21 participants who believed they had ingested a placebo (a capsule described as a beneficial sport supplement), ran progressively faster compared to baseline. Likewise, 21 participants who believed they had ingested a nocebo (a capsule described as a supplement likely to impair performance), ran progressively slower compared to baseline. Findings highlighted the potentially significant impact of positive and negative expectations on sports performance.

However, the study in question (Beedie et al., 2007) lacked a no-treatment control. It is therefore problematic to estimate the true relative magnitude of placebo and nocebo effects reported; changes in performance could be attributed to statistical or methodological artefacts such as regression to the mean or spontaneous improvements/decrements in performance. It is also problematic from this uncontrolled study to discern whether actual effects were all positive, all negative, or whether both placebo and nocebo effects occurred. As a result, the reported magnitude of either the nocebo or placebo effect might have been overestimated. Further, while the sample of 42 was relatively large for an intervention study in sport, it was

too small to facilitate reliable identification of any variables that might have been associated with the placebo and nocebo responses observed.

In most studies of the placebo/nocebo effect in sport, the standard deviation of the dependent measure is greater in experimental conditions than at baseline (e.g. Beedie et al., 2007; Beedie et al., 2006; de la Vega et al., 2017; Foad et al., 2008). This suggests that, even if a mean placebo effect is observed, there is considerable inter-individual variability in response to treatment. Few studies have attempted to identify the variables related to placebo effects, and those that have are arguably methodologically unsatisfactory. For example, Beedie et al. (2008) identified a possible link between placebo responding and personality factors, but the sample size was too small for their findings to be considered reliable. In fact, the small sample sizes of nearly all studies of the placebo effect in sport has precluded the reliable investigation of factors that might be associated with placebo responding (see Table 2.1, p. 25). If knowledge and understanding of the placebo and nocebo effects is to progress beyond simple description, there needs to be a better understanding of the relevant antecedents and mechanisms.

This study therefore aims to extend Beedie et al. (2007) study by 1) including a no-treatment control to improve the precision of determining the magnitude of placebo and nocebo effects of a purported sport supplement and 2) using a sufficiently large sample to reliably identify factors that might be associated with observed placebo and/or nocebo responses.

5.2 Methods

5.2.1 Design

The placebo and nocebo interventions used in this study required the deceptive administration of an inert capsule delivered to members of teams in their usual team

environment. A randomised controlled trial design was therefore used to minimize cross-contamination between experimental and control treatments. Participants completed a pre-experimental questionnaire relating to sport supplementation before performing 5 × 20 m repeat sprints with 30s recovery at baseline. Following Beedie et al's (2007) original design, participants in the positive belief treatment (n = 288) were deceptively administered an inert capsule described as a potent supplement which would improve sprint performance, while participants in the negative belief treatment (n = 232) were deceptively administered an inert capsule described as a potent supplement which would negatively affect sprint performance. However, extending the original study, no-treatment control participants (n = 192) received neither instruction nor placebo. Twenty minutes following the administration of the capsules, participants completed the experimental condition, repeating the 5 × 20 m sprints.

5.2.2 Participants

Participants were recruited in person from sports clubs. Convenience sampling was used, where athletes from a range of sports were invited to participate in the study. Seven hundred and twelve competitive athletes from 43 different teams (number of athletes in each team: median = 14; range = 8 to 40) were initially recruited to the study from sports clubs. Participant demographics are presented in Table 5.1. All participants were aware that their involvement in the study was voluntary and that all data collected would be treated as confidential. Ethical approval was granted by the Institutional Research Ethics Committee. Participants gave written informed consent once they had read the participant information sheet (Appendix 9).

Table 5.1

Demographics of participants between treatments

		Positive	Negative	Control	Overall
n =		288	232	192	712
Gender (%)	*Male*	83.1	76.9	71.0	78.0
	Female	16.9	23.1	29.0	22.0
Age (%)	*18 to 24*	66.7	65.0	79.0	69.4
	25 to 34	29.6	30.0	18.8	26.8
	35 to 44	3.7	5.1	2.3	3.8
Sport (%)	*Rugby Union*	46.2	42.7	22.3	39.0
	Football	42.9	36.9	44.1	41.3
	Field Hockey	5.3	8.9	2.8	5.8
	Other	5.6	11.6	30.7	13.9
Ability (%)	*Club*	25.5	35.4	21.1	27.5
	County	39.9	38.8	30.4	37.0
	Regional	25.9	19.6	32.7	25.7
	National	8.7	6.2	15.8	9.8
Intention to use sport supplements (%)	*Not intending*	23.9	33.5	35.6	30.0
	Undecided	21.6	18.9	18.1	19.8
	Intending	54.5	47.6	46.3	50.2
Use of supplements (%)	*Yes*	51.1	50.9	52.7	51.5
	No	48.9	49.1	47.4	48.5
Frequency of supplement use (%)	*Daily*	24.1	26.6	26.2	25.5
	Weekly	22.6	21.0	24.4	22.5
	Monthly	4.4	3.3	1.8	3.4
	Never	48.9	49.1	47.6	48.6
Mean ± SEM	*Years training*	10.77 ± 0.38	10.94 ± 0.59	9.68 ± 0.45	10.68 ± 0.24
	Hours per week training	6.13 ± 0.25	5.93 ± 0.25	5.84 ± 0.30	5.9 ± 0.15
	Amount of supplements used	1.14 ± 0.10	1.11 ± 0.10	1.20 ± 0.13	1.09 ± 0.06

Note. SEM = standard error of the mean

5.2.3 Measures

5.2.3.1 *Pre-experimental questionnaire*

All participants were asked to complete a pre-experimental questionnaire detailing sex, age, sport played and competitive level (club, county, regional or national; Appendix10). They were asked to indicate whether they used sports supplements (yes or no), the total number of supplements used, and the frequency of use (daily, weekly, monthly or never). They were also asked to indicate their agreement with a statement of their intention to use sport supplements in the next three months on a 6 point Likert-type scale anchored at strongly disagree (1) through to strongly agree (6).

5.2.3.2 Repeat sprint performance

Whereas Beedie et al. (2007) used a 3 × 30 m repeat sprint protocol, Schimpchen, Skorski, Nopp and Meyer (2016) reported that four or more sprints should be used to decrease the typical error and improve the precision of estimating true changes in performance. Furthermore, the majority of sprinting in team sports events occurs over relatively short distances (i.e. <30 m; Cross et al., 2015) and short durations (i.e. <4 seconds; Spencer, Bishop, Dawson, & Goodman, 2005). For these reasons, participants were asked to complete five 20 m maximal intensity repeat sprints with 30 seconds recovery between each sprint. Sprint time was measured using an automated, single-beam photocell, light gate system (Smartspeed Pro^{TM}, Fusion Sport Inc., Australia). Single-beam light gate systems are the most common method for measuring sprint performance and have been shown to have good reliability (Haugen & Buchheit, 2016).

5.2.3.3 Belief manipulation

During the 20-minute recovery period between baseline and experimental conditions, participants in the positive- and negative-belief treatments were given a capsule described as a potent sport supplement, “inorganic nitrate.” Similar to Beedie et al. (2007), the positive-

belief treatment participants were given two red and white, size 1 (20 mm), gelatine capsules containing 200 mg of cornflour (Sainsbury's, London UK) and informed that the "inorganic nitrate" would *improve* both endurance and repeat sprint performance. Negative-belief treatment participants were given two red and black, size 1 (20 mm), gelatine capsules containing 200 mg of cornflour and informed that the inorganic nitrate would improve endurance but have a *negative* effect on sprint speed. The effectiveness of the belief manipulation was assessed during a debrief immediately following the experimental trials, at which point the true nature of the study was revealed. Participants were asked to respond on a 10 point Likert-type scale, how much they believed the treatment influenced their performance (1 = no influence to 10 = high influence).

5.2.4 Procedure

Testing was performed at 43 different training facilities habitually used by the teams recruited to the study. All data for each participant were collected on one day to minimize meteorological and biological variation. Teams were randomised to the three treatments (i.e. positive, negative and control) using a computer generated cluster programme (allocation ratio 1:1:1). To reduce potential confounding, only one team per club were permitted to take part in the study. All treatments were conducted on separate days and at separate sites to maintain the experimental blind.

Participants completed the sprints in footwear and clothing suitable for high intensity exercise, and were encouraged to perform their standard warm-up. They began each sprint in a stationary position, ~50 cm behind the first light gate. They were instructed not to rock back and forth prior to the sprint, but were permitted to start the sprint in any position (e.g. split-stance or crouch start), and replicated this for each sprint. Each sprint was started by a green LED, which would flash up on the photocell. Participants were encouraged to sprint as fast as possible for the full 20 m, with times recorded to the nearest 1/100th of a second. Participants

were given thirty seconds to jog back to the start position and begin the next sprint. This process was continued until each participant had completed five sprints.

After the baseline condition, participants in the positive- and negative-belief treatments received the capsules and the belief manipulation. All participants then completed a 20-minute recovery consisting of light exercise to minimize the search for physiological symptoms associated with the intervention (Foad et al., 2008), before commencing the experimental condition in the same manner as the first. The total duration of the repeat sprint protocol, including recovery, was less than 30 minutes per participant. On completion, participants were debriefed about the true nature of the study in line with American Psychological Association guidelines for deceptive research (American Psychological Association, 2017).

5.2.5 Data analysis

Data were inputted into SPSS version 23.0 (IBM, Armonk, NY, USA) and tested for homogeneity of variance, normal distribution and anomalies. Inspection of the data indicated that 55 participants (8%) did not complete the experimental condition (positive-belief treatment n = 20; negative-belief treatment n = 16; control n = 19). In addition, data values that exceeded 2.5 times the standard deviation were identified as extreme outliers (Leys, Ley, Klein, Bernard, & Licata, 2013). Thirty participants (4%) were identified as extreme outliers (positive-belief treatment n = 7; negative-belief treatment n = 7; control n = 16) and were subsequently removed from further analysis (Judd, McClelland, & Ryan, 2011). Data for the remaining sample of 627 participants (positive-belief treatment n = 261; negative-belief treatment n = 209; control n = 157) were entered into subsequent statistical analyses.

Further inspection of data relating to intentions to “use sport supplements in the next three months” statement revealed unequal responses in Likert-type scale ratings. For example, in the positive-belief treatment, 73 participants “agreed” to the statement whereas

only 9 participants “slightly disagreed.” This was similar in negative-belief and control treatments. Given the unequal responses between scale ratings, responses were categorised into three groups. Those scoring 1 and 2 were grouped as *not intending*, 3 and 4 as *undecided*, 5 and 6 as *intending*.

One-way Analysis of Variance (ANOVA) and chi-square (χ^2) tests were used to compare continuous (years training, hours per week training and number of supplement used) and categorical (sex, age, sport, ability, supplement use, frequency of supplement use and intention to use supplements) variables between treatments, respectively.

Sprint times for each condition (i.e. baseline and experimental) and treatment (i.e. positive, negative and control) were inputted into Hopkins (2015) reliability spreadsheet. Data were log transformed to reduce non-uniform errors and the intra-class correlation (ICC) provided estimates of reliability. The precision of ICC was interpreted as extremely high = .99; very high = .90; high = .75; moderate = .50; low = .20 (Hopkins, 2015).

Hopkins, Hawley and Burke (1999) suggest that research investigating athletic performance should report outcome as a percentage change from baseline. Sprint times were therefore converted to the proportion of the first sprint speed, expressed as a percentage. Differences between participant’s average performance for each condition (i.e. performance average for baseline [sprints 1 to 5] and experimental conditions [sprints 6 to 10]), and the difference in the fastest sprint trial in each condition (i.e. fastest person sprint at baseline minus fastest person sprint at experimental) were calculated.

Repeated measures ANOVA identified differences in sprint performance between each condition, with treatment included as a between-subject factor. Greenhouse-Geisser epsilon was reported where sphericity was violated, and post-hoc LSD tests were conducted where a significant interaction was observed. Point-Biserial correlations (r_{pb}) were used to assess the relationship between performance and categorical variables (i.e. sex, age, ability, sport supplement use, frequency of sport supplement use, intention to use sport supplements,

belief manipulation scores). Variables that correlated significantly with performances were analysed further using repeated measures ANOVA and Multivariate ANOVA (MANOVA). Given the possibility that differences between treatments may reflect the large sample size and sampling variability (38), Cohen's *d* (*d*) effect sizes were calculated. Differences between 0.2 and <0.5 were interpreted as a small effect, between 0.5 and <0.8 as moderate, and ≥0.8 as large (Cohen, 1992). Data are presented as mean ± standard error of the mean (SEM), with statistical significance accepted at $p \leq .05$.

5.3 Results

5.3.1 Participant demographics

No significant differences were observed between treatments for number of years training ($F_{2,573} = 2.072$, $p = .127$), hours per week training ($F_{2,580} = 0.403$ $p = .669$), sex ($\chi^2 = 5.28$, $p = .071$), supplement use ($\chi^2 = 2.32$, $p = .312$), frequency of supplement use ($\chi^2 = 6.50$, $p = .370$) and intention to use supplements ($\chi^2 = 4.65$, $p = .098$). Differences between treatments were observed for age ($\chi^2 = 21.99$, $p = .001$), ability ($\chi^2 = 21.69$, $p = .001$) and sport played ($\chi^2 = 225.76$, $p < .001$). Covariate analysis, adjusting for the differences in categorical variables, revealed no effect on the outcome of the performance sprint data ($p > .05$). The results of the subsequent analyses are therefore reported with unadjusted covariate data.

5.3.2 Reliability of sprint trials

Baseline sprints (i.e. trials 1 – 5) were associated with very high reliability in the positive-belief treatment (ICC = .94), negative-belief treatment (ICC = .96) and control treatment (ICC = .90). Similar reliability coefficients were also observed for experimental

sprints (i.e. trials 6 – 10) in the positive-belief treatment (ICC = .94), negative-belief treatment (TE = .94) and control treatment (ICC = .94).

The possibility that greater reliability was associated with fewer than 5 sprint trials was also investigated. If for example, reliability between sprint trials 1 – 4 or 1 – 3 are more reliable than 1 – 5, this could reduce the error and improve the chances of finding a true effect of the intervention on sprint performance. ICC's were however, similar for trials 1 – 4 (ICC range = .92 to .96) and 1 – 3 (ICC range = .93 to .96). Therefore, sprint trials 1 – 5 are reported in the subsequent analysis.

5.3.3 Differences in baseline and experimental performance between treatments

No between-treatment differences in performance were observed at baseline ($F_{(2,624)}$ = 0.149, p = .861). However, between-treatment differences were observed in experimental trials ($F_{(2,624)}$ = 5.879, p = .001). In the negative-belief treatment, performance in experimental trials was worse than baseline (-1.42 ± 0.15%, $p < .001$, d = 0.56), and worse than performance in experimental trials in the positive-belief (-1.04 ± 0.28%, $p < .001$, d = 0.34) and control treatments (-0.92 ± 0.31%, $p < .001$, d = 0.32). No differences were observed in performance in experimental trials between the positive-belief and control treatments (-0.07 ± 0.27%, p = .696, d = 0.02). Figure 5.1 illustrates the differences in performance for each condition between treatments.

5.3.4 Correlations between performance and categorical variables

Point-Biseral correlations revealed a significant relationship between participants' intentions to use supplements and performance (mean performance in each condition r_{pb} = .106, p = .012; fastest performance difference between conditions r_{pb} = .101, p = .016).

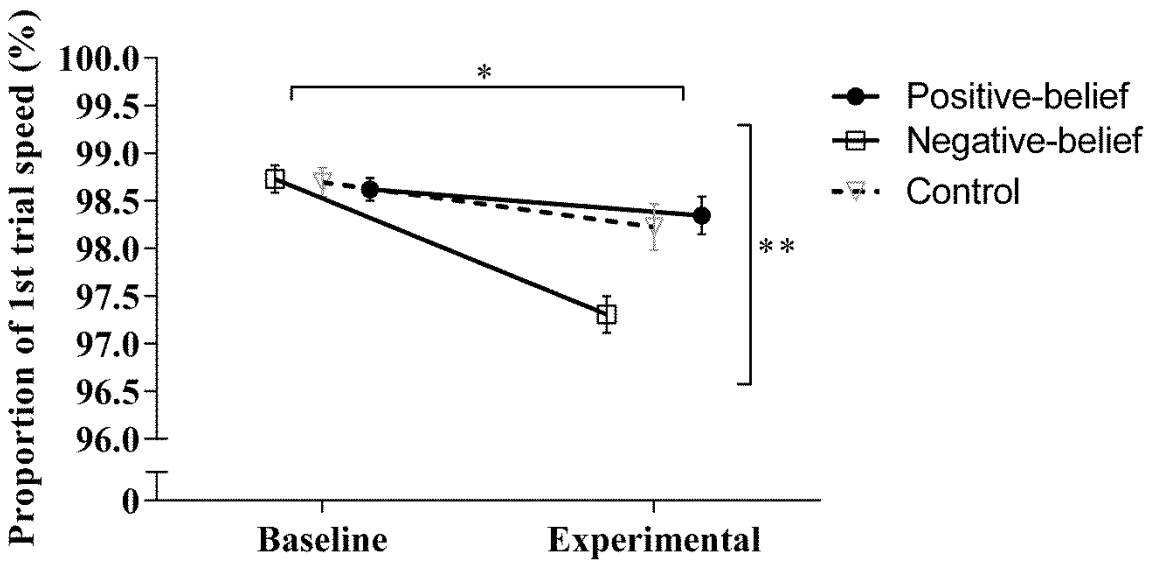

Figure 5.1. Mean performance in each condition between treatments. *Note.* *Baseline *vs*. Experimental for Negative-belief = $p < .05$; **Positive-belief and Control *vs*. Negative-belief = p < .05.

No other significant relationships were observed between other categorical variables for mean performance in each condition (sex r_{pb} = -.009, P = .819; age r_{pb} = .006, p = 0.891; ability r_{pb} = -.039, p = .353; use of supplements r_{pb} = .071, p = .078; frequency of supplements r_{pb} = between conditions (sex r_{pb} = -.014, p = .723; age r_{pb} = .005, p = .906; ability r_{pb} = -.042, p = .318; use of supplements r_{pb} = .075, p = .071; frequency of supplements r_{pb} = -.062, p = .135; belief manipulation scores: r_{pb} = .025, p = .677; fastest performance: r_{pb} =.025, p = .677).

5.3.5 Differences between baseline and experimental performance by supplement intention

Further analysis using repeated measures ANOVA identified differences in participant's repeat sprint performance in each treatment by intention to use sport supplements (i.e. not intending; n = 174; undecided; n = 112; and intending; n = 284). No differences between baseline and experimental conditions were observed for participants in the positive-belief treatment intending to use supplements (0.28 ± 0.14%, p = .886, d = 0.01). However, sprint performance worsened for participants in the positive-belief treatment who

were undecided about supplement use (-0.67 ± 0.36%, p = .039; d = 0.22), and not intending to use sport supplements (-0.64% ± 0.25, p = .036; d = 0.23; Figure 5.2A). No differences in sprint performance by intention to use supplements were observed in the negative-belief (Figure 5.2B) and control (Figure 5.2C) treatments (p > .05).

5.3.6 Between-treatment differences in fastest performance by intention

Differences in fastest sprint performance and intention to use supplements were analysed using MANOVA. The performance of participants intending to use supplements in the positive-belief treatment was better than the performance of participants in the negative-belief (1.29 ± 0.37%, p = .001, d = 0.51) and control treatments (0.90 ± 0.41%, p = .029, d = 0.33). The performance of participants not intending to use supplements in the negative-belief treatment was worse than control treatment (negative-belief *vs.* controls = -1.34 ± 0.48%, p = .005, d = 0.52). This trend was similar between the positive-belief and control treatment (-0.91 ± 0.45%, p = .060; d = 0.38). No differences were observed for participants' undecided about supplement use between all three treatments (p > .05; Figure 5.3).

5.3.7 Within-treatment differences in fastest performance by intention

Differences in fastest sprint performance by intention to use supplements were observed in the positive-belief treatment ($F_{(2,239)}$ = 4.952, p = .008) but not in negative-belief ($F_{(2,197)}$ = 1.247, p = .290) or control treatments ($F_{(2,131)}$ = 0.637, p = .530). In the positive-belief treatment, fastest sprint performance in experimental trials for participants not intending to use supplements decreased by -1.10% ± 0.30% from baseline, and for participants undecided about supplement use, by -0.64% ± 0.43%. However, the performance of participants intending to use supplements improved by 0.19% ± 0.24% between baseline

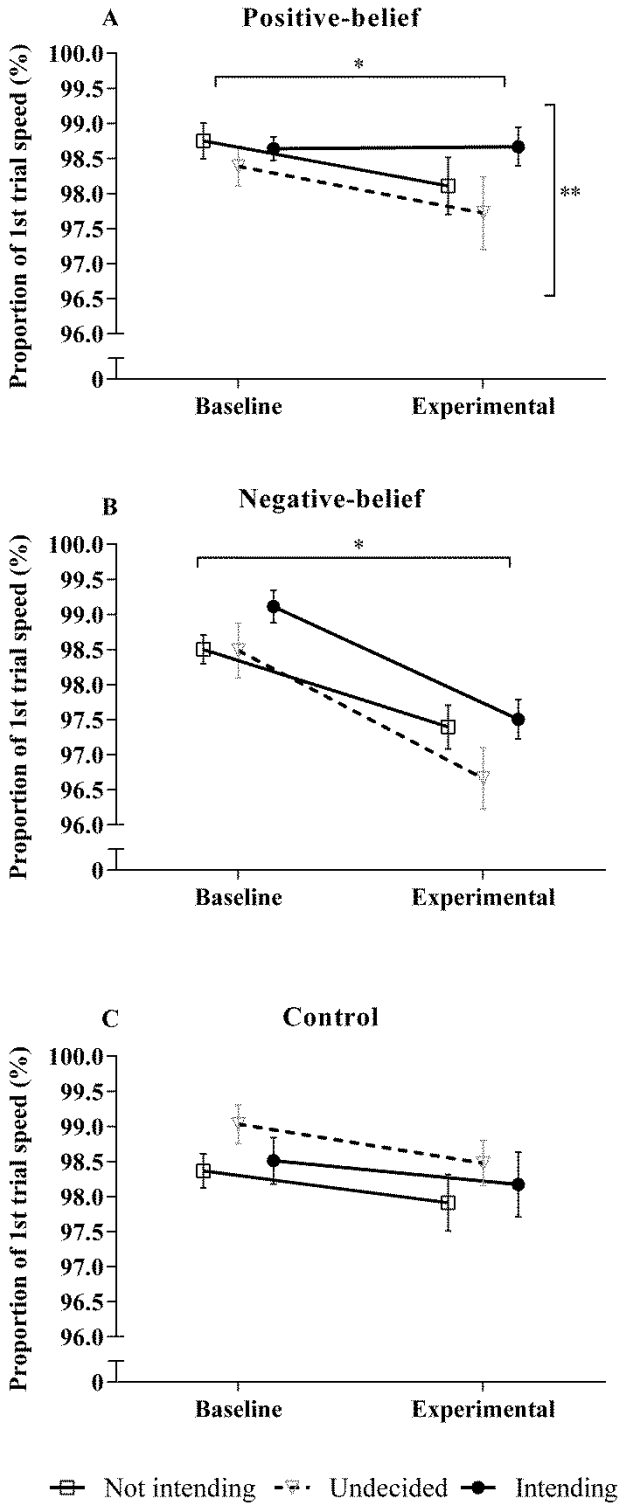

Figure 5.2. Average performance in condition by each treatment separated by participants' intention to use supplements. **A.** Positive-belief treatment. *Note*. *Baseline *vs*. Experimental for those not intending to use supplements = $p < .05$; **intending to use supplements *vs.* not intending to use supplements = $p < .05$. **B.** Negative-belief treatment. *Note*. *Baseline *vs*. Experimental for those not intending, undecided and intending to use supplements = $p < .05$. **C.** No-treatment control.

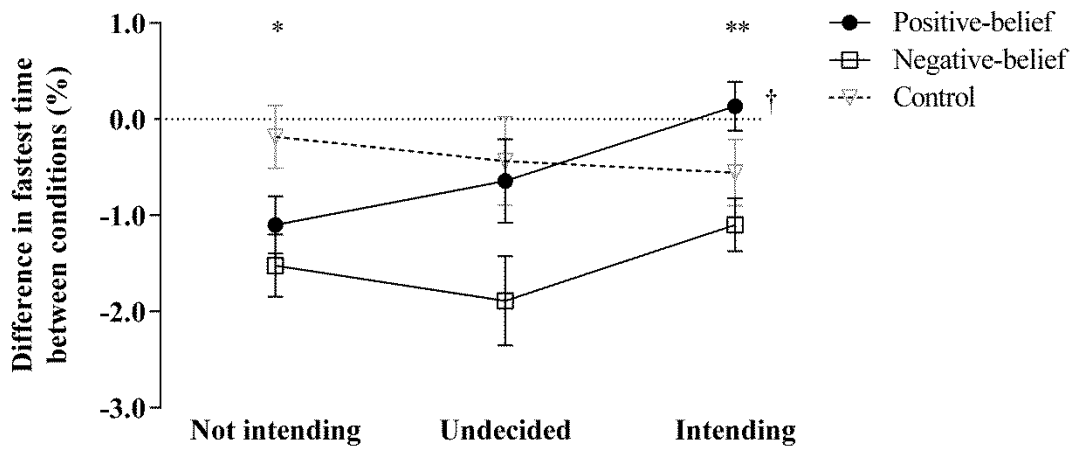

Figure 5.3. Differences in fastest performance between conditions, grouped by intention to use sport supplements. *Note.* *Control vs. Positive-belief and Negative-belief = $p < .05$, **Positive-belief vs. Negative-belief = $p < .05$, †Positive-belief intention vs. Positive-belief no intention = $p < .05$.

and experimental conditions (Figure 5.3). In the positive-belief treatment, performance between baseline and experimental conditions also differed significantly between those participants intending to use supplements and those not intending to use supplements (1.29% ± 0.38%, $p = .003$, $d = 0.49$). No other within-treatment differences in fastest sprint performance between baseline and experimental conditions were observed when classified by intention to use supplements ($p > .05$; Figure 5.3).

5.4 Discussion

This study aimed to examine the magnitude and moderators of placebo and nocebo effects on repeat sprint performance. Results showed a mean nocebo effect in repeat sprint performance across the sample, but no mean placebo effect when compared to a no-treatment control. This suggests that, while receiving a purported harmful supplement significantly impaired performance, receiving a purported beneficial supplement did not enhance it. This finding differs to those of Beedie et al. (2007) who reported significant placebo *and* nocebo effects in repeated sprinting.

Although no mean placebo effect was observed, data from the positive-belief treatment did suggest that the performance of participants intending to use supplements improved to a greater degree in experimental trials than the performance of participants not intending to use supplements (d = 0.49, Figure 5.3). These improvements were also greater than those observed among participants of equivalent intention in the negative-belief (d = 0.51) and control treatment (d = 0.33). Given that effect sizes >0.2 are considered potentially beneficial for sports performance (Hopkins, 2016), these improvements in repeat sprint performance are likely meaningful for athletes. Furthermore, the relationship between intention to use sport supplements and response to placebo in the positive-belief treatment is of particular importance, as it indicates that it is a predictor of the placebo effect and is not attributed to statistical or methodological artefacts.

While intention to use supplements influenced the placebo response, this relationship was not shown for prior supplement use (r_{pb} = .071, p = .078). There was however a strong relationship between intention to use supplements and prior supplement use (r_{pb} = 0.666; p < *.001*). This suggests that intention to use supplements is associated with prior supplement use and may moderate an athlete's response to a placebo intervention.

The results of this study support the proposition that placebo responding is a learned phenomenon. Research has shown that placebo effects can be initiated via verbal instructions (creating an expectation of a drug; Kam-Hansen et al., 2014) and/or via repeat exposure to a drug with a subsequent placebo intervention mirroring the action of that drug (Benedetti et al., 2011). Previous experiences of a drug are therefore remembered, creating a memory of effective and ineffective treatments (Klinger, Colloca, Bingel, & Flor, 2014). This learning process is manifest in specific brain regions, with expectations and conditioning cues mediating and maintaining the turnover of, for example dopamine (Hall, Loscalzo, & Kaptchuk, 2015), and creating rewarding stimuli. On this basis, for a placebo responsive athlete, a placebo-induced improvement in performance is the result of verbal information

about the treatment (e.g. the suggestion that a supplement can improve performance) and/or cued or conditioning (e.g. repeated exposure to a real treatment that results in treatment-like effects even when the treatment is replaced by a placebo). Theoretically, the athlete recalls previous experiences and information about the effectiveness or ineffectiveness of the treatment, which shapes their subsequent intention to use it. This is perhaps one reason why athletes intending to use supplements are more likely to use these substances (Goulet et al., 2010) and are arguably more likely to use other forms of performance enhancements.

The finding that intention may influence the placebo effect has particular relevance to sports practitioners aiming to improve an athlete's performance. Specifically, if improvements in performance following administration of a treatment (e.g. caffeine, sodium bicarbonate, β-alanine) are the result of both pharmacological and placebo effects (Beedie et al., 2015), but the athlete does not have a prior intention to use that treatment, it may not elicit a placebo response and the athlete may not fully benefit from the treatment. Ultimately, a treatment may be more effective when an athlete intends to use it than when they do not. Sport practitioners should therefore be aware of an athlete's intentions towards a treatment prior to its administration, to facilitate the effectiveness of the treatment. This is also important in research, in which intentions towards a treatment could similarly influence outcomes.

Any reference to the results of this study should take into account potential limitations. First, there was no control for the presence of others or social support (e.g. cheering from teammates) during the sprint trials, and this may have affected performance. Second, while participants were asked to report on a Likert-type scale from 1 to 10 the degree to which they believed the treatment influenced their performance, they were not specifically asked if they believed the information they were given. This therefore prevents assessment of the credibility of the belief-manipulation. Finally, the use of self-reported sport supplement use may not be reliable, as there may be differences between what athletes' report and what

they actually think and/or do. However, given that previous studies have used expensive and complex techniques such as positron emission tomography (Atlas & Wager, 2014) and genotyping (Hall et al., 2012) to identify placebo responders/non-responders, a self-report measure could provide a cost-effective and practical alternative.

In conclusion, the results of this study suggest that negative information about the effects of a supplement on repeat sprint performance impaired that performance (a mean nocebo effect), whereas positive information about the effects of supplement elicited no change (i.e. no mean placebo effect was observed). However, participants' intention to use sport supplements influenced the direction and magnitude of subsequent placebo responses, with participants intending to use supplements more likely to respond to the positive intervention. The next step in this research programme is to understand the impact of the placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping. This study is presented in Chapter Six.

Chapter Six

EFFECT OF A POSITIVE AND NEGATIVE BELIEF INTERVENTION ON ATHLETES' BELIEFS AND INTENTION TOWARDS SPORT SUPPLEMENTS AND ATTITUDES TOWARDS DOPING

6.1 Introduction

It has been proposed that athletes aware of placebo effects, or who have direct experience of them, may be less likely to use supplements and banned substances (Beedie, 2007; Kalasountas et al., 2007; Maganaris et al., 2000; McClung & Collins, 2007). However, despite strong anecdotal evidence, this theory remains untested. The purpose of this study is to examine the impact of the placebo intervention described in Study 2 on participants' beliefs and intentions towards sport supplements and attitudes to doping.

In sport, use of banned performance enhancing substances is often referred to as doping. In the last decade, there has been a considerable increase in the understanding of psychosocial variables associated with doping (Ntoumanis et al., 2014). The Theory of Reasoned Action (TRA; Ajzen & Fishbein, 1975) and Theory of Planned Behaviour (TPB; Ajzen, 1985) are the most frequently used frameworks used to explain athletes' doping behaviour (Chan, Hardcastle, et al., 2015). A central tenant of the TRA and TPB is the idea that a person's intention is the most proximal determinant of behaviour (Kirby, Guerin, Moran, & Matthews, 2016), and this intention is influenced by their attitude and subsequent beliefs about the behaviour.

While findings may vary by population group (e.g. male vs. females, elite vs. amateur athletes), there appears to be a consensus that the TRA and TPB largely explain an athlete's decision to dope. For example, Barkoukis et al. (2013) reported that users of banned substances showed greater intentions to use these substances in the future than non-users ($F_{(1,739)} = 486$, $p < .001$, $\eta^2 = 0.39$), while Zelli, Mallia, and Lucidi (2010) reported that favourable attitudes towards doping predicted participant's intention to use substances in the future ($r^2 = .31$, $p < .001$). Similarly, Chan, Hardcastle, et al. (2015) reported that attitudes and beliefs about doping significantly influenced future doping intentions ($p < .001$).

Although this data has provided evidence to explain how variables such as intentions, attitudes and beliefs might predict future doping behaviours, there is a paucity of research utilising this understanding in interventions aimed at preventing doping. Two well-known interventions, the Athletes Training and Learning to Avoid Steroids (ATLAS; Goldberg et al., 1996) and the Athletes Targeting Healthy Exercise and Nutrition (ATHENA; Elliot et al., 2004) programme, involve discussions about alternatives to doping and how to resist it. These discussions are assumed to increase participants' knowledge about doping and are expected to empower them to resist doping. However, studies examining the effectiveness of these interventions have shown only small reductions in the number of participants reporting to use banned substances over a season or school year (Ntoumanis et al., 2014). Similar anti-doping interventions have also reported that participants are more likely to use doping substances when they are educated about healthy alternatives to doping (e.g. nitrate rich beetroot juice instead of erythropoietin). Similar results have been shown by Jalilian, Allahverdipour, Moeini, and Moghimbeigi (2011) and Elbe and Brand (2016), both of whom reported increases in the likelihood of athletes doping following an intervention aimed at preventing it. From the available evidence, it is reasonable to suggest that interventions aimed at preventing banned substance use have been largely ineffective in reducing doping behaviour and in some cases, have increased the likelihood of athletes doping.

A number of factors could explain this. Firstly, interventions often aim to influence athletes' overall health-related behaviours and are not sufficiently focused on doping. The ATLAS and ATHENA interventions, for example, include information and activities about healthy and unhealthy eating, as well as use of alcohol, tobacco, marijuana and anabolic steroids. Secondly, ad hoc instruments are often used to identify changes in psychosocial variables associated with doping. These measures may not be sufficiently accurate or sensitive to identify changes following the intervention. Thirdly, participants' intentions prior to the study may already be low making it difficult to identify changes following the

intervention. Finally, if an athlete admits to doping, they could be banned from competition for up to four years. Even an athlete that is not doping but who is tempted to do so might be reluctant to disclose this. Future interventions aimed at preventing doping behaviours must therefore recognise and address these challenges if such interventions are to be effective.

In a recent meta-analysis, Ntoumanis et al. (2014) reported that doping is significantly associated with non-banned substance use such as sport supplements. One explanation for this association is the gateway hypothesis, which posits that the use of softer drugs can lead to harder ones (Kandel, 1975). Targeting an athlete's use of sport supplements as opposed to banned substances might therefore constitute a legitimate doping intervention, and one that facilitates less problematic evaluation of its effectiveness, given that it is predicated on the use of supplements and not banned substances.

Evidence suggests that the effectiveness of sport supplements may be influenced via the placebo effect (Beedie & Foad, 2009). It has been proposed that athletes aware of this phenomenon, or who have direct experience of it, may be less likely to use supplements and banned substances (Kalasountas et al., 2007; Maganaris et al., 2000; McClung & Collins, 2007). The idea underpinning this proposal is that an athlete aware of the placebo effect might also recognise that this significant psychological contribution to the effectiveness of a supplement is something that they may be able to achieve through other means, such as mental preparation and psychological skills training. If such an athlete is less likely to use supplements, the gateway hypothesis predicts that the athlete is theoretically also less likely to use banned substances.

The aim of this study was to understand the effect of a placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping. Study 2 of this research programme reported the effect of a positive (placebo) and negative (nocebo) intervention on repeat sprint performance among a large sample of athletes. This study

reports the effects of this intervention on participants' beliefs and intentions towards sport supplements and attitudes to doping.

6.2 Method

6.2.1 Design

A three-group, randomised intervention design was used. Intentions to use sport supplements, attitudes to doping and beliefs about sport supplements were assessed pre- and immediately post-treatment. In this study, the term *treatment* refers to the specific experimental condition to which the participant was allocated - positive, negative or control - while *intervention* refers to the entire process, including the subsequent debrief (below).

6.2.2 Participants

Of the 627 participants that completed the placebo intervention outlined in Study 2, 64 (10.11%) did not complete any pre and post-treatment measures. A sample size of 563 remained in this study (Table 6.1). All participants provided written informed consent prior to participation (Appendix 9) and were informed they could withdraw from the study at any time. Ethical approval for the study was granted by the Faculty Research Ethics Committee at Canterbury Christ Church University.

6.2.3 Measures

Pre- and post-treatment, participants completed a bespoke single item question indicating their intention to use sport supplements, the Performance Enhancement Attitude Scale (PEAS; Petróczi, 2006) and the Sports Supplements Beliefs Scale (SSBS; see Study 1). To further understand athletes' experience of the treatment, and the effectiveness or otherwise of the treatment on their decision to use sport supplements, participants in positive-

Table 6.1

Demographics of participants between treatments

		Positive	Negative	Control	Overall
	n =	225	199	139	563
Gender (%)	*Male*	83.3	75.5	79.1	79.6
	Female	16.7	24.5	20.9	20.4
Age (%)	*18 to 24*	66.9	63.1	83.1	69.6
	25 to 34	28.9	31.5	14.2	26.1
	35 to 44	4.1	5.4	2.7	4.2
Sport (%)	*Rugby Union*	49.4	33.5	24.2	42.0
	Football	41.8	38.5	35.3	39.1
	Field Hockey	2.7	7.7	3.3	4.5
	Other	6.1	9.6	35.3	14.3
Ability (%)	*Club*	22.5	35.5	22.2	26.9
	County	41.1	38.6	34.0	38.5
	Regional	27.5	19.8	27.8	25.0
	National	8.9	6.1	16	9.7
Intention to use sport supplements (%)	*Not intending*	25.5	34.8	34.1	30.8
	Undecided	21.3	18.2	17.4	19.3
	Intending	53.1	47.0	48.5	49.9
Mean ± SEM	*Years training*	10.70 ± 0.37	10.87 ± 0.42	9.68 ± 0.45	10.63 ± 0.25
	Hours per week training	6.17 ± 0.25	5.90 ± 0.25	6.23 ± 0.30	6.20 ± 0.16
	PEAS	10.67 ± 0.27	10.37 ± 0.30	10.20 ± 0.36	10.46 ± 0.18
	SSBS	18.47 ± 0.41	18.58 ± 0.52	18.57 ±0.61	18.66 ± 0.29

and negative-belief treatments were asked to respond to a series of open-ended questions.

6.2.3.1 Intention to use supplements

Participants were asked to respond on a scale from 1 (Strongly disagree) to 6 (Strongly agree) how much they agreed with the following statement: "Over the next three months I think I will use sport supplements." Assessing participants' intentions towards the use of performance enhancing substances using single item rating scales has been used in previous research (e.g. Conner, Kirk, Cade, & Barrett, 2001; Lazuras, Barkoukis, Rodafinos, & Tzorbatzoudis, 2010; Lucidi et al., 2008; Mallia et al., 2016). Similar to Study 2, those scoring 1 and 2 were grouped as *not intending*, 3 and 4 as *undecided*, 5 and 6 as *intending*.

6.2.3.2 Attitudes toward doping

Participants were asked to complete the PEAS (Petróczi, 2006) which assesses general doping attitudes on a six-point Likert-type scale (1 = Strongly disagree to 6 = Strongly agree; Appendix 11). The PEAS consists of 17 items, with statements including "Doping is necessary to be competitive" and "The risks related to doping are exaggerated." For the current sample, internal reliability was good ($\alpha = .90$).

6.2.3.3 Beliefs about sport supplements

Participants were asked to complete the SSBS, which assesses athletes' beliefs about sport supplements. The SSBS consists of six items measured on a Likert-type scale ranging from strongly disagree (1) to strongly agree (6). An example item is "Supplements improve my performance." Previous use of this scale indicates that higher scores reflect greater beliefs in the effectiveness of sport supplements, and the scale has shown good internal consistency ($\alpha = .89$; see Study 1). Similar reliability coefficients were evident in the current sample ($\alpha = .91$).

6.2.3.4 Open-ended questions

Qualitative responses to open-ended questions allowed participants to expand on their intentions, attitudes and beliefs towards sport supplements following the treatment (Appendix 12). Participants were asked to respond to questions about the placebo effect and if it had any influence on their beliefs towards sport supplements, how much they believed sport supplements are influenced by the placebo effect, and if knowledge of the placebo effect influenced their decision to use sport supplements.

6.2.4 Procedure

Participants were asked to complete the battery of questionnaires before being randomised to one of three treatments: positive-belief (n = 225), negative-belief (n = 199), or no-treatment controls (n = 139). Participants then performed the repeat sprint protocol outlined in Study 2, which involved participants performing two sets of 5 × 20 m repeat sprints as fast as possible with ~30 seconds of recovery. In the 20 minutes between sets, positive- and negative-belief participants were given two capsules and informed it would be beneficial or harmful to performance respectively. No-treatment controls were told nothing and given nothing. Results of the sprint performance data are reported in Study 2.

Following the performance measure, participants in the positive- and negative-belief treatments were debriefed about the true purpose of the study and informed as to the results of the sprints. During this debrief, they were encouraged to think about their own performance, and whether this was influenced via a placebo effect. Participants were provided with details of research that previously reported placebo effects in sport and exercise, and were informed that the effectiveness of sport supplements may be influenced by the placebo effect. A question and answer session followed, with participants encouraged to critically examine the need to use sport supplements, and to consider the role of placebo effects. Control participants were not shown the results of the sprints and received no

information about placebo effects in sport and exercise. Participants in all treatments then re-completed the pre-treatment measures, while participants in the positive- and negative-belief treatments completed additional open-ended, post-treatment questions.

6.2.5 Data analysis

Before the main statistical analyses, Confirmatory Factor Analysis (CFA) using AMOS 24.0 was used to test the factorial validity of the SSBS and the PEAS. In regards to the PEAS, five other versions have been suggested to have better model fit than the original 17 item version. Gucciardi et al. (2010) used an 11 and 8 item version, Vargo et al. (2014) an 8 item, Elbe and Brand (2016) a 6 item and Gucciardi et al. (2011) a 5 item. All versions of the PEAS scale were inputted into the analysis to test the factorial validity of each version of the PEAS. To assess model fit, Chi-square (χ^2), Tucker-Lewis Index (TLI), Comparative Fit Index (CFI), Root-Mean-Square Error of Approximation (RMSEA), Akaike Information Criterion (AIC) and the Expected Cross-Validation Index (ECVI) were used. Hu and Bentler (1999) suggest that good model fit yields values close to or greater than .95 for CFI and TLI, and values close to, or lower than .06 for RMSEA. The RMSEA 90% confidence intervals were also assessed to assist in interpreting point estimates. The AIC and ECVI do not have a specified acceptable value, but the lower the value amongst competing models is considered to be the most parsimonious.

One-way Analysis of Variance (ANOVA) and Chi-square (χ^2) tests were used to compare continuous (i.e. years training, hours per week training, PEAS, SSBS) and categorical (i.e. sex, age, ability, intention to use supplements) variables between treatments, respectively. To identify mains effects of the intervention, repeated measures ANOVA were conducted. Given that there may be “floor effects” with participants reporting low intentions prior to the beginning of the intervention (Backhouse et al., 2016; Ntoumanis et al., 2014), participants were divided by prior intentions to use sport supplements (i.e. not intending,

undecided and intending). A 2 (pre and post) × 3 (intention, attitude and belief) × 2 (intervention × pre-intention) repeated measures ANOVA was therefore performed. The Greenhouse–Geisser epsilon was reported when the sphericity assumption was violated and the LSD post-hoc analysis conducted to examine differences between means of significant differences and interactions. Cohen's *d* was calculated to determine effect sizes (*d*) of the mean differences and interpreted as 0.2 to < 0.5 = small effect, 0.5 to < 0.8 = moderate effect and ≥ 0.8 = large effect (Cohen, 1992). All data were analysed using SPSS version 23.0 (IBM, Armonk, NY, USA). Data are reported as means ± standard error of the mean (SEM), with the level of statistical significance accepted at $p \leq .05$.

Data from the open-ended, post-treatment questions were transferred to Excel, 2016 (Microsoft, Redmond, WA, USA) and inputted into NVivo 11 (QSR International Pty Ltd, Melbourne, Australia). All responses were read and re-read to establish main themes and emerging issues. A thematic content analysis was conducted, with data coded, indexed and organised into main themes. Throughout the analyses, connections were made between the main themes and the questionnaire change scores to gain a richer understanding of the effectiveness of the treatment.

6.3 Results

6.3.1 Model fit

Confirmatory Factor Analysis of the SSBS revealed good model fit ($\chi^2/df = 2.986$; TLI = .954; CFI = .980; RMSEA = .068, 90% CI = .039 to 0.098; AIC = 62.876; ECVI = 0.146). However, analysis of the 17 item PEAS model (Petróczi, 2006) revealed poor model fit (χ^2/df = 3.532; TLI = .861, CFI = .859; RMSEA = .073, 90% CI = .065 to .080; AIC = 488.259; ECVI = 1.015). Alternative models that have previously shown adequate model fit were tested and compared (Elbe & Brand, 2016; Gucciardi et al., 2010; Gucciardi et al.,

2011; Vargo et al., 2014). All alternative models showed better fit than the original 17 item model (Table 6.2). The model from Gucciardi et al. (2011) showed the best model fit and is used in subsequent analysis. The items remaining in the analysis were: “Athletes often lose time due to injuries and drugs can be used to help to make up the lost time,” “Athletes who take recreational drugs use them because they help them in sport situations,” “The risks related to doping are exaggerated; doping is an unavoidable part of competitive sport” and “There is no difference between drugs and the technical equipment that can be used to enhance performance (e.g. hypoxic altitude simulating environments).”

6.3.2 Preliminary analysis

No differences between treatment groups were observed for number of years training ($F_{(2, 561)} = 1.966$, $p = .137$), hours per week training ($F_{(2, 561)} = 0.408$, $p = .665$), sex ($\chi^2 = 5.28$, $p = .071$), intention to use supplements ($\chi^2 = 4.65$, $p = .098$), attitudes to doping ($F_{(2, 561)}$, $p = .536$) and beliefs about sports supplements ($F_{(2, 561)} = 0.017$, $p = .983$). Differences between treatments were shown for age ($\chi^2 = 21.99$, $p = .001$) and ability ($\chi^2 = 21.69$, $p = .001$).

6.3.3 Treatment score differences pre and post-intervention

Differences between pre- and post-scores for intention to use supplements ($F_{(2, 561)} = 10.012$, $p = .002$, $\eta^2 = 0.022$), attitudes to doping ($F_{(2, 561)} = 42.955$, $p < .001$, $\eta^2 = 0.090$) and beliefs about sport supplements ($F_{(2, 561)} = 19.065$, $p < .001$, $\eta^2 = 0.022$) were shown. LSD post-hoc analysis indicated that the positive- and negative-belief treatment scores decreased following the intervention for intentions (positive belief: $p < .001$, $d = 0.38$; negative belief: $p = .006$, $d = 0.23$), attitudes $d = 0.42$) and beliefs (positive-belief: $p = .001$, $d = 0.49$; negative-belief: $p < 0.001$, $d = 0.45$). Scores were similar between pre- and post-scores in the no-treatment control for intentions ($p = .613$; $d = 0.01$), attitudes ($p = .840$; $d =$

Table 6.2

Model fit indices for competing models of the Performance Enhancement Attitude Scale

Version	*n* of items	χ^2/df	CFI	TLI	RMSEA	Lower	Upper	AIC	ECVI
Petróczi (2006)	17	3.532	.859	.861	.073	.065	.080	488.259	1.015
Gucciardi et al. (2010)	11	2.860	.931	.914	.062	.050	.075	169.821	0.353
Gucciardi et al. (2010)	6	2.277	.961	.936	.052	.022	.081	44.493	0.093
Vargo et al. (2014)	8	1.554	.977	.978	.034	.000	.056	63.073	0.131
Elbe and Brand (2016)	6	2.048	.973	.956	.047	.014	.077	42.433	0.088
Gucciardi et al. (2011)	5	1.251	.995	.990	.023	.000	.070	26.253	0.055

note. CFI = Comparative Fit Index; TLI = Tucker Lewis Index; RMSEA = The Root-Mean-Square-Error of Approximation; Upper = RMSEA Upper 95% Confidence interval; Lower = RMSEA Lower 95% Confidence Interval; AIC = Akaike Information Criterion; ECVI = the Expected Cross-Validation Index

0.04) and beliefs (p = .773; d = 0.03). All differences in scores for each treatment are shown in Figure 6.1.

6.3.4 Treatment score differences pre- and post-intervention grouped by participants' pre-treatment intention to use sport supplements

Significant interactions between pre-treatment intention to use sport supplements and pre- and post-scores for intention to use sport supplements ($F_{(4, 554)}$ = 5.459, $p < .001$, η^2 = 0.046) and beliefs about sport supplements ($F_{(4, 554)}$ = 3.703, p = .006, η^2 = 0.034) were shown. No interaction was shown for attitudes to doping ($F_{(4, 554)}$ = 1.588, p = .176, η^2 = 0.014).

In the positive- and negative-belief treatments, intention scores increased following the intervention for those not intending to use supplements (positive: $p < .001$, d = 0.54; negative: $p < .001$, d = 0.58). However, intention scores decreased for those undecided (positive: p < $.001$, d = 0.59; negative: p = .030, d = 0.47) and intending to use sport supplements (positive: $p < .001$, d = 1.05; negative: $p < .001$, d = 0.90). No differences were identified following the intervention in the control treatment for those not intending (p = .617, d = 0.03), undecided (p = .349, d = 0.03), or intending to use sport supplements (p = .436, d = 0.04).

Following the intervention, beliefs about sport supplement scores decreased for participants intending to use supplements in the positive- ($p < .001$; d = 0.88) and negative-belief ($p < .001$, d = 1.00) treatments. No differences in belief scores were identified for controls (p = .773, d = 0.03). No difference in belief scores were identified for participants not intending or undecided about sport supplement use in the positive-belief (not intending: p = .221, d = 0.01; undecided: p = .100, d = 0.32), negative-belief (not intending: p = .525, d = 0.06; undecided: p = .134, d = 0.32) and control treatments (not intending: p = .829, d =0.02;

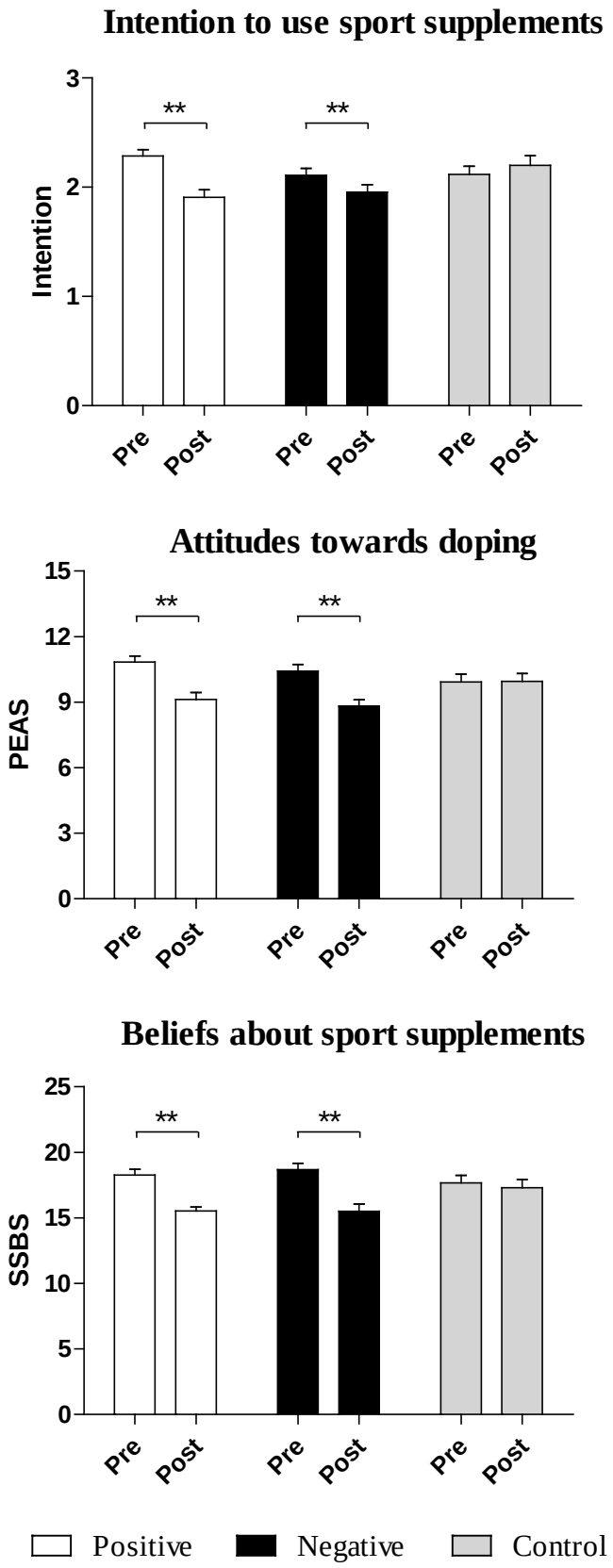

Figure 6.1. Scores pre- and post-intervention between treatments. *Note.* ** = $p < .01$; PEAS = Performance Enhancement Attitude Scale SSBS = Sports Supplements Beliefs Scale".

undecided: p = .741, d = 0.02). Scores pre- and post-treatment between each treatment grouped by participant's prior intention to use sport supplements are shown in Table 6.3.

6.3.5 Post-treatment open-ended questions

Response to open-ended questions indicated that post-treatment, the majority of participants were less likely to use sport supplements. Indicative responses from participants revealed that they believed supplements were "unnecessary" and that they "wouldn't use them after learning about the placebo effect." Many questioned the effectiveness of supplements and "doubted how much they actually work." Responses to open-ended items was consistent with responses to quantitative questionnaires (and with previous qualitative research investigating the effects of athletes experience of the placebo effect of a purported banned substances; Beedie, 2007), indicating that some participants were less likely to use sport supplements following the treatment:

> I take protein, creatine, glutamine and pre-workout. Since realising that they may not be necessary, I will now just eat a more balanced diet and use natural products etc. to aid recovery and help me train.

Consistent with the quote above, several participants indicated that instead of using sport supplements, they considered "moving away from supplements to a balanced diet" and "to put more thought into mental preparation." Participants stated that there was no "magic bullet" to improve performance:

Table 6.3

Pre and post-score differences between treatments and pre-intervention intentions to use sport supplements

Intention to use sport supplements scores (range = 1 to 3)							
Treatment	Pre intention	*n*	Pre	Post	Diff	*p*	*d*
Positive	*Not intending*	52	1.00 ± 0.00	1.39 ± 0.11	0.39 ± 0.11	< .001	0.53**
	Undecided	58	2.00 ± 0.00	1.65 ± 0.10	-0.35 ± 0.10	.001	0.59**
	Intending	115	3.00 ± 0.00	2.31 ± 0.07	-0.69 ± 0.07	< .001	1.05**
	Overall	225	2.26 ± 0.00	1.92 ± 0.06	-0.27 ± 0.06	<. 001	0.38**
Negative	*Not intending*	67	1.00 ± 0.00	1.28 ± 0.10	0.28 ± 0.10	< .001	0.58**
	Undecided	43	2.00 ± 0.00	1.73 ± 0.13	-0.27 ± 0.12	.030	0.47*
	Intending	89	3.00 ± 0.00	2.51 ± 0.08	-0.49 ± 0.08	< .001	0.90**
	Overall	199	2.16 ± 0.00	1.96 ± 0.07	0.20 ± 0.06	.006	0.23**
Control	*Not intending*	45	1.00 ± 0.00	1.06 ± 0.13	0.06 ± 0.13	.617	0.03
	Undecided	33	2.00 ± 0.00	2.12 ± 0.15	0.13 ± 0.15	.394	0.03
	Intending	61	3.00 ± 0.00	2.92 ± 0.10	-0.08 ± 0.10	.436	0.04
	Overall	139	2.19 ± 0.00	2.20 ± 0.09	0.01 ± 0.07	.613	0.01

Table 6.3 cont.

Performance Enhancement Attitude Scale (range = 6 to 30)							
Treatment	Pre intention	*n*	Pre	Post	Diff	*p*	*d*
Positive	*Not intending*	52	9.64 ± 0.64	8.52 ± 0.59	-1.12 ± 0.45	.023	0.31*
	Undecided	58	10.58 ± 0.62	9.04 ± 0.57	-1.53 ± 0.47	.001	0.49**
	Intending	115	11.33 ± 0.43	9.32 ± 0.40	-2.01 ± 0.33	< .001	0.45**
	Overall	225	10.77 ± 0.31	9.12 ± 0.29	-1.65 ± 0.25	< .001	0.40**
Negative	*Not intending*	67	9.55 ± 0.60	7.19 ± 0.56	-2.36 ± 0.46	< .001	0.59**
	Undecided	43	10.00 ± 0.74	8.71 ± 0.68	-1.29 ± 0.57	.024	0.42*
	Intending	89	11.51 ± 0.48	9.96 ± 0.44	-1.55 ± 0.37	< .001	0.38**
	Overall	199	10.60 ± 0.34	8.85 ± 0.31	-1.75 ± 0.27	< .001	0.42**
Control	*Not intending*	45	8.53 ± 0.67	8.74 ± 0.62	0.21 ± 0.51	.682	0.12
	Undecided	33	12.14 ± 0.90	11.67 ± 0.83	-0.48 ± 0.69	.491	0.15
	Intending	61	9.90 ± 0.57	10.37 ± 0.53	0.46 ± 0.44	.294	0.09
	Overall	139	9.78 ± 0.39	9.96 ± 0.36	0.07 ± 0.32	.84	0.04
Sports Supplements Beliefs Scale (range = 6 to 36)							
Treatment	Pre intention	*n*	Pre	Post	Diff	*p*	*d*
Positive	*Not intending*	52	13.68 ± 0.99	15.24 ± 1.15	1.56 ± 1.27	.221	0.09
	Undecided	58	17.04 ± 0.86	15.22 ± 1.00	-1.82 ± 1.10	.100	0.32
	Intending	115	21.64 ± 0.62	15.83 ± 0.72	-5.82 ± 0.79	< .001	0.88**
	Overall	225	17.45 ± 0.49	15.43 ± 0.56	-2.02 ± 0.62	.001	0.49**
Negative	*Not intending*	67	14.41 ± 0.83	15.08 ± 0.96	0.67 ± 1.06	0.525	0.06
	Undecided	43	18.87 ± 1.06	16.83 ± 1.22	-2.03 ± 1.35	.134	0.32
	Intending	89	22.19 ± 0.70	15.18 ± 0.81	-7.01 ± 0.90	< .001	1.00**
	Overall	199	18.49 ± 0.51	15.70 ± 0.58	-2.79 ± 0.65	< .001	0.45**
Control	*Not intending*	45	11.79 ± 0.93	12.05 ± 1.07	0.26 ± 1.19	0.829	0.02
	Undecided	33	18.46 ± 1.18	17.96 ± 1.37	-0.50 ± 1.51	.741	0.02
	Intending	61	20.95 ± 0.78	20.56 ± 0.90	- 0.38 ± 1.00	.703	0.02
	Overall	139	17.07 ± 0.57	16.86 ± 0.65	-0.21 ± 0.72	.773	0.03

Note. Data are means ± standard error of the mean; *d* = Cohen's *d;* * = $p < .05$; ** = $p < .01$.

> There is no easy way to increase fitness and performance. It is a case of persistent hard work and dedication towards a goal. It's more to do with a healthy diet than supplements, because supplements are probably a waste of money.

While qualitative data suggest that many participants would be less likely to use sport supplements, some believed they could still “feel the benefit from using sport supplements.” Participants believed that certain supplements “improve performance regardless” and have “proven benefits.” However, participants also reported that involvement in the study encouraged them to make “a more informed decision before using sport supplements.” Participants stated that they would “put more thought and research in before using supplements” and that they would “not take a supplement without looking into it.”

Participants also referenced the role of placebo effects in the effectiveness of sport supplements:

> I believe that some sport supplements have a desired effect, but this may be because of the placebo effect.

Although providing information about the placebo effect may have decreased the likelihood of participants using sport supplements, a small number of participants not intending to use supplements (6%) suggested that it could have encouraged them to use certain substances. For example, after learning about the placebo effect, one participant reported that “sport supplements may be more useful” whereas another suggested that the treatment may have influenced their decision to use supplements:

> It would influence me to take supplements, such as vitamins. If they improve my performance by my positive mind-set by taking them, and they also provide nutritional benefits, it's a win-win situation.

Finally, the treatment appeared to reaffirm many participants' pre-treatment decision to avoid sport supplements. Participants reported that the "testing has cemented their decision to not use supplements" and that the treatment was "an eye-opener." One participant mentioned that they were already aware of the placebo effect, but recognised the importance of educating other athletes:

> I know about the placebo effect and how it can make athletes believe supplements help. It has reaffirmed my beliefs not to use them and it would be good for other athletes to learn about.

6.4 Discussion

Study 2 of the research programme reported the results of a positive and negative placebo intervention on repeat sprint performance. The aim of this study was to examine participants' beliefs and intentions towards sport supplements and attitudes to doping after the placebo intervention. Results showed that after participating in a placebo intervention, participants reported lower scores for intention to use sport supplements, attitudes to doping and beliefs about the effectiveness of sport supplements. While the overall effect of the treatments appeared positive, this effectiveness was dependent on participants' pre-existing intention to use sport supplements. Although participants identified as intending to use supplements pre-treatment were less likely to use sport supplements post-treatment, those identified as not intending to use supplements pre-treatment were more likely to use supplements post-treatment.

Authors have suggested that informing athletes about the placebo effect may help to prevent doping in sport (Kalasountas et al., 2007; Maganaris et al., 2000; McClung & Collins, 2007). The present study has indicated that informing participants about the role of

placebo effects in the overall effectiveness of supplements can reduce the self-reported likelihood of participants using them. Following a brief educational intervention, participants in this study reported significantly reduced likelihood of future supplement use, whereas controls showed no changes in intention. Given the proposals of the gateway hypothesis, this could suggest that the placebo intervention presented in Study 2 might likewise reduce the risk of participants progressing to doping in the future.

Given the difficulty in detecting changes in questionnaire data for those with low intentions to use sport supplements, an important aspect of this study was the sub-analyses of participants by their pre-treatment intention to use sport supplements (i.e. not intending, undecided and intending). Participants intending and undecided about using sport supplements pre-treatment reported greater post-treatment reductions for intention, attitudes and beliefs (Figure 6.1). While open-ended questions revealed that some participants would still use sport supplements, participants mentioned that they would put more research into the effectiveness and safety of supplements prior to use. This could reduce the risk of participants using banned substances inadvertently, which occurs via sport supplements containing banned substances that are not declared on the label (Maughan, 2013).

For participants that were not intending to use sport supplements, data suggested potential boomerang effects of the treatment (i.e. an increased desire to use banned substances following a treatment aimed to prevent this; Elbe & Brand, 2016). Participants not intending to use supplements pre-treatment were more likely to use sport supplements post-treatment. Given the potentially significant influence of placebo effects on performance, some participants indicated that they could benefit from sport supplementation, albeit psychologically. While delivering information about the placebo effect to participants was aimed at reducing supplement use, data from this group of participants suggests that a placebo treatment may, in fact, encourage it. The knowledge participants received about the

effectiveness of sport supplements could, in part, explain this; it has been reported that users of banned substances have more knowledge about the effects of these substances than non-users (Wanjek, Rosendahl, Strauss, & Gabriel, 2007). This finding is similar to those relating to anti-smoking campaigns, in which greater awareness of the effects of smoking can increase smoking behaviour (Harris, Pierce, & Bargh, 2014). This suggests that involving non-users of banned substances in interventions designed to reduce incidence of use among those already using them may be counter-productive and in fact increase their likelihood of using these substances in the future.

A number of limitations must be considered with respect to the current study. The data relied on information collected via self-report measures, and it is recognised that there may be a difference between what some athletes say and what they really believe (Morente-Sanchez & Zabala, 2013). Secondly, only athletes above the age of 18 or older were recruited to the study. While it may be difficult to obtain ethical clearance for the use of a deceptive intervention on athletes under the ages of 18, future interventions should aim to educate adolescent athletes that are intending to use sport supplements, at a point in time at which they are arguably in a more formative stage of development, to maximise the impact of future banned substance use interventions.

In conclusion, for participants intending to use and undecided about sport supplements, a placebo intervention reduced the reported likelihood of use, and, given the gateway hypothesis, arguably reduced the risk of using banned substances in the future. Importantly, such an approach to prevention might adversely affect the behaviour of athletes not originally intending to use supplements. It is therefore important for researchers to assess participants' intention prior to an intervention aimed at preventing performance enhancing substance use.

Chapter Seven

GENERAL DISCUSSION

7.1 Introduction

The placebo effect has been of scientific interest in sport and exercise for nearly half a century. Ariel and Saville (1972) were the first to suggest that the placebo effect could have a significant impact on sports performance and since this publication, the evidence base in sport and exercise science has grown considerably. Saunders et al. (2017) reported that participants deceptively administered a placebo showed a 3.7% improvement in cycling mean power output when they believed they had ingested caffeine. Similarly, Ross et al. (2015) reported a 1.2% improvement in 3 km time-trial performance when participants self-administered saline injections believing it to be a performance enhancing substance. However, while evidence suggests that the placebo effect can have a significant influence on sports performance, the methods used in the majority of placebo effect studies make it difficult to estimate the true magnitude of its effect. Many of the studies do not include a no-treatment control, impeding differentiation between placebo effects and methodological/statistical artefacts (e.g. regression to the mean). In addition, most studies examining the placebo effect in sport are too small to facilitate reliable identification of variables associated with observed responses. This is problematic as the standard deviation of the dependent measure under investigation is often greater in experimental conditions than at baseline (Beedie & Foad, 2009). Thus if a placebo effect is observed, there is considerable inter-individual variability in the response to treatment which makes it difficult to estimate the true magnitude and moderators of the placebo effect on sports performance. An aim of this research was therefore to understand the magnitude and moderators of placebo effects on a large sample using a controlled randomised design in sport performance.

A second aim of this research was to explore the influence of a placebo intervention on an athlete's beliefs and intentions towards sport supplements and attitudes to doping. Numerous authors have made an explicit link between the placebo effect and doping

prevention in sport (Kalasountas et al., 2007; Maganaris et al., 2000; McClung & Collins, 2007). Maganaris et al. (2000) first suggested that placebo effect studies offer support for the prevention of banned substance use behaviours. Similarly, McClung and Collins (2007) argued that if athletes are made aware of the significant role placebo effects may have in the effectiveness of a substance, they might be less likely to use performance enhancing substances. Although evidence is anecdotal, it does hint at the possibility that if athletes experience, or are made aware of the placebo effect, they might refrain from using performance enhancing substances in the future. Evidence suggests that beliefs about sport supplements influence future sport supplement use behaviours (Dascombe et al., 2010) and that users of sport supplements are at risk of progressing to doping (Backhouse et al., 2013). Hypothetically, therefore, if athletes' beliefs about sports supplements influence current and future supplement use, and if current/future supplement use is a predictor of future doping, it is reasonable to suggest a relationship between current beliefs about supplements and future doping. Thus, this research aimed to empirically test the influence of a placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping. Assessment of athletes' beliefs requires a reliable and valid measure, therefore a further aim of this research was to develop and validate a psychometric instrument that could identify changes in athletes' beliefs following the placebo intervention.

7.2 Executive summary of findings

This research aimed to answer the following questions: 1) What is the magnitude of placebo and nocebo effects on the sprint performance of a large sample of athletes associated with the administration of a purported sport supplement? 2) What factors moderate observed placebo and nocebo effects in repeat sprint performance? and 3) What is the impact of a

placebo intervention on an athlete's beliefs and intentions towards sport supplements and attitudes to doping?

The main findings reported from the three studies include:

1. The Sports Supplements Beliefs Scale (SSBS) is a reliable and valid psychometric tool for assessing athletes' beliefs about sport supplements (Study 1)
2. A placebo deceptively presented as a sport supplement likely to have a positive effect on performance did not elicit a placebo effect on repeat sprint performance (Study 2)
3. A placebo deceptively presented as a sport supplement likely to have a negative effect on performance elicited a significant mean nocebo effect on repeat sprint performance (Study 2)
4. Intentions to use sport supplements moderated the placebo effect in repeat sprint performance (Study 2)
5. A placebo intervention significantly influenced participants' beliefs and intentions towards sport supplements and attitudes to doping (Study 3)
6. Participants not intending to use sport supplements prior to the placebo intervention were more likely to use them after the placebo intervention (Study 3)

The present discussion draws together the main findings from the three studies and focuses on the empirical and practical implications of: 1) placebo and nocebo effects on repeat sprint performance; 2) intention as a moderator of the placebo effect and 3) the influence of a placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping. Strengths and limitations of the research programme and directions for future research are also discussed.

7.3 Empirical and practical implications

The studies in this research extend previous empirical evidence of placebo effect research and have practical implications for sport practitioners and policy makers interested in both improving performance and preventing doping.

Study 2 examined the magnitude of placebo and nocebo effects on repeat sprint performance. Data suggested that performance was unaffected by receipt of a potentially beneficial supplement (i.e. no placebo effect was observed), but impaired by receipt of a potentially harmful supplement (i.e. a nocebo effect was observed). These findings differ from recent placebo effect research whereby significant improvements in sports performance have been shown (de la Vega et al., 2017; Ross et al., 2015; Saunders et al., 2017). Although, no mean placebo effect was observed, further analysis indicated that participant's prior intention to use supplements influenced the direction and magnitude of the placebo effect. That is, the performance of participants intending to use sport supplements improved, while it decreased for those not intending to use supplements. To the author's knowledge, this is the first study to report a relationship between intention to use sport supplements and the response to a placebo supplement.

The current research programme provides some evidence for the role of placebo effects in reducing the risk of athletes progressing to doping. Backhouse et al. (2013) indicated that sport supplement users may be more likely to use banned performance enhancing substances and that beliefs and intentions towards supplements may influence future supplement use. In Study 3 of this research programme, participants reported changes in their beliefs and intentions towards sport supplements and attitudes to doping following the placebo intervention described in Study 2. However, changes in intention to use sport supplements may be influenced by participants' prior intention to use them. That is, participants not intending to use sport supplements were more likely to use sport supplements

after the placebo intervention, whereas those intending and undecided were less likely. These results have potentially important implications for policy makers aiming to prevent future doping behaviours.

7.3.1 Magnitude of placebo and nocebo effects on repeat sprint performance

The difference in findings between Study 2 and Beedie et al. (2007) is possibly attributed to the inclusion of the no-treatment control. Inclusion of a no-treatment control facilitates more accurate identification of effects due to administration of the treatment as opposed to effects attributable to methodological artefacts or regression to the mean (Hróbjartsson & Gotzsche, 2003). In placebo effect studies that do not include a no-treatment control, researchers cannot be certain that the effects of the treatment are all positive, all negative, or whether any placebo and nocebo effects actually occurred. While it is acknowledged that an extra arm in study design requires additional resources, if researchers wish to understand placebo and nocebo effects, they must include a no-treatment condition or control potential confounds to generate accurate inferences about the magnitude, direction and mechanisms of these effects.

The finding of no mean placebo effect in Study 2 also runs counter to the findings of other placebo effect research in sports performance published to date (Table 2.1 p. 25). One explanation for this disparity may be the context in which the placebo treatment was administered. Figure 2.1 (p. 18) suggests that the effectiveness of a treatment can be influenced by the context in which it is administered. A treatment may be more effective when it is delivered in full view of the patient (Amanzio et al., 2001) and/or when the researcher administering it is caring and emphatic (Kaptchuk, Kelley, Conboy, et al., 2008). Participants in this study were informed and administered the treatment within a group. This method may have precluded the key components for eliciting a placebo effect (e.g. attention

to the participant, rapport between researcher and participant) and may have decreased the likelihood of participants responding to the treatment. The rapport and relationship between researcher and participant is arguably weaker during larger sample size studies when the attention given to each individual participant is reduced. In contrast, in smaller sample size studies (e.g. ~20), the opportunity to engage with each participant is greater, which may facilitate a more conducive context for eliciting placebo effects (Kaptchuk, Kelley, Conboy, et al., 2008). However, while the context may have been a limiting factor in eliciting a placebo effect in this research, the 712 athletes recruited far exceed the number of participants recruited in studies investigating the placebo effect on sports performance to date. In fact, of the placebo effect studies reported in Table 2.1 (p. 25), only 24 participants are recruited on average. In these smaller sample size studies, the variation of the dependent measure is often greater in experimental conditions than at baseline, which limits the ability to accurately identify the magnitude and mechanisms of the placebo effect. Generalising these findings can therefore be extremely difficult. A tension clearly exists between small sample size studies with greater control over context but difficulties in generalising findings, and large sample size studies with greater likelihood of generalising findings but less control over context. Given the aims of this study (i.e. to replicate the investigation of Beedie et al. 2007 and understand the magnitude of the placebo effect), a larger sample size was required, but it is recognised that this may have compromised the context in which placebo effect interventions are most effectively delivered.

While no mean placebo effect was identified in Study 2, a significant mean nocebo effect was. This may suggest that nocebo effects are more likely to occur than placebo effects. Providing a clear explanation for this is difficult. In a highly cited review, Baumeister, Bratslavsky, Finkenauer, and Vohs (2001) suggested that negative information has a stronger influence on behaviour than positive information. Rozin and Royzman (2001)

reported that “in most situations, negative events are more salient, potent, dominant in combinations, and generally efficacious than positive events” (p. 297). Although it has been suggested that there is a considerable bias towards the measurement of negative affect in psychology (Peterson & Seligman, 2004; Szalma & Hancock, 2017), it could be suggested from data reported in this research programme, that nocebo effects are more likely to occur than placebo effects, and that the brain responds to negative information more pertinently than to positive information. If this is correct, when participants in the negative-belief treatment were administered the “supplement” and informed it may have *a harmful effect* on performance, they may have paid more attention and processed the information more thoroughly than participants in the positive-belief treatment who were told that the supplement was beneficial. Consequently, during experimental sprint trials, participants in the negative-belief treatment may have had greater expectations of the impact of the treatment than participants in the positive-belief treatment. Participants may also have felt demotivated as a result of the information and subsequently performed worse. Either way, the fact that nocebo effects were more likely to occur than placebo effects highlights the importance of athlete support personnel being aware of the importance of how they communicate with their athletes during administration of a treatment.

To the author’s knowledge, this is only the third study to investigate the nocebo effect on sports performance. This paucity of evidence in relation to nocebo effects in sports performance is somewhat surprising given that, theoretically, negative information or beliefs about a legitimate treatment could offset some or all of the beneficial effects of that treatment. While it is unlikely that an athlete would use a treatment they believed was harmful to their performance, it does highlight that if an athlete does not fully believe in a treatment, they may not fully benefit from it.

The decrease in performance in the negative-belief treatment compared to the no control treatment in Study 2 of this research programme support the findings of Beedie et al. (2007) and Bottoms et al. (2013). These differences in performance could have significant implications for an athlete's performance where it has been noted that reductions in speed of 1% over a 20 m distance translate into distances of around 10-20 cm (Mujika, Padilla, Ibanez, Izquierdo, & Gorostiaga, 2000; Varley & Aughey, 2013). Therefore, changes in performance of this magnitude could have a significant influence during decisive match activities and on the outcome of a competition.

7.3.2 Intention to use sport supplements as a moderator of the placebo effect

It is generally accepted in placebo effect literature that the proportion of people that respond to a placebo treatment varies considerably from study to study. Identifying those who respond to a placebo treatment (i.e. placebo responders) is important for both clinical and applied practice. An aim of this research programme was therefore to examine potential moderators that influence the response to placebo and nocebo treatments. In Study 2, relationships between categorical variables (e.g. sex, sport supplement use, intention to use supplements) and repeat sprint performance in the positive and the negative belief treatment were examined. Although no mean placebo effect was observed, data from the positive-belief treatment suggested that the performance of participants intending to use supplements improved to a greater degree than the performance of those not intending to use supplements (Figure 5.3, p. 99). This relationship was observed only in the positive-belief treatment, suggesting that intention may moderate the placebo effect in this context and that the observed effect is not attributable to statistical or methodological artefacts.

To the author's knowledge, this is the first study to identify an association between intention to use a treatment and response to a placebo. Theoretically, intentions pertain to

volition to perform a given behaviour (Perugini & Bagozzi, 2004) and reflects how hard people are willing to try to enact that behaviour (Ajzen, 1991). In the context of the placebo effect and why intention may moderate the response to a placebo treatment, it is suggested that intention is heavily influenced by a person's belief (Fishbein & Ajzen, 1977). Thus, an athlete who is administered a placebo purported to be a treatment they believe in and intend to use, may be more likely to respond to that treatment.

These results have important implications for researchers and athlete support personnel invested in the efficacy and effectiveness of their treatments. Firstly, participants may not fully benefit from a treatment if they do not intend to use it. As highlighted in Figure 5.3 (p. 100), a significant nocebo effect on performance was observed for participants not intending to use sport supplements. This suggests that receipt of a "supplement" purported to have a beneficial effect on performance actually impaired that performance. While this scenario is unlikely in the real world (i.e. an athlete is unlikely to use a supplement they do not intend to use), in clinical settings, the situation might be quite different. For example, a person recruited to a clinical trial may not necessarily believe that the treatment under consideration will be effective, and this lack of belief may affect their intention to use it in the future and subsequently, adversely affect their response to it. Understanding participants' beliefs and intentions about a treatment may therefore serve to facilitate accurate estimation of the efficacy of a treatment, or at the very least help to explain an observed lack of efficacy. Participants identified as having negative beliefs and no intentions to use a treatment could be withdrawn from the study before assignment to the experimental treatment. While this does carry the risk of bias (i.e. a treatment works only in a predetermined or preselect group of people), it can help to offset potential nocebo effects that may confound accurate estimates of a treatment's efficacy (Shah & Pimentel, 2014).

The second important finding of this study relates to the influence of intention on the effectiveness of a placebo treatment. As shown in Figure 5.3 (p. 99), the performance of participants intending to use sport supplements in the positive belief treatment was significantly faster than the performance of those intending to use sport supplements in the control treatment. This suggests that athletes' intending to use supplements are more likely to respond to a placebo supplement. Using a placebo intervention could therefore be beneficial for athletes intending to use a treatment. However, to knowingly promote the benefits of a placebo through deception and false information is arguably unethical and counter to professional practice guidelines (Beedie et al., 2017). To put this into perspective, imagine an athlete falsely led to believe by their coach that they have ingested a potent sport supplement. While that athlete might produce a better performance than usual, that athlete - upon being debriefed or inadvertently finding out - might have less trust in their coach in future. In any athlete support personnel relationship (e.g. coach, physiotherapist, doctor) the need for trust and honesty is of paramount importance (Beedie et al., 2015).

Clearly, use of a deceptive placebo treatment in applied practice is unethical. However, placebo effect research has highlighted that, in many instances, there is considerable headroom to improve an athlete's performance by promoting the benefits of a treatment. If placebo effects are observed after the administration of a placebo, then this is arguably evidence of headroom between an athlete's baseline and potential (Beedie et al., 2017). Given the results of Study 2, intention may therefore influence the headroom for improvement after administration of a placebo, and arguably, from a legitimate treatment (e.g. sport supplement, training programme or physiotherapy). The extant placebo effect literature across disciplines suggests that the effects of a verum treatment are often the result of an interaction between the pharmacological (e.g. the drug) and psychological (e.g. the placebo effect) components of that treatment. In sport, if a coach administers a treatment to

an athlete, the psychological component of the treatment is influenced by the context in which it is administered, the person administering it, and the psychology of the athlete (e.g. personality, beliefs, and intentions). With respect to intention, if an athlete intends to use a treatment, the psychological component of that treatment may be maximised and the athlete may be more likely to exhibit an improvement in performance following receipt of that treatment. Intention to use a treatment could therefore be a strong component influencing how well, or not so well, a treatment works. On this basis, it is reasonable to suggest that athlete support personnel should endeavour to maximise the placebo effect component of a legitimate treatment by engendering a positive belief in its effectiveness. A positive belief in the efficacy of a treatment may increase intention to use (and to adhere) to that treatment, enhancing its effect. No deception is needed, it is simply applying an understanding of placebo effects to potentiate the response to a legitimate treatment.

7.3.3 Using a placebo intervention as an anti-doping intervention

The aim of Study 3 was to examine the influence of a placebo intervention on an athlete's beliefs and intentions towards sport supplements and attitudes to doping. Differences between pre and post intervention scores revealed a reduction in intention to use sport supplements, less favourable attitudes to doping and modified beliefs about the effectiveness of sport supplements. However, while the intervention appeared to be effective in reducing self-reported likelihood of supplement use, sub-analyses indicated that ~25% of participants not intending to use supplements before the intervention were *more likely* to use them after. These results have important implications for researchers and policy makers aiming to prevent doping in sport.

Given the difficulty in detecting changes in athletes' doping behaviour (see Box 2.1, p. 46), an important aspect of this study was the sub-analyses of participants by their pre-

treatment intention to use sport supplements (i.e. not intending, undecided and intending). The unintended consequence of the intervention increasing the likelihood of supplement use among participants with no intention to use sport supplements at the outset suggests that involving these participants in anti-doping interventions may be counterproductive and actually increase the likelihood of them doping in the future. While the data presented here only relate to this specific study, there is no reason to believe that the findings would be restricted to this style of intervention. James et al. (2010) reported that participants were more likely to use banned substances, such as EPO, after an intervention designed to reduce this behaviour and Elbe and Brand (2016) reported that athletes' attitudes to doping increased after an ethical decision making training intervention. Agencies responsible for the delivery of anti-doping interventions (e.g. UKAD, USADA, and WADA) should therefore not only consider the possibility that participants may be more likely to use doping substances following an anti-doping intervention, but should actively investigate the risk of promoting the behaviours they seek to prevent via evaluation and research.

Reasons for these unintended consequences could include priming and exposure to the use of sport supplements. Based upon associative models of human memory, it is suggested that a person's mind is made up of connecting links that are activated in response to a stimulus (Anderson & Bower, 2014). Research has shown, for example, that children can become more aggressive after exposure to interventions designed to reduce aggression, with Byrne, Linz, and Potter (2009) reporting an increase in aggressive thoughts after children watched violent video clips. The authors concluded that exposure to the stimulus increased the salience of aggressive thoughts and in turn, children's willingness to be aggressive. In the context of this study, administration of a "sport supplement" purported to influence sports performance may have primed participants with no intention to use sport supplements towards these supplements, increasing their likelihood of use.

With this in mind, the results of this study highlight the importance of assessing participants' intentions to use sport supplements prior to an anti-doping intervention. If the aim of the intervention is to discourage athletes' use of sport supplements, including athletes who have no, or minimal intention to use sport supplements may be unnecessary and potentially counterproductive. If an athlete with no intention to use sport supplements is involved in an anti-doping intervention, which exposes them to information and focuses their attention on sport supplements, they may be more willing to consider using them in the future. Thus, prior assessment of athletes' intentions could enable anti-doping facilitators to make more informed decisions about the necessity or appropriateness of an anti-doping intervention for a particular athlete.

While participants with no prior intention to use sport supplements reported an increase in their likelihood of using sport supplements, participants intending and undecided about using sport supplements exhibited a decrease in their intention (Table 6.3, p. 118). Specifically, these athletes reported lower scores on the Sports Supplements Beliefs Scale (SSBS) developed and validated in Study 1 after the placebo effect intervention.

Dietz et al. (2013) reported that banned substance use was significantly greater among athletes using sport supplements and Backhouse et al. (2013) reported that sport supplement users were three and a half times more likely to use banned substances than non-users. Therefore the extant evidence suggests that supplement use can increase the likelihood of doping and that athletes with stronger beliefs about sport supplements are more likely to use these supplements (Dascombe et al., 2010). Given these reported relationships, it is reasonable to suggest that athletes that do not believe in the effectiveness of sport supplements may be less likely to use supplements and doping substances and, in the context of this study, athletes with lower scores on the SSBS after the placebo intervention may be less likely to progress to banned substances. These results are supported by changes in

athletes' intentions to use sport supplements, as well as changes in their attitudes towards doping reported in Study 3 (Figure 6.1, p. 116).

Open-ended questions revealed that some participants would still use sport supplements following the intervention. However, a number of these participants reported that they would conduct more research into the efficacy and safety of a substance prior to use. This could reduce the risk of participants using a banned substance inadvertently, which occurs via sport supplements containing banned substances (Maughan, 2013). This is an increasing occurrence in sport, where in 2012, 44% of United Kingdom anti-doping rule violations were attributed to the use of sport supplements (SENr, 2016). International and national anti-doping organisations advocate that athletes evaluate and research the safety and effectiveness of any sport supplement prior to use (e.g. British Athletics). Athletes in this study reported greater due diligence with respect to researching supplements prior to their use, which may prevent them from using a banned substance unintentionally.

Although the results of this research demonstrate that a placebo intervention can influence athletes' beliefs and intentions towards sport supplements and attitudes to doping, it has not explicitly assessed or reported changes in sport supplement or doping use. An assumption of the Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) is that a change in belief, attitude and intention is evidence of a change in behaviour. However, the overall predictive power of these theories in explaining changes in behaviour is subject to debate (Sniehotta, Presseau, & Araujo-Soares, 2014). One of the most highly debated issues is the association between intention and behaviour, in which intention is argued to be the most proximal determinant of behaviour. While intention is often the largest and most reliable psychosocial predictor of behaviour, with meta-analyses showing medium to large effect sizes for, for example, alcohol use (r = .62; Cooke, Dahdah, Norman, & French, 2016), physical activity adoption (r = .48; McEachan, Conner, Taylor, Lawton, 2011)

and condom use (*r* = .49; Starfelt Sutton & White, 2016), a change in intention does not necessarily indicate a change in behaviour. As Sniehotta et al. (2014) state:

> The main focus of criticism has been the limited predictive validity of the TPB. Reviews clearly show that the majority of variability in observed behaviour is not accounted for by measures of the TPB. In particular, the problem of "inclined abstainers," individuals who form an intention and subsequently fail to act, has been a recognised limitation of the TPB that remains unaddressed by the theory (p. 2).

In fact, taking the average effect size of the three meta-analyses reported above (i.e. Cooke et al., 2016; McEachan et al., 2011; Starfelt Sutton & White, 2016), 74% of the variability is unexplained, which is problematic when intention is considered the gate through which all social cognitive variables must pass to affect behaviour (Rhodes & Rebar, 2017). It is perhaps not surprising that authors such as Sniehotta et al. (2014) have suggested the TPB should be effectively retired.

It is clear that the TRA and TPB do have limitations, with these limitations recognised by Ajzen and Fishbein (1975; 1985) decades ago. However, despite such limitations, these theories have been shown to accurately predict a number of different health behaviours (e.g. physical activity, smoking and doping) and have made a considerable contribution to explanations for a variety of different behaviours. Conner (2015) suggested that the information gained from these theories should be used to identify key determinants of intentions and behaviour, and such an approach has been effectively used to demonstrate how non-conscious/automatic processes (Rebar et al., 2016; Sniehotta, 2009) and volitional factors (Bélanger-Gravel et al., 2013; Schwarzer, 2008) influence intention and behaviour. More specifically, and within the doping literature, this approach has been used to

demonstrate that performance enhancing substance use is rooted in two different kinds of thinking: fast and automatic processes influenced by emotional factors, and slower, reasoned processes consciously monitored by the intention to perform the behaviour (Baumgarten, Lucidi, Mallia, Zelli, & Brand, 2016).

In the context of Study 3 of this research, it is recognised that a change in intention to use sport supplements does not necessarily indicate a change in supplement use, however, it does indicate a change in a central construct in the processes in which people engage in prior to supplement use. The results of Study 3 therefore have important implications for researchers and policy makers aiming to reduce athletes' risk of doping. An important consideration for future research is to assess whether there are any other determinants of intentions or behaviours that are not currently considered by the TRA or TPB. This research should seek to assess the amount of variance explained by other variables, the extent to which they overlap with existing variables, and their value across other types of behaviour.

7.4 Limitations

This research has provided evidence of the magnitude and moderators of placebo and nocebo effects on repeat sprint performance. In addition, it has shown that a placebo intervention can significantly influence athletes' beliefs and intentions towards sport supplements and attitudes to doping. However, these findings need to be interpreted in light of a number of limitations.

Given that there is no universal definition of a sport supplement (Knapik et al., 2016; Maughan et al., 2018), participants' responses to questions related to supplement use may have varied. While a brief definition of sport supplements was provided before participants responded to the relevant sport supplement questions (Appendix, pg xx), this may not have reflected participants understanding of a sport supplement, which in turn may have

influenced responses. In light of this, the validity of the SSBS (developed and validated in Study 1) may be limited and caution should be given to any inferences made from the use of this scale.

The context in which the treatment was administered in Study 2 may not have been optimal for eliciting placebo effects. Placebo and nocebo effects are influenced by a range of individual and psychosocial factors, including expectation; previous experiences; the interaction between participant and researcher; trust; empathy; and the ritual surrounding the administration (Benedetti, 2013). It is recognised that conducting the placebo intervention and administering the treatment in a group setting in Study 2 may not have been the most appropriate context by which to induce placebo effects.

This research examined the influence of a purported sport supplement and not that of a legitimate treatment (e.g. sport supplement, cold-water immersion and physiotherapy). While the results of Study 2 suggest that intention influenced the effects of a placebo treatment, these effects may operate somewhat differently in the presence of a legitimate treatment. Foad et al. (2008) speculated that when a treatment is received, participants are consciously or unconsciously responding to the subtle-cues that might suggest its presence. Thus, in a study where both verum and placebo treatments are administered, the participant's intention may change during the course of the study when they are in a position to make a comparison between the two treatments.

In placebo effect research a key methodological characteristic is that participants are led to believe that the treatment they receive will influence their performance. However, some participants in Study 2 may not have believed the information they received about the purported sport supplement. This may therefore have resulted in no change in their performance. Hulston and Jeukendrup (2009) reported no placebo effect on cycling performance after the ingestion of water informed to be carbohydrate, and Bottoms et al.

(2014) reported no change in peak minute power during incremental arm crank geometry after the ingestion of a 500ml “fatigue inducing” drink. Thus, while participants were administered a placebo coupled with information about its effectiveness, they may not have believed this information, which in turn may have resulted in no change in performance.

The results of Study 3 reflect assessment of athletes’ beliefs, attitudes and intentions immediately before and after the intervention; no follow-up assessment was conducted. It is therefore not possible to provide any indication of the impact of the intervention on athletes’ beliefs, attitudes and intentions over time. An absence of longitudinal study is evident in most anti-doping education intervention evaluations (Backhouse et al., 2016) and the lack of follow-up measures makes it impossible to determine whether changes are sustained. A further limitation relates to the age of participants sampled in Study 3 (>18). Interventions should ideally be targeted at adolescence (11 to 17), a formative period in the development of attitudes and beliefs (Elbe & Brand, 2014). Delivering the intervention at this stage of development may have a greater and more sustained impact on an athlete’s beliefs and intentions towards sport supplements and attitudes to doping.

7.5 Future research directions

Where possible, future research should aim to include no-treatment controls alongside placebo and experimental treatments. Inclusion of a no-treatment control is vital to enable researchers to accurately differentiate between effects due to a placebo and those due to methodological/statistical artefacts. The results of Study 2 in this research programme highlight that without no-treatment controls, the results of placebo and nocebo effect studies could be misinterpreted. Including no-treatment controls will not only improve the validity and reliability of findings from placebo effect research; it will also help to increase our

understanding of role of the placebo effect in the outcomes of treatment, an understanding that could have a significant influence on both research and applied practice.

Secondly, the finding that intention moderates the placebo effect in Study 2 was only shown after a single placebo administration. It could be argued that participants who respond to a particular placebo treatment may not respond in a similar way to subsequent administrations. Reproducibility of participants' response to a placebo treatment is subject to debate (Horing et al., 2014; Kaptchuk, Kelley, Deykin, et al., 2008) and there is a lack of evidence to suggest that whatever predicts a placebo effect on one occasion will be predictive on another. Future research should aim to replicate the findings from Study 2 of this research and determine if intention accurately and reliably predicts the placebo effect across multiple placebo administrations.

While it has been recognised for some time that the placebo effect could be used as a vehicle to prevent substance use behaviours (Beedie, 2007; Kalasountas et al., 2007; Maganaris et al., 2000; McClung & Collins, 2007), to the authors knowledge, Study 3 of this research programme is the first to empirically test whether a placebo intervention can influence an athlete's beliefs and intentions towards sport supplements and attitudes to doping. However, future research is needed to extend this research and determine the extent to which a placebo intervention influences future doping *behaviours*, challenging though this is recognised to be. Furthermore, and in light of the finding that around a quarter of participants with no intention to use supplements prior to the placebo intervention reported they were more likely to after the intervention, future research is needed to determine the effectiveness of other types of anti-doping interventions. It is possible that other anti-doping education interventions elicit similarly unintended effects, but this proposition remains untested. International (e.g. WADA, IAAF and UCI) and national (e.g. UKAD, USADA and ASADA) anti-doping organisations implement educational interventions worldwide but there

is little evidence regarding the efficacy of these interventions. Future research should prioritise the evaluation of anti-doping educational interventions to ensure they are achieving their objectives.

7.6 Conclusion

This research programme investigated the magnitude and moderators of the placebo and nocebo effect on sport performance and the impact of a placebo intervention on athletes' beliefs and intentions towards sport supplements and attitudes to doping. Data from Study 2 of this research suggest that on average the ingestion of a purported sport supplement does not improve performance (i.e. no mean placebo effect was observed), but can significantly impair it (i.e. a mean nocebo effect). These findings run counter to the majority of placebo effect research reported elsewhere, which suggest both placebo and nocebo effects significantly influence sports performance. An explanation for the difference in findings may be attributed to the inclusion of the no-treatment control, which facilitates more accurate identification of effects. Although no mean placebo effect was observed, results indicated that athletes' intention to use sport supplements influenced the direction and magnitude of subsequent placebo responses, with athletes intending to use supplements more likely to respond to a placebo intervention. These results highlight the significant contribution intention may have in the effectiveness of a treatment and have particular relevance for sport practitioners and researchers invested in the efficacy of a treatment and the validity of an intervention respectively.

The results of this study also highlight the significant impact of a placebo intervention on athletes' beliefs and intention to use sport supplements and attitudes to doping. While a placebo intervention appeared to be effective in reducing the self-reported likelihood of supplement use, sub-analyses indicated that approximately one quarter of participants not

intending to use supplements prior to the intervention were *more likely* to use them afterwards. This highlights the potential risk of administering anti-doping interventions to athletes not intending to use supplements, as exposure may increase sport supplement use and their risk of progressing to doping. Anti-doping interventions designed to reduce incidence of substance use among those not intending to use them may therefore be counter-productive. These findings have potentially important implications for the interventions used by policy makers and national governing bodies, and suggest that it is important to assess participants' intention prior to any intervention aimed to reduce performance enhancing substance use.

Chapter Eight

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Chapter Nine

APPENDICES

Appendix 1 – Participant information sheet and informed consent for Study 1 (phase 1)

Information Sheet and informed consent

Validation of the Sports Supplements Beliefs Scale

Thank you for showing an interest in this research project. Please read the information below carefully and decide if you would like to participate.

Participant Information

This research will be conducted by Philip Hurst as part of a PhD at Canterbury Christ Church University.

Background

Doping in sport is a widespread occurrence across all Olympic events. The World Anti-Doping Agency aims to prohibit doping behaviour through medical, analytical and physiological investigations. However, it also includes prevention and education investigations through understanding athlete's intentions, attitudes and beliefs about banned performance enhancing substances. Research now suggests that athletes who use non-banned sport supplements are more likely to progress to banned substance. It is proposed that athletes who hold a positive belief towards banned substances will be more likely to use such substances. However, measuring athletes' beliefs using a validated questionnaire has not been

achieved. This interview is therefore aimed at understanding athlete's beliefs towards sport supplements.

What is the aim of this research?

This research is aimed to understand athlete's beliefs about sport supplements through semi-structured interviews. The semi-structured interviews will allow an in-depth understanding of athlete's beliefs towards sport supplements, and what causes and shapes these beliefs. The research undertaken is part of a PhD in Sport and Exercise Science, and forms the first part for validating a questionnaire.

What will be required from this session?

If you agree to take part, you will be asked to attend a semi-structured interview that will last approximately 30 to 60 minutes at Canterbury Christ Church University. The session will be aimed at understanding your beliefs towards sport supplements and what influences your beliefs to use these substances. There will be a variety of questions for you to answer in your own time. If you do not wish to answer any questions, this is entirely acceptable and you may leave the interviewing process at any time. All interviews will be audiotaped to ensure all phrases are recorded. Once data has been recorded, you will be sent an email copy of the transcript, to allow you to read what was said. You will be given the opportunity to add, delete or make changes to the transcript if you wish.

Typical questions will include:

- Please could you describe what you believe to be a sport supplements
- Please tell me any experience you may have had with sport supplements
- Please describe your decision to either use, or not use, sport supplements

Confidentiality

All information collected by the researcher will be stored securely in accordance with the Data Protection act (1998) and the University's own data protection requirements. You will

be given a copy of the transcript and have the opportunity to adapt, change or delete any statements you have made until the transcript is shared with the research team. All personal data e.g. names and email addresses, will be removed and you will be given a unique character I.D. Dr Abigail Foad, Dr Damian Coleman and Dr Chris Beedie will then be given access to the data once all personal information is removed. The transcript shown to the research team and any other third parties will not indicate any information identifiable to you. For example, if you were a 1500m runner with a personal best of 3:41 that lives in Kent, this information will be transcribed as: The athlete is involved in an individual sport, is national standard and resides in the South East of England. No personal information e.g. email address or date of birth, will be shared publicly.

Dissemination of results

The results will help formulate and shape a questionnaire to understand athlete's beliefs towards sport supplements. No information that could identify an individual will be contained in the questionnaire. The results obtained through the interview may be disseminated through journal articles, conference proceedings/posters and thesis.

If you have any questions or queries regarding the study please do not hesitate to contact me. If you are willing to participate, you will be free to withdraw at any time without reason.

Philip Hurst
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Department of Sport Science, Tourism and Leisure
Canterbury Christ Church University
North Holmes Road
Canterbury
Kent CT1 1QU
01227 767 700 (extension 3130)
Email: Philip.hurst@canterbury.ac.uk

Informed Consent

I have read the following information sheet concerning this research and understand what the study entails. All my questions have been answered to my full satisfaction and I understand that I am free to leave at any stage during this study.

I fully recognise what is expected of me from this study and understand that my results will be used for academic purposes. I know that I am able to ask any questions regarding the procedure. I understand why the interview will be recorded and I know how the information will be used. I am aware I can adapt or change my transcript once it has been transcribed.

I …… have read the information above and fully understand what is expected of me in this study. I am now ready to take part in the research process.

Participant's signature
Signed: ..... *Date*: ...../...../.....

Researchers Signature
Signed: ..... *Date*: ...../...../.....

Appendix 2 – Social media recruitment poster for Study 1 (phase 1)

PhD research project at Canterbury Christ Church University is investigating athletes' beliefs towards sport supplements.

If you are an athlete over the age of 18, and have played at a competitive level (country or above) please get in touch. All is required is a discussion about sport supplements in person or over Skype.

This study is not solely interested in athletes that use sport supplements, non-users are encouraged to also participate

For more information please contact:

Phil Hurst
philip.hurst@canterbury.ac.uk
@Phil_Hurst1

Canterbury Christ Church University

Appendix 3 – Interview questions used in Study 1 (phase 1)

Layout of interview

Demographic information

1. What is your age?
2. What sport do you compete in?
3. Do you compete for individual or team purposes? Or both?
4. What is the highest level of competition you have competed for?
    a. School
    b. Local or club level
    c. County
    d. Regional
    e. National
5. How many years have you been training?
6. How many hours a week do you train?
7. What is your highest level of education?
    a. High school
    b. College
    c. University
    d. Postgraduate

Sports supplements beliefs

1. Please could you describe what you believe to be a sport supplement
2. Please tell me any experience you may have had with sport supplements
3. Please could you describe your beliefs about sport supplements
4. Do you feel sport supplements are necessary?
5. Please describe your decision to either use, or not use sport supplements
6. If you feel there are any influences to use, or not use, sport supplements, please describe them
7. If you have experienced any of the following, please could you detail
    a. A teammate's experience of using sport supplements
    b. A coach's experience of sport supplements
    c. A competitor's experience of using sport supplements
8. After a competition or training session when you have used sport supplements, could you describe it?
    a. If you have not used sport supplements during training or competition, but felt on an occasion that it may have been beneficial, please describe it
9. Tell me about sport supplements you are aware of
10. Claims are often made about sport supplements, how do you feel about the claims made?
    a. How have these claims influenced your beliefs about sport supplements
11. If you feel sport supplements enable you to perform better than usual, please describe it
12. 'Sport supplements are necessary to reach your athletic potential' – how do you feel about this statement?
13. Please describe a situation where you feel you maybe more likely to use a sport supplement
14. Please describe any other experiences of when you have, or have been tempted to use sport supplements?
15. Are there any other aspects of your experiences of sport supplements, that have not been discussed, you would like to tell me about?

Appendix 4 – Example email to experts for Study 1 (phase 2)

Dear (Experts name)

I am a PhD researcher at Canterbury Christ Church University where I am investigating athletes' beliefs towards sport supplements. You have been identified as an expert in this field and I was wondering if you would be able to evaluate an instrument for content validity that has recently been developed.

Myself and my research supervisors have created an initial instrument of 26 items that we think pertain to athletes beliefs about sport supplements. These items were generated through interviewing athletes' about the reasons they use sport supplements. The next stage would be to obtain expert opinion and determine the validity of each item.

If you choose to evaluate the instrument could you please click on the link below and follow the instructions. I would appreciate any comments (positive and negative) you may have for each item and encourage you to be as honest and critical as possible.

Athlete Belief Questionnaire

If you have any questions, please don't hesitate to contract me.

Thank you,

Philip Hurst
Canterbury Christ Church University
philip.hurst@canterbury.ac.uk
+44 (0)1227 767700 Ext 3130

Appendix 5 – Expert survey used in Study 1 (phase 2)

Beliefs about Sports Supplements

Questionnaire

Thank you for taking part in this research project.

The questionnaire you have been asked to evaluate aims to understand athletes' beliefs towards sports supplements (e.g. whey protein, caffeine, and creatine).

Twenty six items are included in the measure and relate to athletes use of sports supplements, whether they believe these substances influence performance and if they believe sports supplements are necessary for training and competition. The measure requires athletes' to respond to each item on a 6 point Likert-type scale ranging from strongly disagree to strongly agree. No neutral point is offered, with a high score indicating a positive belief towards sports supplements and a low score indicating a negative belief.

Please rate the relevancy of each item from 1 to 4 (1 = not relevant to 4 = highly relevant). After each item, there is space provided for any other comments you may have.

If you have any further comments relating to each item or general structure and coherence of the measure, please use the free text boxes provided at the bottom of the webpage.

Beliefs about Sports Supplements

Please read each question carefully and specify your level of agreement (between “not relevant and “relevant”) with the following:

1. **Sport supplements improve my performance**

   □ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

   Specific comments:

2. **Sports supplements are necessary for me to be competitive**

   □ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

   Specific comments:

3. **Sport supplements help me make up for lost time during injury**

   □ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

   Specific comments:

4. **Sports supplements improve my confidence**

   □ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

   Specific comments:

5. **My chances of winning improve when I use sports supplements**

   □ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

   Specific comments:

6. **Sport supplements help me realise my potential**

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

7. **Sports supplements are necessary for me to perform**

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

8. **Sport supplements reduce fatigue from performing**

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

9. **Sports supplements allow me to improve the quality of my training**

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

10. **Sports supplements reduce the pain I feel**

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

11. **A higher consumption of sports supplements is needed to manage higher training loads, maximise recovery and improve performance**

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

12. Sports supplements improve my recovery

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

13. Athletes using sports supplements are usually the ones who medal at major championships

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

14. I don't perform well when I have used sports supplements

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

15. I am more in control of my performance when I use sports supplements

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

16. Sports supplements provide a greater improvement compared to a healthy diet

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

17. My training is compromised when I use sports supplements

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

18. I don't believe sports supplements improve my performance, but I take them just in case

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

19. Sports supplements have more of an effect on elite level athletes

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

20. Sports supplements are just the same as having the most up to date equipment

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

21. Sports supplements reduce my anxiety

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

22. Sports supplements used by other athletes gives them an advantage

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

23. I am satisfied with the outcomes sports supplements have on my performance

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

24. I am optimistic about my performance when I use sports supplements

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

25. Training increases the need for sports supplements

□ Not relevant □ Somewhat relevant □ Quite relevant □ Highly relevant

Specific comments:

26. Are there any questions relating to the instrument that you feel are missing?

27. Are there any other comments or concerns you have about the instrument?

Thank you

Thank you for evaluating the questionnaire.

I am very grateful for your responses and taking the time to complete it.

If you have any questions or queries about the research or measure, please do not hesitate to contact me.

Phil Hurst
Canterbury Christ Church University
philip.hurst@canterbury.ac.uk

Appendix 6 – Athlete survey used in Study 1 (phase 2)

Beliefs about Sports Supplements Scale

Thank you for considering taking part in this research project.

My name is Phil Hurst and I am a PhD researcher at Canterbury Christ Church University. I was wondering if you would be interested in evaluating a questionnaire that aims to understand athletes' beliefs about sport supplements (e.g. protein shakes, caffeine, creatine).

The questionnaire has initially been developed and it would be useful to gain feedback about the clarity and conciseness for each question.

The research takes part in two stages:

- The first stage will require you to complete the questionnaire that assesses your beliefs about sport supplements.
- The second stage asks you to comment about the questionnaire and if there are any improvements or amendments you feel are necessary

This process is completely voluntary and if you choose to accept you may withdraw from the study at any time. Consent will be taken once you have completed the questionnaire.

If you have any questions or would like more information about the study, please do not hesitate to contact me.

Philip Hurst
philip.hurst@canterbury.ac.uk

Demographic information

1. **What is your gender**

   □ Female □ Male

2. **What is your age**

   □ Under 18 □ 35 to 44 □ 65 to 74

   □ 18 to 24 □ 45 to 54 □ 75 or older

   □ 25 to 34 □ 55 to 64

3. **What sport do you compete in?**

4. **What event or position?**

5. **What is your highest level of competition**

6. **How many years have you been training?**

7. **How many hours a week do you train?**

8. **What is your highest level of education?**

   □ High school □ MSc University degree or equivalent

   □ College/A-level □ PhD

   □ BSc University degree or equivalent

Sport Supplement Use

Sport supplements are substances used by athletes with the belief that they will improve or facilitate athletic performance (e.g. Lucozade, multi-vitamins, caffeine, and creatine).

1. **Do you use sport supplements?**

   □ Yes □ No

2. **If yes, please select which sport supplements you use**

   □ B-Alanine □ Creatine □ Protein shakes

   □ Beetroot juice □ Electrolytes □ Vitamins and minerals

   □ Caffeine □ Energy gels

   Other (please specify):

3. On average, how often do you use sport supplements?

   □ Never □ Monthly □ Weekly □ Daily

Beliefs about Sport Supplements

Please read each question carefully and specify your level of agreement (between “not relevant and “relevant”) with the following:

1. **Sport supplements improve my performance**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

2. **Sports supplements are necessary for me to be competitive**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

3. **Sport supplements help me make up for lost time during injury**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

4. **Sports supplements improve my confidence**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

5. **My chances of winning improve when I use sports supplements**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

6. **Sport supplements help me realise my potential**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

7. **Sports supplements are necessary for me to perform**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

8. **Sport supplements reduce fatigue from performing**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

9. **Sports supplements allow me to improve the quality of my training**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

10. **Sports supplements reduce the pain I feel**

    □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

11. **A higher consumption of sports supplements is needed to manage higher training loads, maximise recovery and improve performance**

    □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

12. Sports supplements improve my recovery

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

13. Athletes using sports supplements are usually the ones who medal at major championships

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

14. I don't perform well when I have used sports supplements

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

15. I am more in control of my performance when I use sports supplements

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

16. Sports supplements provide a greater improvement compared to a healthy diet

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

17. Supplements are a substitute for hard work

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

18. My training is compromised when I use sports supplements

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

19. I don't believe sports supplements improve my performance, but I take them just in case

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

20. Sports supplements have more of an effect on elite level athletes

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

21. Sports supplements are just the same as having the most up to date equipment

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

22. Sports supplements reduce my anxiety

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

23. Sports supplements used by other athletes gives them an advantage

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

24. I am satisfied with the outcomes sports supplements have on my performance

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

25. I am optimistic about my performance when I use sports supplements

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

26. Training increases the need for sports supplements

□ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

Questionnaire Evaluation and Feedback

1. **Are there any questions you find difficult to understand or interpret?**

   □ Yes □ No
   If yes, which questions?

2. **Are there any questions that you feel are missing and need including?**

   □ Yes □ No
   If yes, what questions could be included?

3. **Did you find yourself becoming bored while doing the questionnaire?**

   □ Yes □ No
   If yes, what could be changed?

4. **Are there too many or too few questions?**

   □ Yes □ No
   If yes, how many questions would be more appropriate?

5. **Is there anything about the questionnaire that you feel needs changing?**

   □ Yes □ No
   If yes, what should be included?

6. **Is there anything else you feel may need to be included?**

   □ Yes □ No
   If yes, what should be included?

7. **Do you think that this questionnaire assess athletes' beliefs about sport supplements**

   □ Yes □ No
   Any others comments?

8. **Are there any other comments you have about the questionnaire?**

Thank you

Thank you for completing the questionnaire.
I am very grateful for your responses and taking the time to complete it.

If you know anyone else that would be interested in taking part in the research, could you please forward them the link below:
https://www.surveymonkey.com/s/Athletesbeleifs

If you have any questions or queries about the research or questionnaire, please do not hesitate to contact me.

Phil Hurst
Canterbury Christ Church University
philip.hurst@canterbury.ac.uk

Appendix 7 – 11 item questionnaire survey for Study 1 (phase 3)

Introduction

Thank you for considering taking part in this research project.

My name is Phil Hurst and I am a PhD researcher at Canterbury Christ Church University. I am conducting a research project aimed at understanding athletes' beliefs about sport supplements

The research will ask a series of questions about your use and beliefs of sport supplements (e.g. caffeine, creatine and beetroot juice) and will take no longer than 10 minutes.

All information collected will be used for research purposes only.

Note: This research is open to anyone who is over the age of 18. Pease do not complete if you are younger as your information will not be use

Demographic information

9. What is your gender

□ Female □ Male

10. What is your age

□ Under 18 □ 35 to 44 □ 65 to 74

□ 18 to 24 □ 45 to 54 □ 75 or older

□ 25 to 34 □ 55 to 64

11. What sport do you compete in?

12. What event or position?

13. What is your highest level of competition

14. How many years have you been training?

15. How many hours a week do you train?

16. What is your highest level of education?

□ High school □ MSc University degree or equivalent

□ College/A-level □ PhD

□ BSc University degree or equivalent

Sport Supplement Use

Sport supplements are substances used by athletes with the belief that they will improve or facilitate athletic performance (e.g. Lucozade, multi-vitamins, caffeine, and creatine).

4. **Do you use sport supplements?**

   □ Yes □ No

5. **If yes, please select which sport supplements you use**

   □ B-Alanine □ Creatine □ Protein shakes

   □ Beetroot juice □ Electrolytes □ Vitamins and minerals

   □ Caffeine □ Energy gels

   Other (please specify):

6. On average, how often do you use sport supplements?

   □ Never □ Monthly □ Weekly □ Daily

Beliefs about Sport Supplements

Please read each question carefully and specify your level of agreement (between “not relevant and “relevant”) with the following:

1. **Sport supplements improve my performance**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

2. **Sports supplements are necessary for me to be competitive**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

3. **Sports supplements improve my confidence**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

4. **My chances of winning improve when I use sports supplements**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

5. **Sport supplements help me realise my potential**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

6. **Sports supplements allow me to improve the quality of my training**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

7. **Athletes using sports supplements are usually the ones who medal at major championships**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

8. **Sports supplements provide a greater improvement compared to a healthy diet**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

9. **Sports supplements are the same as having the best equipment**

   □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

10. **Using supplements make me optimistic about my performance**

    □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

11. **Training increases the need for sports supplements**

    □ Strongly disagree □ Disagree □ Slightly agree □Slightly agree □ Agree □Strongly agree

Thank you

Thank you for completing the questionnaire.

I am very grateful for your responses and taking the time to complete it.

If you have any questions or queries about the research or questionnaire, please do not hesitate to contact me.

Phil Hurst

Canterbury Christ Church University

philip.hurst@canterbury.ac.uk

Appendix 8 – Sports Supplements Beliefs Scale (SSBS)

Sports Supplements Beliefs Scale

Please read each statement carefully and specify your level of agreement (between 'strongly disagree' to 'strongly agree') with the following:

		Strongly Disagree	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1	Supplements improve my performance	1	2	3	4	5	6
2	Supplements are necessary for me to be competitive	1	2	3	4	5	6
3	Supplements improve my confidence	1	2	3	4	5	6
4	My chances of winning improve when I use supplements	1	2	3	4	5	6
5	Supplements help me realise my potential	1	2	3	4	5	6
6	Supplements improve the quality of my training	1	2	3	4	5	6

Appendix 9 – Information sheet and informed consent for Study 2 and 3

Information sheet

Attitudes and sport supplements

Thank you for considering taking part in this research. Please read all the information carefully and decide whether you would like to take part in this study.

What is the aim of the research?

The main aim of this research is to determine the effectiveness of inorganic nitrate during repeat sprint performance. A secondary aim is to understand your attitudes towards sport supplements. This research is being undertaken as part of the requirements of a PhD in Sport and Exercise Science.

What will happen during the research?

You will then be asked to complete two questionnaires that aim to determine your beliefs and attitudes towards performance enhancing substances.

After the presentation you will complete a standardised warm up and perform 5 x 20m repeat sprints. These sprints will be run at maximal intensity, with a 2 minute rest in between sprints. Following completion of the first set of sprints you will you receive the supplement, which has been shown to influence repeat sprint and endurance performance. Once you have received the supplement, a 20 minute 'break' will follow that will include light exercise before performing the final set of 5 x 20m sprints.

On completion of the second 20m sprints, you will be debriefed about the results of the study. To understand the variation of beliefs and attitudes about performance enhancing supplements, you will be asked to complete the same belief and attitude questionnaires that you completed earlier in the session.

What are the benefits?

For an athlete, this is a rare opportunity to benefit from involvement in a research project that is at the forefront of sports medicine. This is one of the first research studies investigating the effects this supplement has on repeat sprint performance. There is also the opportunity to determine your acceleration and speed over a 20m sprint and your endurance capabilities of repeating this over a short period of time. This could give you an understanding of the areas you may need to improve to allow you to perform to a higher standard.

Are there any risks and discomforts?

The supplement should pose no health risks or discomfort. It is important however that following ingestion, you continue to exercise to ensure that the supplement has been fully digested. **Please do not take any other sport supplements (e.g. caffeine, sodium bicarbonate, and creatine) other than what is provided by the research team.** If you have used any other sport supplements during the day of testing, please inform the lead researcher. As the protocol involves maximally sprinting, it is important that a full warm up is completed to limit any possibility of injury. You may have some discomfort within the next 48 hours caused through the sprinting protocol. Delayed onset of muscle soreness (DOMS) is commonly associated with this type of exercise. For this reason, please make sure that you have cooled down after the protocol and that you have adequate food and water to maximise your recovery following the session.

You should experience no discomfort over and above the repeat sprint itself, however, your safety is a priority, so should you feel any pain or discomfort, please tell the researcher immediately.

What information is collected and how will it be used?

Your beliefs and attitudes towards sport supplements will be measured using two validated questionnaires (Sports Supplements Beliefs Scale and the Performance Enhancement Attitude scale). You will be asked about your current use of sport supplements and how often you use these. Performance measures will include your 20m sprint times collected over 10 runs. The data collected will be used as part of a PhD thesis and may be published in an academic journal. Disclosure of your personal information (e.g. name, email address) will not be revealed to anyone outside of the research team, ensuring that the results cannot be traced back to you.

Who will have access to my results?

Your results will be kept in accordance with the Data Protection Act (1998) and Canterbury Christ Church University's own data protection requirements (2008). All your data will be stored either on a password protected computer or locked filing cabinet. Information will only be accessed by the research team (Philip Hurst, Dr Abby Foad, Dr Damian Coleman and Dr Chris Beedie). All results will be kept secure from anyone outside of the research team.

Can I withdraw?

This research is completely voluntary and you have the right to withdraw at any time without reason. You will not be placed at any disadvantage whatsoever if you decide to withdraw.

If you have any questions about the study or would like to know more about the research, please do not hesitate in contacting Phil Hurst in person, via email: philip.hurst@canterbury.ac.uk or phone: 01227 783130.

Informed Consent

Attitudes and performance enhancing supplements

Please read and sign the information below if you would like to participate in this study

Statement by participant

I understand that:

- This research project is completely voluntary
- I can withdraw at any time without reason
- I am satisfied with the methods in which the data will be stored and distributed
- I know that the results will not be able to be traced back to me
- I am aware of the benefits of the research
- I am aware of the possible risks and discomforts
- I am aware the supplement may influence my repeat sprint performance

I have read the information sheet and consent form and fully understand what is expected of me. I agree to take part in this research:

Signed (Participant): **Date:**

Signed (Witness): **Date:**

Appendix 10 – Example of questionnaire used in Study 2 and 3

Demographic information

1. What is your full name: ……
2. What is your email address: …….
3. What is your gender: ☐ Male ☐ Female
4. What is your age: ☐ Under 18 ☐ 18 to 24 ☐ 25 to 34 ☐ 35 to 44 ☐ 45 to 54 ☐ 55 to 64 ☐ 65 or older
5. What sport do you compete in: ……
6. What event or position: ……..
7. Do you compete for individual or team purposes: ☐ Individual ☐ Team ☐ Both
8. What is your highest level of competition: ☐ club ☐ county ☐ regional ☐ international
9. How many years have you been training: ……
10. How many hours a week do you train: ……..

Sport Supplement Use

Sport supplements are substances used by athletes with the belief that they will improve or facilitate athletic performance (e.g. Lucozade, multi-vitamins, caffeine, and creatine).

1. **Do you use sport supplements?**

   □ Yes □ No

2. **If yes, please select which sport supplements you use**

   □ B-Alanine □ Creatine □ Protein shakes

   □ Beetroot juice □ Electrolytes □ Vitamins and minerals

   □ Caffeine □ Energy gels

   Other (please specify):

3. **On average, how often do you use sport supplements?**

   □ Never □ Monthly □ Weekly □ Daily

Appendix 11 – Performance Enhancement Attitude Scale (PEAS)

Please read each question carefully and specify your level of agreement (between 'strongly disagree' to 'strongly agree') with the following:

		Strongly Disagree	**Disagree**	**Slightly Disagree**	**Slightly Agree**	**Agree**	**Strongly Agree**
1	Doping is necessary to be competitive.	1	2	3	4	5	6
2	Doping is not cheating since everyone does it.	1	2	3	4	5	6
3	Athletes often lose time due to injuries and drugs can be used to help to make up the lost time.	1	2	3	4	5	6
4	Only the quality of performance should matter, not the way athletes achieve it.	1	2	3	4	5	6
5	Athletes in my sport are pressured to take performance enhancing drugs.	1	2	3	4	5	6
6	Athletes who take recreational drugs use them because they help them in sport situations.	1	2	3	4	5	6
7	Athletes should not feel guilty about breaking the rules and taking performance enhancing drugs.	1	2	3	4	5	6
8	The risks related to doping are exaggerated.	1	2	3	4	5	6
9	Athletes have no alternative career choices, but sport.	1	2	3	4	5	6
10	Recreational drugs give the motivation to train and compete at the highest level.	1	2	3	4	5	6
11	Doping is an unavoidable part of competitive sport.	1	2	3	4	5	6
12	Recreational drugs help to overcome boredom outside of competition	1	2	3	4	5	6
13	There is no difference between drugs and the technical equipment that can be used to enhance performance (e.g. hypoxic altitude simulating environments)	1	2	3	4	5	6
14	The media should talk less about doping	1	2	3	4	5	6
15	The media blows the doping issue out of proportion.	1	2	3	4	5	6
16	Health problems related to rigorous training and injuries are just as bad doping side effects.	1	2	3	4	5	6
17	Legalizing performance enhancements would be beneficial for sports	1	2	3	4	5	6

Appendix 12 – Post Questionnaire used in Study 3

Canterbury Christ Church University

1. **What is your name?** ……..

2. **Do you think that athletes may benefit from learning about the placebo effect?**

   Yes ☐ No ☐

3. **Do you believe if other athletes knew about the placebo effect they may be less likely to use sport supplements?**

   Yes ☐ No ☐

5. **On a scale of 1 to 10 (1 no influence and 10 high influence), how much did you believe the supplement would influence your performance**

   1 2 3 4 5 6 7 8 9 10

4. **Over the next 3 months I think I will use sport supplements:**

1	2	3	4	5	6
Strongly Disagree	Disagree	Slightly Disagree	Slightly Agree	Agree	Strongly Agree

6. **How has knowledge of the placebo effect influenced your beliefs towards sport supplements?**

   ……

   ……

7. **In your opinion, how do you think other sport supplements (e.g. caffeine, creatine, protein shakes) are influenced by the placebo effect?**

   ……

   ……

8. **How may knowledge of the placebo effect influence your decision to using sport supplements?**

   ……

   ……

9. **Do you have any other comments about the study**

   ……

   ……