THE PLACEBO EFFECT OF ANKLE TAPEING ON ANKLE
INSTABILITY

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Thesis presented in partial fulfilment of the degree of Bachelor of
Applied Science (Physiotherapy) with Honours

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Declaration

I, Kate Sawkins, hereby declare that this submission is my own work and that it contains no material previously published or written by another person except where acknowledged in the text. Nor does it contain material which has been accepted for the award of another degree.

In addition, ethical approval from the University of Sydney Human Research Ethics Committee was granted for the study presented in this thesis. Participants were required to read a participant information document and informed consent was gained prior to data collection.

Name  Kate Sawkins

Signed _______________

Date _______________
Supervisor’s Certificate

This is to certify that the thesis entitled “The placebo effect of ankle taping on ankle instability” submitted by Kate Sawkins in partial fulfilment of the degree of Bachelor of Applied Science (Physiotherapy) with Honours is ready for examination.

Name _______________

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Date _______________
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PART 1. LITERATURE REVIEW.................................1

1.1 Introduction.........................................................1

1.2 Ankle sprains.......................................................1

1.2.1 Epidemiology...................................................1

1.2.2 Chronic problems.............................................2

1.3 Chronic ankle instability.................................2

1.3.1 Mechanical Instability.....................................3

1.3.2 Functional Instability.....................................3

1.3.2.1 Mechanical instability as a cause of functional
instability.......................................................4

1.3.2.2 Impaired proprioception as a cause of functional
instability......................................................5

1.3.2.3 Weak musculature as a cause of functional
instability......................................................7

1.4 Proposed mechanisms of effect of ankle taping.............9

1.4.1 Mechanical support theory..............................9

1.4.2 Proprioception theory....................................12

1.4.2.1 Joint position and movement sense.................12
PART 3. APPENDICES .......................................................76

Appendix 1  Ethics approval ..................................................76
Appendix 2  Participant information sheet .................................78
Appendix 3  Participant consent form ........................................80
Appendix 4  Participant recruitment advertisement ......................81
Appendix 5  Cumberland Ankle Instability Tool (CAIT) ..................82
Appendix 6  Participant debrief statement .................................83
Appendix 7  Power calculation ..................................................84
Appendix 8  Additional results ..................................................85
Appendix 9  Instructions to authors from Medicine and Science in Sports and Exercise ..................................................89
List of Figures

Figure 1  Application of tape for the real tape condition………………68
Figure 2  Application of tape for the placebo tape condition…………69
Figure 3  The single-limb hopping test…………………………………70
Figure 4  The modified star excursion balance test…………………71
Figure 5  Bar graph of participants’ perceptions of stability, confidence
and reassurance on the single-limb hopping test………………72
Figure 6  Bar graph of participants’ perceptions of stability, confidence
and reassurance on the modified star excursion balance
   test…………………………………………………………….73
Figure A1 Bar graph of participants’ preferred condition………………86

List of Tables

Table 1  Participant characteristics………………………………………74
Table 2  Performance in the single-limb hopping test and the modified
   star excursion balance test……………………………………75
Part 1- Literature Review

1.1 Introduction

Ankle injuries are the most common injury in sport, accounting for up to 45% of all injuries (59). It is the risk of re-injury that makes ankle injuries problematic, with recurrence in up to 73% of athletes (117). Ankle taping is commonly used to prevent ankle injury, and while taping does reduce the risk of injury (30), the mechanism underlying its effectiveness is not clear. The following literature review outlines the epidemiology and chronic problems associated with ankle joint injury, and describes the current theories proposed to explain the effectiveness of ankle taping, including the limitations of each theory. The placebo effect is proposed as an alternative mechanism by which ankle taping may prevent ankle injuries, and an overview of the underlying theory and evidence for the placebo effect is provided. Finally, the functional performance tests selected as outcome measures for the study are evaluated based on current research. The literature review concludes with a statement of the research aims and hypotheses.

1.2 Ankle Sprains

1.2.1 Epidemiology

Ankle injuries are the most common injury in sport and recreational activity (29, 59, 72, 77, 78, 82, 92, 99), accounting for up to 45% of all sporting injuries (59). More specifically, eighty-five percent of ankle injuries are sprains (83, 92, 94), making the acute ankle sprain the most common
musculoskeletal injury among athletes regardless of age or level of competition (77, 78). While the ankle has been reported as the body region most commonly involved in severe sporting injuries (115), it is the frequency and risk of re-injury, rather than the severity that makes ankle sprains problematic (117).

1.2.2 Chronic problems

Recurrence of ankle sprain occurs in up to 73% of athletes (21, 72, 76). In a study of Chinese athletes it was found that those with a past history of ankle sprain were up to five times more likely to re-injure their ankle than athletes with no history of ankle injury (117). In addition to the high rates of recurrence, up to 73% of athletes experienced significant disability and residual symptoms following ankle sprain, and 59% complained of one or more residual symptoms of pain, crepitus, instability or weakness (117). Furthermore, there was a trend towards an increased number of residual symptoms with an increased number of sprains (117).

1.3 Chronic Ankle Instability

Chronic ankle instability is defined by repetitive bouts of ankle instability resulting in numerous ankle sprains (40). Chronic ankle instability following ankle sprain has been proposed to be closely associated with residual symptoms, including recurrent injury (53). Mechanical instability and functional instability have been proposed as possible causes of chronic ankle instability, and these are described below.
1.3.1 Mechanical instability

Mechanical instability results from structural damage to the ligaments following ankle injury (41), and is defined as movement beyond the physiological limit of the ankle’s range of motion (106). This increase in joint range may diminish the ability of the joint to passively restrain excess movement, causing the ankle to give way under conditions of mild stress (67).

Chronic ankle instability, however, cannot solely be attributed to the presence of mechanical instability. A large percentage of individuals with complaints of chronic ankle instability do not exhibit any gross laxity of the ankle on examination (41, 108). Furthermore, a study of 200 asymptomatic ankles found 11% of the ankles to be mechanically unstable (100). Additional factors other than mechanical instability must therefore contribute to chronic ankle instability following ankle sprain.

1.3.2 Functional instability

Functional instability has also been proposed to contribute to chronic ankle instability. Functional instability was first defined as the patient’s complaint of giving way at the ankle joint and/or recurrent sprains (25, 26). The definition of functional instability has since been broadened to encompass the contribution of neuromuscular and proprioceptive deficits (41, 106). Mechanical instability, impaired proprioception and weak musculature surrounding the ankle joint have been proposed to contribute to the development of functional instability.
1.3.2.1 Mechanical instability as a cause of functional instability

In addition to its proposed primary role in the development of chronic ankle instability, mechanical instability has also been proposed to contribute to the development of functional instability. The majority of studies, however, have failed to find a correlation between mechanical instability and functional instability (98, 108, 109). On examination, only 24-42% of functionally unstable ankles were found to be mechanically unstable (98, 108, 109). Furthermore, while Lentell et al (67) found statistically significant mechanical instability in participants with functional instability, mechanical instability was only deemed to be clinically significant in one-third of the functionally unstable ankles, thus suggesting that mechanical instability may not be a cause of functional instability.

The inability to establish a correlation between mechanical instability and functional instability may be due to inaccuracies associated with measuring mechanical instability with stress radiography (49). To improve evaluation of mechanical instability, Hubbard et al (49) used ankle arthrometry combined with stress radiography to measure ankle joint laxity. While arthrometry measurements of anterior and total antero-posterior displacement, and radiographic measurements of anterior displacement were significantly greater in ankles with functional instability, the clinical significance of these findings were not investigated.

The relationship between mechanical instability and functional instability therefore remains unclear. The evidence suggests that while mechanical
instability may contribute to functional instability in some individuals, functional instability may also be present in the absence of mechanical instability. Factors other than mechanical instability are therefore likely to contribute to functional instability.

1.3.2.2 Impaired proprioception as a cause of functional instability

Proprioception is the term used to describe a group of sensations including sensations associated with muscle force and the sensation of movement and position of the joints (27). In relation to impairments associated with ankle sprain, impaired proprioception generally refers to deficits in joint position and/or movement sense (91). The contribution of proprioceptive deficits to the development of functional instability was first proposed by Freeman et al (26). It was hypothesised that injury to the ligament during ankle sprain caused disruption of articular nerve fibres and decreased sensory input from mechanoreceptors (26), resulting in reduced proprioception, and thereby predisposing the ankle to further injury.

The effect of ankle injury on joint position sense remains unclear. While the ability to actively replicate joint position has been reported to be impaired at various angles of plantarflexion (33) and inversion (11, 50, 114) in individuals with functional instability, it has also been suggested that ankle joint injury has no impact on judgements of active joint position sense in the inversion-eversion plane (36). Studies investigating passive position sense also report conflicting results. While impaired passive inversion position sense has been reported in individuals with functional instability (11), it has also been
suggested that passive position sense is not impaired in individuals with functional instability for either inversion or eversion (31, 36, 114). The lack of consistency in studies investigating joint position sense may be accounted for by variations in testing procedures. The position of the ankle during testing was not standardised across studies, nor was the number of trials, number of directions tested, measurement apparatus or participant inclusion criteria. This makes comparison between studies difficult. The effect of ankle sprain on active and passive joint position sense is therefore not entirely clear.

Investigations into joint movement sense also present inconsistent findings. The majority of studies investigating movement in the plantarflexion-dorsiflexion plane have reported significantly greater ability to detect plantarflexion movements in uninjured ankles compared to those with a past history of ankle sprain (24, 28, 110). In contrast, a more recent study reported no significant difference in the ability to detect plantarflexion or dorsiflexion movements between recurrent ankle sprainers and controls at any velocity of movement tested (91). With the exception of one study (48), joint movement sense has also been shown to be impaired in both the inversion (67, 90, 110) and eversion (90) direction in individuals with functional instability. While the majority of research suggests that joint movement sense is impaired in individuals with functional instability, the methodological quality of these studies is questionable. In most of these studies, either sufficient movement trials were not performed to enable adequate detection of movement threshold, or movement stimuli were only presented at one magnitude or in one direction, hence not conforming with the requirements of psychophysical testing (91). It,
therefore, cannot be concluded that joint movement sense is impaired in individuals with functional instability.

Postural control and peroneal reaction time have also been investigated in individuals with functional instability. While impairments in postural control and peroneal reaction time are often referred to as proprioceptive deficits, this terminology is incorrect (69). Postural control and peroneal reaction time are components of neuromuscular control rather than proprioception (69) and therefore will only be briefly discussed here. The role of peroneal reaction time and postural control in functional instability remains unclear. While some studies have reported an increased peroneal reaction time in individuals with functional instability (45, 55, 60, 61, 73), others have detected no difference between stable and unstable ankles (20, 23, 86). Conflicting results have also been reported regarding the effect of ankle injury on postural control (6, 15, 31, 44, 61, 66, 107, 108). Therefore, there is insufficient evidence to conclude that postural control or peroneal reaction time is impaired in individuals with functional instability.

1.3.2.3 Weak musculature as a cause of functional instability

Evertor muscle weakness has traditionally been cited as a cause of functional instability (10). It is proposed that as the foot and ankle are forced into inversion, a strong response by the evertors counteracts the inversion moment and prevents injury (53). Weakness of this musculature may result in impaired ability to resist inversion, allowing the ankle to give way (67).
Evertor strength has been thoroughly investigated in individuals with functional instability. One of the first studies to investigate the relationship between evertor muscle strength and functional instability detected strength deficits in the peroneal muscles in participants with functional instability using manual muscle testing (10). This method of measuring strength, however, is highly subjective (53) and less accurate than alternative methods (54). Isokinetic testing is less subjective and hence more accurate. The majority of studies using isokinetic testing have reported no strength deficits in the evertor muscles in participants with functional instability either concentrically (54, 67, 68, 79, 98, 113) or eccentrically (6, 54, 88). Only 2 recent studies have disputed these results, finding decreased concentric and eccentric evertor strength in participants with functional instability (38, 114). These results, therefore, suggest that evertor muscle weakness is not a cause of functional instability.

Invertor muscle weakness has also been proposed to contribute to functional instability. It has been suggested that invertor strength may play an important role in preventing excessive inversion via eccentric contraction to decelerate lateral movement of the lower leg during closed chain movement (112). While some studies have detected invertor strength deficits in individuals with functional instability (38, 98, 113), others have found no significant difference in invertor strength between functionally stable and unstable ankles (6, 68). While invertor strength deficits may be present in individuals with functional instability, their role in the development of functional instability remains unclear.
In a thorough review of the literature examining the contribution of muscle weakness to functional instability, it was concluded that deficits in ankle muscle strength are not correlated with ankle instability (53). Factors other than muscle weakness must therefore contribute to the development of functional instability.

The factors contributing to the development of chronic ankle instability therefore remain unclear. Regardless of the cause, chronic ankle instability is associated with recurrent injury, and hence prevention of recurrence should be a major focus of rehabilitation following ankle injury.

1.4 Proposed Mechanisms of Effect of Ankle Taping

Ankle taping has long been proposed as a method of protecting the ankle from injury (111). It is the most common method for supporting the chronically unstable ankle (57) and the principle means of preventing ankle sprains in sport (95). While ankle taping is effective in preventing recurrent ankle injuries (30), the mechanism underlying its effectiveness is not clear. Research has focused on two main mechanisms by which ankle taping has been proposed to decrease the incidence and severity of ankle injuries; mechanical support and proprioception, and these are described below.

1.4.1 Mechanical support theory

The mechanical support theory suggests that taping adds mechanical support to the ligaments and limits the extreme ranges of motion at the talar and subtalar joints (39). Most research has focused on the ability of ankle taping to
limit inversion range of motion, as the majority of sprains are inversion sprains (13). Immediately following tape application ankle inversion range is reduced (1, 37, 74, 93). Under non weight-bearing conditions reductions in both active (74) and passive (37) inversion range have been reported. In addition, taping effectively reduces inversion under weight-bearing conditions (1, 93), an important finding because ankle sprains usually occur under weight-bearing conditions.

Few studies have investigated the restrictive effect of taping in other directions of movement. A significant reduction in eversion (37) and plantarflexion (74), however, have been reported immediately following tape application.

The initial restrictive function of ankle taping is significantly reduced by exercise (14, 37, 57, 63, 74, 75, 85, 89, 93). While exercise of varying duration has been reported to decrease the restrictive effects of taping, a review of the literature concluded that 10 minutes of exercise is sufficient to reduce the restriction provided by taping (14). As much as a 40% decrease in the net supportive strength of taping occurs in this time (89).

While it is evident that tape loosens following exercise, what remains in dispute is whether the consequent reduction in restriction is sufficient to diminish the ability of tape to prevent ankle sprains. Several studies have demonstrated that following exercise the restrictive effect of taping was still significantly higher than pre-application values (37, 74). More precisely, it has been reported that taping offers a residual restriction to inversion of 10
degrees compared to the untaped condition (93). While several authors have suggested that the effectiveness of taping may lie in its residual restriction of the extreme ranges of motion (55, 57), it remains to be investigated whether this residual restriction is sufficient to prevent ankle sprains.

An alternative theory by which the initial and residual restriction provided by taping may prevent ankle sprains has been proposed. Total inversion, average inversion velocity and maximum inversion velocity are all reduced with taping (93). Time to maximum inversion is also greater with the ankle taped both before and after exercise (93). The reduced inversion velocity and increased time to maximum inversion may provide time for the body’s natural reflexes to activate, and thus prevent inversion or decrease the severity of the injurious moment (1, 74, 93). This proposal, however, has not been thoroughly examined, and therefore requires further investigation.

While a significant volume of research has been conducted on the mechanical effects of ankle taping, limitations exist in the studies performed. Most studies do not adequately simulate the forces involved in ankle sprain, and hence exaggerate its ability to limit range of motion (95). Furthermore, since the force required to injure ankle ligaments in vivo is unknown (95), it is difficult to determine whether the supportive function of ankle taping is sufficient to prevent injury. A review of the literature on the mechanical effects of ankle taping concluded that the restriction provided by taping is probably insignificant when considering the forces associated with sporting injuries (95).
1.4.2 Proprioception theory

Limitations in the mechanical support theory have prompted researchers to investigate alternative mechanisms to explain the effectiveness of ankle taping. The proprioception theory suggests that taping may prevent ankle sprains by enhancing proprioception and stimulating muscular control (39).

1.4.2.1 Joint position and movement sense

It is commonly believed that ankle sprains recur because proprioception is impaired by the initial sprain (90). Impaired proprioception in the form of inadequate foot position awareness may result in poor foot placement and consequently re-injury (96). Several theories have been proposed by which taping may enhance proprioception. Traction of the tape on the skin may provide cutaneous cues of foot position and orientation to promote appropriate foot placement and therefore prevent re-injury (96). It has also been hypothesised that taping may increase cutaneous input in the afferent nerves (91). Convergence of cutaneous afferents on muscle afferents in the spinal cord may result in a higher background discharge in the muscle afferents to enable them to detect movement at a smaller threshold and hence respond accordingly (91).

The first study to examine the effect of tape on joint position sense at the ankle investigated the ability to detect surface slopes in the plantar flexion-dorsiflexion plane in full weight-bearing before and after exercise (96). Taping influenced foot position awareness, particularly after its supportive function
had diminished following exercise (96). The proprioceptive effects of taping were further examined using a position matching task (39). Taping significantly improved active joint position sense for both inversion and plantar flexion (39). Whether these results can be generalised to the combined inversion-plantar flexion movement and weight-bearing activities in which ankle sprains most commonly occur is unknown.

In contrast to findings on joint position sense, the application of tape does not improve perception of passive motion in the plantar flexion-dorsiflexion (92) or inversion-eversion (48, 51) plane in recurrent ankle sprainers. In fact, detection of passive motion in the inversion-eversion plane is significantly worse with the ankle taped compared to the untaped condition (48). These results therefore suggest that the protective effect of taping does not arise from enhanced proprioception in terms of improved perception of passive motion.

1.4.2.2 Peroneal muscle activity

Cutaneous cues provided by taping have also been proposed to result in a decreased peroneal reaction time (39). Peroneal muscle activation is necessary to counteract potentially injurious forces upon landing (111).

Peroneal reaction time during sudden weight-bearing inversion has been investigated in participants with normal and mechanically unstable ankles (56, 61). While a decreased peroneal reaction time with taping has been observed in ankles with a high degree of mechanical instability (56), it has also been reported that the application of tape does not reduce peroneal reaction time in
unstable ankles (61). The effect of taping on peroneal reaction time, and hence the role of a decreased peroneal reaction time in the prevention of ankle sprains with taping, therefore, remains unclear.

Research investigating the current theories on the mechanism of ankle taping has reported conflicting results. Hence the mechanism behind the effectiveness of ankle taping remains unclear. Further research is required to investigate alternative mechanisms by which ankle taping may reduce the incidence and severity of ankle injuries.

An alternative theory is that if an athlete believes that taping will protect them from injury, they may participate with greater confidence (75). Anecdotal reports have also suggested that the athlete’s belief that taping will protect them from injury may play a role in the effectiveness of taping. That is, ankle taping may have a placebo effect.

1.5 The Placebo Effect

The term placebo is Latin for “I shall please”, and was adopted into medical terminology to refer to a medicine given more to please than to benefit the patient (32). By the mid-1950s the medical profession’s view of placebos had changed following a series of studies which demonstrated placebo interventions to have similar effects to active interventions (3, 65). This led to a more contemporary definition of a placebo as “any therapeutic procedure (or that component of any therapeutic procedure) which is given deliberately to have an effect, or unknowingly has an effect, on a patient, symptom,
syndrome, or disease, but which is objectively without specific activity for the condition being treated” (101).

1.5.1 Theory of the placebo effect

The mechanism by which placebo interventions exert their effectiveness is unknown. The expectancy theory, the conditioning theory and the biological approach have been proposed to explain the placebo effect.

1.5.1.1 The expectancy theory

The expectancy theory is the most commonly accepted basis for the placebo effect (102). This theory proposes that the placebo effect is not due to the placebo itself, but rather the belief or expectation of the patient (22). It is based on the premise that the patient’s expectations for improvement are causally linked to symptom improvement (62). The cornerstone of the expectancy theory is the patient’s belief or expectation that the placebo intervention will be effective (5, 22).

The role of expectation in the placebo effect was demonstrated in a series of clinical trials investigating the treatment of postpartum pain (103). The first trial compared the effects of paracetamol and a placebo analgesic. Patients in this trial were informed that they may receive a placebo analgesic. In the second trial the effects of paracetamol and naproxen were compared. In this trial patients knew they would receive one of two active drugs. Interestingly the effect of paracetamol was greater in the second trial. The authors proposed that the patients in the second trial expected and therefore experienced
considerable effects of the paracetamol because they knew it was an active analgesic. Patients in the first trial were sceptical that they may have received a placebo analgesic, hence resulting in a smaller effect of the paracetamol.

The effects of expectancy were further demonstrated in a study of the psychological impact of aerobic exercise (18). Two groups of healthy young adults completed the same 10-week exercise program. The experimental group was led to believe that their program was specifically designed to enhance psychological well-being. The control group had no such expectation. Self-esteem significantly improved in the experimental but not the control group, providing further support for the role of expectation in the placebo effect.

The expectancy held by the individual may arise from 2 sources: personal experience or verbal information imparted by an authority (22, 105). The previously mentioned studies are examples of expectancy engendered by verbal information. Expectancies related to personal experience form the basis of the conditioning theory.

**1.5.1.2 The conditioning theory**

Classical conditioning was discovered by Ivan Pavlov and is defined as a learning process whereby “an originally neutral stimulus becomes associated with a particular physiological or emotional response” (104). Pavlov discovered that the sight of food (unconditioned stimulus) caused a dog to salivate (unconditioned response). Pavlov then paired the sound of a bell (conditioned stimulus) with the presentation of the food (unconditioned
stimulus). After many repetitions, the sound alone (conditioned stimulus) prompted the dog to salivate (conditioned response) (104). The placebo effect has been proposed to work in a similar way. The unconditioned stimulus is the medical intervention that is known to work (22). The unconditioned response is the symptom improvement following treatment (22). The conditioned stimuli include factors such as syringes, pills or the entire therapeutic setting, which are repeatedly paired with the unconditioned stimulus (i.e. the real treatment) (22, 105). Conditioned placebo effects occur when a patient learns that such stimuli uniquely and reliably predict the administration of an effective treatment (105). This theory therefore proposes that the placebo effect is a conditioned response which occurs following the presentation of conditioned stimuli (105).

Classical conditioning and the expectancy theory have traditionally been described as mutually exclusive and competing theories (22, 105). More recently, however, the relationship between the two has become apparent (22). Classical conditioning can be considered as a component of the expectancy theory, given that conditioning is one way in which beliefs or expectations may be acquired (22). Through direct experience, the patient learns that certain stimuli predict the administration of an effective treatment. When such stimuli are presented in the absence of an active treatment the patient still expects that the treatment will be effective. This expectation subsequently produces a placebo effect (22, 105).
1.5.1.3 The biological approach

In contrast to the expectancy theory, the biological approach attempts to explain the placebo effect in terms of physiological rather than psychological mechanisms. While the majority of the literature on the biological approach relates the placebo effect to the release of endogenous opioids (22, 32, 62, 81, 105), dopamine release has also been suggested as an explanatory mechanism (16).

The role of opioids in the placebo effect was first implicated by a study investigating the effects of placebo analgesic on post-surgical pain (71). The researchers discovered that placebo analgesia can be reversed by naloxone (an opioid antagonist) (71). This original study did not include a control group and administration of naloxone was not blinded. With the exception of one study (34), however, all subsequent research taking these factors into consideration have replicated the findings of the original study (4, 35, 70). Hence it appears that endogenous opioids are involved in placebo analgesia. The role of opioids in placebo effects on symptoms other than pain, however, has not been thoroughly investigated.

Dopamine release has also been suggested to play a role in mediating the placebo effect (16). In an extension of the expectancy theory it has been proposed the placebo effect is mediated through a reward-related mechanism in which the expectation of reward (i.e. clinical benefit) triggers the response (16). Based on research investigating drug dependence (97) this theory proposes that dopamine is released in the brain in response to the expectation
of reward (16). Furthermore, neuroanatomical relationships between regions of the brain suggest that dopamine may also play a significant role in controlling opioid release, and could therefore play a role in the transmission and perception of pain (16).

The theories proposed to explain the placebo effect are often presented as competing theories. From the preceding discussion, however, it can be seen that these theories need not be considered mutually exclusive. As summarised by Stewart-Williams (105), “the placebo effect is a complex phenomenon and is likely to involve the interplay of a variety of factors”.

1.5.2 Evidence for the placebo effect

From around 1955 there has been a widespread belief that placebo interventions have significant and reliable effects (47). This view was strongly influenced by an article by Beecher (3) in one of the first studies to combine the results of several randomised trials. Throughout the 1980s and 1990s further narrative reviews supported the results of Beecher’s (3) study, reporting significant effects of placebo on a variety of clinical conditions (12, 64). These studies, however, calculated the placebo effect as the difference before and after treatment of patients in the placebo group of a randomised trial (46). This approach does not distinguish the placebo effect from the natural course of the disease (46). The effect of placebo can only be estimated reliably by comparison with a control group.
More recent research has investigated the placebo effect using comparison to a control group. The most recent evaluation of the placebo effect is a Cochrane review conducted by Hrobjartsson and Gotzsche (47). The review investigated the effect of placebo on a variety of clinical conditions, using only randomised placebo-controlled trials in which a no treatment group was used as a comparison. There was no significant pooled effect of placebo in studies with binary outcomes, for either patient-reported or observer-reported outcomes. In studies with continuous outcomes there was an overall significant pooled effect of placebo. This effect was only significant for patient-reported outcomes. An investigation of individual health conditions revealed a significant effect of placebo interventions on pain and phobia in studies with continuous outcomes. The authors, however, suggested that the effect on phobia was unreliable due to the small number of trials with low methodological quality. Furthermore, the effect on pain could not be clearly distinguished from bias. It was therefore concluded that there was no evidence that placebos in general have clinically important effects.

This conclusion however must be interpreted with caution. The standard model of testing the placebo effect is one in which the participant is randomised to an active treatment, placebo or control group, but is not informed about their group allocation. In this circumstance the participant knows there is a chance they may be receiving the placebo treatment, thus presenting an element of doubt. This model is not consistent with the expectancy theory of the placebo effect because under no condition is the participant absolutely certain that the treatment will be effective. Studies
investigating the placebo effect should use a model in which the participant is under the belief or expectation that the treatment is going to be effective.

1.6 Measures of Function

Residual symptoms of ankle instability can greatly compromise an individual’s ability to perform functional tasks and participate in sporting activities. Ankle taping may be used to assist return to such activities (57, 95). In order to determine whether there is a placebo effect with ankle taping, functional performance tests were therefore selected as outcome measures for the present study. Such outcome measures must be reliable and sufficiently sensitive to discriminate between stable and unstable ankles.

Functional performance tests aim to simulate, in a controlled environment, the normal forces the ankle joint is exposed to during athletic participation (17). Current lower limb functional performance test include: single-leg hop for distance (2, 8, 9, 19, 116), single-leg 6 metre hop for time (2, 8, 9, 116), 30 metre single-leg agility hop (9, 116), single-leg triple hop for distance (2, 8), single-leg triple cross-over hop for distance (2, 8, 84), agility hop test (17), single-limb hopping test (50, 80), single-leg vertical hop (2), side hop (19), up-down hop (19), figure-of-8 hop (19), shuttle run test (17, 84), co-contraction test (17), single-leg standing balance tests (7, 50, 52), star excursion balance test (42, 43, 58, 87), and descending a staircase (52).
1.6.1 Reliability of measures of function

Research investigating functional performance tests has primarily focused on the reliability of these tests. The majority of the functional hopping tests have been shown to be highly reliable (ICC 0.85-0.99) (2, 8, 9, 80, 116). While the single-leg 6 metre hop (ICC 0.66-0.92) (2, 8, 9, 116) and the 30 metre single-leg agility hop (ICC 0.09-0.92) (9, 116) had lower reliability estimates, small standard error of measurement or confidence interval values suggest that inconsistencies in measurement would only occur within a small range and hence the tests would still be reliable (8, 9). High reliability estimates have also been reported for single-limb standing balance (ICC 0.85-0.89) (7) and the star excursion balance test (ICC 0.78-0.96) (43). No reliability estimates could be found for the side hop, up-down hop or figure-of-8 hop tests.

1.6.2 Sensitivity of measures of function

Few studies have investigated the ability of functional performance tests to discriminate between stable and unstable ankles in participants with ankle instability. The single-leg hop for distance (116), single-leg 6 metre hop for time (116), 30 metre single-leg agility hop (116), single-leg triple cross-over hop (84), shuttle run (17, 84), co-contraction (17), and agility hop test (17) are unable to detect differences between stable and unstable ankles. Only five functional performance tests have been demonstrated to be sufficiently sensitive to discriminate between stable and unstable ankles: one-leg standing on an unstable surface (50), side hop (19), figure-of-8 hop (19), single-limb hopping test (50) and the star excursion balance test (87). Of these tests only the later two have also been shown to be highly reliable.
The single-limb hopping test and modified star excursion balance test are the only two lower limb functional performance tests which are both highly reliable and sufficiently sensitive to discriminate between stable and unstable ankles. These tests were therefore selected as outcome measures for the present study.

1.7 Summary

Ankle injuries are the most common injury in sport. It is the frequency and risk of re-injury that makes ankle injuries problematic, with recurrence of ankle sprain in up to 73% of athletes. The development of chronic ankle instability following ankle injury has been proposed to be associated with recurrent injury.

Ankle taping is the most common method of supporting the chronically unstable ankle and the principle means of preventing ankle sprains. While ankle taping is effective in reducing the risk of injury, the mechanism underlying its effectiveness remains unclear. Research has been unable to confirm the role of increased mechanical support or enhanced proprioception in the prevention of ankle injuries with taping. Alternative theories therefore need to be investigated.

If an athlete believes that ankle taping will protect them from injury they may participate with greater confidence. The athlete’s belief in the effectiveness of
taping may also contribute to the prevention of ankle injuries with taping. That is, taping may have a placebo effect.

The expectancy theory is the most commonly accepted basis for the placebo effect. The cornerstone of the expectancy theory is the patient’s belief or expectation that the placebo intervention will be effective. The standard model of testing the placebo effect is not consistent with the expectancy theory. Studies investigating the placebo effect should use a model in which the participant is under the expectation that the treatment will be effective.

The single-limb hopping test and the star excursion balance test are both highly reliable and sufficiently sensitive to discriminate between stable and unstable ankles. These tests were therefore selected as outcome measures for the present study.

1.8 Research Aims and Hypotheses

1.8.1 Research Aims

General

- The aim of the study was to determine whether there was a placebo effect with ankle taping in individuals with ankle instability.
Specific

The specific aims of the study were to:

1. Determine whether ankle taping influenced functional performance on the single-limb hopping test and the modified star excursion balance test in individuals with ankle instability.
2. Determine whether placebo ankle taping influenced functional performance on the single-limb hopping test and the modified star excursion balance test in individuals with ankle instability.

1.8.2 Research Hypotheses

General

- The experimental hypothesis was that there would be a placebo effect with ankle taping in individuals with ankle instability.

Specific

The specific experimental hypotheses were that:

1. Ankle taping would improve functional performance on the single-limb hopping test and the modified star excursion balance test in individuals with ankle instability.
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The Placebo Effect of Ankle Taping on Ankle Instability

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Running Title: The Placebo Effect of Ankle Taping
Abstract

**Purpose:** Recurrence of ankle sprains is common among athletes. While ankle taping reduces the risk of injury, the mechanism underlying its effectiveness remains unclear. Anecdotal reports suggest a role for the athlete’s belief that taping will protect them from injury. That is, taping may have a placebo effect. The purpose of the present study was to determine whether there was a placebo effect with ankle taping in individuals with ankle instability.

**Methods:** 30 participants with ankle instability completed a single-limb hopping test and a modified star excursion balance test under three conditions: 1) real tape, 2) placebo tape, and 3) control (no tape). Participants were blinded to the purpose of the study and were informed that the study aimed to compare two methods of ankle taping referred to as “mechanical” (real) and “proprioceptive” (placebo). The order of testing the three conditions and the two functional tests was randomised.

**Results:** There was no significant difference in performance among the three conditions for the single-limb hopping test ($p=0.865$) or the modified star excursion balance test ($p=0.491$). A secondary exploratory analysis, however, revealed that real and placebo ankle taping influenced participants’ perceptions of stability, confidence and reassurance when performing the functional tests.
Conclusion: The role of the placebo effect with ankle taping in individuals with ankle instability remains unclear. Clinicians, therefore, should continue to use ankle taping techniques of known efficacy. They should, however, focus on maximising patients’ belief in the efficacy of ankle taping, since its application reassured participants and improved perceived stability and confidence. The effect of ankle taping on participants’ perceptions may contribute to its effectiveness in preventing injury. This proposal requires further investigation.

Key words: ankle sprain, ankle inversion sprain, tape.
Introduction

Paragraph Number 1 Ankle injuries are the most common injury in sports and recreational activities accounting for up to 45% of all sporting injuries (17). Eighty-five percent of ankle injuries are sprains (20), making the acute ankle sprain one of the most common musculoskeletal injuries among athletes. It is the frequency and risk of re-injury that makes ankle sprains problematic, with recurrence of sprain in up to 73% of athletes (30). Recurrent ankle sprains result in significant disability and residual pain and instability (30), and therefore, prevention of recurrence should be a major focus of rehabilitation.

Paragraph Number 2 Ankle taping has long been proposed as a method of protecting the ankle from injury. It is the most common method for supporting the unstable ankle and the principle means of preventing ankle sprains in sport (26). While ankle taping is effective in the prevention of ankle injuries (5), the reason why ankle taping prevents injury is not clearly understood. Increased mechanical support and enhanced proprioception are thought to contribute to the prevention of ankle injuries with taping.

Paragraph Number 3 The mechanical support theory suggests that taping adds mechanical support to the ligaments and limits the extreme ranges of motion at the talar and subtalar joints (8). A significant reduction in ankle inversion (e.g. 7, 21), eversion (7) and plantarflexion (21) range have been reported immediately following tape application. Following as little as 10
minutes of exercise, however, the restrictive function of taping is significantly reduced (e.g. 4, 21, 23).

**Paragraph Number 4** A second theory is the proprioception theory. It is commonly believed that ankle sprains recur because proprioception is impaired by the initial sprain. The proprioception theory suggests that traction of the tape on the skin increases cutaneous cues about foot position and orientation (27), and increases background discharge in muscle afferents to enable movement detection at a smaller threshold (25). Ankle taping has been found to improve active joint position sense for inversion and plantarflexion (8), and ability to detect surface slopes in the plantarflexion-dorsiflexion plane (27) in participants with no history of ankle injury. It does not, however, improve perception of passive movement in the plantarflexion-dorsiflexion (25) or inversion-eversion plane (13). Hence the role of enhanced proprioception in the prevention of ankle sprains is debatable.

**Paragraph Number 5** Taping has also been proposed to result in earlier and enhanced muscular contraction, in particular a decreased peroneal reaction time (8). Studies investigating the effect of ankle taping on peroneal reaction time during sudden weight-bearing inversion, however, have reported inconsistent results. While a decreased peroneal reaction time has been reported in ankles with a high degree of mechanical instability (15), it has also been suggested that the application of tape to unstable ankles does not reduce peroneal reaction time (18). It cannot be concluded, therefore, that a decrease
in peroneal reaction time is responsible for the prevention of ankle sprains with taping.

**Paragraph Number 6** The mechanism by which ankle taping prevents injury therefore remains unclear. An alternative theory is that if an athlete believes that taping will protect them from injury, they may participate with greater confidence (23). Anecdotal reports have also suggested that the athlete’s belief that ankle taping will protect them from injury may play a role in the prevention of ankle sprains with taping. That is, ankle taping may have a placebo effect. A placebo intervention is defined as “any therapeutic procedure (or that component of any therapeutic procedure) which is given deliberately to have an effect, or unknowingly has an effect, on a patient, symptom, syndrome, or disease, but which is objectively without specific activity for the condition being treated” (28). The expectancy theory is the most commonly accepted basis for the placebo effect and presumes that the patient’s expectations for improvement are causally linked to symptom improvement (19). The cornerstone of the expectancy theory is the patient’s belief or expectation that the placebo intervention will be effective (1).

**Paragraph Number 7** Current evidence of the placebo effect is best summarised by a recent Cochrane review which investigated the effect of placebo on a variety of clinical conditions (12). It was concluded that there was no evidence that placebos in general have clinically important effects. This conclusion, however, should be interpreted with caution. The standard model of testing the placebo effect is one in which the participant is
randomised to an active treatment, placebo or control group, but is not informed about their group allocation. In this circumstance the participant knows there is a chance that they may be receiving the placebo treatment, thus presenting an element of doubt. This model is not consistent with the expectancy theory of the placebo effect, because under no condition is the participant absolutely certain that the treatment will be effective. Studies investigating the placebo effect should use a model in which the participant is under the belief or expectation that the treatment is going to be effective even if it is not. That is, participants should be informed *a priori* that all treatments are effective and the possibility of placebo should not be mentioned.

**Paragraph Number 8** The purpose of the present study was to determine whether there was a placebo effect with ankle taping in individuals with ankle instability, using a model in which the participant was exposed to the belief that the placebo tape would be effective. We hypothesised that performance of functional tasks by individuals with ankle instability would be improved with placebo taping. Evidence that there is a placebo effect with ankle taping could have a substantial impact on clinical practice. Greater emphasis would be placed on the credibility of taping and perhaps less emphasis on the actual taping technique.
Methods

Participants

Paragraph Number 9 Thirty participants (11 male and 19 female) with ankle instability volunteered for this study (mean age ± SD, 21.0 ± 3.3 yrs) (Table 1). Ankle instability was defined as a score of ≤ 24 out of 30 on the Cumberland Ankle Instability Tool (CAIT) (11) (Appendix 5). The average (±SD) CAIT score of the ankles tested was 18 (± 5). Participants had a history of, on average, 7 sprains on their test leg with an average of 11 (± 9) months since their last sprain. Participants were excluded from the study if they had a past fracture of the lower limb, past surgery of the lower limb, an ankle sprain within the last three weeks, palpable pain or effusion of the ankle at the time of testing, neurological, visual or vestibular deficit or other orthopaedic or arthritic problem in the test leg which may affect performance, or any other significant injury or condition likely to cause a disturbance of balance or affect the participant’s performance.

Paragraph Number 10 Participants were blinded to the true purpose of the study and were informed that the aim of the study was to compare two methods of ankle taping, referred to as “mechanical” (real) and “proprioceptive” (placebo) taping. Participants were debriefed at the conclusion of testing regarding the true purpose of the study. The study was approved by The University of Sydney Human Research Ethics Committee and written informed consent was obtained from all participants prior to data collection.
Paragraph Number 11 Statistical power calculations indicated that a sample of 30 participants would provide a better than 80% chance of detecting a 1 second difference between the conditions on the single-limb hopping test, assuming a standard deviation of 1.3 seconds (14) (Appendix 7). A difference of 1 second has been found to discriminate between stable and unstable ankles on the single-limb hopping test (14).

Protocol

Paragraph Number 12 Data were collected from each participant in a single 1.5 hour testing session. Baseline information was obtained regarding history of ankle sprains, and inversion/eversion range of motion was measured. One ankle of each participant was tested. In participants with unilateral ankle instability the unstable ankle was tested. In participants with bilateral ankle instability the most unstable ankle, determined by the CAIT score was tested. For participants whose ankles scored equally on the CAIT, the test ankle was randomly selected.

Paragraph Number 13 Participants were tested under three conditions in a random order: 1) real (“mechanical”) tape, 2) placebo (“proprioceptive”) tape, and 3) control (no tape). For each condition participants completed two functional performance tests in a random order, the single-limb hopping test (3) and the modified star excursion balance test (10, 16, 24). Prior to data collection participants were given instructions and the examiner demonstrated each test. Participants then completed six practice trials of each test without
the ankle taped. During data collection participants completed three trials of each test under each condition. The best effort was used for data analysis.

**Paragraph Number 14** Following each functional test under each condition participants were questioned regarding their perceived level of stability, confidence and reassurance when performing the test compared to the practice trials. Stability referred to how steady and controlled the participant felt, confidence referred to how well the participant felt they could perform the test, and reassurance referred to how confident the participant was that they would not sprain their ankle when performing the test. On completion of testing participants were asked which condition they preferred: 1) in general, 2) for each test, and 3) for each direction on the star test.

**Tape Application**

**Paragraph Number 15** The real tape consisted of a technique commonly used by sports physiotherapists and athletes to prevent ankle inversion injuries. An anchor, three stirrups, a low anchor, a figure of six and a heel lock were applied using inelastic tape (Fig. 1). Endura-Fix self-adhesive underwrap (Endura Tape Pty Ltd, Sydney AUS) was offered to male participants. Participants were informed that this method of taping aimed to prevent ankle sprains by increasing mechanical support to stabilize the ankle and decrease range of motion at the ankle joint. They were also told that this method of taping was expected to improve their performance on the functional tests.
**Paragraph Number 16** The placebo tape consisted of a single strip of inelastic tape approximately 10cm long on the lateral aspect of the lower leg above the lateral malleolus (Fig. 2). The tape was aligned vertically over the tendon of peroneus longus. Participants were informed that this method of taping aimed to prevent ankle sprains by increasing cutaneous input to improve proprioception. An explanation of the proprioception theory of taping was provided to enhance the credibility of the placebo tape. Participants were told that this method of taping was expected to improve their performance on the functional tests.

**Paragraph Number 17** Participants were essentially blinded to the true nature of the tape condition by the examiner’s instructions (that is, the placebo tape was referred to as “proprioceptive” tape and the real tape was referred to as “mechanical” tape). To further minimise bias participants were blindfolded during tape application and a “skirt” was used to cover the foot and ankle, without intruding on the sole of the foot during all testing.

**Functional Performance Tests**

**Paragraph Number 18** Participants’ performance was evaluated using the single-limb hopping test and the modified star excursion balance test. The tests were selected based on their high reliability and ability to discriminate between stable and unstable ankles (10, 14, 24).
**Single-limb hopping test**

**Paragraph Number 19** The single-limb hopping test was designed by Chambers et al (3) to measure single-limb agility on uneven surfaces. It has been shown to be sufficiently sensitive to discriminate between stable and unstable ankles (14). Pilot research conducted in our laboratory has also shown the test to have a high intra-rater reliability (ICC$_{2,1} = 0.95$).

**Paragraph Number 20** The course consisted of eight squares, four of which were level, one square providing a 15° incline, another square a 15° decline, and two squares with a 15° lateral inclination (Fig. 3). Each square was 35 cm$^2$. Participants commenced the test by standing 35 cm behind the first square. They were then instructed to hop around the course on the test leg as fast as possible by landing on each square once, then returning to their original starting position by completing the course in the opposite direction (Fig. 3). The time taken to complete the course was measured in seconds using both an electronic timing device and a stopwatch. A 1 second time penalty was incurred each time the participant landed outside the boundaries of the course or completed the course in the incorrect sequence. A participant’s score was the sum of the time taken to complete the course and the total number of penalties. Rest periods of 90 seconds were provided between trials to minimise fatigue. The course was completed with participants barefoot wearing loose, comfortable clothing.
Modified star excursion balance test (MSEBT)

**Paragraph Number 21** The modified star excursion balance test is a test of dynamic balance adapted from that described by Kinzey and Armstrong (16) and Hertel et al (10). The original star excursion balance test was found to be highly reliable (intra-rater ICC$_{2,1}$ = 0.78-0.96) (10) and sufficiently sensitive to discriminate between stable and unstable ankles (24). Using eight reach directions with sufficient practice trials, however, proved to be extremely time consuming. Therefore, after communicating with experts in the field, and on the basis of their recent laboratory findings, three directions (anterior, posterior and posteromedial) were chosen. The selection of the posteromedial direction was further supported by preliminary research (9).

**Paragraph Number 22** The test layout consisted of four 1.5 m tape measures arranged on the floor: one in the anterior direction, one posterior and two extending at 45° posteromedially and posterolaterally (relative to the test leg) from the centre of the star (Fig. 4). Participants initially assumed a bilateral stance at the centre of the star with the feet touching and one foot on either side of the tape measure. They were then instructed to stand barefoot on the test leg and reach as far as possible with the contralateral leg in the appropriate direction. Participants lightly touched the furthest point possible on the line with the most distal part of the reach foot before returning to bilateral stance. They were instructed to move in any way possible to achieve a maximal reach distance. Participants completed reaches in three directions: anterior, posterior and posteromedial relative to the test leg. When reaching in the anterior direction participants began with their toes behind a line marked at the centre...
of the star. When reaching in the posterior and posteromedial directions participants began with their heel in front of the line. Trials were discarded and repeated if participants lifted the stance foot, lost balance, did not maintain start and return positions for 1 second, or if the reach foot was used to provide considerable support. Considerable support was defined as participants transferring any weight onto their reach foot. Participants were instructed to keep their weight on the test leg.

**Paragraph Number 23** During data collection participants completed three reaches in each direction with 15 seconds rest between reaches. The order of testing the directions was randomised between clockwise and counter clockwise.

**Data Analysis**

**Paragraph Number 24** For the single-limb hopping test, a one-way repeated measures analysis of variance (ANOVA) was conducted to compare performance among the three conditions. The within-subjects factor was condition (real, placebo, control). Data for the modified star excursion balance test were analysed with a two-way repeated measures ANOVA in which the within-subjects factors were reach direction (anterior, posterior and posteromedial) and condition (real, placebo, control). Means and standard deviations are reported unless otherwise stated. The significance level was preset at $\alpha = 0.05$. Statistical analysis was performed using SPSS 12.0.
A secondary exploratory analysis was performed on the qualitative responses provided by the participants. Participants’ perceptions of stability, confidence and reassurance were examined for each condition on each functional test. The number of participants who reported an improvement in stability, confidence and reassurance compared to the practice trials for each condition on each test was recorded. On examination of the participants’ responses, patterns or commonalities in the responses were also identified.

Results

There was no significant difference in performance among the three conditions on either of the functional tests. Participants performed equally well both with and without their ankle taped, regardless of whether the tape was real or placebo. A secondary exploratory analysis, however, revealed that ankle tape, both real and placebo, influenced participants’ perceptions of stability, confidence and reassurance when performing the functional tests.

Single-limb hopping test

There was no significant difference in performance among the three conditions on the single-limb hopping test (p=0.865). Participants completed the single-limb hopping test with the real tape applied in 10.45 ± 3.56 s, with the placebo tape applied in 10.52 ± 3.58 s, and without tape (control) in 10.47 ± 3.67 s (Table 2).
Modified star excursion balance test

Paragraph Number 28 There was no significant difference in performance among the three conditions on the modified star excursion balance test (p = 0.491). Furthermore, there was no significant interaction between the condition (real, placebo, control) and reach direction (anterior, posterior, posteromedial) (p = 0.080). In the posteromedial direction, for example, participants reached a mean distance of 77.17 ± 9.85 cm with the real tape applied, 77.77 ± 8.91 cm with the placebo tape applied, and 77.02 ± 9.37 cm without tape (control) (Table 2).

Secondary Analysis

Paragraph Number 29 Ankle tape, both real and placebo, influenced participants’ perceptions of stability, confidence and reassurance when performing the functional tests. The real tape condition had the greatest influence on participants’ perceptions of stability, confidence and reassurance for both the single-limb hopping test and the modified star excursion balance test (Fig. 5 and 6). The greatest effect of the real tape was on perceived stability, with 97% (n = 29) of participants on the single-limb hopping test and 80% (n = 24) of participants on the modified star excursion balance test reporting an increase in perceived stability with the real tape compared to the practice trials.

Paragraph Number 30 The placebo tape had a much greater influence on participants’ perceptions of stability, confidence and reassurance than the control condition. At least 17% (n = 5) of participants reported an increase in
perceived stability, confidence and reassurance with the placebo tape on both
the single-limb hopping test and the modified star excursion balance test. The
greatest effect of the placebo tape was on perception of stability on the single-
limb hopping test, with 27% (n = 8) of participants reporting an improvement
compared to the practice trials. No participants reported an improvement in
perceived stability, confidence or reassurance on either of the functional tests
with the control condition.

Discussion

Paragraph Number 31 While ankle taping reduces the risk of ankle injury (5),
the mechanism underlying its effectiveness remains unclear. The purpose of
the present study was to determine whether there was a placebo effect with
ankle taping in individuals with ankle instability. There was no significant
difference in functional performance among the conditions on either of the
functional tests. An analysis of participants’ responses, however, revealed that
ankle tape, both real and placebo, influenced participants’ perceptions of
stability, confidence and reassurance when performing the functional tests.

Paragraph Number 32 The placebo tape had a much greater influence on
participants’ perceptions of stability, confidence and reassurance than the
control condition. These results suggest that while the placebo tape does not
influence performance on the functional tests studied, it does affect the way
the individual feels when performing such tests. While it is possible that this
change in perception with the placebo tape may be related to the effects of the
actual tape, it is also possible that simply instilling in participants the belief
that the tape would protect them from injury (i.e. the placebo effect) has the potential to improve perceived stability, confidence and reassurance when performing functional tasks.

**Paragraph Number 33** The real tape condition also influenced participants’ perceptions of stability, confidence and reassurance. In fact, the real tape had a much greater influence on these variables than either the placebo or control condition on both of the functional tests. This may be related to the supportive or restrictive nature of this method of taping. Several participants spontaneously volunteered that the feeling of support provided by the real tape made them feel more stable when performing the functional tests. They further suggested that this increase in stability resulted in an increase in confidence and/or reassurance that the tape would protect them from injury. It is possible that this feeling of support provided by the tape may trigger a placebo effect. That is, although the physical restriction provided by the tape diminishes with exercise (4), the individual’s perception of stability and therefore confidence and reassurance may remain. Since the means by which ankle taping prevents injury is unknown, it may be related to the way the individual feels with their ankle taped, and their continued belief that the tape will protect them from injury. This proposal is merely speculative and requires further investigation.

**Paragraph Number 34** While not being a specific aim of the study, it was interesting to note that ankle taping did not impair participants’ performance on either of the functional tests. It is a common concern among high performance athletes and coaches that the restrictive properties of taping may
impede performance (29). Previous research investigating the effect of ankle taping on performance has reported conflicting results (2, 6, 22, 29). While differences in experimental protocols may partially explain the variability in results amongst the studies, the effect of ankle taping on performance may also depend on the functional task being tested. With respect to single-limb agility during a short duration hopping course and dynamic single-limb balance on a balance reaching task, results of the present study suggest that ankle taping does not appear to impair functional performance. This finding is new and important since it relates specifically to individuals with ankle instability and has significant implications for athletes participating in sports where similar demands, such as hopping, are placed on the ankle. Athletes can be confident that ankle taping will minimise the risk of injury without compromising their performance. These findings, however, cannot be generalised to other functional tasks and further research is required to determine the effect of ankle taping on performance during specific sporting activities.

**Paragraph Number 35** While ankle taping did not affect performance on the functional tests used, it is possible that the tests were not sufficiently sensitive to detect differences that may have existed between the conditions. These tests were selected based on a thorough review of the literature on lower limb functional performance tests. They are the only two lower limb functional tests that have been shown to be both highly reliable and sufficiently sensitive to discriminate between stable and unstable ankles (10, 14, 24). While we know that these tests have the ability to differentiate stable from unstable ankles, it is unknown whether ankle taping would alter performance on these tests. A test
for which taping would improve performance would be beneficial, in that if participants performed better with their ankle taped than untaped, it would then be possible to accurately gauge the effect of the placebo tape compared to the real tape. In the present study the real tape condition did not improve participants’ functional performance. Therefore, although there was no effect of the placebo tape on participants’ performance, it cannot be concluded that there is no placebo effect with ankle taping. Based on the current findings it remains unclear whether there is a placebo effect with ankle taping.

**Paragraph Number 36** While we know that ankle taping is effective for reducing the risk of ankle sprains (5), its effect on functional performance is not as clear. Since this is the first study to investigate the placebo effect in relation to ankle taping, functional performance tests were used as the outcome measures. Although placebo tape did not improve performance on the functional tests, the placebo effect may still contribute to the effectiveness of ankle taping in terms of the prevention of ankle injury. Ideally a study using injury recurrence as the outcome measure would be performed to provide further information regarding the potential contribution of the placebo effect to the prevention of ankle injuries with taping. Such a study, however, would have significant ethical implications. The application of a placebo tape, which has no preliminary evidence of effectiveness, may place the participant at an increased risk of injury. Until preliminary studies can show that placebo taping improves functional performance, it would be unethical to perform such a study. Furthermore, it would be unethical for clinicians to apply placebo ankle
taping to patients. Clinicians, therefore, should continue to use ankle taping
techniques of known efficacy.

**Paragraph Number 37** It may be suggested that participants were potentially
aware of the true nature of the placebo tape. Numerous measures were taken,
however, to ensure that participants were adequately blinded to the placebo
condition. From the time they were recruited for the study until the completion
of data collection participants were unaware of the true purpose of the study.
Participants were informed that the aim of the study was to compare two real
but different methods of ankle taping referred to as “mechanical” and
“proprioceptive” taping. At no time were participants under the impression
that one of the tape conditions would be a placebo. For the placebo tape to be a
true placebo it could have little, if any physical effect on the participants. For
this reason, only minimal quantities of tape could be used, and a single strip of
tape was placed longitudinally over the tendon of peroneus longus. To
overcome the perceived lack of effect of this method of taping, participants
were informed that the placebo tape aimed to prevent ankle sprains, not by
increasing mechanical support but by increasing proprioceptive input.
Participants were told that traction of the tape on the skin would stimulate
cutaneous receptors, activating a proprioceptive feedforward loop via afferent
and efferent nerve fibres. This proprioceptive input would increase activation
of the peroneus longus muscle in order to decrease peroneal reaction time and
prevent inversion sprains. Participants were explicitly told that this method of
taping was expected to improve their performance on the functional tests.
Participants were also blindfolded during all tape applications and a skirt was
placed over the ankle during testing to minimise any visual cues which may have influenced the participant’s opinion of the tape. Furthermore, naive participants with no previous knowledge of taping or the effects of taping were preferentially recruited. Based on the measures taken we suggest that participants were adequately blinded to the placebo condition.

**Paragraph Number 38** The mechanism underlying the ability of ankle taping to prevent injury remains unclear. From the results of the present study it cannot be concluded that there is a placebo effect with ankle taping in individuals with ankle instability. Clinicians therefore, should continue to use ankle taping techniques of known efficacy. They should, however, focus on maximising the credibility of taping, since the participants’ belief that taping would protect them from injury appeared to influence their perception of stability, confidence and reassurance when performing the functional tests. The ability of ankle taping to influence perception of stability, confidence and reassurance may contribute to its effectiveness in preventing injury. This proposal requires further investigation.
Acknowledgements

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References


Figure Captions

Figure 1- Application of tape for the real tape condition. The ankle was taped using an anchor, three stirrups, a low anchor, a figure of six and a heel lock, applied to restrict inversion. Inelastic adhesive tape was used.

Figure 2- Application of tape for the placebo tape condition. A single strip of tape approximately 10cm long was applied to the lateral aspect of the lower leg over the tendon of peroneus longus. Inelastic adhesive tape was used.

Figure 3- The single-limb hopping test. The course consisted of eight squares, four of which were level, one square providing a 15° incline, another square a 15° decline, and two squares with a 15° lateral inclination. Participants began behind square 1 and hopped around the course on the test leg from square 1 to 8. They then made an about turn and completed the course in the reverse sequence (square 8 to 1) to return to the original starting position.

Figure 4- The modified star excursion balance test. Four 1.5m tape measures were applied to the floor in the anterior and posterior directions, and at 45° posteromedially and posterolaterally (relative to the test leg) from the centre of the star. Participants stood at the centre of the star and completed reaches in the anterior (A), posterior (P) and posteromedial (PM) directions relative to the test leg. The directions shown in the figure apply to participants who completed testing on their right leg.
Figure 5- Bar graph of participants’ perceptions of stability, confidence and reassurance on the single-limb hopping tests with the real tape (white bars), placebo tape (black bars) and control condition. The y axis represents the number of participants who reported an improvement in stability, confidence and reassurance with each condition compared to the practice trials.

Figure 6- Bar graph of participants’ perceptions of stability, confidence and reassurance on the modified star excursion balance test with the real tape (white bars), placebo tape (black bars) and control condition. The y axis represents the number of participants who reported an improvement in stability, confidence and reassurance with each condition compared to the practice trials.
Figures

Figure 1
Figure 5

Single-limb hopping test

Number of participants

- Stability
- Confidence
- Reassurance

- Real tape
- Placebo tape
- Control
Figure 6

Modified star excursion balance test

Number of participants

Real tape
Placebo tape
Control

Stability  Confidence  Reassurance
## Tables

### Table 1- Participant Characteristics

<table>
<thead>
<tr>
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<th>Mean ± SD</th>
<th>Range</th>
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<tbody>
<tr>
<td>Age (yr)</td>
<td>21.0 ± 3.3</td>
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<tr>
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<td>18.0 ± 5.0</td>
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<tr>
<td>Number of sprains on test leg</td>
<td>7.0 ± 5.2</td>
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</tr>
<tr>
<td>Time since last sprain (months)</td>
<td>11.0 ± 9.0</td>
<td>1-42</td>
</tr>
</tbody>
</table>

Mean, SD and range for age, height, weight, CAIT score, number of sprains on test leg and time since last sprain for all participants. CAIT score is out of 30 with a score of ≤ 24 indicative of functional ankle instability.
Table 2- Performance in the Single-limb hopping test and the Modified star excursion balance test

<table>
<thead>
<tr>
<th>Condition</th>
<th>Single-limb hopping test (s)</th>
<th>MSEBT Anterior (cm)</th>
<th>MSEBT Posterior (cm)</th>
<th>MSEBT Posteromedial (cm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real tape</td>
<td>10.45 ± 3.56</td>
<td>62.58 ± 6.79</td>
<td>77.57 ± 10.61</td>
<td>77.17 ± 9.85</td>
</tr>
<tr>
<td>Placebo tape</td>
<td>10.52 ± 3.58</td>
<td>63.28 ± 5.59</td>
<td>77.78 ± 9.54</td>
<td>77.77 ± 8.91</td>
</tr>
<tr>
<td>Control</td>
<td>10.47 ± 3.67</td>
<td>63.62 ± 6.38</td>
<td>76.40 ± 10.77</td>
<td>77.02 ± 9.37</td>
</tr>
</tbody>
</table>

Mean and SD for time in the single-limb hopping test and reach distance in the modified star excursion balance test (MSEBT) with the real tape, placebo tape and control (no tape).
16 September 2004

Professor K Refshauge
School of Physiotherapy
Faculty of Health Sciences
Cumberland Campus – C42

Dear Professor Refshauge,

Thank you for your correspondence dated 23 August 2004 addressing comments made to you by the Committee. After considering the additional information, the Executive Committee at its meeting on 15 September 2004 approved your protocol entitled “Placebo effect of ankle taping in ankle instability”.

Details of the approval are as follows:

Ref No.: 09-2004 / 2 / 7655
Approval Period: September 2004 to September 2005
Completion Date of Project: November 2005
No. of Participants: 80
Authorised Personnel: Professor K Refshauge
Dr S Kilbreath
Miss K Sawkins
Mr P Ooms
Dr J Raymond

To comply with the National Statement on Ethical Conduct in Research Involving Humans, and in line with the Human Research Ethics Committee requirements this approval is for a 12-month period. At the end of the approval period, the HREC will approve extensions for a further 12-month, subject to a satisfactory annual report. The HREC will forward to you an Annual Progress Report form, at the end of each 12-month period. Your first report will be due on 30 September 2005.
Conditions of Approval Applicable to all Projects

(1) Modifications to the protocol cannot proceed until such approval is obtained in writing. (Refer to the website www.usyd.edu.au/ethics/human under 'Forms and Guides' for a Modification Form).

(2) The confidentiality and anonymity of all research subjects is maintained at all times, except as required by law.

(3) All research subjects are provided with a Participant Information Sheet and Consent Form, unless otherwise agreed by the Committee.

(4) The Participant Information Sheet and Consent Form are to be on University of Sydney letterhead and include the full title of the research project and telephone contacts for the researchers, unless otherwise agreed by the Committee.

(5) The following statement must appear on the bottom of the Participant Information Sheet. Any person with concerns or complaints about the conduct of a research study can contact the Manager, Ethics Administration, University of Sydney, on (02) 9351 4811.

(6) The standard University policy concerning storage of data and tapes should be followed. While temporary storage of data or tapes at the researcher's home or an off-campus site is acceptable during the active transcription phase of the project, permanent storage should be at a secure, University controlled site for a minimum of seven years.

(7) A report and a copy of any published material should be provided at the completion of the Project.

Yours sincerely

[Signature]

Associate Professor Stewart Kellie
Chairman, Human Research Ethics Committee

Encl. Participant Information Sheet
    Participant Consent Form
    Debrief Statement
    Advertisement
    CAIT Questionnaire

cc: Ms K Sawkins, 40 Goorama Drive, Cambewarra NSW 2540
    Mr P Ooms, School of Physiotherapy, Faculty of Health Sciences, Cumberland Campus – C42, The University of Sydney
THE PLACEBO EFFECT OF ANKLE TAPING IN ANKLE INSTABILITY

PARTICIPANT INFORMATION SHEET

You are invited to take part in a research study designed to determine the contribution of the placebo effect of ankle taping to the effectiveness of ankle taping in subjects with chronic ankle instability. The object is to investigate the role of the placebo effect in ankle taping in subjects with chronic ankle instability. Two different methods of ankle taping will be investigated with particular emphasis on the role that the placebo effect plays in their effectiveness. If we can determine whether the placebo effect contributes to the effectiveness of ankle taping we will be able to suggest modifications to methods of ankle taping in clinical practice. The study is being conducted by Kate Sawkins, forming the basis for the degree of Bachelor of Applied Science (Physiotherapy) Honours at The University of Sydney, and by Pim Ooms, forming the basis of a Masters of Exercise Science (Maastricht University) both under the supervision of Prof. Kathryn Refshauge and Dr Sharon Kilbreath.

If you agree to participate in this study, you will initially be asked to attend the Ankle Laboratory at the Faculty of Health Sciences, University of Sydney. The entire procedure will take no more than two (2) hours to complete. First we will ask some questions about your past medical history and general health and get you to complete a questionnaire (Cumberland Ankle Instability Tool) to determine whether you meet the requirements to participate in the study.

If you meet the requirements for the study you will then be given instructions, a demonstration and the opportunity to practice on the four (4) tests involved in the study. You will then be asked to complete the four (4) tests without your ankle taped and your results will be recorded. Following this you will be randomly allocated into one of two groups, with each group testing a different method of ankle taping. Within this group you will complete the four (4) tests under three (3) different conditions:

1. With your ankle taped according to the specific method.
2. With your ankle taped using a placebo method.
3. With your ankle taped with a 50:50 chance that the method of taping could be real or placebo.

The conditions and tests will be undertaken in a random order and sufficient rest time will be provided between each condition.

After completing these four (4) tests, the same procedure will then be repeated, testing the alternate method of taping. Overall, you will complete the four (4) tests under seven (7) different conditions.
THE PLACEBO EFFECT OF ANKLE TAPING IN ANKLE INSTABILITY

Tests

1. *Hopping course*- consists of 8 squares, with 4 squares inclined at 15 degree angles. The time taken to complete the course will be recorded.

2. *Star Excursion Balance Test*- involves balancing on your injured ankle whilst reaching in 8 different directions with your uninjured leg. The distance reached will be recorded.

3. *One-leg standing balance*- involves balancing on your injured ankle for 30 seconds with your eyes closed. Your level of stability during this time will be recorded.

4. *Figure of 8 running*- involves running four (4) laps of a figure of eight running course. The time taken to complete four (4) laps will be recorded.

There is also another question involved in the research, however it is important that you do not know beforehand what this question concerns. This part of the research is not harmful, and we will fully inform you at the end of testing.

Risks

There is minimal risk associated with the study, however, due to the nature of the performance tasks and the instability of your ankle, there is a small risk that during the study you may re-sprain your ankle. Should this occur qualified physiotherapists will be available to assist and advise you. Any adverse effects should last no longer than one week.

All aspects of the study, including results, will be strictly confidential and only the investigators named above will have access to information on participants. A report of the study may be submitted for publication, but individual participants will not be identifiable in such a report.

Benefits

While we intend that this research study furthers medical knowledge and may improve treatment of ankle instability in the future, it may not be of direct benefit to you.

Participation in this study is entirely voluntary. You are not obliged to participate and if you do participate you can withdraw at any time. Whatever your decision, it will not affect your relationship with the staff or other researchers. The Information Sheet is for you to keep and should you have any further questions regarding your involvement in this study please do not hesitate to ask or contact the investigators (see below). The Human Research Ethics Committee of The University of Sydney has approved this study.

Any person with concerns or complaints about the conduct of a research study can contact the Manager for Ethics Administration, University of Sydney on phone: (02) 9351 4811, fax: (02) 9351 6706 or email: research@reschols.usyd.edu.au

Contact details for the investigators:

<table>
<thead>
<tr>
<th>Name</th>
<th>School of Physiotherapy</th>
<th>The University of Sydney</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prof. Kathryn Refshauge</td>
<td>School of Physiotherapy</td>
<td>The University of Sydney</td>
</tr>
<tr>
<td>Dr Sharon Kilbreath</td>
<td>School of Physiotherapy</td>
<td>The University of Sydney</td>
</tr>
<tr>
<td>Kate Sawkins</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Phone: 9351 9180
K.Refshauge@fhs.usyd.edu.au

Phone: 9351 9272
S.Kilbreath@fhs.usyd.edu.au

Phone: 0402460282
ksaw6218@mail.usyd.edu.au
The University of Sydney

School of Physiotherapy

Faculty of Health Sciences

Kathryn Refshauge
DipPhty GradDipManip Ther
MBiomedE (UNSW) PhD (UNSW)
Professor

PO Box 170
Lidcombe NSW 1825
Telephone: +61 2 9351 9180
Facsimile: +61 2 9351 9601
Email: KRefshauge@fhs.usyd.edu.au

PARTICIPANT CONSENT FORM
THE PLACEBO EFFECT OF TAPPING IN ANKLE INSTABILITY

I, ........................................................................................................................................,
Name (please print)
give consent to my participation in the above research project conducted by
Kate Sawkins, Prof Kathryn Refshauge, Dr Sharon Kilbreath, Dr Jacqui
Raymond and Pim Ooms.

In giving my consent I acknowledge that:

1. The procedures required for the project have been explained to me,
and any questions I have about the project have been answered to my
satisfaction.

2. I have read the Participant Information Sheet and have been given the
opportunity to discuss the information and my involvement in the
project with the researcher/s.

3. I understand that I can withdraw from the study at any time, without
affecting my treatment or my relationships with the researcher(s) now
or in the future.

4. I understand that my involvement is strictly confidential and no
information about me will be used in any way that reveals my identity.

Signed: ........................................................................................................................................
Name: ........................................................................................................................................
Date: ........................................................................................................................................

If you have any inquiries please contact one of the investigators:
Kate Sawkins 0402 460 282 ksaw6218@mail.usyd.edu.au
Prof Kathryn Refshauge 9351 9180 K.Refshauge@fhs.usyd.edu.au
Dr Sharon Kilbreath 9351 9272 S.Kilbreath@fhs.usyd.edu.au
Dr Jacqui Raymond 9351 9528 J.Raymond@fhs.usyd.edu.au

Any person with concerns or complaints about the conduct of a research
study can contact the Manager for Ethics Administration, University of
Sydney on phone: (02) 9351 4811, fax: (02) 9351 6706 or email:
research@reschols.usyd.edu.au
ARE YOU INTERESTED IN BEING A SUBJECT FOR AN 'ANKLE TAPING STUDY'? 

We are looking for 30 subjects with a history of ankle sprains. Data collection requires approximately 2 hours of your time. The study will be conducted in the ankle laboratory in N block.

If would like to be involved in this study or want to know more about it, please contact:

Dr Sharon Kilbreath       S245A  📞9351 9272
                          📧S.Kilbreath@fhs.usyd.edu.au
Prof Kathryn Refshauge    0152  📞9351 9180
                          📧K.Refshauge@fhs.usyd.edu.au
Kate Sawkins              📞0402460282
                          📧ksaw6218@mail.usyd.edu.au
Appendix 5

Cumberland Ankle Instability Tool (CAIT)

Please tick the ONE statement in EACH question that BEST describes your ankles.

<table>
<thead>
<tr>
<th>Question</th>
<th>LEFT</th>
<th>RIGHT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. I have pain in my ankle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>During sport</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running on uneven surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Running on level surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking on uneven surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Walking on level surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. My ankle feels UNSTABLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes during sport (not every time)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequently during sport (every time)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes during daily activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Frequently during daily activity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. When I make SHARP turns my ankle feels UNSTABLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes when running</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Often when running</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. When going down the stairs my ankle feels UNSTABLE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>If I go fast</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Occasionally</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Always</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. My ankle feels UNSTABLE when standing on ONE leg</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>On the ball of my foot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With my foot flat</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. My ankle feels UNSTABLE when</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I hop from side to side</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I hop on the spot</td>
<td></td>
<td></td>
</tr>
<tr>
<td>When I jump</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. My ankle feels UNSTABLE when</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I run on uneven surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I jog on uneven surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I walk on uneven surfaces</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I walk on a flat surface</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. TYPICALLY when I start to roll over (or 'twist') on my ankle I can stop it</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Immediately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Often</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sometimes</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Never</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have never rolled over on my ankle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Following a TYPICAL incident of my ankle rolling over, my ankle returns to 'normal'</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Almost immediately</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than one day</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-2 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>More than 2 days</td>
<td></td>
<td></td>
</tr>
<tr>
<td>I have never rolled over on my ankle</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Participant Debrief Statement

We informed you that there was another question involved in the research that we did not want to inform you about before data collection. That question was about whether placebo taping was as effective as real taping used by sports physiotherapists. This means that several trials were conducted using a placebo taping protocol on your ankle. If you are interested, we will let you know your results when we have analysed the data.

We would prefer that you do not tell other potential participants in this study about the placebo taping. We need participants to be naïve to this condition to be able to test it properly.

Thank you very much for your participation.
## Power Calculation

### ENTER INPUTS HERE …

(asterisked items are compulsory)

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>effect to be detected*</td>
<td>1</td>
</tr>
<tr>
<td>SD*</td>
<td>1.3</td>
</tr>
<tr>
<td>alpha (suggest 5%)*</td>
<td>5</td>
</tr>
<tr>
<td>power (suggest 80%)*</td>
<td>80</td>
</tr>
<tr>
<td>non-compliance (%)</td>
<td>0</td>
</tr>
<tr>
<td>dropouts (%)</td>
<td>0</td>
</tr>
<tr>
<td>intraclass correlation co-efficient</td>
<td>0</td>
</tr>
<tr>
<td>mean cluster size</td>
<td>0</td>
</tr>
<tr>
<td>correlation (r) with covariate:</td>
<td>0</td>
</tr>
</tbody>
</table>

### ANSWER IS RETURNED HERE …

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>n (per group):</td>
<td>27</td>
</tr>
<tr>
<td>width of confidence interval:</td>
<td>+/- 0.36</td>
</tr>
</tbody>
</table>
Additional Results

Participants’ Preferred Condition

On completion of testing participants were asked which condition they preferred: 1) in general, 2) for each test, and 3) for each direction on the modified star excursion balance test. Participants’ preferred condition appeared to be influenced by several factors.

Overall the majority of participants preferred the real tape condition (n = 21). Five participants preferred the placebo tape and four participants preferred the control condition (no tape) (Fig. A1). Given the effect of each condition on participants’ perceptions of stability, confidence and reassurance on each functional test (Fig. 5 and 6), this finding is not surprising. The real tape condition had the greatest impact on participants’ perceptions of stability, confidence and reassurance on both the single-limb hopping test and the modified star excursion balance test. Furthermore, the placebo tape had a greater impact on perceived stability, confidence and reassurance than the control condition. The extent to which each condition improved the participants’ perceptions of stability, confidence and reassurance, therefore, appeared to be a predictor of the participants’ preference for that condition.
Preferred condition and functional test

Participants’ preferred condition for each functional performance test was also examined. Participants’ preference appeared to be related to the specific demands of the functional test and the ability of the condition to meet those demands.

Single-limb hopping test

For the single-limb hopping test, the majority of participants preferred the real tape condition (n = 22), with an equal number of participants preferring the placebo tape and the control condition (no tape) (n = 4). While the single-limb hopping test is designed to measure agility, it also requires stability at the ankle joint. Interestingly, 97% (n = 29) of participants reported an improvement in perception of stability on the
single-limb hopping test with the real tape condition. The ability of the real tape to meet the stability requirements of the single-limb hopping test, may therefore explain the strong preference for the real tape on this test.

Modified star excursion balance test

For the modified star excursion balance test, preference for the real tape condition was not as strong. In the anterior direction, for example, the majority of participants preferred the control condition (no tape) \(n = 10\). Eight participants preferred the real tape, seven participants preferred the placebo tape and five participants could not distinguish one condition as being their preferred. On examination of the participants’ responses regarding perception of stability on the modified star excursion balance test, it was noted that a large number of participants \(n = 18\) perceived the real tape condition as being restrictive, particularly in the anterior direction. The modified star excursion balance test requires mobility at the ankle joint in order to achieve a maximal reach distance. The real tape condition may impede mobility for this test, which may explain why the majority of participants’ preferred the control condition (no tape), as it did not offer any restriction to movement.

Participants’ preferred condition appears to be influenced by the demands of the functional task. In tasks requiring stability, such as the single-limb hopping tests, participants may prefer restrictive methods of taping such as the real tape condition. In contrast, in tasks requiring mobility, such as the modified star excursion balance test, participants’ may prefer the freedom of movement associated with not having their ankle taped.
Preferred condition and previous experience with ankle taping

The effect of previous experience with ankle taping on participants’ preference was also investigated. In order to do this the sample was divided into participants who had and had not previously taped their ankle. Twenty-four participants had previously taped their ankle, while six participants had no prior experience with ankle taping. Interestingly, a higher percentage of individuals who had taped their ankle preferred the real tape condition (75%) compared to participants who had not previously taped their ankle (50%). Furthermore, a smaller percentage of participants who had previously taped their ankle (12.5%) preferred the placebo tape compared to participants who had not previously taped their ankle (33%). These results suggest that participants’ preference may be related to their previous experience with ankle taping. Caution must be taken, however, when interpreting these results. The difference in sample size between the groups makes direct comparison inappropriate. Furthermore, other variations between the groups were not examined, and therefore not controlled for, and may have a compounding effect on the results. Further research would be required to determine the exact relationship between experience with ankle taping and taping preference.
Appendix 9

Instructions to Authors from Medicine and Science in Sports and Exercise

Author Resources

- Copyright Transfer (.doc)
- Manuscript Submission Form (.doc)
- Commercial Reprints Only
- Permissions Requests
- ePrints
- Reprints

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To be an author, each individual shall have contributed to the manuscript in at least two of the following areas:

- Significant manuscript writer
- Significant manuscript reviewer/reviser
- Concept and design
- Data acquisition
- Data analysis and interpretation
- Statistical expertise

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Medicine & Science in Sports & Exercise
401 West Michigan Street
Indianapolis, IN 46202-3233 USA
Phone: 317-634-8932
Fax: 317-634-8927
msse@acsm.org

Submission Requirements
Manuscripts that do not comply with the following requirements and directives for process, style, and format will not enter the peer-review process.

Manuscripts shall be submitted electronically via Editorial Manager® (www.editorialmanager.com/msse). Detailed information regarding registration and use of Editorial Manager® is found on the site. Hard-copy submissions will not be accepted by the Editorial Office and will be discarded.

Authors submitting manuscripts for review shall also submit:
Manuscript Requirements
The manuscript file must be in a document format, not PDF format. The manuscript shall be formatted so that it is set in Times Roman font with 12-point font size; has margins of 1" top, 1" bottom, 1.5" right, 1.5" left; and is double-spaced throughout. Typical manuscript length is approximately 20 pages including references, but excluding tables and figures. Do not put figures and tables in the manuscript file. Submit all figure and table files separately from the manuscript text file. Do not use Microsoft Word for figure formatting. Please use a recognized image format—preferably .tiff.

Paragraphs should be numbered; for example, “Paragraph Number 1 The subjects of this study...“ Paragraph numbers serve as an effective method for relaying reviewer comments back to the author. Begin paragraph numbering with the first paragraph in the Introduction and end before the References section. Do not use an automatic paragraph numbering option, as titles, subtitles, abstracts, etc., are not numbered.

Revised Manuscripts
Authors submitting revised manuscripts shall adhere to the above requirements and submit through Editorial Manager® (www.editorialmanager.com/msse). When returning a revised manuscript, author point-by-point responses to reviewer comments must be a separate document.

Blind Reviews
All reviews are “open,” with the author identities known to the reviewers.

Human & Animal Experimentation Policy Statements
Failure to comply with the guidelines that follow and to guarantee such conformance by a statement in the manuscript will result in rejection of the manuscript.

Studies and case reports involving the use of human subjects shall conform to the policy statement regarding the use of human subjects and written informed consent as published by Medicine & Science in Sports & Exercise®. All studies involving animal experimentation shall be conducted in conformance with the policy statement of the American College of Sports Medicine on research with experimental animals as published by Medicine & Science in Sports & Exercise®.

Policy Statement Regarding the Use of Human Subjects and Informed Consent
By law, any experimental subject or clinical patient who is exposed to possible physical, psychological, or social injury must give informed consent prior to participating in a proposed project. Informed consent can be defined as the knowing consent of an individual or his legally authorized representative so situated as to be able to exercise free power of choice without undue inducement or any element of force, fraud, deceit, duress, or other form of constraint or coercion. The Editorial Board of Medicine & Science in Sports & Exercise® requires that all appropriate steps be taken in obtaining the informed
written consent of any and all human subjects employed by investigators submitting manuscripts for review and possible publication. In most cases, informed consent should be obtained by having the subject read a document (an Informed Consent Form) presenting all information pertinent to the investigation or project and affixing a signature indicating that the document has been read and consent given to participation under the conditions described therein. The document should be written so that it is easily understood by the subjects and provided in a language in which the subjects are fluent.

Investigators are requested to consider the following items for inclusion in an Informed Consent Form as appropriate to the particular project:

- A general statement of the background of the project and the project objectives.
- A fair explanation of the procedures to be followed and their purposes, identification of any procedures that are experimental, and description of any and all risks attendant to the procedures.
- A description of any benefits to be reasonably expected and, in the case of treatment, disclosure of any appropriate alternative procedures that might be advantageous to the subject.
- An offer to answer any queries of the subject concerning procedures or other aspects of the project.
- An instruction that the subject is free to withdraw consent and to discontinue participation in the project or activity at any time without prejudice to the subject.
- An instruction that, in the case of questionnaires and interviews, the subject is free to deny answer to specific items or questions.
- An instruction that, if services or treatment are involved in the setting or context of the project, they will be neither enhanced nor diminished as a result of the subject’s decision to volunteer or not to volunteer participation in the project.
- An explanation of the procedures to be taken to ensure the confidentiality of the data and information to be derived from the subject. If subjects are to be identified by name in the manuscript, permission for same should be obtained in the Informed Consent Form or obtained in writing at a later date.

If the subject is to be videotaped or photographed in any manner, this must be disclosed in the Informed Consent Form. The subject must be advised as to whom will have custody of such videotapes or photographs, who will have access to the tapes or photographs, how the tapes or photographs are to be used, and what will be done with them when the study is completed.

The informed consent document shall not contain any exculpatory language or any other waiver of legal rights releasing, or appearing to release, an investigator, project director, or institution from liability. At the bottom of the form, provision shall be made for the signature of the subject (and/or a legally authorized representative) and the date. It is generally advisable to precede this with a statement to the effect that the subject and/or representative have read the statement and understand it. In the case of minors, one or both parents should sign (as appropriate). For minors of sufficient maturity, signatures should be obtained from the subject and the parent(s).

The Editorial Board endorses the Declaration of Helsinki of the World
Medical Association as regards the conduct of clinical research. Physicians are expected to comply with the principles set forth in this declaration when research involves the use of patients. In the case of psychological research, investigators will be expected to comply with the principles established by the American Psychological Association. These principles are presented in the publication, "Ethical Principles in the Conduct of Research with Human Participants" (American Psychological Association, Washington, D.C., 1982). The use of subjects should be approved by an ethics committee prior to the investigation.

It will not be necessary for an author to describe in the manuscript the specific steps that were taken to obtain informed consent, to ensure confidentiality of results, or to protect the privacy rights of participating subjects. It will be satisfactory for the author to indicate that, “Written informed consent was obtained from the subject,” or by similar wording. It will be understood by the editors that such a statement indicates the author’s guarantee of compliance with the directives presented above.

**Policy Statement of the American College of Sports Medicine on Research with Experimental Animals**

The ability of science to enhance the well being of humans and animals depends directly on advancements made possible by research, much of which requires the use and availability of experimental animals. Therefore, all who propose to use animals for research, education, or testing purposes must assume the responsibility for their general welfare. It is essential to recognize and to appreciate that the intent of scientific research is to provide results that will advance knowledge for the general and specific benefits of humans and animals. To accomplish these goals, the American College of Sports Medicine (ACSM) will support research of high scientific merit that includes the use of experimental animals.

Before the College will consider supporting research projects, the College must receive written assurances from the institution that the policies and procedures detailed in the *Guide for the Care and Use of Laboratory Animals* as published by the U.S. Department of Health and Human Services and proclaimed in the Animal Welfare Act (PL89-544, PL91-979, and PL94-279) are policy of the institution. Furthermore, the ACSM endorses the rules, procedures, and recommendations for the care of laboratory animals as advocated by the American Association for Accreditation of Laboratory Animal Care (AAALAC). Support for research and publication of research findings by the ACSM require that the institution where the research was conducted confirm it has filed a National Institutes of Health assurance and/or has AAALAC approved facilities.

**Submission Types**

In addition to original investigations, the Journal publishes

- Clinical Investigations & Case Studies
- Brief Reviews
- Symposium Proceedings
- Special Communications
  - Methodological Advances
  - Rapid Communications
  - Letters to the Editor-in-Chief
Clinical Investigations & Case Studies
Authors are encouraged to submit manuscripts describing specific clinical cases that provide relevant information on diagnosis and therapy of a particular case that proves unique to clinical sports medicine. Manuscripts should be current, concise, accurate, and understandable and should contain the following:

- An abstract that contains the clinical implications.
- An introduction that provides commentary with regard to the clinical problem, which will be explained using the case as an example. It is important to document the patient’s agreement to the use of their clinical data in the presentation.
- A brief case report including history, physical examination, and laboratory findings followed by treatment and outcome.
- A discussion section that explains in detail the clinical implications over the course of the case as well as key aspects of the case that may be unique or may differ from similar reported cases in the medical literature.

Brief Reviews
Brief review articles (maximum 25 double-spaced pages, including references—limit 50) will be screened by the Editor-in-Chief before entering the review process. Authors of review articles shall be established, recognized experts in the field. Literature reviews in conjunction with collegiate thesis work are not acceptable review articles.

Symposium Proceedings
Submission of ACSM Annual Meeting symposia papers is by Editor-in-Chief invitation only. Symposia papers from any ACSM Annual Meeting must be received in the Editorial Office before December 1 of the year of presentation. Previously stated submission requirements shall be followed; however, presentations should not exceed 15 typewritten, double-spaced pages. Authors who use previously published material shall obtain prior written permission to reprint from the publisher holding the copyright and provide a quality original for publication. (See “Previously Published Material.”) All invited symposia manuscripts are subject to the peer-review process and accepted manuscripts are subject to the standard page charges. Organizers of symposia concerned with new developments in sports medicine and exercise science are encouraged to contact the Managing Editor regarding the possibility of publication.

Special Communications

Methodological Advances
Manuscripts that deal with new methods, important modifications of existing ones, or applications of new equipment will be considered for publication in a section titled Special Communications. Authors are strongly encouraged to familiarize themselves with the recently published articles in *Medicine & Science in Sports & Exercise*, as the Journal will not consider for publication those manuscripts that present results of articles previously published.

Rapid Communications
Authors are encouraged to submit manuscripts suitable to be considered as "Rapid Communication" articles for the purpose of releasing cutting-edge information expeditiously. There are two types of rapid communication articles:
1. Brand-new methodology
2. Revolutionary new findings

Authors must declare in writing the uniqueness of the paper at the time of submission. These papers are subject to the peer-review process and must follow MSSE® style.

Letters to the Editor-in-Chief
Letters addressed to the Editor-in-Chief will be considered for publication if they promote intellectual discussion of an article recently published. Letters should contain an informative title and follow the submission requirements for manuscripts. Letters are limited to 500 words and a maximum of eight (8) references. If acceptable, a copy will be sent to the author of the original article with an invitation to submit a rebuttal that will be published with the letter. Letter responses will be held to the same length and number-of-reference requirements.

Books for Review
ACSM is pleased to provide readers with the most current reviews of just released publications from Doody Publishing Review and, therefore, does not accept books from publishers or authors for the purpose of independent review. Publishers or authors may still contribute books to ACSM Library by sending the materials to: ACSM National Center, Attn: Library, 401 West Michigan Street, Indianapolis, IN 46202-3233.

Manuscript Preparation

Text Guidelines

Language
English is the language of the publication. Authors who speak English as a second language are encouraged to seek the assistance of a colleague experienced in writing for English language journals. Authors of accepted manuscripts who cannot meet the Journal's standard English usage are encouraged to seek assistance from the publisher, Lippincott Williams & Wilkins, who provides rewriting services for a fee.

Authors are encouraged to use nonsexist language as defined in the American Psychologist 30:682–684, 1975, and to be sensitive to the semantic description of persons with chronic diseases and disabilities, as outlined in an editorial in Medicine & Science in Sports & Exercise®, 23(11), 1991. As a general rule, only standardized abbreviations and symbols should be used. If unfamiliar abbreviations are employed, they should be defined when they first appear in the text. Authors should follow Webster’s Third New International Dictionary for spelling, compounding, and division of words. Trademark names should be capitalized and the spelling verified. Chemical or generic names should precede the trade name or abbreviation of a drug the first time it is used in the text.

Previously Published Material
Medicine & Science in Sports & Exercise® will accept only original, unpublished illustrations and tables, except in the cases of review articles, symposia, and meta-analyses. Authors of review articles, symposia, and meta-analyses papers who do use previously published material shall obtain prior written permission to reprint from the publisher holding the copyright and be able to provide a quality original to the Editorial Office for publication. It is also customary that written permission from the original
Order of Manuscript
An original investigation should contain the following items and satisfy the given specifications.

- Title Page
  1) Title of no more than 85 characters, including spaces. Do not use a complete sentence as a title.
  2) Full names of the authors—Only those investigators who contributed substantially or who had a primary role in the research represented in the manuscript should be listed as authors. Manuscripts listing more than six (6) authors should provide justification. The Editor-in-Chief reserves the right to request that the author list be reduced.
  3) Institutional affiliation of each author clearly identified; linked to each author by use of superscript numbers
  4) Corresponding author name, mailing address, telephone, fax, and e-mail information
  5) Running title of no more than 45 characters, including spaces

- Abstract
  1) Limit of 275 words, including numbers, abbreviations, and symbols
  2) Structure states purpose, methods, results, and conclusion

- Key Words
  1) Four (4) to six (6) words following the abstract
  2) Should not repeat terms or phrases from the title

- Introduction
  1) State clearly the purpose and hypothesis of the study
  2) Provide relevant references
  3) Do not exhaustively review the subject

- Methods
  1) Present subject information
  2) Describe the experimental subjects and their controls
  3) Insert “written informed consent” statement or animal-use statement and ethics committee approval statement (required) (see “Human & Animal Experimentation Policy Statements”)
  4) Identify the methods, apparatus, and procedures employed with sufficient details to allow others to reproduce the results
  5) Provide references for established methods and statistical procedures
  6) Provide rationale for use and include a description of possible limitations for utilized methods not well known
  7) Denote statistical significance when appropriate and include detailed statistical analyses, mathematical derivation, or computer programs in an appendix

- Results
  1) Present findings of the study in the text, tables, or figures
  2) Do not include the same data in tables and figures

- Discussion
  1) Emphasize the original and important features of the study and avoid repeating all the data presented within the results section
  2) Incorporate the significance of the findings and the
relationship(s) and relevance to published observations
3) Provide only those conclusions that are supported by the study

• Acknowledgments
  1) Identify funding sources
  2) Identify external reviewers, if any
  3) Current contact information of corresponding author
  4) Contact for reprints, if any

• Conflict of Interest
  Authors are required to state in the acknowledgments all funding
  sources, and the names of companies, manufacturers, or outside
  organizations providing technical or equipment support. In
  particular, authors should:
  ▪ 1) Disclose professional relationships with companies or
     manufacturers who will benefit from the results of the
     present study
  ▪ 2) State that the results of the present study do not
     constitute endorsement of the product by the authors or
     ACSM

Failure to disclose such information could result in the rejection of
the submitted manuscript.

• References
  The format for references is that which has been adopted by the
  United States National Library of Medicine and employed in Index
  Medicus. For those not included in Index Medicus, adhere to the
  form established by the American National Standard for
  Bibliographic References. The reference list shall be in alphabetic
  order, rather than in the order of citation, and numbered. All
  references shall appear in the text. Examples of the types of
  references are as follows:
  1) Books
     ▪ American College of Sports Medicine. Guidelines for Exercise
       Testing and Prescription. Philadelphia, PA: Lea and Febiger,
     ▪ Paffenbarger, R. S., R. T. Hyde, and A. L. Wing. Physical
       activity and physical fitness as determinants of health and
       longevity. In: Exercise, Fitness, and Health. C. Bouchard, R.
  2) Doctoral Dissertations—Crandall, Craig. Alterations in human
     baroreceptor reflex regulation of blood pressure following 15 days
     University of North Texas HSC, Dept. of Physiology, Fort Worth,
     Texas, August 1993.
  3) Government Reports—U.S. Department of Health and Human
     Services. Healthy People 2000: National Health and Disease
     Prevention Objectives (full report, with commentary). Washington,
     DC: Department of Health and Human Services, Publication
  4) Journal Articles—Blair, S. N., N. M. Ellsworth, W. L. Haskell,
     M. P. Stern, J. W. Farguhar, and P. D. Wood. Comparison of
     nutrient intake in middle-aged men and women runners and
  5) Software Manuals—SAS Institute. SAS/STAT Software: The
3: Appendices

1054 pp.


7) **Abstracts**—An abstract can be cited when it is the only source of information.

**Note:** In-text reference citations shall be baseline in parentheses, not superscripts [e.g., (14,15), not 14,15]. Internet sources, Master of Science theses, personal communications, or other unpublished material are not acceptable as references. There should not be more than 30 references for original investigations. Review articles are limited to 50 references. All book references require page numbers. Examples to follow for corporate authors, chapters, editors, center publication, etc., can be observed in the *British Medical Journal* 1:1334–1336, 1978. Journal abbreviations should follow the abbreviations of *Index Medicus* published by the Library of Congress. Use of et al.—If fewer than seven (7) authors are listed, all should be mentioned. When seven or more authors are named, list only the first three.

- **Figure Captions**
  1) Provide a caption for each figure
  2) List captions together following references section

### Technical Guidelines

#### Terminology and Units of Measurement

To promote consistency and clarity of communication and to avoid ambiguity, it is directed that authors use standard terms generally acceptable to the field of exercise science and sports medicine.

The units of measurement shall be Système International d'Unités (SI). Permitted exceptions to SI are heart rate—beats per min; blood pressure—mm Hg; gas pressure—mm Hg. Authors should refer to the *British Medical Journal* 1:1334–1336, 1978 and the *Annals of Internal Medicine* (106:114–129, 1987) for the proper method to express other units or abbreviations. When expressing units, authors must locate the multiplication symbol midway between lines to avoid confusion with periods; for example, mL·min\(^{-1}\)·kg\(^{-1}\).

The basic and derived units most commonly used in reporting research in this Journal include the following:

- mass—gram (g) or kilogram (kg); force—newton (N); distance—meter (m), kilometer (km); temperature—degree Celsius (°C); energy, heat, work—joule (J) or kilojoule (kJ); power—watt (W); torque—newton-meter (N·m); frequency—hertz (Hz); pressure—pascal (Pa); time—second (s), minute (min), hour (h); volume—liter (L), milliliter (mL); and amount of a particular substance—mole (mol), millimole (mmol). Selected conversion factors: 1 N = 0.102 kg (force); 1 J = 1 N·m = 0.000239 kcal = 0.102...
kg·m; 1 kJ = 1000 N·m = 0.239 kcal = 102 kg·m; 1 W = 1 J·s⁻¹ = 6.118 kg·m·min⁻¹.

Sample Size
Authors should justify the adequacy of their sample size by providing calculations regarding the power of their statistical tests. While there are different approaches that authors may take in performing these calculations, the text by Cohen (1988) is recommended as an appropriate starting point. (Cohen, J. *Statistical Power Analysis for the Behavioral Sciences*, 2nd Ed. Hillsdale, NJ: Lawrence Erlbaum Associates, Publishers, 1988.)

Formulas and Equations
Formulas and equations should be kept to a minimum and always presented in a single line:

\[(a + b) / (x + y).\]

Presentation in the text as requires \((a + b) / (x + y)\) hand composition and adds an additional line of space. All unusual characters must be accompanied by a definition or explanation.

Figures
*Medicine & Science in Sports & Exercise*® will accept either electronic files or camera-ready artwork. Captions are required for all figures.

Preparation of Electronic Artwork:
- Do not submit artwork that is embedded in a text file from a word-processing program.
- Artwork should be submitted in final size and should be cropped and rotated as it will appear in the final printed piece.
- Files should be saved as and submitted in .tiff or .eps format—jpeg, .gif, or files downloaded from the Internet are not acceptable.
- Color files should be submitted as CMYK (not RGB).
- Line art should be saved at a resolution of at least 1200 dpi (dots per inch). Photographs, CT scans, radiographs, etc. should be saved at a resolution of at least 300 dpi. Images saved at 72 dpi are not acceptable for printed publications.
- Save each figure in a separate file.

Camera-Ready Artwork
- The design of original figures should be consistent, drawn to the same scale, and designed as simply as possible.
- There should be no gray shading or dot patterns.
- Distinguish data by the use of intermittent symbols.
- Appropriate distinctions for bar graphs would be a white bar, black bar, diagonal line in either or both directions, checkered pattern, horizontal or even vertical lines.
- Multipanels should be aligned vertically, not horizontally, ¼–3/8 inches apart. There should be no more than three panels to any one figure.
- Figures should be unmounted, high-contrast black-and-white prints designed to a one-column width of 3¼ inches, including axis labels.
• Lettering (symbols, letters, and numbers) should be a minimum 10-point font and should be of professional quality with consistent spacing and alignment.
• Dot matrix prints are not acceptable.
• Line width should be ¾ point or greater. Two original sets of line and bar graphs should be submitted and properly identified on the reverse as to position, author, and title of manuscript.
• Two (2) sets of photographs (halftones) are required (if applicable).
• Indicate the top of the figure, especially when it is a radiological or histological photograph.

Tables
• Tables must be typed double-spaced and should be designed to fit a one-column width (3¼ inches) or a two column width (7 inches).
• Each table shall have a brief caption; explanatory matter should be in footnotes below the table.
• The table shall contain means and the units of variation (SD, SE, etc.) and must be free of nonsignificant decimal places.
• Abbreviations used in tables must be consistent with those used in the text and figures. Definition symbols should be listed in the order of appearance, determined by reading horizontally across the table and should be identified by standard symbols.

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