The effects of self-talk on endurance performance: A systematic review

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Declaration

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Abstract

Background: Self-talk in sport can be defined as dialogue one uses, either aloud or internal, to help to interpret, evaluate and regulate feelings, while also providing feedback. This method is used by both top level and novice athletes in all kinds of athletic tasks, regardless of the form it takes. **Purpose:** The purpose of this systematic review was to critically asses up to date research on the area of self-talk during endurance performance. Specifically, the purpose was to look not only the performance outcome and the effects self-talk had on this, but to look deeper, at what type of self-talk method were used, whether it was individualized based on the athletes' needs, and whether or not they freely choose their own self-talk phrases and the rationales behind the selection. **Methods**: Searches for articles was carried out from five online electronic databases. Studies had to meet s strict inclusion criteria; 1) Peer-reviewed academic journals, written/published in English. 2) investigations looking specifically the effect of self-talk on; Swimming, Cycling, Ultra-Marathon, and Cross-Country running. 3) Participants must be recreationally trained, and currently active twice a week 4) Participants must be between 17-50 years of age. Studies were specifically excluded if self-talk was asses in conjunction with any other psychological training such as mental skills packages. **Results:** A total of 11 studies met the criteria. Of these, 10 reported performance improvements. Additionally, five studies used assigned self-talk, 4 used a mix, and two used self-generated statements. **Conclusion:** The reviewed literature enhances the theory that self-talk improves athletic performance, by adding endurance performance to the growing list of activities which it benefits. Various psychological theories, however, are not considered in the literature, such as the performance pyramid and the process of any self-talk progressions.

Glossary of Abbreviations

ST = Self-talk

MST = Motivational Self-talk

IST = Instructional Self-talk

PO = Power Output

RPE = Rate of Perceived Exertion

HR = Heart Rate

RCT = Randomized Control Trial

PEDro = Physiotherapy Evidence Database

PRISMA = Preferred Reporting Items for Systematic and Meta-Analysis

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1.0 Introduction

Due to the increasing professionalisation of sports in the last quarter of a century, the area of sports science has become increasingly prominent, and can be argued to be an essential component to any athlete/team looking to succeed. Within the sports science domain, areas such as Strength and Conditioning, Nutrition, Biomechanics and Psychology (among many others), have been researched extensively, and are being used to facilitate athletic development. Psychology is one area which has been widely researched with athletes who compete in individual sports, such as tennis, golf, and various endurance based activities, as these athletes are in control of how they do things and are not relying on teammates to get them by. Endurance performance has been defined as whole body, dynamic exercise, which requires sustaining continuous effort (McCormick, Meijen, and Marcora, 2015), often low resistance activities, such as (but not limited to) cycling and running (Aubert, Seps, and Beckers, 2003). These athletes are generally categorized as competing in long distance, low-intensity events which uses primarily the aerobic energy system. Within endurance performance, one of the most commonly used psychological methods for improving performance is self-talk. This method can be used individually or as part of a psychological skills package, which includes a variety of techniques, such as imagery, goal setting, relaxation, self-talk (Thelwell, and Greenlees, 2003) and segmentation (Díaz-Ocejo, Kuitunnen, and Mora-Mérida, 2013). Self-talk in sport is most commonly defined as personal dialogue (internal/aloud), in which an individual interprets feelings and regulates, evaluates, while also giving instruction/feedback (Hackfort and Schwenkmezger,1993). Although self-talk can be aloud, it is generally used internally by athletes (Hardy, Hall, and Hardy, 2005; Van Raalte, Vincent, and Brewer, 2016), regardless of gender or level.

2.0 Literature Review

2.1 Past Research on Self Talk in Sport

Self-talk in sport has been extensively researched for a long period of time, with the first studies being carried out in the late 1970s by Ziegler (1987), although, athletes long before this time have reported using this technique. Within this study, as it was the first of its kind published, the idea of “self-talk” was then referred to as “stimulus cueing”, whereby the athlete was instructed to use cue words in a tennis return, to keep focused on appropriate and relevant stimuli. This idea was then progressed where athletes began to use phrases or positive and negative statements when executing a skill, to improve their performance. This was seen in Van Raalte, Brewer, Lewis, and Linder (1995), who analysed the effectiveness of positive self-talk and negative self-talk on a darts throw and compared it to a control group. Once more, progressions were made from this, when self-talk was then divided and categorized into being instructional or motivational. This was a crucial step forward for self-talk research as this meant there was a clear distinction between the two forms and also that both had their benefits, depending on the activity being performed. This was experimentally analysed by Theodorakis, Weinberg, Natsis, Douma, and Kazakas (2000), whereby four experiments were carried out, two of which was looking at accuracy-based activities, and two being strength/power based. Results showed that there was a significant difference (improvement) in performances from the instructional self-talk group in trials which required accuracy and precision, compared to the motivational self-talk group and control group. Contrastingly, for power/strength-based experiments, the motivational self-talk groups outperformed the instructional and control groups, however, the results were not deemed significant. This was critical information at the time as this is the first study to compare the effects of two types of self-talk within various athletic challenges.

2.2 The Use of Psychology in Sport

The use of psychology in sport is not as easy as simply doing it or not doing it. Learning to use self-talk is a process like any other and must be learned and trained before it can be used effectively (Radcliffe, Comfort, and Fawcett, 2015). Lesyk (1998), posits that there are nine specific mental skills which successful athletes have acquired and use to be successful in both sports and in their general lives (see figure 1). From these

nine mental skills, a performance pyramid was designed, which consists of three phases (Basic skills/Level 1, Preparatory Skills/Level 2, and Performance skills/Level 3). Within each of these phases, specific mental skills are located. Level 1/Basic skills are located at the bottom of the pyramid and consist of Attitude, Goals and Commitment and people skills. These mental skills are ones which are required regularly, on a day to day basis and in training. Self-talk and mental imagery are located within Level 2 or in the preparatory skills section, which is in the middle of the performance pyramid. These skills relate to things which are used before performances of immediately before performing a closed skill, such as a free throw in basketball. Above this again, is Level 3/performance skills, which contains managing anxiety, managing emotions, and concentration. The mental skills located within this phase are performed during an athletic performance. In essence, this diagram is stating that athletes need to have the basic skills in order to be able to carry out the skills in level 2 effectively, such as self-talk. From this basic concept, developed by Lesyk (1998), the importance of the individualisation of self-talk can clearly be seen. If an athlete does not have the basic skills required, such as the correct attitude or sufficient motivation, they will not be able to execute self-talk in an effective manner. If an athlete then proceeds to use self-talk, it can be debilitative to their performance, as opposed to improving performance, which would have been the initial goal. Therefore, if self-talk is to be used effectively, it is recommended that athletes are screened prior to an intervention being prescribed, to ensure the athlete is going to be able to execute self-talk in a positive manner. Additionally, the coach can/should play a significant role in the athletes' use of self-talk and be aware when the use of self-talk may be becoming detrimental to the athlete's performance. Weinberg and Comar (1994) highlight that if a coach is able to recognize this, there are various forms of cognitive restructuring available to change an athlete's self-talk habits. One such method used is a self-talk progression known as "repair", "train" "game". This method of cognitive restructuring is about acknowledging that there is a potential issue with an athletes use of self-talk, and through the use of training, can regulate the "problem" and engrain a positive alternative into the athlete's head so that it is autonomous come to a game situation, thus eliminating the initial negative self-talk/the potentially debilitating self-talk. The repair phase focuses on changing the athlete's perception of a certain thought/self-talk phrase and turning it into a positive, which can be used to enhance the athlete's performance in the future. So, methods such as cognitive

reconstruction and the concept of the performance pyramid should be analysed and questioned when discussing self-talk interventions with a group of athletes.

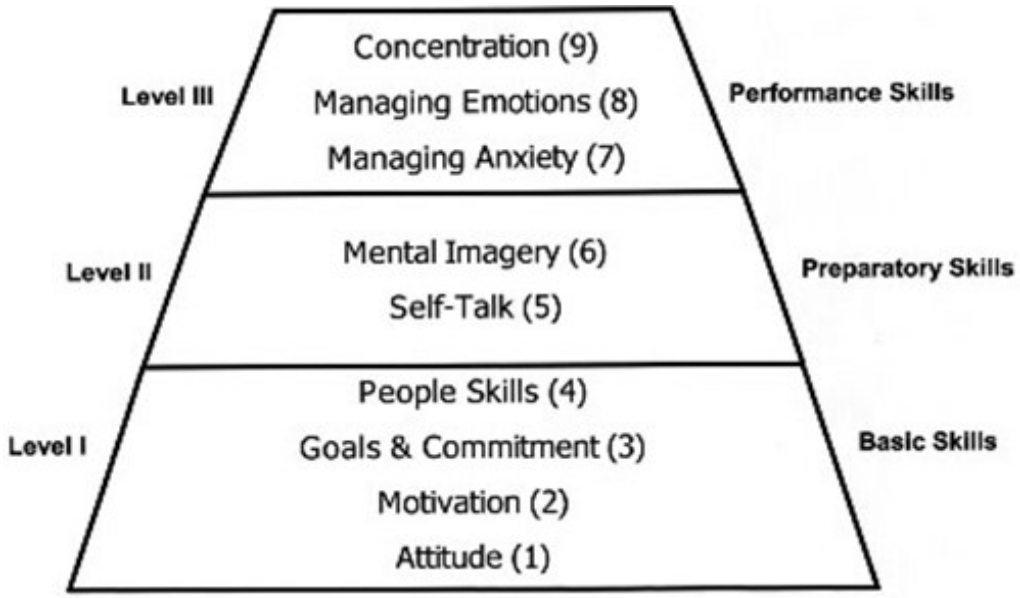

Figure 1. The Performance Pyramid (Lesyk, 1998).

2.3 Self-Talk use in Endurance Performance

Endurance competition is extremely unique in sport as quite often is the case, you are on your own, competing against other athletes, for a very long duration, with no help. The only voice which these athletes often hear/listen to is the voice in their head. Kress and Statler (2007), discuss the theory that for any endurance-based athlete to be successful or excel, they must confront one key element – exertion pain. This pain exertion was examined with Olympic cyclists and how important it was to have strategies to overcome this pain barrier, one of which was self-talk. Similarly, Baron, Moullan, Deruelle, and Noakes (2011), looked at the crucial role which emotions play in athletes who compete in middle to long distance endurance events. It was suggested here that to manage these emotions, athletes should use some form of pacing strategy alongside various psychological methods to control the emotional responses. Adding to this, Cox (2002), states that self-talk can be an effective tool for both controlling an athlete thought process, and confidence, as well as their performance in marathons. Van Raalte, Morrey, Cornelius and Brewer (2015), found that self-talk was a regular part of many marathon runners routines during an event. This self-talk was completely self-generated, whereas most laboratory experiments

assign a type of self-talk to an athlete/group. Of the surveyed participants, 88% (N= 483) of athletes used self-talk during marathons, showing that self-talk appears to be a regular technique used by athletes who partake in marathons. Furthermore, one of the most popular methods which are often used in conjunction with self-talk during long-duration activities is segmenting. This technique has been proven to be effective for activities such as an ironman (Myburgh, Kruger, and Saayman, 2014), and the 3000-metre steeplechase (Díaz-Ocejo, Kuitunnen, and Mora-Mérida, 2013), but has also been effective for sports such a golf, where a round may take over four hours. This has been highlighted by Theodorakis, Hatzigeorgiadis, and Zourbanos (2012), that situational factors play a significant role in an athletes' self-talk, such as the type of and progression of a competition, and the athletes' performance in that competition, although alluded to the fact that much more needs to be explored in this area. This can though, add weight to the importance of segmenting during endurance performance, as different points during the lengthy activity may require different methods. Some sections may require dissociation self-talk for distraction, or instructional, motivational or associative self-talk to focus on what needs to be done. This particular idea was examined by Mallett, and Hanrahan (1997), on 100-metre sprint performance under race conditions. The 100-metre track was split into three sections, 0-30 metres (acceleration phase), 30-60 metres (max velocity phase), and 60-100 metres (speed endurance phase). Each phase was given a cue word which was deemed most relevant for that phase. For example, the word for 0-30 metres was "push" as that was deemed the most appropriate word to improve an athlete's acceleration. Overall, every single athlete improved their 100-metre sprint time from baseline, after being given the segmenting and self-talk intervention. On average, athletes also reported an increase in split times between every section from baseline also.

2.4 Reason for termination of exercise

Exercise has long been seen as a purely physiological construct and any reason to stop was due to physiological reasons, such as VO_2 Max, aerobic enzyme capacity, cardiac output, glycogen stores, etc. (Kayser, 2003). This theory has since been disputed and proven to be false by authors such as Noakes (2000), Marcora, Bosio, and de Morree, (2008), and also Kayser (2003), who posits that any exercise (short

term or endurance) both begins and ends in the brain. Theoretically, the body can only be pushed to its maximum and terminate exercise for a physiological reason when the body drops unconscious (Kayser, 2003). Additionally, it has been experimentally proven, that an athletes' power output following "exhaustion" was significantly more than the power output which was required to continue exercising (Marcora, and Staiano, 2010). These results were further supported by Morales-Alamo et al., (2015), through the use of muscle biopsies, when following an incremental time to exhaustion test, muscles still had sufficient metabolic energy to continue exercising for an extra seven to eight minutes at 100% Vo_2. From this, it can be deduced that there is some contributing factor(s) in an athlete's choice to terminate exercise. These reasons can be explained by the psychobiological model of endurance. This model looks at the effects which potential motivation and perception of effort have on one's decision to stop exercising. The term "potential motivation" or "motivational intensity theory" was first discussed by Brehm, and Self (1989), and proposes that motivational factors can determine the maximum effort which someone is willing to exert in a task. So, when the effort required to maintain a task exceeds that of which somebody is willing to exert, they will then disengage from a task, or reduce their effort. This research was then added to by Marcora, Bosio, and de Morree, (2008), whereby the perception of effort was included. It was found that exercising with muscle fatigue increases an athlete's perception of effort compared to a non-fatigued athlete who is executing the same task. So, in other words, pre-fatigued athletes reached the maximum level of effort which they were willing to exert, sooner the non-fatigued athletes. It can be concluded from this research that the main parameter which caused the reduction in athletic performance was the perception of effort. Consequently, if two athletes have a similar perception of effort, but potential motivation is the lower in one, then they will stop an activity earlier than the other. Similarly, when potential motivation is high, but one has a higher perception of effort, then they will reach the maximum level of effort which they are willing to exert earlier than someone who perceives the task to be easier. Once again, this study was expanded on by Marcora, Staiano, and Manning (2009). This study was to test to see if you could manipulate performance by changing someone's perception of effort, without changing anything physiologically. This was done by inducing mental fatigue via a ninety-minute cognitive task, and then doing the same time to exhaustion test as was done by Marcora, Bosio, and de Morree, (2008). The significance of this was that almost the exact same results were found by inducing

mental fatigue (Marcora, Staiano, and Manning 2009), as inducing muscle fatigue (Marcora, Bosio, and de Morree, 2008), which was increased perception of effort and disengagement with exercise earlier than the non-fatigued group. The most interesting thing here is that although the underlying mechanisms are very different (mental fatigue vs physical fatigue), they still have very similar results on athletic performance.

2.5 Summary and Rationale

This systematic literature review was conducted to examine the effectiveness of self-talk on endurance performance. The research to date has conclusively proven that the use of self-talk can help aid sports performers in the acquisition of a skill (Cutton, and Landin, 2007; Perkos, Theodorakis, and Chroni, 2002), improving accuracy in target situations (Theodorakis, Weinberg, Natsis, Douma, and Kazakas, 2000), and power output/ability to throw further (Hatzigeorgiadis, Theodorakis, and Zourbanos, 2004). The benefits which self-talk could have on endurance performance and logical rationales could be easily hypothesized prior to systematically reviewing literature, however, the purpose of this review is to look deeper than only the effects, but rather, how certain methods may affect the performance. Although the primary goal is to see how the use of self-talk effects endurance performance, the secondary goal will be to see whether self-talk is individualised for the athletes during the intervention process, and, if so, how does the individualisation of self-talk compare with those who are assigned particular self-talk phrases.

2.6 Research Questions

1) Is self-talk individualized or generalized for athletes?
2) If so, is the process of “repair” “train”, and “game” an inherent part of self-talk literature?
3) Does self-generated vs assigned self-talk have a significant difference in performance when compared with each other?
4) How long should an intervention be to make sure athletes learn self-talk in a way to improve performance?

3.0 Methodology

This systemic review of literature will be carried out to examine the effects which self-talk has on the endurance performance of an athlete. This search strategy was carried out to comply with Preferred Reporting Items for systematic and Meta-Analysis (PRISMA) guidelines for a systematic review. This PRIMSA scale is used to ensure that the review is transparent and allows readers to asses both the strength and weakness of the investigation while reducing the risk of flawed reporting (Moher, Simera, Schulz, Hoey and Altman, 2008). This scale involves a 27-item checklist and a four-phase low diagram (see figure 2). The four-phase flow diagram will be used for study selection, by filtering articles based on the inclusion/exclusion criteria. The PRISMA scale will be used in conjunction with the PEDro scale and the inclusion/exclusion criteria (discussed below), when selecting studies to use for the review. Table 1 indicates the score each reviewed study received on the PEDro scale. Alongside the use of the PEDro scale, the 27-item checklist and the four-phase flow chart, the T.A.P method will also be used when selecting papers. The T.A.P method looks at Title, Abstract, and Paper as ways of narrowing down paper selections, based on the inclusion and exclusion criteria. The number of titles excluded because of reading the Title, Abstract and Paper are recorded and visually presented below in figure 2, to give clarity to the process of selecting papers. Also, Appendix 2 provides details and characteristics of each reviewed article, while Appendix 3 details the results found within these studies.

3.1 Conceptual Framework

It has been reported extensively that the use of self-talk does have significant performance benefits, but gaps within the research still exist. The consistency and way in which self-talk interventions have been used with athletes is varied greatly and does not consider vital research such as that of Lesyk (1998) or the self-talk progressions which have been proposed. In essence, research out there is too generalized (in most cases) and not tailored to the specific needs of the athlete in question. The purpose of this review is to evaluate the performance benefits of using self-talk during an endurance-based exercise, and the effects which it may have on other contributing variables such as the rate of perceived exertion.

3.2 Identification of Studies

The studies used in this review were sourced from five electronic databases; SPORTDiscuss, Research Gate, Taylor and Francis Group, PubMed, and Science Direct. Searches were made for peer-reviewed journal articles only, with no limitation placed on the publication date. Several search terms were used to source specific articles which were relevant, based on the inclusion/exclusion criteria. Search terms were used both as keywords and string words and include “Endurance Performance” AND “Regulation of Fatigue” AND “Self-Talk” AND “Running Performance” AND/OR “Marathon Running” AND/OR “Ultra-Marathon” AND/OR “Cycling Performance”. Due to the term “endurance performance” being subject to debate on what may classify as “endurance”, some search terms included specific activities which would be included in this review. The full list of activities included for review is listed below within the eligibility criteria.

3.3 Eligibility Criteria

A strict criterion was developed, which would ensure the quality of all included studies, while also ensuring specific variables were being reviewed consistently throughout, with no ambiguity. Studies which were considered for this review would have to meet the entire criterion, with no exceptions. The criterion for inclusion was as follows: (A) Peer-Reviewed, academic journals which were written/published in English. (B) Articles which looked specifically at the effects of self-talk on performance in the following activities; Cycling, Cross Country Running, Ultra-Marathon Running, and Swimming. (C) Athletes being tested must be a minimum of recreationally trained and currently be training a minimum of twice a week. (D) Athletes being tested must be between the ages of 17 – 50 years of age. Studies were specifically excluded from this review if self-talk was used as part of a mental skills package intervention to improve performance.

3.4 Variables

The literature has examined a wide variety of variables which impact the effect which self-talk has on endurance performance. These variables include; Time to exhaustion, type of self-talk used and manipulation tests. Other variables which influence results will also be taken into consideration, such as; athletic experience, type of test which was conducted and the testing protocol which was adopted. Changes in athletic performance (depending on variable analysed within the study; time to exhaustion or time trial) would ideally have been reviewed pre and post-intervention and a standardization method was implemented to allow for comparable data. However, this was not possible as there was no common variable which each of the 11 studies reviewed analysed, thus, making comparisons impossible. Only generalizations are able to be made based on the results, which will not be accurate.

3.5 Data Collection Methods

All search results were processed through Microsoft Excel for Windows. Following on from this, all duplicates were removed by sorting article titles using the A – Z filter tool within the Microsoft Excel software. When all duplicated studies were removed, the strict eligibility criteria was applied to select the specific articles which would be used within the review. Firstly, articles were screened based on their titles, then abstract, and finally the paper itself, if it is unclear whether it should be included in the final review. For screening under “title”, a “Yes” or “No” scoring system was used, based on the relevance of the title subject. Articles received a “Yes” score if self-talk was included, as well as “Endurance”, “running”, “swimming”, “marathon” or “cycling”. Self-talk was essential for the title, as this excluded psychological skills packages and their effectiveness on endurance performance. Once studies were excluded based on the relevance of their titles, the remaining were then screen using their abstract. Here, the content was analysed based on the inclusion criteria and relevance of the content to the criteria. Again, articles were scored using a “Yes/No” system as to whether they were considered for inclusion in the next step. If a study made it through based on the title abstract, the paper itself would then be assessed as the last measure as to if it would be included within the reviewing process.

3.6 Data Analysis

Following the extraction of the literature which met the eligibility criterion, it will then be reviewed using the Physiotherapy Review Database (PEDro) scale. This will be the final examination which the literature undergoes before being included in the systematic review. The PEDro scale (see Appendix 1) is an 11-point test in which to score the scientific rigor of a research article. This scale has been proven to an effective and valid way of measuring the methodological quality of clinical trials (de Morton, 2009). The sum of the scores can be considered a valid method to distinguish between high- and low-quality studies (Maher, Sherrington, Herbert, Moseley, and Elkins, 2003).

3.7 Ethical Considerations

There are some important ethical considerations, which need to be considered when compiling a systematic review. All contributors and authors should be acknowledged correctly, so to ensure there are no issues with plagiarism, and that all conflicts of interest are clearly declared, so to avoid any bias (Wager and Wiffen, 2011). Furthermore, general publication ethics should also be considered and followed.

4.0 Results

Following the search first for articles using the keywords and phrases listed above, a total of 518 articles were identified, from five databases (Research Gate, SportsDiscuss, Taylor and Francis Group, PubMed, and Science Direct). Only articles which had "full-text" access were included in the 518 articles returned. Duplicates were then removed (183) by sorting all articles from A – Z with Microsoft Excel. Articles were then removed based on the Title (238), Abstract (74) and paper (3), which left 20 articles. A further 11 articles were removed based on the eligibility criteria, with 2 being added following the reading of bibliographies on screened articles. Following the final screening, a total of 11 articles remained for and would be included in the full review (see figure 2).

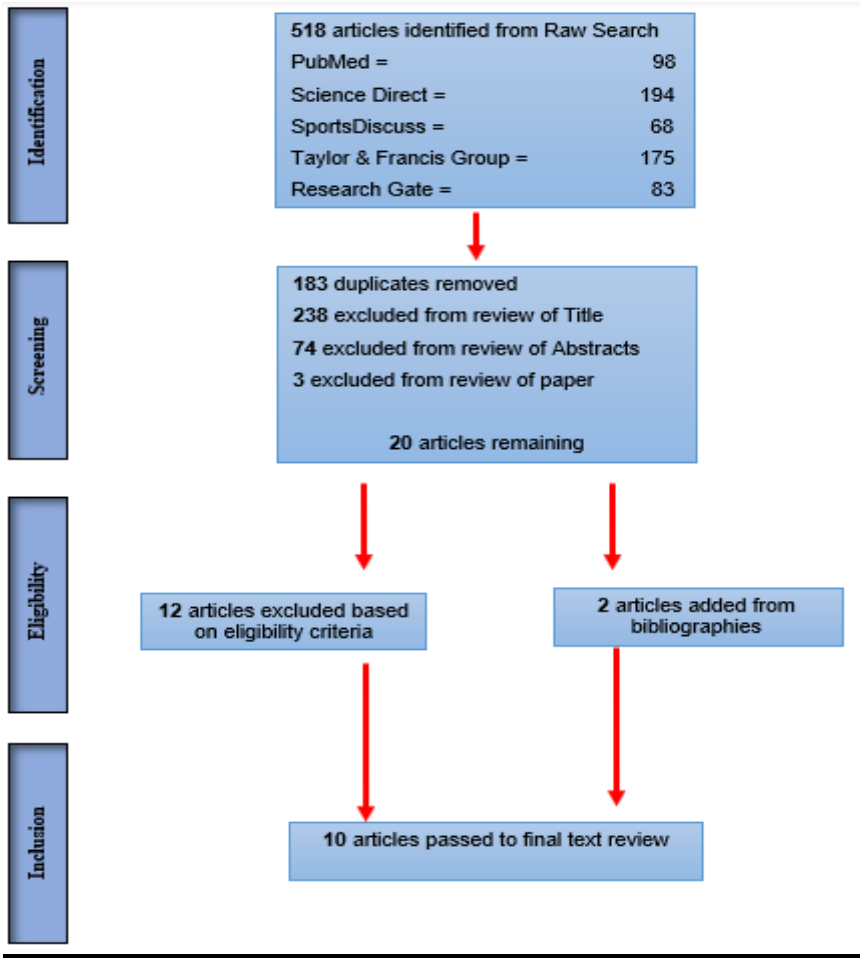

Figure 2.PRISMA four-phase flow diagram

4.1 Study Quality

Finally, nine of eleven articles which were to be included in the review following the screening process were assessed for their quality by using the Physiotherapy Evidence Database (PEDro) scale. The quality of study for the included articles ranged from 4 – 7 (out of 11), with the mean score being 5.7. Three questions with the PEDro scale relate to the blinding of participants/therapists/assessors. All but two studies (Latinjak et al., 2018 and McCormick, Meijen, and Marcora (2017) scored a “No” (0) on the scale. The studies by Latinjak et al. (2018), and McCormick, Meijen, and Marcora (2017) used blinding of the assessors who was measuring at least one key outcome. Latinjak et al. (2018), also blinded the participants as to the purpose of using self-talk. Two of the eleven studies (Barwood et al., 2015, and Weinberg, Miller and Horn, 2012) were excluded from being assessed with the PEDro scale, as they were not “randomised control trials” (RCT). Weinberg, Miller, and Horn (2012), specifically grouped participants based on their pre-test results, to see the effectiveness of six forms of self-talk (motivational vs instructional singularly and combined and assigned vs self-set with motivational and/or instructional). Barwood et al. (2015), didn’t state in their study that participants were randomized. It was only stated that participants were “matched and allocated to a self-talk group”, so for this reason, this study was not considered an RCT.

Table 1. The Physiotherapy Evidence Database (PEDro) scale

Authors	1	2	3	4	5	6	7	8	9	10	11	∑
Hamilton, Scott, & MacDougall (2007).	0	0	0	0	0	0	0	1	1	1	1	**4**
Hatzigeorgiadis et al. (2017).	1	1	1	0	0	0	0	0	1	1	1	**6**
McCormick, Meijen, Marcora (2017).	1	1	0	0	0	0	1	0	1	1	1	**6**
Wallace et al. (2017).	0	1	1	1	0	0	0	1	1	1	1	**7**
Latinjak et al. (2018).	0	1	1	0	1	0	1	0	1	1	1	**7**
Katarachia. (2017).	1	1	0	0	0	0	0	0	1	1	1	**5**
Blanchfield et al. (2013).	1	1	0	0	0	0	0	1	1	1	1	**6**
Onstad-Hawes, Conte, & Laurin (2017).	0	1	1	0	0	0	0	1	1	1	1	**6**
Hatzigeorgiadis et al. (2013).	0	1	0	1	0	0	0	0	1	1	1	**5**
Weinberg, Miller, and Horn (2012).	1	0	0	0	0	0	0	1	1	1	1	**5**

4.2 Participant Demographics

From the 11 studies which were included in the review process, sample sizes (*n* =) ranged from 9 up to 85, with a mean sample size of (*n = 35.18*) per study. All participants were a minimally of recreationally trained and were taking part in exercise a minimum of three times per week. Participants ages ranged from 17 (± 1.23) to 50 years of age (no SD reported). Only four of the articles reviewed (Weinberg, Miller, and Horn, 2015; Hatzigeorgiadis et al., 2013; Wallace et al., 2017; McCormick, Meijen and Marcora, 2015) tested athletes within the same field which they were experienced in (cycling, swimming, running, etc), with six studies not stating what the athletes experience was within the field which they were tested (Hamilton, Scott, and MacDougall, 2007; Hatzigeorgiadis et al., 2017; Latinjak et al., 2018; Katarachia, 2017; Blanchfield et al., 2013; Onstad-Hawes, Conte, and Laurin, 2017), and one study revealing the athletes had no prior experience within the field (Hamilton, Scott, and MacDougall, 2007). There was an overall gender imbalance within the reviewed studies, with 61.5% (n=238) of all participants being male, and 38.5% (*n= 149*) of participants being female. Two studies (Barwood et al., 2015; Hatzigeorgiadis et al., 2017) used zero females for their studies, with no justification as to why this was the case.

4.3 Duration of Self-Talk Intervention

Self-talk is a very individualised process and thus the optimal required intervention duration can be argued. This can be seen from the literature reviewed, based on the significant disparity with intervention durations. The studies included, had intervention durations ranging from five minutes, to five days to ten weeks. An average intervention duration cannot be calculated as several studies did not clearly state how long their study duration was. Both Barwood et al. (2015), and Latinjak et al. (2018), used a similar method of having four laboratory testing days, to avoid athlete familiarization, and to allow athletes achieve a stable pacing template. The time frame which was given for these testing days were "a minimum of two days between test days", but this was not a consistent two days. If an athlete took part in any structured exercise activity 24 hours before their test day, then the test would be postponed (Latinjak et al. 2018). McCormick, Meijen, and Marcora (2018), conducted a randomized post-test only intervention whereby participants with no prior experience in using self-talk, took part in either a self-talk intervention or a control group. A lot of details was given on various contributing factors influencing the athlete's performance and were assessed 21 days (±6) prior to the performance, with the self-talk workbooks being distributed between 10 and 14 days prior to the event. Katarachia (2018), used a post-test experiment, whereby participants practiced self-talk during their five-minute warm-up, before completing their test. This was the only experience/practice which the athlete got with the use of self-talk. These interventions are in contrast to the likes of the study done by Hatzigeorgiadis, Galanis, Zourbanos, and Theodorakis (2013), in which a ten-week intervention was carried out on experienced young swimmers. Within this period, the participants practiced a variety of self-talk methods and phrases to try and determine which phrases were most effective for each athlete so that their self-talk was tailored to suit them. The most common intervention duration was two weeks and was the preferred duration of three studies (Onstad-Hawes, Conte and Laurin, 2017; Wallace et al., 2017; Blanchfield et al., 2014). Participants were instructed to use the self-talk cues which had been learned in the subsequent two weeks in all their practices and training and record the type and frequency for the purpose of manipulation and compliance checks. Weinberg, Miller, and Horn (2012), only opted for one week however gave a specific justification for this time frame, which was that one week was

would not be long enough for their participants to elicit physiological adaptations, and thus any performance improvements could be put down to the self-talk intervention. Apart from Weinberg, Miller, and Horn (2012), no study gave a justification for why they chose the intervention duration which was prescribed.

4.4 Assigned vs Self-generated self-talk

Given the nature of how individualized self-talk can be, whether or not athletes were allowed to choose their self-talk or not, is an unavoidable variable which is essential in evaluating an athlete's response to an intervention. This was particularly highlighted by Hamilton, Scott, and MacDougall (2007), as they used self-talk in three forms; Positive self-generated, Positive Assisted, and Negative assisted. Their results show the effectiveness of each method depending on the individual. It was also highlighted that not only should the category of self-talk be matched with the sport, but also be matched with the individual which is using it. Hatzigeorgiadis, Galanis, Zourbanos, and Theodorakis (2013), likewise attempted to tailor the type of self-talk used, to their participants, through letting them sample each form (Motivational – two weeks, Instructional – 2 weeks, Combination of the two – four weeks, their own plan – two weeks). The intervention duration, along with the sampling of each form of self-talk, allowed for the participants to gain sufficient experience with using each form, then being allowed to choose which suited them best. Weinberg, Miller, and Horn (2012), used six forms of self-talk (individually and combined) to asses which method would be more effective in their sport (cross country running). Again, although the use of self-talk is incredibly individual, this method allowed for statistical comparison of a variety of methods and forms of self-talk within the group in the same sport. Two studies focused only on self-generated self-talk with their participants (Barwood et al., 2015; Latinjak et al., 2018), where athletes were not shown any self-talk statements used in past literature. The important thing to note here, however, is the athlete experience, or lack of in this case, with using self-talk, and the implications which that could have on the study results. This will be discussed below, with both the positives and negatives considered and how they will affect results. Five studies attempted to mitigate against this being an issue (Hatzigeorgiadis et al., 2017; McCormick, Meijen and Marcora, 2018; Katarachia, 2017; Blanchfield et al., 2014; Onstad-Hawes, Conte and Laurin, 2017) by showing their participants self-talk phrases which had been used

in previous research and had them choose which ones they felt would be most beneficial to their own performance. These studies are classed as “assigned” self-talk, as although participants choose their phrases, it was from a pre-determined list, meaning their selection of phrases was not completely independent.

4.5 Effect of Self-Talk on Performance Outcome

As was mentioned above, self-talk has been experimentally proven to cause a significant improvement in athletic performance, regardless of the domain (precision based, power based, and endurance based). The results found from this review proved to be no different, however, comparisons are difficult due to the variety of outcome measures. Four studies (Blanchfield et al., 2014; Onstad-Hawes, Conte and Laurin, 2017; Latinjak et al., 2018; Wallace et al., 2017) analysed the effect which self-talk has on an athlete’s time to exhaustion during a cycling experiment on a cycle ergometer. Blanchfield et al. (2014), found that following a two-week motivational self-talk intervention, the intervention group exhibited a significant increase in their time to exhaustion when compared to the Pre-test time ($P<0.005$). It was also reported that there was a significant reduction in RPE at 50% isotime ($P<0.005$) but no statistically significant difference at 0% iso-time, and the reason for this was put down to self-talk. Onstad-Hawes, Conte, and Laurin (2017), reported similar findings following a two-week motivational self-talk intervention, as a significant increase was seen in participants time to exhaustion ($P<0.001$). Wallace et al. (2017), likewise found a significant increase in time to exhaustion ($P=0.021$) with athletes' using motivational self-talk when compared with their pre-test times. No significant difference in RPE was reported within the study ($P=0.324$). Latinjak et al. (2018), reported no statistically significant difference between groups pre and post-test (P=0.157). An interesting finding here, however, was that RPE was increased following the intervention, despite it being hypothesized (and shown in previous studies) that motivational self-talk would decrease perceived exertion. Barwood et al. (2015), took a different approach to find similar results, by having participants complete a 10-kilometre cycle in as quick a time as possible. Split times between each kilometre were analysed to see at what point (if at all), did the use of self-talk begin to show through time reductions. Overall, a significant reduction in overall time to completion was seen ($P=0.009$), with the motivational self-talk group completing the time trial an average of 77 (± 53) seconds

between the motivational self-talk group and neutral self-talk group in time trial four. Importantly, consistent improvement in the motivational self-talk group was seen from kilometre seven to ten, with a significant reduction in time seen through kilometre 10 (*P=0.004*), with an average between-group difference of 55 (± 17) seconds for this three-kilometre section. Like was found with Latinjak (2018), there was no difference between the two groups reported RPE, with it increasing linearly over the course of the time trial, and reaching its peak in the tenth kilometre. Weinberg, Miller, and Horn (2012), also conducted a time-trial test, though on cross country runners, testing one-mile run times. Unlike previous studies, no control group was used in this study, rather, a variety of self-talk forms, which was discussed in section 4.1 (study Quality). Three of the six groups reported a significant improvement in their times from pre to post-test, specifically, the self-set motivational and instructional self-talk groups. An improvement of 10-seconds was reported for these groups (*P<0.01*), with a calculated effect size (*d=1.07*) which is considered very large (Cohen, 1988). Hamilton, Scott, and MacDougall (2007), used a single subject multiple-baseline design to test the effects of both positive and negative assisted self-talk and self-generated positive self-talk on how much work a participant could complete in 20-minutes. All but two participants in this intervention improved their performance following the intervention from baseline by a minimum of 22%, with the assisted self-talk group average a 33.3% improvement. One participant had an improvement of 7.9%, and just one participant in the entire study reported a performance decrease, which was of 5.6%. Importantly, the small improvement of 7.9% and the decrease of 5.6% were both in the negative self-talk group. However, the second largest percentage improvement of all the groups (33.7%), was also part of the negative self-talk group. No other statistical analysis or values were reported within this study. Hatzigeorgiadis et al., (2017), examined athletes' performance in the heat, with a 30-minute cycle, where athletes were instructed to remain an RPE of 14 for the entire duration. Unlike previous studies, the dependent variable here was power output and the effects which motivational self-talk had on power output when an athlete is placed in a stressful situation with fatigue (warm environment). The intervention consisted of a five-day intervention, with day one being VO_2 peak test, day two and three athletes were introduced to self-talk and practiced it during familiarization sessions, day four was a rest day, and finally day five was the assessment. Between-group comparisons were made, with no significant differences found in power output between minutes 5, 10, 15 and 20, but significant

differences were found from minute 25 (*P<0.01*) and minute 30 (*P<0.01*), with the intervention group exhibiting a larger power output than that of the control group. No differences were found for the other measures, oxygen consumption, or temperature. McCormick, Meijen, and Marcora (2018), measured athletes' self-efficacy, perceived control and expectations in their post-test only study on ultra-marathon runners. Following recruitment athletes completed a survey, documenting their self-efficacy, perceived control and expectations. A two-week motivational self-talk intervention was used prior to the marathon, with athletes' being assessed on the aforementioned variables 30 – 90 minutes before the race began. No performance benefit was found, with self-efficacy and perceived control reportedly decreasing in the self-talk group, and expectations being slightly higher. Notably, self-efficacy increased in the control group pre-race and perceived control decreased slightly. This was the first study of its kind to do a follow-up, where athletes took a survey reporting their experience using self-talk. Although performance improvements were not found during the ultra-marathon, participants still reported the use of self-talk being helpful, with 12 out of 14 continuing to use self-talk following the intervention. Katarachia (2017), conducted a study examining the effects which self-talk has on a moderate intensity, 20-minute cycle on an ergometer. Athletes' in the intervention group were instructed on self-talk and how to use it during a five minutes warm-up and asked to practice various self-talk cues which were presented on a sheet of paper in front of them. Athletes were instructed to stay at the same RPM throughout, so that, by the end of the 20-minute cycle, all participants would have completed the same distance, so that the only differentiating factor would be how difficult they perceived the exercise. Results showed that using self-talk during moderate intensity exercise can reduce an athletes' perception of effort, despite exhibiting a higher average heart rate, and lower average power output than that of the control group. No pre-test analysis was conducted; therefore, no information is known about any of the participant's endurance capacity prior to the intervention. Hatzigeorgiadis, Galanis, Zourbanos, and Theodorakis (2013), was the only one of the reviewed studies to examine the effects which self-talk has on endurance athletes' during a competition. Athletes in this study sampled a variety of self-talk methods, including their own, in a 10-week intervention to give the athlete a good range, so they could use which one was best suited to themselves. Due to athletes' competing in different events, performance improvements were calculated based on the improvements which were made by athletes in their respective event

from pre and post-test. No individual times were reported based on the event which the athletes partook in, nor was any P values reported. It was only reported that the self-talk group exhibited a larger mean percentage improvement in their performance *(M = 1.43 ± 2.15 seconds),* than that of the control group (*M = 0.05 ± 2.28 seconds*). A moderate effect size of 0.62 was also conveyed between the two groups. A performance improvement of 1.46% in the intervention group reported as being a considerable difference and can make a meaningful difference during the performance.

5.0 Discussion

The primary aim of this review was to examine the effectiveness of self-talk programmes on endurance performance. Despite the plethora of research in the area of self-talk in sports performance, few have looked specifically at the effect which self-talk on its' own, has on an athletes' endurance performance. The secondary aim was then to see what significance the intervention duration and type of self-talk used had, if any, on the athletes' performance, and whether there was any consistency with it.

5.1 Participants

It was found that from this review, that the recruitment of participants was very basic and in general, not considered to be important. Four of the eleven studies reviewed (Weinberg, Miller, and Horn, 2015; Hatzigeorgiadis et al., 2013; Wallace et al., 2017; McCormick, Meijen and Marcora, 2015), specifically recruited athletes who were experienced in the field which they were being tested in (minimum experience of four years). The use of more experienced athletes would make the results of these studies more generalisable to the general sporting population. Also, the use of non-experienced athletes may bias the results and skew them towards causing a significant improvement in performance, whereas, in reality, the athlete improvement may be because of familiarized with the activity, as opposed to the intervention being prescribed. This was found in previous research by Kraemer & Ratamess (2004), which found that untrained and inexperienced athletes will have an initial rapid performance improvement, regardless of the intervention type undergone, with improvements slowing down as the athlete becomes more trained. This can perhaps add credence to the notion that the experience of the athlete which is used during sporting interventions, should be considered more carefully.

5.2 Study Quality

The overall quality of the studies used within this review should be discussed before there can be any meaningful takeaway points. Firstly, the mean score in the PEDro scale for this review was 5.7 out of 11, which is a moderate score, trending towards high. The average PEDro scale score is 5.1, which is considered low to moderate score (PEDro, 2019). This is important because, as was mentioned above, three of

the 11 questions within this scale relate to the blinding of participants, therapists, and assessors, However, this is not entirely possible for interventions using the likes of self-talk, as participants will know they are doing the intervention. As a result, scores for sporting trials such as this are generally low to moderate (0 - 5), which shows that the included studies within this review adhered to rigorous methods to ensure they were of a moderate-high quality (5 - 6). One figure which can greatly affect the quality of a study (although not questioned within the PEDro scale), is the sample size which was used. The mean sample size for the reviewed studies was calculated to be 35.17 participants, which would be moderately high for a sporting laboratory trial. Despite this, it is, however, worth noting that there are two very large outliers with over 80 participants (Katarachia, 2017; Weinberg, Miller and Horn, 2012), which skews the averages and give an inaccurate representation. Should these two studies be removed, the mean sample size comes down to 22, which is moderate for these kinds of studies. Biau, Kernéis, and Porcher (2008), discuss the importance which sample size plays on a clinical study, and the importance of complete randomisation when selecting participants. If the results are intended to be generalised to the appropriate population, then sample size must be moderate to high, with the purpose of minimizing the exaggeration or misrepresentation of findings and a type 2 error. Larger sample sizes, therefore, allow for more accurate interpretations of significant results. Nayak (2010), also reported on the potential issues with large sample sizes, stating that in RCT's, it is not ethical to recruit a large sample size, as they are being denied a better programme due to receiving a placebo/inferior intervention. From this, it can be deduced that having small sample sizes may weaken both internal and external validity of studies, while sample sizes which are too large may not be ethically approved due to wasting resources and participant time. Therefore, the validity of the reviewed studies by Hamilton, Scott, and MacDougall (2007), and Latinjak et al. (2018), could be brought into questions due to their very small sample sizes ($n=9$ and $n=12$).

5.3 Intervention Duration

The duration of any intervention, regardless of its objective, is arguably the most important aspect, as the intervention needs sufficient time to take effect. Self-talk is no different and, like any other skill, is trainable and needs to be learned and refined over time (Edwards and Steyn, 2008). In literature in general, the individual needs of the athletes/participants are rarely considered when using interventions, as the same duration of the intervention is used for all subjects. The effects of both long and short intervention have been tested in the past, with interventions of three days being used (Hatzigeorgiadis, Zourbanos, Mpoumpaki, and Theodorakis, 2009), and also interventions of up to 12 weeks (Perkos, Theodorakis, and Chroni, 2002). The use of longer duration interventions can be dependent however, on what is being tested. For example, when endurance training is the variable being assessed, longer duration interventions may not represent accurate results, as the athletes' endurance capacity may be have grown and thus the intervention may not be the cause of the performance improvement. Weinberg, Miller, and Horn (2012), acknowledged that this would potentially be an issue when working with endurance athletes, and used this as their justification for only a one-week intervention. Díaz-Ocejo, Kuitunnen, and Mora-Mérida (2013), recognised similar issues for their intervention using segmentation and self-talk on an athlete competing in a 3000-metre steeplechase. Due to time restraints and the athletes' endurance capacity, an intervention duration of 10-days was chosen. So, with the issue of time being a mediating factor when working with endurance athletes, it seems like this may be the determining factor when choosing an intervention duration, rather than the specific needs of the athlete.

5.4 Assigned vs Self-Generated Self-Talk

Similarly, to the intervention duration, the type of self-talk which the athlete uses, could be critical to its success on altering the athletes' performance. From the literature reviewed, there was a mix of methods used, with five studies using assigned self-talk (Hatzigeorgiadis et al., 2017; McCormick, Meijen and Marcora, 2018; Katarachia, 2017; Blanchfield et al., 2014; Onstad-Hawes, Conte and Laurin, 2017), four using a mix of methods (Hamilton, Scott and MacDougall, 2007; Hatzigeorgiadis, Galanis, Zourbanos, and Theodorakis, 2013; Weinberg, Miller and Horn, 2012; Wallace et al., 2017), and two studies using the self-generated method (Barwood et al., 2015;

Latinjak et al., 2018). There is still some disagreement in research about which method elicits better results, based on the large majority of literature still using the assigned method. Hardy, Gammage, and Hall (2001), posits that for athletes' competing in endurance events, self-talk should be structured and personalised to the individual. This theory was supported by Theodorakis, Hatzigeorgiadis, and Zourbanos (2012), who explored the idea that, although letting the athlete use self-generated self-talk may be less controllable, it could be more effective as it not only meets the needs of the athlete, but also meets their personal preferences. It was, nevertheless, noted that because no direct comparisons have been made being the use of the two methods (self-generated vs assigned), there can be no definitive conclusions made about which is the superior method. A countering argument to this could be, although scientific or empirical evidence is lacking, is that allowing athletes who have no experience with self-talk, to choose their own phrases/mantras, may be equally as questionable as assigning them phrases to use. This was acknowledged in the reviewed study by Hamilton, Scott, and MacDougall (2007), whereby participants in the assisted self-talk grouped elicited considerably larger improvement than those in the self-generated and negative self-talk group. The proposed reason for this was the lack of experience which the athlete had with using self-talk. It was suggested that this finding was important for coaches who are working with inexperienced athletes, and that by helping and aiding the athlete in the early acquisition phase, that the athlete may acquire the skill faster, developing their confidence in using the method, which should, in turn, help them find what works specifically for them. This could perhaps explain the results found by Latinjak et al., (2018), as the self-generated self-talk groups results got significantly worse following the intervention. It is also worth noting that this was one of the reasons for a longer duration of intervention by Hatzigeorgiadis, Galanis, Zourbanos, and Theodorakis (2013), who allowed athletes to sample a variety of self-talk methods and learn them thoroughly, which would help them to come up with their own competitive self-talk plan. It was also believed that by doing this it would increase the participant's commitment and interest to the intervention, while also making them believe in its effectiveness.

5.5 Effect of Self-Talk on Performance Outcome

The use of self-talk has been used at the highest level of sports for decades, such as Olympic games, world championships and in other professional sporting organisations such as Golf (Thomas and Fogarty, 1997), rugby (Golby and Sheard, 2004; Neil, Mellalieu, and Hanton, 2006), and tennis (Van Raalte, Brewer, Rivera, and Petitpas, 1994; Landin and Hebert, 1999). Durand-Bush and Salmela, (2002), revealed that in their research with 10 two time Olympic or world champions, every one of them used a form of self-talk at some point during and in preparation for their event. Additionally, Mahoney and Avener (1977), found that male gymnasts who qualified for the US Olympic team used self-talk considerably more in practice and competition compared to those who did not qualify. This shows how self-talk may be essential for athletes looking for any sort of marginal gains they can to get to the top of their field. In this review though, due to the vast difference in outcome measures, meaningful statistical analysis and comparisons are difficult and, in some cases, impossible to make. However, the volume of confounding variables can almost reinforce how important self-talk can be during endurance performance. The reviewed literature shows that self-talk can improve power output, and self-efficacy long term (Barwood et al., 2018; Hatzigeorgiadis et al., 2017; ; McCormick, Meijen, and Marcora, 2017), while reducing RPE (Blanchfield et al., 2017; Katarachia, 2017), despite sometimes having higher heart rates, which can lead to an increased time to exhaustion (Onstad-Hawes et al., 2017; Wallace et al., 2017), or can increase the amount of work which can be done in a given time (Weinberg, Miller and Horn, 2012; Barwood et al., 2018). As was discussed above, Marcora, Staiano, and Manning (2009) examined the importance which an athletes' perceived exertion has on their overall endurance performance, and that perceived effort can have the same effects as having fatigued muscle on an athletes' performance during an endurance activity. This is important because research by Zinsser, Bunker and Williams (2006) and Theodorakis, Hatzigeorgiadis, and Chroni (2008), can contribute to this idea as they explained that self-talk is a way to regulate ones' perception of effort when fatigued, and the impact which self-talk has on an athletes' perceived exertion can be potentially critical during competition, which will be discussed below. Hatzigeorgiadis et al., (2017) also reported that self-talk can play a significant role in increasing an athletes' power output when fatigued. So, not only is the use of self-talk important for overall improvement in endurance performance, but can be done by targeting very specific areas, as was mentioned.

Once more, this is reinforced by Theodorakis, Hatzigeorgiadis, and Chroni (2008), who postulated that self-talk can be used to regulate effort, control cognitive and emotional reactions, increase confidence and enhance attentional focus.

5.6 Ecological Validity

The term ecological validity has been defined as "the relationship of measurement with what is taught and to the fact that the assessment is done in context" (Gardner, 1992), and can be characterized by informed and systematic attempts to analyse actual behaviour within specific environmental contexts, using realistic, and reliable methods of investigation (Davids, 1988). The crucial part from both aforementioned definitions is "environment" and "context", which leads into the ecological issues within this review. These ecological issues which are apparent in the above review, are two-fold. First, the environment in which the participants were being examined, and secondly, the nature in which they are doing the exercise. Of the 11 reviewed papers, just three (Weinberg, Miller, and Horn, 2015; Hatzigeorgiadis et al., 2013; McCormick, Meijen, and Marcora, 2017), took place in the environment in which they would be competing. However, the study by Hatzigeorgiadis et al. (2013), was the only one which took place within a competitive environment (participants were assessed during their competition). This is a critical part of sports research and has been highlighted by Martin, Vause, and Schwartzman (2005), and the implication which this has, is that generalizations can only be offered with caution, as the environment can play such an important role. This issue was again highlighted by McCormick, Meijen, and Marcora (2015), who discussed the notion that when a competition is important to an athlete, or there is uncertainty about what will happen during an event, then it can evoke various stressors on the athlete. These stressors are not accessible to the athlete during a laboratory experiment, only in competition. Even outside of competition, aspects such as the weather could be considered stressors, and the athlete needs to be prepared and knows how to deal with these stressors. Lazarus (2000), and Baron, Moullan, Deruelle, and Noakes (2011), discussed the role which emotions can play on sports performance and the roles which it can play on pacing strategies in middle to long duration events. In general, it was found that emotions can take over an athletes' thought process when fatigued, which can, in turn, lead to reduced performance levels and abilities, and termination of exercise in some cases. With this taken into

consideration, it seems essential that athletes should be exposed to these types of conditions, so that they can develop relevant coping strategies, such as self-talk. From the review of current literature, the only stressors which athletes are exposed to is fatigue, and in some cases heat, whereas there are so many more, some of which are listed above. Martinent and Ferrand (2009), support this and discuss how important it is that athletes be able to deal with this prior to their competition as it can elicit potentially negative emotional responses, which will lead to non-optimal performance. Hatzigeorgiadis, and Biddle, (2008), also highlight this, suggesting what is going on during an event can alter how an athlete feels, and their tendencies to think negatively/use negative self-talk. It was also suggested that pre-event anxiety can likewise lead to negative cognitions, increasing the likelihood of negative affirmations. This, again, reinforces the importance of the use of "segmenting" during endurance events, as the body will encounter different pains or will have to deal with different emotions at various points throughout their performance, and they must be able to deal with them. One method or self-talk phrase is generally not going to suffice, so the athlete must be aware pre-performance of what potential issues could arise and have pre-determined plans for these "segments" of their performance.

5.7 Limitations

The limitations within this research relate predominantly to the lack of research available, due to the specificity of the title and criteria, and the outcome measures from these studies, which made comparative statistical analysis difficult. The most common literature on self-talk interventions was found to be in precision or power activities, which limited the number of studies which were available to be reviewed. Additionally, when self-talk is used with endurance athletes, it is seldom used on its own, rather, accompanied by other forms of mental skills, in the form of a mental skills packages. These tend to focus on imagery, relaxation techniques, segmentation, and self-talk, though, studies which included these techniques were specifically excluded, as performance improvement could not solely be due to self-talk.

5.8 Conclusion and Practical Applications

This research review supports the theory that self-talk improves endurance performance and could be a beneficial method used by coaches when training athletes, and by athletes during competition. It is, however, inherently clear from the reviewed literature above that the concept of the performance pyramid and the various phases are not analysed or acknowledged in self-talk literature for athlete's competing in endurance events. Moreover, the use of "Repair", "Train", "Game" is not evident within literature either, nor acknowledged. This can be considered a gap in the current research and should be addressed in future studies in order to give a truly accurate account of the effects of which self-talk has on endurance performance. An athletes' use of self-talk should always be progressive and used during their session, while employing the "Repair", "Train", "Game" theory self-talk is being debilitative.

6.0 Bibliography

Aubert, A. E., Seps, B., & Beckers, F. (2003). Heart rate variability in athletes. Sports Medicine, 33(12), 889–919

Baron, B., Moullan, F., Deruelle, F., & Noakes, T. D. (2011). The role of emotions on pacing strategies and performance in middle and long duration sport events. *British Journal of Sports Medicine*, *45*(6), 511-517.

Barwood, M. J., Corbett, J., Wagstaff, C. R., McVeigh, D., & Thelwell, R. C. (2015). Improvement of 10-km time-trial cycling with motivational self-talk compared with neutral self-talk. *International journal of sports physiology and performance*, *10*(2), 166-171.

Biau, D. J., Kernéis, S., & Porcher, R. (2008). Statistics in brief: the importance of sample size in the planning and interpretation of medical research. *Clinical orthopaedics and related research*, *466*(9), 2282-2288.

Blanchfield, A. W., Hardy, J., De Morree, H. M., Staiano, W., & Marcora, S. M. (2014). Talking yourself out of exhaustion: the effects of self-talk on endurance performance. *Med Sci Sports Exerc*, *46*(5), 998-1007.

Brehm, J. W., & Self, E. A. (1989). The intensity of motivation. *Annual review of psychology*, *40*(1), 109-131.

Cohen, J. (1988). Statistical power and analysis for the behaviors sciences (2nd ed.). Hillsdale, NJ: Erlbaum.

Cox, R.H. (2002). Sport Psychology: Concepts and Applications (5th ed.). McGraw-Hill. P. 26.

Cutton, D. M., & Landin, D. (2007). The effects of self-talk and augmented feedback on learning the tennis forehand. *Journal of Applied Sport Psychology*, *19*(3), 288-303.

Davids, K. (1988). Ecological validity in understanding sport performance: some problems of definition. *Quest*, *40*(2), 126-136.

de Morton, N. A. (2009). The PEDro scale is a valid measure of the methodological quality of clinical trials: a demographic study. *The Australian Journal of Physiotherapy*, *55*(2), 129–133.

Díaz-Ocejo, J., Kuitunnen, S., & Mora-Mérida, J. A. (2013). An intervention to enhance the performance of a 3000-metre steeplechase athlete with the use of segmentation and self-talk. *Revista de psicología del deporte*, *22*(1), 0087-92.

Durand-Bush, N., & Salmela, J. H. (2002). The development and maintenance of expert athletic performance: Perceptions of world and Olympic champions. *Journal of applied sport psychology*, *14*(3), 154-171.

Edwards, D. J., & Steyn, B. J. (2008). Sport psychological skills training and psychological well-being. *South African Journal for Research in Sport, Physical Education and Recreation*, *30*(1), 15-28.

Gardner, H. (1992). Assessment in context: The alternative to standardized testing. In *Changing assessments* (pp. 77-119). Springer, Dordrecht.

Golby, J., & Sheard, M. (2004). Mental toughness and hardiness at different levels of rugby league. *Personality and individual differences*, *37*(5), 933-942.

Hamilton, R. A., Scott, D., & MacDougall, M. P. (2007). Assessing the effectiveness of self-talk interventions on endurance performance. *Journal of Applied Sport Psychology*, *19*(2), 226-239.

Hardy, J., Gammage, K., & Hall, C. (2001). A descriptive study of athlete self-talk. *The Sport Psychologist*, *15*(3), 306-318.

Hardy, J., Hall, C. R., & Hardy, L. (2005). Quantifying athlete self-talk. *Journal of Sports Sciences*, *23*(9), 905-917.

Hatzigeorgiadis, A., & Biddle, S. J. (2008). Negative Self-Talk During Sport Performance: Relationships with Pre-Competition Anxiety and Goal-Performance Discrepancies. *Journal of Sport Behavior*, *31*(3).

Hatzigeorgiadis, A., Bartura, K., Argiropoulos, C., Comoutos, N., Galanis, E., & D. Flouris, A. (2017). Beat the Heat: Effects of a Motivational Self-Talk Intervention on Endurance Performance. *Journal of Applied Sport Psychology*, *30*(4), 388-401.

Hatzigeorgiadis, A., Galanis, E., Zourbanos, N., & Theodorakis, Y. (2013). Self-talk and competitive sport performance. *Journal of Applied Sport Psychology*, *26*(1), 82-95.

Hatzigeorgiadis, A., Theodorakis, Y., & Zourbanos, N. (2004). Self-talk in the swimming pool: The effects of self-talk on thought content and performance on water-polo tasks. *Journal of Applied Sport Psychology*, *16*(2), 138-150.

Hatzigeorgiadis, A., Zourbanos, N., Mpoumpaki, S., & Theodorakis, Y. (2009). Mechanisms underlying the self-talk–performance relationship: The effects of motivational self-talk on self-confidence and anxiety. *Psychology of Sport and exercise*, *10*(1), 186-192.

Katarachia, Σ. (2017). *Effects of self-talk on perceived exertion during moderate intensity exercise* (Master's thesis).

Kayser, B. (2003). Exercise starts and ends in the brain. *European journal of applied physiology*, *90*(3-4), 411-419.

Kraemer, W. J., & Ratamess, N. A. (2004). Fundamentals of resistance training: progression and exercise prescription. *Medicine & Science in Sports & Exercise*, *36*(4), 674-688.

Kress, J. L., & Statler, T. (2007). A Naturalistic Investigation of Former Olympic Cyclists' Cognitive Strategies for Coping With Exertion Pain During Performance. *Journal of Sport Behavior*, *30*(4).

Landin, D., & Hebert, E. P. (1999). The influence of self-talk on the performance of skilled female tennis players. *Journal of applied sport psychology*, *11*(2), 263-282.

Latinjak, A., de las Heras, B., Sacot, A., Fernandez, D., Robinson, D., & Lane, A. (2018). Effects of Reflection to Improve Goal-Directed Self-Talk on Endurance Performance. *Sports*, *6*(2), 55.

Lazarus, R. S. (2000). How emotions influence performance in competitive sports. *The sport psychologist*, *14*(3), 229-252.

Maher, C. G., Sherrington, C., Herbert, R. D., Moseley, A. M., & Elkins, M. (2003). Reliability of the PEDro scale for rating quality of randomized controlled trials. *Physical therapy*, *83*(8), 713-721.

Mahoney, M. J., & Avener, M. (1977). Psychology of the elite athlete: An exploratory study. *Cognitive therapy and research*, *1*(2), 135-141.

Mallett, C. J., & Hanrahan, S. J. (1997). Race modeling: An effective cognitive strategy for the 100 m sprinter? The Sport Psychologist, 11, 72-85.

Marcora, S. M., & Staiano, W. (2010). The limit to exercise tolerance in humans: mind over muscle?. *European journal of applied physiology*, *109*(4), 763-770.

Marcora, S. M., Bosio, A., & de Morree, H. M. (2008). Locomotor muscle fatigue increases cardiorespiratory responses and reduces performance during intense cycling exercise independently from metabolic stress. *American Journal of Physiology-Regulatory, Integrative and Comparative Physiology*, *294*(3), R874-R883.

Marcora, S. M., Staiano, W., & Manning, V. (2009). Mental fatigue impairs physical performance in humans. *Journal of applied physiology*.

Martin, G. L., Vause, T., & Schwartzman, L. (2005). Experimental studies of psychological interventions with athletes in competitions: Why so few?. *Behavior modification*, *29*(4), 616-641.

Martinent, G., & Ferrand, C. (2009). A naturalistic study of the directional interpretation process of discrete emotions during high-stakes table tennis matches. *Journal of Sport & Exercise Psychology*, *31*, 318–336.

McCormick, A., Meijen, C., & Marcora, S. (2015). Psychological determinants of whole-body endurance performance. *Sports medicine*, *45*(7), 997-1015.

McCormick, A., Meijen, C., & Marcora, S. (2018). Effects of a motivational self-talk intervention for endurance athletes completing an ultramarathon. *The Sport Psychologist*, *32*(1), 42-50.

Morales-Alamo, D., Losa-Reyna, J., Torres-Peralta, R., Martin-Rincon, M., Perez-Valera, M., Curtelin, D., ... & Calbet, J. A. (2015). What limits performance during whole-body incremental exercise to exhaustion in humans? *The Journal of physiology*, *593*(20), 4631-4648.

Myburgh, E., Kruger, M., & Saayman, M. (2014). Segmentation by age of triathletes participating in Ironman South Africa.

Nayak, B. K. (2010). Understanding the relevance of sample size calculation. *Indian journal of ophthalmology*, *58*(6), 469.

Neil, R., Mellalieu, S. D., & Hanton, S. (2006). Psychological skills usage and the competitive anxiety response as a function of skill level in rugby union. *Journal of sports science & medicine*, *5*(3), 415.

Noakes, T. D. (2000). Physiological models to understand exercise fatigue and the adaptations that predict or enhance athletic performance. *Scandinavian Journal of Medicine & Science in Sports: Review Article*, *10*(3), 123-145.

Onstad-Hawes, E. C., Conte, E. A., & Laurin, E. M. (2017). The effect of motivational and instructional self-talk on precision and endurance performance tasks.

PEDro; Physiotherapy Evidence Database. (2019). Retrieved April 4, 2019, from https://www.pedro.org.au/english/downloads/pedro-statistics/

Perkos, S., Theodorakis, Y., & Chroni, S. (2002). Enhancing performance and skill acquisition in novice basketball players with instructional self-talk. *The Sport Psychologist*, *16*(4), 368-383.

Radcliffe, J. N., Comfort, P., & Fawcett, T. (2015). Psychological strategies included by strength and conditioning coaches in applied strength and conditioning. *The Journal of Strength & Conditioning Research*, *29*(9), 2641-2654

Thelwell, R. C., & Greenlees, I. A. (2003). Developing competitive endurance performance using mental skills training. *The Sport Psychologist*, *17*(3), 318-337.

Theodorakis, Y., Hatzigeorgiadis, A., & Chroni, S. (2008). Self-talk: It works, but how? Development and preliminary validation of the functions of self-talk questionnaire. *Measurement in Physical education and exercise Science*, *12*(1), 10-30.

Theodorakis, Y., Hatzigeorgiadis, A., & Zourbanos, N. (2012). Cognitions: self-talk and performance. The oxford handbook of sport and performance psychology. 191-212.

Theodorakis, Y., Weinberg, R., Natsis, P., Douma, I., & Kazakas, P. (2000). The effects of motivational versus instructional self-talk on improving motor performance. *The sport psychologist*, *14*(3), 253-271.

Thomas, P. R., & Fogarty, G. J. (1997). Psychological skills training in golf: The role of individual differences in cognitive preferences. *The Sport Psychologist*, *11*(1), 86-106.

Van Raalte, J. L., Brewer, B. W., Lewis, B. P., & Linder, D. E. (1995). Cork! The effects of positive and negative self-talk on dart throwing performance. *Journal of Sport Behavior*, *18*(1), 50.

Van Raalte, J. L., Brewer, B. W., Rivera, P. M., & Petitpas, A. J. (1994). The relationship between observable self-talk and competitive junior tennis players' match performances. *Journal of Sport and Exercise Psychology*, *16*(4), 400-415.

Van Raalte, J. L., Morrey, R. B., Cornelius, A. E., & Brewer, B. W. (2015). Self-talk of marathon runners. *The Sport Psychologist*, *29*(3), 258-260.

Van Raalte, J. L., Vincent, A., & Brewer, B. W. (2016). Self-talk: Review and sport-specific model. *Psychology of Sport and Exercise*, *22*, 139-148.

Wager, E., & Wiffen, P. J. (2011). Ethical issues in preparing and publishing systematic reviews. *Journal of evidence-based medicine*, *4*(2), 130-134.

Wallace, P. J., Mckinlay, B. J., Coletta, N. A., Vlaar, J. I., Taber, M. J., Wilson, P. M., & Cheung, S. S. (2017). Effects of motivational self-talk on endurance and cognitive performance in the heat. *Medicine & Science in Sports & Exercise*, *49*(1), 191-199.

Weinberg, R. S., & Comar, W. (1994). The effectiveness of psychological interventions in competitive sport. *Sports Medicine*, *18*(6), 406-418.

Weinberg, R., Miller, A., & Horn, T. (2012). The influence of a self-talk intervention on collegiate cross-country runners. *International Journal of Sport and Exercise Psychology*, *10*(2), 123-134.

Ziegler, S. G. (1987). Effects of stimulus cueing on the acquisition of groundstrokes by beginning tennis players. *Journal of applied behavior analysis*, *20*(4), 405-411.

Zinsser, N., Bunker, L., & Williams, J. M. (2006). Cognitive techniques for building confidence and enhancing performance. *Applied sport psychology: Personal growth to peak performance*, *5*, 349-381.

7.0 Appendices

Appendix 1.0: The Physiotherapy Evidence Database (PEDro) scale

PEDro scale

1.	eligibility criteria were specified	no ❑ yes ❑ where:
2.	subjects were randomly allocated to groups (in a crossover study, subjects were randomly allocated an order in which treatments were received)	no ❑ yes ❑ where:
3.	allocation was concealed	no ❑ yes ❑ where:
4.	the groups were similar at baseline regarding the most important prognostic indicators	no ❑ yes ❑ where:
5.	there was blinding of all subjects	no ❑ yes ❑ where:
6.	there was blinding of all therapists who administered the therapy	no ❑ yes ❑ where:
7.	there was blinding of all assessors who measured at least one key outcome	no ❑ yes ❑ where:
8.	measures of at least one key outcome were obtained from more than 85% of the subjects initially allocated to groups	no ❑ yes ❑ where:
9.	all subjects for whom outcome measures were available received the treatment or control condition as allocated or, where this was not the case, data for at least one key outcome was analysed by "intention to treat"	no ❑ yes ❑ where:
10.	the results of between-group statistical comparisons are reported for at least one key outcome	no ❑ yes ❑ where:
11.	the study provides both point measures and measures of variability for at least one key outcome	no ❑ yes ❑ where:

Appendix 2.0: Study Characteristics

STUDY	ACTIVITY TESTED	TEST DESIGN	GENDER	ATHLETE EXPERIENCE	INTERVENTION DURATION
HAMILTON, SCOTT, & MACDOUGALL (2007).	Cycling	Single subject multiple-baseline design	Female = 3 Male = 6	Recreational	Varied Greatly 10 sessions (2 per week)
HATZIGEORGIADIS ET AL. (2017).	Cycling	Repeated-measure design	Female = 0 Male = 16	Recreational	5 days
MCCORMICK, MEIJEN, MARCORA (2017).	Ultra-Marathon	Post-Test only design	Female = 4 Male = 25	Experienced	10 - 14 days
WALLACE ET AL. (2017).	Cycling	PRE/POST test design (4 sessions)	Female = 4 Male = 14	Experienced	2 weeks
KATARACHIA (2018).	Cycling	Post-test only	Female = 38 Male = 47	Recreational. (participant experience on a bike not stated).	One lab visit. 4-minute ST instruction, followed by the use of ST for 20 minutes
BARWOOD ET AL. (2018).	Cycling	Repeated-measure design	Female = 0 Male = 14	Recreational (no maximal effort cycling experience)	Not stated exactly. 4 testing days, intervention given between test 3 and 4. Minimum 2 days between tests
BLANCHFIELD ET AL. (2013).	Cycling	PRE/POST test design	Female = 9 Male = 15	Recreational (Cycling experience not stated)	2 weeks
WEINBERG, MILLER, & HORN (2012).	Cross Country Running	PRE/POST test design	Female = 40 Male = 41	Experienced (running experience of 12 years)	One week
ONSTAD-HAWES, CONTE, & LAURIN (2017).	Cycling	2 mixed-factorial design	Female = 18 Male = 18	Not stated	2 weeks
HATZIGEORGIADIS ET AL. (2013).	Swimming	PRE/POST test design	Female = 19 Male = 22	Experienced (8 years' experience average)	10 weeks
LATINJAK ET AL. (2018)	Cycling	Repeated-measure design	Female = 14 Male = 20	Recreational	Not stated exactly. 4 testing days, min 2 days apart. Intervention begins on day 2

Appendix 3.0: Study Results

STUDY	SELF-TALK USED	VARIABLE MEASURED	MAIN FINDINGS	P. VALUE (IF STATED)
HAMILTON, SCOTT, & MACDOUGALL (2007).	Mixed (Self-generated and assigned)	Work completed in 20 minutes	All but one athlete was able to complete more work when using ST (including negative)	P value not stated
HATZIGEORGIADIS ET AL. (2017).	Assigned	Power Output Oxygen Consumption	Participants in the ST group produced significantly more power output in final third of the trial than the control group	P<0.01 (PO)
MCCORMICK, MEIJEN, MARCORA (2017).	Assigned	Self-Efficacy Perceived Control Performance expectations	A performance benefit was not found. Potentially due to performance times differing as event was so long and a small sample group.	P value not stated
WALLACE ET AL. (2017).	Mixed (Self-generated and Assigned)	Time to Exhaustion. Cognitive function in the heat	MST improves endurance capacity and psychophysiological control of fatigue plays an important role in improving endurance capacity.	P value not stated
KATARACHIA (2018).	Assigned	RPE Heart rate Heart Rate Reserve	ST helped maintain a lower perception of effort during moderate intensity exercise.	P value not stated
BARWOOD ET AL. (2018).	Self-generated	Time taken to complete 10km cycle Power Output RPE	ST intervention led to significant reduction in time trial times. Also led to a significant increase in power output. No significant difference in RPE	P=0.009 (reduction TT time) P=0.006 (PO) P=0.236 (RPE)
BLANCHFIELD ET AL. (2013).	Assigned	Time to exhaustion RPE	ST had a significant effect on time to exhaustion from pre to post-test. RPE was also reduced among self-talk group	P<0.05 (TTE)

WEINBERG, MILLER, & HORN (2012).	Mixed (Self-generated and assigned)	One mile run time trial	Motivational and instructional combined ST (self-set) showed most significant performance increase Significant improvement was also found in the motivational self-set and instructional assigned ST groups. Other groups showed improvements but not significant.	P<0.01 (TT improvement for MST self-set group) P<0.01 (TT improvement for MST self-set and IST assigned)
ONSTAD-HAWES, CONTE, & LAURIN (2017).	Assigned	Time to exhaustion	MST group significantly increased time to exhaustion compared to control group.	P<0.001 (MST improvement in TTE)
HATZIGEORGIADIS ET AL. (2013).	Mixed (Self-generated and assigned)	Athletes individual time improvement	Athletes in ST group had a bigger improvement in times (M = 1.43 ± 2.15) compared to control group (*M* = 0.05 ± 2.28).	P value not stated
LATINJAK ET AL. (2018)	Self-Generated	Time to exhaustion RPE Heart Rate	Goal-directed ST did not make athletes perform better or reduce heart rate. Also, this ST made athletes RPE get significantly higher compared to the control group	P=0.025 (RPE)