INVESTIGATING THE EFFECT OF SELF-TALK ON RATING OF PERCEIVED EXERTION AND HEART RATE AMONG MALE RUNNERS

NAVIN KAUSHAL

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by

Navin Kaushal

A thesis submitted to the
School of Graduate Studies
in partial fulfilment of the
requirements for the degree of
Master of Science
in
Kinesiology

Memorial University of Newfoundland

May 2011

St. John's Newfoundland

ABSTRACT

The purpose of this study was to determine if the mental training technique of self-talk would alter an athlete's heart rate and the perception of exertion during a one-hour steady-state running test. Twenty nine athletic male runners aged 18 to 55 (37.9 ± 11.71) participated in this study. The athletes were randomized into three groups: 1) positive self-talk, 2) negative self-talk, and 3) control. Participants underwent a maximal oxygen uptake determination test (VO_2 max test) and a steady-state running test which was 70% of their VO_2 max. In the later test, participants' heart rate was measured and their Borg's Rating of Perceived Exertion (RPE value) was recorded after every five minutes. Participants in groups one and two attended a mental training session and created their own positive and negative self-talk statements. Participants in group 3 listened to a neutral documentary and completed a recall test after their run. There was no significant physiological difference between the three groups during the maximal oxygen uptake determination test ($p = .627$). The steady-state running test showed that there was no physiological difference in their maximal heart rate ($p > .05$). However, there was a significant difference of RPE value between the three groups ($F_{(2, 26)} = 6.346, p = .006$). Tukey's HSD post hoc test revealed that the positive self-talk group (1.89, ± .928) had significantly lower RPE values than the negative group (4.60, ± 2.50, $p=.005$). Amongst a physiologically homogeneous group, the results suggest that positive self-talk can increase the performance of athletes by concealing their awareness of feeling exerted.

Keywords: self-talk, heart rate, perceived exertion, RPE, running

ACKNOWLEDGEMENTS

It has been a great pleasure working with the faculty at the School of Human Kinetics and Recreation at Memorial University. I would first like to thank my supervisor, Dr. Basil Kavanagh, for accepting me into the program and providing me the opportunities to explore my potentials in research and teaching. We have shared some interesting discussions and from these discussions emerged a fascinating and unexplored research topic which eventually became my thesis. Dr. Kavanagh has been a great mentor during my time in the program and through the stages of my thesis. Despite his busy schedule, he was always very prompt in responding to my e-mails and accessible in person to discuss about any of my inquiries. I appreciate Dr. Kavanagh's support in helping me achieve my goals in the program and for his encouragement to reach my future goals.

I would like to thank Dr. Fabien Basset, who collaborated on my thesis and provided his expertise in exercise physiology. He provided some interesting insights from a physiological perspective and he was very resourceful in the progression of my research. I appreciate the work of Dr. Duane Button, who was also on my research committee. He provided some insightful feedback and helped me with the formatting and editing of my thesis. He was also helpful in addressing my questions about graduate school.

I would like to thank Dr. Tim Alkanani, who helped me become familiar with the equipment I was using and for his help in the laboratory. Both, Dr. Alkanani and Dr. Basset have been great in helping me fix the equipment during the summer evenings and weekends. I

appreciate the help from Zach Hynes and Liam Kelly, who have assisted me during the data collection phase.

I was pleasantly surprised to receive a lot of feedback and support regarding research and graduate school from Dr. Angela Loucks-Atkinson, Dr. Jeanette Byrne and Dr. David Behm. From them, I have acquired tactics which have strengthened my research skills and learned some important advice on becoming a successful researcher in the future.

Interacting with the faculty which consisted of diverse research backgrounds and experience provided me with a large scope in interpreting and developing various research techniques. I am glad that I made the choice to join the School of Human Kinetics and Recreation at Memorial University for my Master's program as the experience and wealth of knowledge I have learned will certainly be a powerful asset in helping me achieve my future goals.

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CHAPTER 1: INTRODUCTION

1.1 Overview

Self-talk is a mental training technique which has been applied and researched across several disciplines. It has been studied in various fields such as behavioural medicine, educational psychology, health psychology and sport psychology. In the area of behavioural medicine, it has been used for helping reduce: psychological stress in surgical patients, distress during chemotherapy, catastrophizing cognition in children, dropout rate in cardiac rehabilitation programs, headaches (Brown, O'Keeffe, Sanders, & Baker, 1986; Dahlquist, Gil, & Armstrong, 1985; Langer, Janis, & Wolfer, 1975; Scopp, 2003; Stetson, Frommelt, Boutelle, & Cole, 1995). In the area of educational psychology, self-talk has been used for helping students: with independent school assignments, enhance their writing skills, use more effort and improve their classroom performance, with emotional or behavioral disorders, cope with dyslexia (Callicott & Park, 2003; Manning, 1990; Singer, 2008; Solley & Payne, 1992; Wolters, 1999). In the field of health psychology, self-talk has helped in: avoidance of alcohol beverages (Birkimer, Druen, Holland, & Zingman, 1996), smoking reduction (Kelly, Zuroff, Foa, & Gilbert, 2010) and motivating adults to be physically active (Gammage, Hardy, & Hall, 2001; O'Brien Cousins & Gillis, 2005). Though self-talk has been applied in a variety of contexts, the majority of literature regarding self-talk is in the field of sport psychology.

With regards to sport psychology, self-talk, when used in a positive manner, or positive self-talk, has been shown to enhance performance in various studies (Chroni & Kourtesopoulou, 2002; Hamilton, Scott, & MacDougall, 2007; Harvey, Van Raalte, & Brewer, 2002;

Hatzigeorgiadis, Theodorakis, & Zourbanos, 2004; Hatzigeorgiadis, Zourbanos, Goltsios, & Theodorakis, 2008; Johnston-O'Connor & Kirschenbaum, 1986; Masciana, Van Raalte, Brewer, Branton, & Coughlin, 2001; Rogerson & Hrycaiko, 2002; Rushall, Hall, Roux, Sasseville, & Rushall, 1988; Rushall & Shewchuk, 1989; Theodorakis, Chroni, Laparidis, Bebetsos, & Douma, 2001; Van Raalte, et al., 1995).

On the other hand, negative self-talk, which has not been investigated as extensively as positive self-talk, has been shown to debilitate performance (Dagrou, Gauvin, & Halliwell, 1992; Harvey, et al., 2002; Hatzigeorgiadis & Biddle, 2008; Hatzigeorgiadis, et al., 2008; Van Raalte, et al., 1995; Wrisberg & Anshel, 1997). However, research has still not clearly determined how self-talk influences the athlete's performance. For instance, is positive self-talk simply a distracter so the athlete does not notice performance fatigue or does it affect the athlete physiologically by varying heart rate and thus impacting performance? There is a lack of research which does not measure the athlete's heart rate or his perception of exertion while using self-talk.

1.2 Purpose of Study

The purpose of this thesis was to determine if the mental training technique of self-talk would alter an athlete's heart rate, and their perception of exertion. Investigating the effects of self-talk may potentially explain why this mental training technique is effective. The study may also provide future research questions that may help examine the effects of other mental training techniques.

1.3 Research Questions

This research study focused on investigating the effect of self-talk on heart rate and perception of exertion among male runners. The study sought to investigate the following questions:

1. Will the type of self-talk have an influence on the athlete's heart rate while running?
2. Will the type of self-talk have an influence on the athlete's perception of exertion?
3. Will the type of self-talk create a discrepancy between the athlete's physiological stress levels (heart rate) and his perception of exertion? For instance, can positive self-talk conceal the athlete's awareness of feeling exerted?

1.4 Significance of Study

It is important to determine if the use of the mental training technique, self-talk, will lower physiological symptoms of stress. If the use of self-talk lowers physiological symptoms of stress, the findings will suggest that athletes will be able to perform at a higher intensity or longer endurance. Moreover, the scientific evidence will be a strong incentive for coaches to train their athletes about the use of self-talk and for athletes to learn this technique. The scientific evidence can also contribute to the industry. The ability to control physiological stress responses (heart rate) can lead to a decrease in anxiety, increase in effort, persistence and overall improve work performance.

1.5 Definitions

The following definitions will be used in this study.

Self-Talk. Self-talk can: "(a) be verbalizations or statements addressed to the self; (b) be multidimensional in nature; (c) have interpretive elements association with the content of statements employed; (d) be somewhat dynamic; and (e) serve at least two functions; (i) instructional and (ii) motivational, for the athlete" (Hardy, 2006, p.84).

Perceived exertion. Perceived exertion is defined as "the act of detecting and interpreting sensations arising from the body during physical exercise" (Noble & Robertson, p.4, 1996).

VO_2 max. *VO_2 max* or maximum volume of oxygen, is defined as the greatest amount of oxygen that can be used at the cellular level for the entire body. VO_2 max is measured in ml/kg /min (Franklin, 1998).

1.6 Summary

The preceding chapter provided a brief overview of self-talk, the purpose of the study as well as the research questions, the significance of the study, and provided the definitions. Chapter 2 describes the review of literature on self-talk, and Borg's Rating of Perceived Exertion (RPE). The review discusses each of the topics and research that overlap the constructs.

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CHAPTER 2: REVIEW OF LITERATURE

2.1 Self-Talk Introduction

Self-talk is a mental training technique which has been studied using quantitative and qualitative techniques and has been shown to be effective in a variety of sport contexts (Chroni & Kourtesopoulou, 2002; Dagrou, Gauvin, & Halliwell, 1992; Edwards, Tod, & McGuigan, 2008; J. Hardy, Hall, & Alexander, 2001; Harvey, Van Raalte, & Brewer, 2002; Hatzigeorgiadis, Theodorakis, & Zourbanos, 2004; Hatzigeorgiadis, Zourbanos, Goltsios, & Theodorakis, 2008; Johnston-O'Connor & Kirschenbaum, 1986; Landin & Hebert, 1999; Masciana, Van Raalte, Brewer, Branton, & Coughlin, 2001; Perkos, Theodorakis, & Chroni, 2002; Rogerson & Hrycaiko, 2002; Rushall, Hall, Roux, Sasseville, & Rushall, 1988; Rushall & Shewchuk, 1989; Theodorakis, Chroni, Laparidis, Bebetsos, & Douma, 2001; Van Raalte & Brewer, 1994; Van Raalte, et al., 1995; Wrisberg & Anshel, 1997). As previously discussed in Chapter 1, self-talk has also been used in a variety of other contexts such as behavioural medicine, educational psychology, and health psychology. For the purpose of this investigation, the aforementioned topics are beyond the scope of the study and will receive no further attention. The purpose of this review of literature is to investigate the effects of self-talk on Rating of Perceived Exertion (RPE) and heart rate among male runners in an attempt to determine if the effect is facilitative or debilitative. For instance, does self-talk influence an athlete's perception of exertion or does it cause some physiological changes such as change in heart rat

An extensive literature review revealed a lack of research which explores the connection between self-talk and perception of exertion, and self-talk and change of heart rate.

To investigate this topic, a literature review on self-talk examined the findings and the effects that self-talk has had on athletes across various sports. The literature review is subdivided into the following sections: definitions of self-talk, concepts, methods on isolating variables to examine valid effects of self-talk, and finally unexpected findings that have arose from studying self-talk. Since self-talk is not exclusively referred to as a mental training technique for enhancing sport performance, several definitions of self-talk have been established.

By examining different definitions, some insight may be provided as to how self-talk influences and is perceived by the athlete.

2.1.1 Definition

Self-talk does not have one specific definition. Based on the context and perception of self-talk, several researchers have created their own self-talk definitions. Hardy (2006) gathered the most prominent definitions in the literature that define self-talk. He posited that self-talk can: (a) be verbalizations or statements addressed to the self; (b) be multidimensional in nature; (c) have interpretive elements associated with the content of statements employed; (d) be somewhat dynamic; and (e) serve at least two functions; (i) instructional and (ii) motivational, for athletes. An important definition that was not mentioned in the article is one from Weinberg & Gould (2007). They state that self-talk can also be a potential internal distracter. It can distract an athlete from the task at hand or distract the athlete from other distracters. Another important definition involves viewing self-talk as a dialogue (Hackfort & Schwenkmezger, 1993). Hackfort and Schwenkmezger stated that self-talk is a "dialogue (in which) the individual

interprets feelings and perceptions, regulates and changes evaluations and convictions, and gives him/herself instructions and reinforcement" (p.355). As there are many varied definitions for self-talk, there are also several concepts which explain the effects self-talk. The following section will explore these concepts.

2.1.2 Concepts of Understanding Self-Talk

A common area of self-talk, proposed as the valence dimension, surmises that self-talk can be positive or negative (Hardy, 2006). The review of literature revealed that the topics which have been explored in the valence dimension indicate that there are more studies which investigated the effects of positive self-talk than negative self-talk, and researchers have preferred to examine the self-talk affects on individual sports instead of team sports. With regards to the former finding, perhaps researchers believed that it would be more productive to investigate methods, which facilitate performance, rather than investigating methods, which debilitated performance. The later finding could have resulted from the fact that it would be easier to observe and record improved performance on individual sports (ie. golf) instead of a team sport (ie. football). It is also easier to monitor and control self-talk usage on an individual athlete rather than an entire team.

With regards to the valence dimension, the positive self-talk statements are those which, praise and assist the athlete in focusing on the present task at hand (Moran, 1996). Positive self-talk has been shown to enhance athletic performance in various sports such as: tennis, golf, sprinting (100 meter dash), darts, hockey, and swimming (Hatzigeorgiadis, Zourbanos, Goltsios, & Theodorakis, 2008; Johnston-O'Connor & Kirschenbaum, 1986; Mallett & Hanrahan, 1997;

Masciana, Van Raalte, Brewer, Branton, & Coughlin, 2001; Rogerson & Hrycaiko, 2002; Rushall & Shewchuk, 1989). However, misuse of positive self-talk may not result in improved performance or it may result in hindering the athlete. For instance, Van Raalte, et al., (2000), found that 15 out of 18 tennis players' positive self-talk was not related to the outcome of the following point. It is important to note that the participants were only limited to using certain kinds of self-talk in this study. Hence, the perceived quality and relevance of the statements are essential. Self-talk should be brief, phonetically simple, and should be matched with the timing of the task (Landin, 1994). Moreover, using self-talk too often can result in debilitative performance which is termed "paralysis by analysis" (James Hardy, Hall, & Hardy, 2005). Schmidt, (1982) explains that motor movement requires conscious thought. However, the conscious thought of executing a movement adds stress to the performance and can lead to "paralysis by analysis".

On the opposite side of the dimension is negative self-talk. This includes internalized statements that criticize the athlete. Negative self-talk may debilitate the athlete's performance because it is irrational, produces anxiety, and is counterproductive (Moran, 1996; Theodorakis, et al., 2000). The debilitating effects have been examined in sports such as: golf, middle-distance (2.5 miles) cross-country running, darts, tennis, and hockey (Harvey, Van Raalte, & Brewer, 2002; Hatzigeorgiadis & Biddle, 2008; Van Raalte, et al., 1995; J. L. Van Raalte & Brewer, 1994; Wrisberg & Anshel, 1997). Interestingly, some studies have shown negative self-talk to enhance the performance of some people. This has occurred in tasks such as: performing logic puzzles, performance on ergometer cycles, and competitive tennis (Goodhart, 1986; J. L. Van Raalte, Cornelius, Hatten, & Brewer, 2000). For the first two referenced studies, the researcher prepared the self-talk statements. For the third study, the athletes created their own statements,

which were evaluated by the researchers using the Self-Talk and Gestures Rating Scale (STAGRS). Furthermore, Van Raalte & Brewer (1994) assessed the use of overt self-talk during a youth competitive tennis match. They concluded that the match winners and losers used the same amount of positive self-talk. However, the winners used less negative self-talk compared to the losers. The authors of this study concluded that negative self-talk could motivate tennis players and eventually concluded that the differences between winners and losers accounted for how the athletes responded to the self-talk statements, rather than how the statement was generated. In other words, the manner in which the athlete perceives the statement is more important than if the statement is positive or negative.

In 2001, Hardy, et al., completed a qualitative study to determine why athletes use self-talk statements. The researchers concluded that self-talk serves two main purposes: motivation and instruction. Hatzigeorgiadis, et al., (2004) investigated these two categories with different sports to further understand their effectiveness. It was found that instructional self-talk facilitated performances, which required accuracy, fine motor movement, skill and timing. Their findings for motivational self-talk indicated that it was facilitative for sports which require gross motor skills. Research evidence supporting instructional self-talk has been found in skiing, accuracy tasks: soccer kicking and delivering a badminton serve, a basketball-shooting task, golf putting, and water polo tasks requiring precision (Harvey, et al., 2002; Hatzigeorgiadis, et al., 2004; Rushall, et al., 1988; Theodorakis, et al., 2001; Theodorakis, et al., 2000). Research supporting the effectiveness of motivational self-talk has been found in studies on: sport climbing, water polo tasks requiring power, push-ups (Chroni & Kourtesopoulou, 2002; Hatzigeorgiadis, et al., 2004; Kolovelonis, Goudas, & Dermitzaki, 2011). Interestingly, for gross motor tasks such as

vertical jump and knee extension, equal improvements were found regardless of which self-talk strategy was employed (Edwards, et al., 2008; Theodorakis, et al., 2000).

With regards to the effectiveness of self-talk, Theodorakis, et al., (2000), stated that practice is required for self-talk to be effective. They suggested that the athletes should become familiar and comfortable with their specific self-statements before the effects are measured. Furthermore, with regards to practice and frequency, Mahoney & Avener, (1977) have found a positive correlation between successful athletes and the frequency they used self-talk. In addition, Highlen & Bennett (1983) found that wrestlers who qualified for Pan American Games used more positive self-talk than those who did not qualify.

The next section will discuss methods researchers used in order to maintain their research validity. Maintaining the validity of studies regarding the effectiveness of self-talk or any other mental training techniques is difficult for two reasons. First, the researchers will never know or be able to control the participant's thoughts (Johnson, et al., 2004). Hence, the participant can claim to be using self-talk but could be thinking of irrelevant thoughts. Second, assigned self-talk statements will not produce the same effect for all athletes. Some mediating variables might include personality traits and cultural background. It is important to consider these challenges when designing a self-talk study. The following subsection will discuss tactics researchers have used in order to increase the validity of their findings on self-talk.

2.1.3 Methods of Isolating Variables to Examine the Effects of Self-Talk

In some studies, researchers have assigned specific positive and negative self-talk statements to the athletes (Dagrou, et al., 1992; Landin & Hebert, 1999; Perkos, et al., 2002;

Theodorakis, et al., 2000; Van Raalte, et al., 1995). The researchers used this method with an intention to control the content of the self-talk statements that the participants were using. However, these studies did not make some important considerations. First, each athlete may perceive the same self-talk statements differently. Second, the laboratory setting may be unnatural to the athletes. The validity of the study may be increased if the setting simulates the athlete's performance environment. Rushall, et al., (1988) stated that during practice and competition, the athletes will be in a natural setting and it is more likely that they will generate their own self-talk statements. Hence, these researchers allowed elite cross-country skiers to create their own positive self-talk statements while performing outdoors. The researchers found that the athlete's performance improved by 3% when the athletes were free to create and use their own self-talk statements compared to group that did not use any self-talk statements. Furthermore, Theodorakis, et al., (2000) also advised that athletes should create self-talk statements, which work best for themselves.

Hardy (2006) explained that there is a difference if the athlete is allowed to create the self-talk statements or if it is assigned. Hardy stated that according to Deci & Ryan's (1985) Cognitive Evaluation Theory, it can be inferred that self-created self-talk statements will have a greater motivational effect. The Cognitive Evaluation Theory states that humans strive to feel competent based on their own autonomy. Hence, self-talk statements, which are created by the athletes, allow them to experience a higher level of autonomy, as the statements are more personal to their motivation.

Another tactic to control the use of self-talk is to ensure that athletes use it overtly instead of covertly. Only one study was discovered in which the researchers have measured the use of self-talk in an overt manner (Van Raalte & Brewer, 1994). For this experiment, the researchers

created a specific scale, the Self-Talk and Gestures Rating Scale (STAGRS) to measure overt self-talk. Although this method confirmed to the researchers the type of self-talk the athletes were using, athletes were not always using overt statements during a real performance as it could alter their natural breathing and interfere with their performance. MacKay (1992) outlined some important differences between overt and covert self-talk; in particular, there are more variables to consider with overt self-talk. In overt self-talk, one can alter the pitch and volume of the statements. This could affect the tone of the statements and it might influence how the statements are perceived. MacKay also stated that overt self-talk can impersonate another, whereas this is not the case in covert self-talk. Though no study has been found which compares the effects of the two types of self-talk, there is a possibility of differences due to the variables mentioned.

The previous section discussed how the use of certain methods of isolating variables could influence the perception of self-talk statements. However, it is also important to consider other variables, or mediators that could also affect the athlete's perception of self-talk. A mediator that appears in the literature is self-efficacy and this topic will be briefly described in the next section.

2.1.4 Self-talk and Self-efficacy

Self-efficacy is described as "beliefs in one's capabilities to organize and execute the courses of action required to produce given attainments" (Bandura, 1997, p.3). Bandura has also stated that positive statements made can boost one's self efficacy in the task. Studies have investigated the relationship between self-talk and self-efficacy and have indicated positive self-

talk is positively correlated with self-efficacy (James Hardy, et al., 2005; Landin & Hebert, 1999; Weinberg, Grove, & Jackson, 1992). Self-efficacy can also influence the duration, intensity of an exercise or task (McAuley, Lox, Rudolph, & Travis, 1994). Hence, an athlete who has a high level of self-efficacy believes that he/she has a strong likelihood of accomplishing a task. With strong thoughts of accomplishing the task, a person is likely to produce thoughts or self-talk statements, which support accomplishing the particular task. Based on Bandura's definition, it may be inferred that if one has a high level of self-efficacy for a task, the person is less likely to engage in negative self-talk statements. Hence, it is possible that there is a reciprocal relationship between the type of self-talk and level of self-efficacy.

2.1.7 Self-Talk Conclusion

The literature review has revealed some important insight and consideration with regards to using self-talk. The review provided some important points to consider when designing the current experiment. First, from comparing the studies between assigned and self-created self-talk statements, the literature provided rationale to use the latter method rather than the former. Second, the athletes in the current study were going to be running on a treadmill in a laboratory environment. Since the task involves gross motor movement, the literature suggests that motivational self-talk would be more effective than instructional. Third, a scale which measures an athlete's instructional and motivational self-talk scores should be administered to further assist in understanding the results. The scale would help confirm the finding in the literature if motivational self-talk is positively correlated with gross motor sport. Details of the Self-Talk Scale are discussed in Methodology section. Fourth, the athletes will use their self-talk

statements covertly. Although overt self-talk offers more control, speaking over the treadmill noise will likely hinder the athlete's performance

Though the literature shows patterns in which self-talk can be effective, the mechanism of how self-talk helps athletes is unclear. For instance, Theodorakis et al., (2000) found that the use of motivational self-talk helped enhance strength performance, however, they stated that the underlying mechanism, whether a change in arousal (physiological) or a change in confidence (psychological), remains uncertain. They suggested that future research is needed in this area to help understand the mechanism of how self-talk enhances performance. A study by St Clair, Gibson, & Foster (2007) explored a neurophysiological approach to explain how self-talk is processed in different regions of the brain. However, the study did not conclude with any suggestions (psychologically or physiologically) to explain the mechanism of how self-talk is effective.

Rushall, et al., (1988), investigated if heart rate is one of the physiological mechanisms that was influenced by self-talk. They measured the heart rates of cross country skiers in a repeated measures design. They found that performance and heart rate significantly increased when the athletes used positive self-talk compared to the control trial when the athletes were told to "ski normally". Interestingly, the researchers stated that the participants were not aware of any effort differentials between the trials. Unfortunately, this statement was not validated by using any questionnaires or scales. It may have provided useful information if the researchers had used a valid instrument to measure the athletes' perception of effort or exertion across the trials.

A reliable and valid instrument that has been extensively used in exercise experiments is the Borg's Rating of Perceived Exertion (RPE). The following section will discuss this instrument.

2.2 Borg's Rating of Perceived Exertion: Introduction

Borg's Rating of Perceived Exertion (RPE) is a widely used instrument that measures perceived exertion during exercise (Bolgar, Baker, Goss, Nagle, & Robertson, 2010; Borg, 1973, 1982, 1998; Chen, Fan, & Moe, 2002; Pandolf, 1978). After investigating several studies, Noble & Robertson (1996) found that the scale correlates well with a variety of physiological measures, such as: heart rate, ventilator drive and creatine. In a meta-analysis, Chen, et al., (2002) stated that the most common criterion physiological measures used in research on ratings of perceived exertion are: heart rate, blood lactate concentration and various measures of oxygen uptake (%VO2max, VO2, ventilation, respiration rate). Perceived exertion score has also been found to be influenced by the changes occurring in the central nervous system during prolonged endurance exercise (Swart, et al., 2009). The following section will discuss the validity of the scale in relation to heart rate and other physiological variables.

2.2.1 Measurement of Physiological Variables

Heart Rate

Borg's RPE scale was initially validated against heart rate (Borg, 1973, 1982; G. Borg & Linderholm, 1970). Borg's validation yielded a correlation of 0.85 between heart rate and the scale in a study by Noble and Robertson, (1996). Since that time numerous other studies have used RPE when heart rate was measured for exercise tasks such as: running on a treadmill, skiing, cycling, one repetition maximum muscular strength (Astorino, Rohmann, & Firth, 2008;

Chaffin, Berg, Zuniga, & Hanumanthu, 2008; Oliver, Costa, Walsh, Laing, & Bilzon, 2009; Scheiber, Krautgasser, Duvillard, & Müller, 2009)

Travlos & Marisi (1996) found that the correlation of RPE and heart rate depended on the individual's fitness levels. They found that highly-fit individuals perceived themselves under less exertion than did the group low in fitness. Furthermore, they noted a stronger relationship between RPE and heart rate and RPE and core temperature for the highly fit individuals than for the less fit. These conditions lead to less variability in the results of their study. Hence, a method of improving validity of the results in the present study would be to use regular runners who are physically fit.

Other Physiological Variables

Zeni, Hoffman, & Clifford (1996) found a correlation of RPE and heart rate for a variety of aerobic tasks as well as blood lactate levels. With regards to blood lactate levels, Steed, Gaesser, & Weltman (1994) concluded that RPE is a physiologically valid tool for prescribing exercise intensity when the intensity criterion is lactate threshold and/or blood lactate concentration. In a meta analysis by Chen, et al., (2002), the researchers concluded that the highest correlations between ratings of perceived exertion and various physiological criterion measures occur when male participants are required to maximally exert themselves (%VO_2max), and when the exercise task is unusual such as swimming while measuring heart rate and VO_2 (Chen, et al., 2002). The following section will discuss variables that have been found to influence a participant's perception of exertion.

2.2. 2 External Variables Which Influence RPE

Variables such as mood (Parfitt & Eston, 1995; Parfitt, Eston, & Connolly, 1996), exercise history (Parfitt, et al., 1996; Parfitt, Markland, & Holmes, 1994) and physiological condition (Russell, 1997), may influence the relationship between ratings of perceived exertion and physiological variables of exercise intensity. Perception of exertion can also be influenced by psychological variables such as the presence of a competitor (Wilmore, 1968), exercise self-efficacy (Rudolph & McAuley, 1996) and monetary reward (Cabanac, 1986). It is likely that the participant's thoughts on these variables act as a distracter, which interferes with their awareness of exertion. For instance, if a competitor is present, the athlete could be focused on delivering a strong performance to appear intimidating.

2.2.3 RPE and Self-Talk

A literature review revealed no studies that investigated the effect of RPE when the participants used any kind of self-talk (positive or negative) while performing an exercise task. It appears that little, if any, knowledge exists on whether self-talk influences an athlete's score on Borg's RPE scale. This is important to investigate, since Borg's RPE has been correlated with various physiological changes that occur to the athlete during physical activity. An investigation into this matter may provide some insight into whether self-talk impacts RPE scores and affects an athlete's physiology during a performance.

2.2.4 RPE Conclusion

The primary focus of this literature review on Borg's RPE was to: (i) Confirm that heart rate that has been correlated with RPE and hence several studies have measured performance of heart rate and RPE together and (ii) Investigate research that has studied the effects of self-talk on RPE and the correlation of self-talk and RPE. In summary, a literature review revealed that currently, there appears to be little or no research investigating if self-talk influences an athlete's RPE score.

2.3 Summary

The review of literature on self-talk and RPE has revealed areas of research that have been thoroughly investigated and some areas that still have some unanswered questions. For instance, the majority of studies have shown positive self-talk to enhance performance and negative self-talk has been correlated with debilitating performance in sport. In particular, motivational self-talk has been shown to improve performance in gross motor sports and instructional self-talk has been shown to facilitate performances, which require fine motor movements. However, there is a lack of physiological evidence to support any of the self-talk findings such as heart rate. Although Borg's RPE scale has been highly correlated with heart rate, the effect of self-talk on an athlete's perception of exertion has not been explored. Since the review of literature revealed the validity of Borg's scale to measure the level of perceived exertion among athletes during physical activity, it would be interesting to use this scale to determine if the type of self-talk (positive or negative) influences the athlete's perception of exertion.

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CHAPTER 3: CO-AUTHORSHIP STATEMENT

I will address the development of my thesis idea, and the contributions of my co-authors in the following four statements:

i) I have completed a Joint Honors degree in Health Sciences and Psychology from the University of Western Ontario. I selected this program because of my interest in both research domains: health science and psychology. Hence, when pursing a thesis topic, I also wanted to include both disciplines in my research. I have had several discussions with my supervisor, Dr. Basil Kavanagh, in which we have discussed about a variety of my research interests. As I progressed in my Master's program, my supervisor introduced me to the idea of examining the change of heart rate while running when using positive self-talk. This idea sparked my interest and I began to brainstorm on the scales, psychological variables and groups (positive, negative and control) for my experiment.

ii) My supervisor introduced this idea to Dr. Fabien Basset, who provided us with his expertise in exercise physiologically. Dr. Kavanagh, Dr. Basset and I designed the experimental methodology to ensure validity in collecting the psychological and physiological data. Dr. Kavanagh advertised the study to local running groups and introduced me to the participants. He further helped me in organizing a timeline to collect the data and complete the thesis. I ensured that the participants followed each step of the research protocol, designed and provided the mental training sessions, and was present for every running test. With the exception of calibration of the metabolic cart, I setup the remainder of the equipment for each running test. I learned how to create a physiological fitness report from Allied health Services and I produced a fitness report for each of the participants who completed the study. I performed all of the calculations and analyses from the raw psychological and physiological data.

iii) Dr. Kavanagh edited the thesis and confirmed the calculations. Dr. Duane Button helped with structuring the writing of the thesis and also confirmed the calculations.

iv) Liam Kelly and Dr. Basset calibrated the metabolic cart prior to testing of 60% of the participants. Zach Hynes calibrated the metabolic cart prior to testing of 40% of the participants' and he provided me with the details of his procedure in a section of the methodology.

CHAPTER 4: INVESTIGATING THE EFFECT OF SELF-TALK ON RATING OF PERCEIVED EXERTION AND HEART RATE AMONG MALE RUNNERS

NAVIN KAUSHAL, FABIEN BASSET, DUANE BUTTON, ZACH HYNES, LIAM KELLY and BASIL KAVANAGH

School of Human Kinetics and Recreation
Memorial University of Newfoundland
St. John's, Newfoundland, Canada

Corresponding Author: Basil Kavanagh Ph.D
School of Human Kinetics and Recreation
Memorial University of Newfoundland
St. John's, Newfoundland, Canada A1C 5S7
(709) 864-8676
basilk@mun.ca

Running Title: Concealing Exertion with Self-talk

4.1 Abstract

The purpose of this study was to determine if the mental training technique of self-talk would alter an athlete's heart rate and the perception of exertion during a one-hour steady-state running test. Twenty nine athletic male runners aged 18 to 55 (37.9, ± 11.7) participated in this study. The athletes were randomized into three groups: 1) positive self-talk, 2) negative self-talk, and 3) control. Participants underwent a maximal oxygen uptake determination test (VO_2 max test) and a steady-state running test which was 70% of their VO_2 max. In the latter test, participants' heart rate was measured and their Borg's Rating of Perceived Exertion (RPE value) was recorded after every five minutes. Participants in groups one and two attended a mental training session and created their own positive and negative self-talk statements. Participants in group 3 listened to a neutral documentary and completed a recall test after their run. There was no significant physiological difference between the three groups during the maximal oxygen uptake determination test ($p = .627$). The steady-state running test showed that there was no difference in their maximal heart rate ($p > .05$). However, there was a significant difference of RPE value between the three groups ($F_{(2, 26)} = 6.346$, $p = .006$). Tukey's HSD post hoc test revealed that the positive self-talk group (1.89, ± .928) had significantly ($p=.005$) lower RPE values than the negative group (4.60, ± 2.50). Amongst a physiologically homogeneous group, the results suggest that positive self-talk can increase the performance endurance of athletes by concealing their awareness of exertion.

Keywords: treadmill, mental training, RPE, VO_2 max, running

4.2 Introduction

Often a tennis player displays a positive or negative gesture (or form of chatter to themselves) after winning or losing, respectively. This internal chatter to oneself, or self-talk, has been associated with various meanings such as dialoguing with oneself (Hackfort & Schwenkmezger, 1993) or acting as an internal distracter (Weinberg & Gould, 2007). In 2006, Hardy gathered the most prominent literature definitions that defined self-talk. He suggested that self-talk can: "(a) be verbalizations or statements addressed to the self; (b) be multidimensional in nature; (c) have interpretive elements association with the content of statements employed; (d) be somewhat dynamic; and (e) serve at least two functions; (i) instructional and (ii) motivational, for the athlete" (p.84).

A common area of self-talk, the valence dimension, surmises that self-talk can be positive or negative (Hardy 2006). On one side, positive self-talk are statements which praise and assist the athlete in focusing on the present task at hand (Moran, 1996). Positive self-talk has been shown to enhance athletic performance in various sports such as: tennis, golf, sprinting (100 meter dash), darts, hockey, and swimming (Hatzigeorgiadis, Zourbanos, Goltsios, & Theodorakis, 2008; Johnston-O'Connor & Kirschenbaum, 1986; Mallett & Hanrahan, 1997; Masciana, Van Raalte, Brewer, Branton, & Coughlin, 2001; Rogerson & Hrycaiko, 2002; Rushall & Shewchuk, 1989).

On the opposite side of the valence dimension is negative self-talk. This includes internalized statements that criticize the athlete. Negative self-talk may debilitate the athlete's performance because it is irrational, produces anxiety, and is counterproductive (Moran, 1996; Theodorakis, Weinberg, Natsis, Douma, & Kazakas, 2000). The debilitating effects have been

examined in sports such as: golf, middle-distance (2.5 miles) cross-country running, darts, tennis, and hockey (Harvey, Van Raalte, & Brewer, 2002; Hatzigeorgiadis & Biddle, 2008; Van Raalte, et al., 1995; J. L. Van Raalte & Brewer, 1994; Wrisberg & Anshel, 1997). Depending on the dimension in which self-talk is used, it can have a profound effect in facilitating or debilitating performance subject to particular antecedents.

There are two important antecedents linked to the effectiveness of self-talk. First, practice is required for self-talk to be effective and second, athletes should create their own self-talk statements (Theodorakis, et al., 2000). Theodorakis, et al., (2000) suggested that athletes should become familiar and comfortable with their personalized self-statements before the effects are measured. In some studies, researchers have assigned specific positive and negative self-talk statements with the intention to control the content of the participant's self-talk statements (Dagrou, Gauvin, & Halliwell, 1992; Landin & Hebert, 1999; Perkos, Theodorakis, & Chroni, 2002; Theodorakis, et al., 2000; Van Raalte, et al., 1995). However, these studies may have overlooked that each participant may perceive the same self-talk statements differently. In fact, Rushall, Hall, Roux, Sasseville, & Rushall (1988) posited that during practice and competition, athletes are more likely to generate their own self-talk statements. In their study, which was performed on elite cross-country skiers, they let the skiers create their own positive self-talk statements. As a result, the skiers' improved their best performance times by 3%. The improved performance was attributed to a higher heart rate, compared to a matched control skier group. However, there is still a lack of research investigating the correlation between heart rate and self-talk.

Athletes use self-talk statements for motivational and instructional purposes (Hardy, Hall, & Alexander, 2001). Instructional self-talk is used for improving performance in sports which require accuracy, fine motor movement, skill and timing (Hatzigeorgiadis, Theodorakis, & Zourbanos, 2004; Rushall, et al., 1988; Theodorakis, Chroni, Laparidis, Bebetsos, & Douma, 2001; Theodorakis, et al., 2000), whereas motivational self-talk has improved performances for sports which require gross motor skills (Chroni & Kourtesopoulou, 2002; Hatzigeorgiadis, et al., 2004; Theodorakis, et al., 2000).

Although the use of self-talk can be facilitative, the physiological or psychological mechanism(s) of how self-talk enhances athlete's performance is unclear. For instance, Theodorakis, et al., (2000) found that motivational self-talk enhanced strength performance but the effect of the self-talk remains uncertain. For instance, did self-talk change the athlete's arousal (physiological) or confidence (psychological) levels, or a combination of both? They suggested that future research should investigate the link between self-talk and enhanced performance. Rushall, et al., (1988) found that performance and heart rate significantly increased when the athletes used positive self-talk, compared to the control (i.e. no positive self-talk) amongst cross-country skiers. Unfortunately, no psychometric tools were used to measure the athletes' perception of effort or exertion to validate these findings. One psychometric tool that may have been useful in validating these findings would be the Borg's Rating of Perceived Exertion (RPE) scale.

Borg's Rating of Perceived Exertion (RPE) is a widely used instrument that is used to measure perceived exertion during exercise (Bolgar, Baker, Goss, Nagle, & Robertson, 2010; Borg, 1973, 1982, 1998; Chen, Fan, & Moe, 2002; Pandolf, 1978). Noble & Robertson (1996)

found that the RPE scale correlates well with a variety of physiological measures such as: heart rate, ventilatory drive and creatine. In a meta analysis by Chen, et al., (2002), the researchers stated that the most common criterion physiological measures used in research on ratings of perceived exertion are: heart rate, blood lactate concentration and various measures of oxygen uptake (%$\dot{V}$O2max, $\dot{V}$O2, ventilation, respiration rate). Perceived exertion scores have also been found to be influenced by changes occurring in the central nervous system during prolonged endurance exercise (Swart, et al., 2009). Perception of exertion can also be influenced by psychological variables such as the presence of a competitor (Wilmore, 1968), exercise self-efficacy (Rudolph & McAuley, 1996) and monetary reward (Cabanac, 1986). A thorough literature review found no published studies that had investigated the effect of RPE when the participants use any kind of self-talk (positive or negative) while performing an exercise task.

The purpose of this study was to determine whether self-talk would affect the participants' heart rate and the perception of exertion during a steady-state one-hour running test (70% of the athlete's $\dot{V}O_2$ max). Specifically, the objectives of the study were (a) to investigate whether negative or positive self-talk would modify the athlete's perception of exertion and (b) to determine if the type of self-talk (positive or negative) would affect the athlete's physiological response to exercise stress. It was hypothesized that the participants in the positive self-talk group would have a lower level perception of exertion and heart rate values compared to the negative and control groups.

4.3 Methods

Subjects

Twenty-nine (N = 29) male participants who were affiliated with a local running group completed this study. Experienced male runners were also recruited through Newfoundland and Labrador Running News, which is an electronic email that provides running & cross training news and resources for Newfoundland and Labrador. A message was also posted on the website of each running group asking for volunteers to participate in the study. The participants ages ranged from 18 to 55 (37.9, ± 11.71). Training frequencies per week ranged from 3 to 7 (4.8, ± 1.11). The participants training status are displayed in Table 1. Participants were verbally informed of the procedures, and if willing to participate, read and signed a consent form prior to participation. The study was approved by the Memorial University of Newfoundland Human Investigation Committee.

Independent Variables

There were two sets of independent variables; group and self-talk scores. Participants were randomly assigned to three groups: 1) the *Positive Self-talk group* who recited their own positive self-talk statements during their run, 2) the *Negative Self-talk group* who recited their own negative self-talk statements during their run, and 3) the *Control/Neutral group* who did not engage in any self-talk during their run. The independent variable of self-talk scores was obtained from administering the Self-Talk Questionnaire (S-TQ) (Zervas, Stavrou, & Psychountaki, 2007) to each participant. The questionnaire consists of eleven items which

measure motivational (n=7) and instructional (n=4) functions of self-talk on a 5-point Likert-type format. *Motivational self-talk* is a type of self-talk which facilitates performance by using cue words which help increase confidence, effort, and energy expenditure (Theodorakis, et al., 2000). *Instructional self-talk* is a type of self-talk which facilitates performance by using cue words which guide the athlete in performing a technique or correcting attentional focus (Theodorakis et al., 2000). The Cronbach alphas (internal consistency) for motivational and instructional/cognitive self-talk were strong; they were 0.91 and 0.84 respectively. The Cronbach's alpha for the total S-TQ was 0.92 (Zervas, et al., 2007).

Dependent Variables

There were two dependent variables; perceived exertion score and heart rate. The dependent variables were collected while the participants performed a steady-state 70% $\dot{V}O_2$ max test for one hour. *Perceived exertion score* was measured using Borg's Rating of Perceived Exertion Scale. The points on the scale range from 6-20 (no exertion-maximal exertion) (Noble & Robertson, 1996). Borg's Rating of Perceived Exertion (RPE) is a widely-used instrument which measures perceived exertion during exercise (Bolgar, Baker, Goss, Nagle, & Robertson, 2010; Borg, 1973, 1982; Chen, Fan, & Moe, 2002; Pandolf, 1978). Borg's RPE scale has been validated against heart rate and has yielded a correlation of 0.85 (Chen, et al., 2002). *Heart rate* was measured by a Polaris S810i heart rate monitor attached to the participant to measure heart beats per minute throughout the 70% $\dot{V}O_2$ max test run.

Experiment Design

The participants completed the experimental protocol in seven sessions over a maximum of fourteen days.

During session one, all participants were introduced to the laboratory and completed the consent form, Par-Q, and Self-Talk Questionnaire (See Appendix 1). The participants were then randomly assigned to the positive, negative, or control group.

During session two, the participants completed an incremental running test on the treadmill (Trackmaster, modified model TMX55, JAS Fitness Systems, Newton, KS) to determine their maximal oxygen uptake, maximum aerobic speed (MAS), and maximal heart rate. Care was taken to accurately determine the MAS. In the post-running test analysis, the velocity at the final stage was calculated as follows: First, the 2-min stages were divided into four quarters corresponding to 0.25, 0.50, 0.75, and 1 km · hour^{-1}. Secondly, the $\dot{V}O_2$ peak was determined as the highest thirty-second average during the running test and thirdly, the time corresponding to this value was matched with the corresponding quarter of the 2-min stage. For instance, a runner who reached $\dot{V}O_2$ peak at 100-sec into the 17 km · hour^{-1}, a 0.75 km · hour^{-1} was added to the actual velocity, that is, his MAS was 17.75 km · hour^{-1} (Leger & Boucher, 1980). From this test, the 70% MAS was calculated.

During session three, the participants randomly assigned to the positive and negative self-talk groups received a mental training session on self-talk delivered by the investigator. At the end of the forty-minute session, the participants completed *The Self-Talk Creation Form*

(STCF), a form that was created by the primary researcher (See Appendix 2). The participants were asked to create their own self-talk statements in the STCF which fit into three categories: slightly encouraging self-talk (level 1), moderately encouraging self-talk (level 2) and highly encouraging self-talk (level 3). To create the "slightly encouraging self-talk", participants were asked to write statements that would give them a slight boost at the start of a race. To create the moderately encouraging self-talk boost" the participants were asked to write statements they would use halfway through a race, when they were feeling moderately exhausted. To create "highly encouraging self-talk" the participants were asked to write down statements they would use near the end of the race to summon all of their remaining energy. The participants then repeated this process by creating negative self-talk statements in three parallel categories: i) slightly negative self-talk, ii) moderately negative self-talk and iii) highly discouraging self-talk statements.

During sessions four and five participants were asked to run on their own outdoors for one hour at 70% MAS monitored by a GPS-enabled sports watch (Model Forerunner 205/305, Garmin Ltd, Kansas City, TX) and practice using their positive self-talk statements. The purpose of this run was to ensure that participants in the positive self-talk group became familiar with their statements.

Session six was a rest day and during the seventh session, the participants attended the laboratory to complete a Steady-State 70% $\dot{V}O_2$ max run.

Prior to each treadmill running test ($\dot{V}O_2$ max and 70% $\dot{V}O_2$ MAS), the participants were asked if they were taking any prescribed medication, were not feeling well, or if they were

injured. If they answered yes to any of these questions, their running test was rescheduled. The participants were instructed to follow the CSEP (Canadian Society of Exercise Physiology) guidelines prior to both running tests. The participants' blood pressure was also checked. If their blood pressure was above 140/90, then the participants were dismissed from the study. After each running test, the participants were allowed to cool down at a comfortable pace until the heart rate displayed heart rate indicated a reading of 100 beats per minute or lower if they desired.

Testing Protocol

Leger- Boucher VO_2 max Test Protocol

The participants were given a ten-minute warm-up on the treadmill at their own jogging pace with a 1% grade. After the warm up, there was a five minute rest break before the test began. It started at seven km · hour^{-1} and increased by 1 km · hour^{-1} after every two minutes until the participant felt exhausted and could no longer maintain the pace (Leger & Boucher, 1980). After the test, the participant was given a five minute recovery period prior to running at 105% MAS for as long as they could. The purpose of this square-wave supra-maximal running test is to confirm if the participant had reached his $\dot{V}O_2$ max during the incremental running test (Rossiter, Kowalchuk, & Whipp, 2006). If participants did reach a higher $\dot{V}O_2$ value during the verification phase, the incremental running test was considered invalid.

Steady-State 70% VO_2 max run

Participants ran for an hour at 70% MAS. After every 5-minutes during the square-wave running test, the participants were visually shown the Borg scale to rate the level of perceived exertion (See Appendix 3). After twenty minutes of running, the participants in the positive and negative-self talk groups were cued to their personal self-created "level one" self-talk statements. After 20 minutes had elapsed, the participant's self-talk statements were cued every minute to remind them to recite their self-talk statements. At the thirty-five-minute mark, the "level two" self-talk statements were cued to the participant in a similar fashion and at the fifty-minute mark. The "level three" self-talk statements were similarly cued in. RPE and heart rate were examined at three points to observe the participants' values during the start (5 minutes), middle (35 minutes) and end (59) parts of the test. The control group listened to a documentary: "Steven Hawking: Master of the Universe" (Johnstone, 2008), from a Sony MP3 player (model NWZ-E436F) while they performed their run. The participants were allowed to place the MP3 player in a position they felt most comfortable, either attached to the treadmill or on an arm strap attached to their arm. The intent of the documentary was to serve as a distracter. Listening to music has been shown to influence performance (Mok & Wong, 2003; Potteiger, Schroeder, & Goff, 2000; Szmedra & Bacharach, 1998). Hence, an irrelevant, monotone, documentary was used on the premise that it would not motivate or discourage the participant. Participants were instructed to remember as much of the documentary as they could. This was an attempt to prevent them from using any mental training techniques and to minimize the likelihood that participants were thinking performance-related thoughts.

Metabolic Cart Calibration

During the laboratory test, oxygen uptake ($\dot{V}O_2$), expiratory volume ($\dot{V}E$), breathing frequency (*fr*) and tidal volume (V_T) were continuously collected with an automated open circuit gas analysis system using O_2 and CO_2 analyzers (Model S-3A and Anarad AR-400, Ametek, Pittsburgh, PA), and a pneumo-tachometer (Model S-430, Vacumetrics/Vacumed Ltd., Ventura, CA) with a 4.2L mixing chamber. Prior to testing, volume and gas analyzers were calibrated with a 3 L calibration syringe and medically certified O_2 and CO_2 calibration gases that were 16%O_2 and 4% CO_2, respectfully. All calibrations were performed in the same location and in a thermal neutral environment. Heart rate was recorded by a Polar heart rate monitor (model S810i, PolarElectro, Kempele, Findland). The data was online digitalized from an A/D card to a computer for monitoring the metabolic rate. The metabolic parameters were displayed over thirty-second intervals and later averaged per minute. The highest average value was considered the $\dot{V}O_2$ peak.

Statistical Analysis

All statistical analyses were performed using SPSS Statistics 16 for Windows. A one-way ANOVA (group: positive self-talk, negative self-talk, control X $\dot{V}O_2$ max values) was performed to determine if the performance level between the groups significantly differed. Runners' performance levels were defined by five categories, which included times for 5K, 10K, 10 mile, half marathon, marathon.

A (3X5) MANOVA (group: positive self-talk, negative self-talk, control X Delta HR, Delta RPE, RPE at 5-min, 35-min, 59-min) was performed to determine the effect of self-talk on

heart rate and RPE during the square-wave running test. Delta RPE was the difference of the participants RPE value at 59 mins and 5 mins. Delta HR was also calculated in this manner.

A (3X3) two-way ANOVA (group: positive self-talk, negative self-talk, control X motivational self-talk score: high, medium and low) was used to investigate if the participant's motivational self-talk score and their group category influenced their Delta RPE during the 70% MAS. The participant's motivational self-talk scores were ranked from highest to lowest and divided into sections of high (top 10), medium (middle 10), and low (bottom 9).

For the MANOVA and two-way ANOVA, if a significant main effect occurred, a Tukey's HSD post-hoc test was performed to find where significant differences existed. For all ANOVAs, a value of $p < 0.05$ was considered statistically significant.

4.4 Results

Homogeneity of groups

The ANOVA indicated that all three groups did not significantly ($F_{(2, 26)} = 0.475$, $p = .627$) differ in their VO_2 max scores. With regards to the participant's training status, the MANOVA revealed that the groups did not significantly differ in any of the five training time categories. The means and standard deviations of seven background questions also did not differ between the groups (Table 1). Based on the training status similarities between groups, the investigator concluded that the participants in all three groups were physiologically homogenous.

70% VO_2 max steady-state run: Heart Rate, RPE Delta and RPE Intervals

The MANOVA revealed that heart rate did not significantly differ between the three groups during the 70% MAS, ($p > 0.05$). See Figure 1.1 for heart rate data. Interestingly, if the runners were to continue running, the predicted trend lines indicate that the negative self-talk group would have reached their maximal heart rate before the positive self-talk group (See Figure 1.2). The mean maximal heart rates from the athlete's $\dot{V}O_2$ max test for the positive, negative and control group were (182, ± 8.09), (178, ± 14.13), and (180, ± 8.28) beats/minutes respectively. Hence, if the three groups were instructed to run for an indefinite amount of time, it appears that the amount of time it takes for the positive self-talk group to reach their maximal heart rate will be significantly longer than the negative and control self-talk groups.

When the three groups were compared across three RPE intervals (5 mins, 35 mins, 59 mins), the MANOVA revealed that the groups did not significantly differ. However, there was a significant ($F_{(2, 26)} = 6.346$, $p = .006$) main effect of group on Delta RPE. To determine group differences of RPE Delta scores, Tukey's HSD post hoc test revealed that the positive self-talk group RPE Delta scores (1.89 ± .928) were significantly ($p = .005$) lower than the negative group (4.60, ± 2.50). There was a trend ($p = 0.063$) for the RPE Delta score to be lower in the control/neutral group compared to the negative self-talk group and there was no significant ($p = 0.482$) difference between neutral and positive groups RPE Delta values (Figure 2.1). Table 2 displays the RPE values between the three groups. Similar to the pattern of heart rate, if the runners were to continue running for an indefinite period, the predicted trend lines indicate that

the negative self-talk group will perceive themselves to be maximally exerted much sooner than the positive self-talk group (Figure 2.2).

Motivational Self-Talk Scores

There was no significant relationship between the Delta RPE values and the participants scores on motivational self-talk.

4.5 Discussion

The present study was exploratory in nature as a review of literature did not reveal any studies which investigated the effects of self-talk on RPE. The results showed that Delta RPE values of the positive self-talk group were significantly lower than the Delta RPE values of the negative self-talk group but the heart rate values did not significantly differ across the groups. This indicates that although physiologically, the self-talk groups did not significantly differ (heart rate values), the negative self-talk group perceived themselves to be more physiologically exerted. Hence, the participants' rate of perceptions differed.

With regards to heart rate, the results did not show that positive self-talk helped lower the athlete's heart rate and that interestingly, the heart rates were numerically higher but not significantly higher than the negative group. These findings are similar to the results of a previous study. Rushall, et al., (1988), who examined the effects of self-talk on heart rate during performance found that skiers who used positive self-talk had significantly higher heart rates than the control group. Though the heart rate patterns are similar in the two studies, the contexts are different and thus the implications of the results are also different. First, the positive self-talk

improved the skiers' performance which consequently resulted in an increase of heart rate. In the present study, since the treadmill speed was fixed, the athletes did not have the opportunity to use the motivational boost to increase their speed when they heard the self-talk statements. Second, if the participants in the present study run for their maximum duration, the heart rate displays different patterns (trend lines discussed in the next paragraph). The effects of the laboratory setting and autonomy of the participants are further discussed. However, it is first important to address the predicted trends of RPE and heart rate values.

When examining Figure 2.2, the trend lines predict that approximately after 135 minutes of running, the negative group would reach maximal exertion and the neutral group would approach their maximal exertion before the positive group. With regards to each group reaching their maximal heart rate (Figure 1.2), the trend lines predict that the positive group would reach their maximal heart rate at 135 minutes followed by the negative and neutral groups. Although the trend lines predict that the positive self-talk group would be the first to reach their maximal heart rate, this is based upon the assumption that all of the runners will be maintaining the same pace throughout the entire race. Though the negative group will reach their maximal heart rate after the positive group, they will perceive themselves to be maximally exerted first. It is likely that this perception will influence them to believe that they have reached their maximal heart rate before the positive self-talk group and thus quit sooner. It would be interesting to investigate how RPE scores would affect the pace of a runner during a real race.

As mentioned previously, the setting of the laboratory is important to address as it may have influenced the results. Overall, the laboratory setting could be referred to as a "catch 22". Since the runners were accustomed to training outdoors at their own speed, running at a constant

speed on the treadmill while attached to the breathing apparatus produced an unnatural running condition. Conversely, this setting provided a couple of strengths to the study. First, the laboratory environment provided a controlled environment for all of the runners ensuring that they consistently ran at the same elevation and speed with no wind resistance. Second, Chen, et al., (2002) suggested that the highest correlations between RPE and heart rate occur when the task is "unusual" to the participants. Running at a constant speed in the laboratory setting (as performed in the present study) could be deemed "unusual" to the participants as they customarily train in a field setting. Given Chen's posit, and the unusual task, it could have been surmised that no significant difference would have occurred. However, the effects of positive and negative self-talk were strong enough to significantly weaken the correlation (heart rate and RPE) and cause significant difference in Delta RPE scores between the groups. This finding suggests that self-talk can be a mediating variable which can influence the results between the exercise task and RPE scores.

The unnatural laboratory setting could also explain the insignificant difference of heart rate between the three groups. Running outdoors provides a novelty of stimulus such as change in wind, running speed, running path, and most importantly the change in the surrounding environment. Out of these variables, the ability to alter speed and direction provides a sense of autonomy. Hence, the setting may have psychologically restricted the participants and produced a masking effect. Since it would be difficult to maintain the validity of the study when testing outdoors, future research can provide novelty to the runners in the laboratory to simulate their natural training environment. For instance, the treadmill can alter in speed and incline, a rotating fan can be used in intervals, and a large screen can be placed front of the participants, which

would display a video of someone running outdoors from a first person perspective. The level of incline and speed can be calculated to ensure that all participants will produce the same proportion of work during the test.

Since motivational self-talk has been correlated with improvements in sports which require gross motor movement (Chroni & Kourtesopoulou, 2002; Hatzigeorgiadis, et al., 2004; Theodorakis, et al., 2000), it was determined the participants with higher scores on motivational self-talk would find the 70% MAS test easier to perform. Contrary to previous research, the present study found that the participants' scores on motivational self-talk did not correlate with their RPE values. This is likely because the participant's scores on the S-TQ reflect their self-talk scores prior to the participation of the study. In the study, the participants created self-talk statements, practiced two runs, and performed the 70% MAS using only motivational self-talk. Hence, their previous self-talk views were likely influenced as the study progressed. Their motivational self-talk score may not represent their self-talk perspective by the time they were performing the 70% MAS. A post administration of the S-TQ, after the 70% MAS would likely reveal scores that reflected their self-talk during the 70% MAS.

The present study attempted to build upon past research and incorporate improvements to methodology. Firstly, from comparing studies between assigned and self-created self-talk statements, the literature suggested reasons to use the latter method rather than the former. In this regard, participants created their own self-talk statements. Secondly, the control stimulus of the documentary served as a distracter as opposed to advising the participants to not think of anything while running. The participants were told that they would perform a memory recall test after the run hopefully ensuring that the participants listened to the documentary. Though the

documentary use was exploratory in nature, this method may have contributed to athletes refraining from using any mental training techniques. This may be an improvement to the methodology rather than just instructing the participants to perform "normally" as in Rushall et al., (1988).

Although the present study found that self-talk weakened the correlation between heart rate and RPE scores, future research should investigate if there were any changes in other physiological variables, such as cortisol concentration. It would also be interesting to examine the effects on female runners; however, Chen et al., (2002) found that the mean validity coefficient between rating of perceived exertion and $\dot{V}O_2$ in males is much higher than that in females. This experiment could also be repeated with inexperienced runners. Since inexperienced runners are less likely to be familiar with mental training techniques, it would be interesting to investigate if positive self-talk statements would have a greater effect on their RPE scores compared to the experienced runners in the present study. The effects of self-talk on RPE can also be investigated in other endurance sports such as rowing and cycling.

Although these findings are only generalizable to male runners, since the use of positive-self talk lowered the athlete's perception of exertion, it may be concluded that male runners will be able to run at higher intensities or endure longer running durations. This finding supports and extends the evidence which suggest that positive self-talk enhances performance. Positive self-talk could result in improved times and performances for male runners and could have a profound effect in developing or adapting current training methods. Astute coaches and educators may opt to formally schedule and deliver positive self-talk training as the scientific evidence provides a strong incentive and rationale.

4.6 References

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4.7 Tables and Figures

TABLE 1

Training Status Variables of the Three Groups

Participant Training Status

	Positive	Negative	Neutral
5K	18.1 ± 1.75	18.6 ± 1.41	20.03 ± 7.04
10K	33.1 ± 13.57	40.7 ± 7.20	39.5 ± 9.50
10 mile	79.1 ± 22.50	68.6 ± 7.40	66.2 ± 12.14
Half marathon	94.4 ± 20.82	106.7 ± 23.48	91.7 ± 51.78
Marathon	190.9 ± 44.09	201.8 ± 39.16	152.7 ± 85.39
Number of years training	6.8 ± 4.97	7.9 ± 9.86	11.97 ± 11.62
# training times/week	4.8 ± 1.41	4.7 ± 1.11	4.87 ± 0.98
# Interval training sessions of 70% V02 max	2.7 ± 1.12	3.1 ± 1.45	2.30 ± 1.12
Longest single distance run within one week?	35.1 ± 8.51	34.3 ± 15.31	34.1 ± 14.05
Longest total distance ran in one week?	90.7 ± 35.75	78.7 ± 35.44	89.3 ± 20.25
How many hours per week do your run?	5.7 ± 2.50	4.7 ± 1.72	4.97 ± 2.03
Do you consider yourself competative?	0.8 ± .44	0.9 ± 0.32	0.83 ± 0.39
Weight Train and how many sessions?	0.7 ± 0.87	1.35 ± 1.49	1.66 ± 1.61

Table 1 displays the mean and standard deviations of the Participant's Training Status values across the three groups. Pos.= Positive Self-talk group, Neg. = Negative Self-talk group, Neu. = Neutral/control group.

TABLE 2

RPE Values of the Three Groups

Group	5 minutes	35 minutes	59 minutes	Delta
Positive	11.89 ± 0.78	13.22 ± 1.24	13.56 ± 1.24	1.67 ± 1.32
Negative	10.7 ± 1.83	13.6 ± 2.58	15.3 ± 2.58	4.6 ± 2.50
Neutral	10.7 ± 1.7	12.7 ± 2.12	13.5 ± 2.12	2.8 ± 1.14

Table 2 displays the mean and standard deviations of the participants RPE scores across three intervals of the 70% MAS (5 mins, 35 mins, 59 mins) and the Delta RPE.

FIGURE 1.1

Heart Rate Values of the three Groups

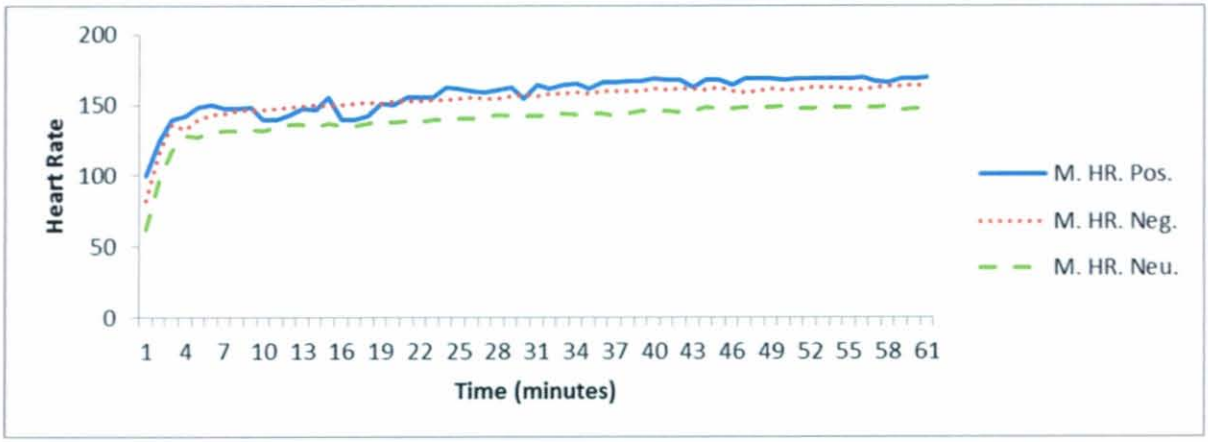

Figure 2.1. Heart rate values of the three groups across three RPE intervals during the 70% MAS test.

FIGURE 1.2

Predicted Heart Rate Values of the three Groups

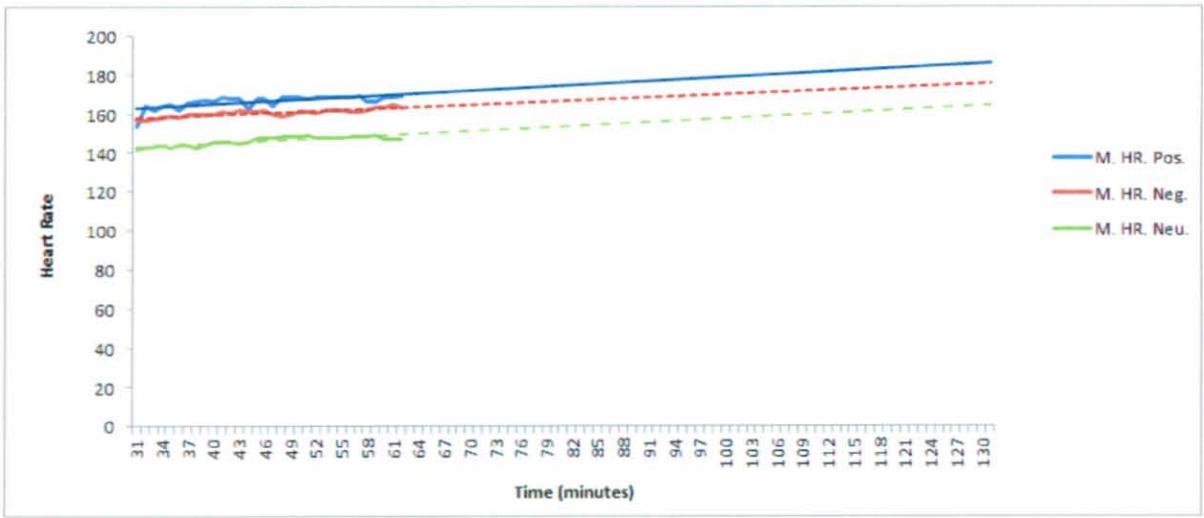

Figure 1.2. Based on the HR values recorded during the 70% MAS test, predicted trend lines were extrapolated to determine the time it would take for the runners to reach their maximum HR.

FIGURE 2.1

RPE Values of the three Groups

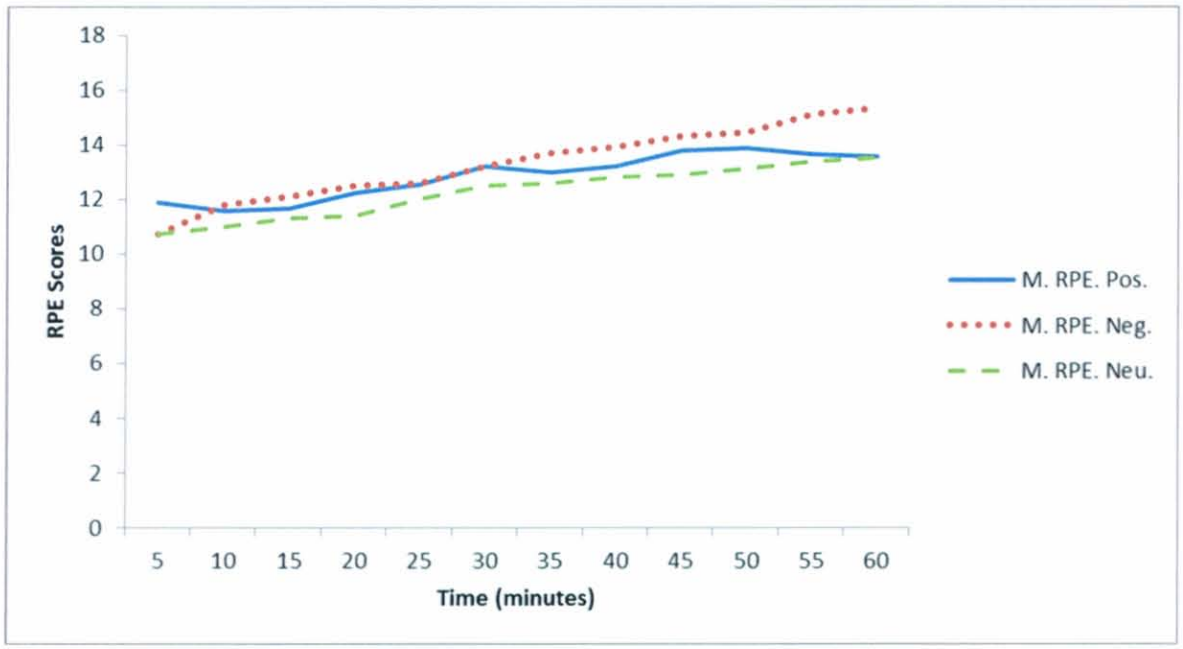

Figure 2.1. RPE scores of the three groups across three RPE intervals during the 70% MAS test.

FIGURE 2.2
Predicted RPE Values of the three Groups

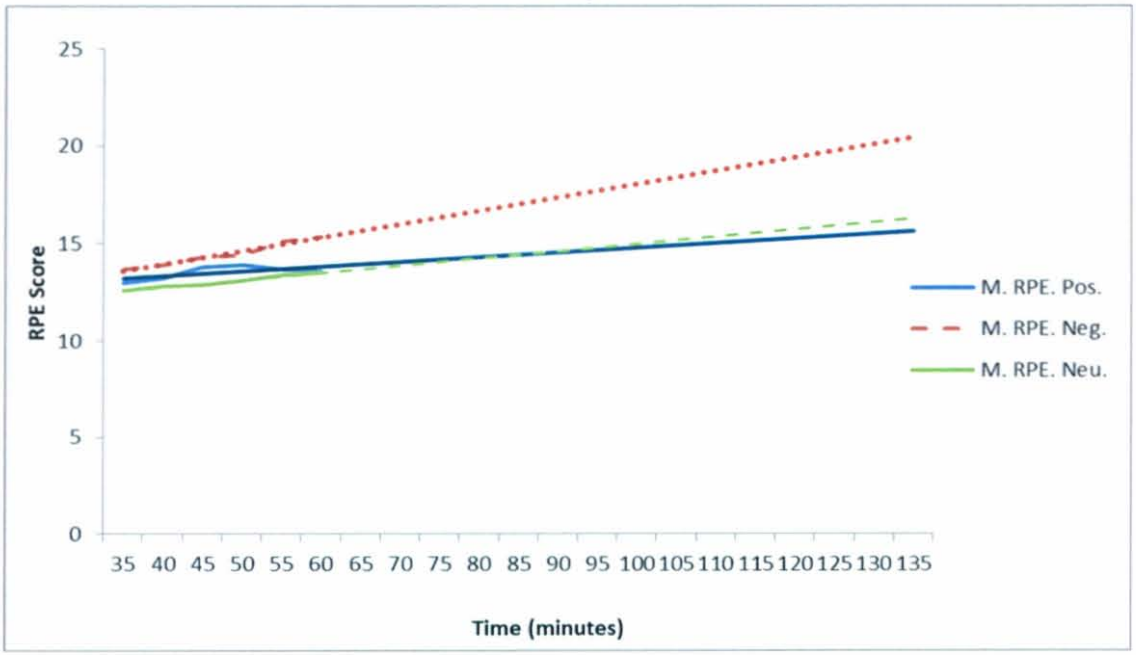

Figure 2.2. Based on the RPE values reported during the 70% MAS test, predicted trend lines were extrapolated to determine the time it would take for the runners to reach their maximum perceived ratings of exertion.

4.8 Appendix

APPENDIX 1

SELF-TALK QUESTIONNAIRE (S-TQ)

DIRECTIONS: Below are some statements that describe athletes' self- talk during an important competition. Please read each one carefully and indicate **how often** you have used self-talk. Your answers will be treated as absolutely confidential.

	When I compete:	Never	Rarely	Some times	Often	Always
1.	I talk to myself in order to be able to concentrate more fully on the competition.....	1	2	3	4	5
2.	I talk to myself about the technical elements of the competition.	1	2	3	4	5
3.	I talk to myself to give directions	1	2	3	4	5
4.	I talk to myself to enhance my self-confidence.....	1	2	3	4	5
5	I talk to myself to motivate myself.....	1	2	3	4	5
6.	I talk to myself to increase my effort.....	1	2	3	4	5
7.	I talk to myself to encourage myself.....	1	2	3	4	5
8.	I talk to myself to strengthen a positive thought.....	1	2	3	4	5
9.	I talk to myself to stop negative thinking.....	1	2	3	4	5
10.	I talk to myself in order to help myself to relax.....	1	2	3	4	5
11.	I talk to myself to correct my mistakes.....	1	2	3	4	5

Appendix 2

Self-Talk Creation Form

Positive Self-Talk Statements:

List one or two self-talk statement in each slot based on the instructions provided.

Statement One: Positive self-statement(s) that would give you a little boost during running.

1 _____

2 _____

Statement Two: Positive self- statement(s) that will give you a bigger boost or help maintain your performance under moderate stress while running.

1 _____

2 _____

Statement Three: Very positive and strong self-talk statement(s) that will help maintain or push you to your peak performance when fatigued while running.

1 _____

2 _____

Negative Self-Talk Statements:

Statement One: Negative statement(s) that would make you want to slow down a little.

1 _____

2 _____

Statement Two: Negative statement(s) which would cause you to decrease your speed and make you become aware of how tired you are.

1 _____

2 _____

Statement Three: Negative and self-defeating statement(s) which would demoralize you and make you want to quit.

1 _____

2 _____

Appendix 3

Borg's Rating of Perceived Exertion (RPE) Scale

Borg's RPE Scale	
6	No exertion at all
7	Extremely light
8	
9	Very light
10	
11	Light
12	
13	Somewhat hard
14	
15	Hard (Heavy)
16	
17	Very hard
18	
19	Extremely hard
20	Maximal exertion

CHAPTER 5: BIBLIOGRAPHY AND REFERENCES

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