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SELF-GENERATED EMOTIONS AND THEIR INFLUENCE ON PHYSICAL PERFORMANCE

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Affidavit following the section 2, paragraph 7, No. 4 and 5 of the doctorate rules from the German Sports University Cologne, from February 2th, 2013.

Hereby I declare: The work presented in this thesis is the original work of the author except where acknowledged in the text. This material has not been submitted or in part for a degree at this or any other institution. Those parts or single sentences, which have been taken verbatim from other sources, are identified as citations. I further declare that I complied with the actual "guidelines of qualified scientific work" of the German Sport University Cologne.

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Abstract

The main aim in the current research program was to investigate the impact of discrete self-generated emotions on physical performance. Chapter 2 presents different models related to the understanding of the emotion-performance relationship and provides a review on the current state of research in this area. In Chapter 3, the research approach employed and main research questions addressed in this thesis are presented. Chapter 4 focuses on the physical performance of strength and presents the influence of different self-generated emotions on: the strength of the finger musculature, the jumping height within a counter-movement jump and throwing strength. Results demonstrate that participants produce better physical performances when recalling happiness or anger emotions in contrast to anxiety, sadness emotions or an emotion-neutral state. In Chapter 5, two experiments highlight the influence of self-generated emotions on the physical performance of speed. Results indicate that this performance is greater when recalling happiness compared with anxiety and an emotion-neutral state. Chapter 6 investigates the efficiency of a new intervention program (the wingwave method; Besser-Siegmund & Siegmund, 2010) for reducing anxiety and enhancing physical performance and compares an experimental group (EG) with a control group (CG) at two times of measurement (T1 and T2). This study revealed that the wingwave method decreases the intensity of anxiety and the state and trait anxiety from T1 to T2. Additionally, the study demonstrates that the physical performance under the induction of participants' anxiety increases after the intervention with the wingwave method. Finally, Chapter 7 specifies how the research program has broadened and extended the emotion-performance relationship literature, having both theoretical and practical implications, and offering some promising avenues for future investigations.

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Chapter 1

Introduction

It is August 19, 2008. On this day the Olympic Games in Beijing and a lot of people around the world in front of their televisions experience one of the most emotional moments in the history of competitive sports. The 26 year-old Matthias Steiner celebrates his so far biggest success of his sporting career and becomes Olympic superheavyweight weightlifting champion. With an overall weight of 461 kilograms (203 kg snatch and 258 kg clean and jerk) he wins the Olympic gold medal and becomes the first German Olympic champion of superheavyweight in 16 years. Immediately after his victory, Matthias Steiner shows a photo of his wife Susann to the cameras, who died in a car accident in the summer of the last year, and credits his success to her. The question is now: How can a man who lost his beloved wife manage to deal with such an emotional tragedy and simultaneously become the "strongest man of the world" one year later? Matthias Steiner himself delivers insight into his inner life before the Olympic Games and describes a possible source of his strength with the following quotation:

> My wife is always with me. She will always be in my heart. She is in my head and motivates me, she is my push. There is an enormous anger inside me and I try to apply power from this anger (Steiner, 2008, "Fortune and tragedy of the strongest man in the world").

Especially the last sentence of this quote describes a possible connection between an emotional state (here: anger) and the ability to generate strength with it. Parallel to this quotation by Steiner, there can be phrases found in everyday language that postulate a connection between emotions and physical states. Think for example of "to leap up into the air," "to be scared stiff," or "to sink into the earth out of shame." These are all examples for introducing the key issue with which this thesis deals: the influence of emotions on physical performance.

Aims of the Thesis

Although researchers have acknowledged the importance of emotions in sport (e.g. Hanin, 1997; Lazarus, 2000a, 2000b), research on this topic is underdeveloped and "the existing knowledge base could not offer an adequate solution to understand emotion in performance (McCarthy, 2011, p. 50)." For this reason, researchers have transferred theoretical models from other fields of psychology (Jones, 1995; Uphill & Jones, 2004; Woodman et al., 2009) or developed and investigated models exclusively for sports (Hanin, 1997; Jones, Meijen, Mc Carthy & Sheffield, 2009) to understand the influence of emotions in them. The objective of this work is to analyze the influence of emotions which are induced by the recall of autobiographical memories (so-called self-generated emotions; Damasio et al., 2000) on physical performance. The main focus of this thesis is centered on the question of which emotions can possibly be performance-enhancing or performance-reducing in different physical skills. Furthermore, the efficiency of a new method, the so-called wingwave method (Besser-Siegmund & Siegmund, 2010), in the treatment of emotional anxiety and the potential consequences of performance enhancement effects in a physical skill will be investigated. Before describing the conducted studies, the relevant theoretical constructs drawn upon in this thesis are introduced.

Chapter 2

Theoretical Background

Definition of Emotion

As early as 1884, the famous American philosoph and psychologist William James asked the question, "What is an emotion?" in the corresponding title of his paper (James, 1884). Even today, however, scientists are still working on a consistent answer to this question (McCarthy, 2011). Consensus exists between different research groups (Young, 1973; Deci, 1980; Mandler, 1984; Lazarus, 1991a; Ekman, 1992; Frijda & Mesquita, 1994), certainly in response to emotions being made up of different components. One central component is the changes in the physiology of a human being who experiences an emotion. These physiological changes can, for example, be reflected in the: heart rate, blood pressure, neurotransmitter level, skin conductance or the face (Vallerand & Blanchard, 2000). If for example a basketball player scores a game-winning basket shortly before the end of a game during a world championship, the assumed emotion of happiness will change his physiology. Another central component of an emotion composes the so-called action tendencies (Arnold & Gasson, 1954; Frijda, 1986; Lazarus, 1991a; Lazarus, 1991b) which come along with discrete emotions. For example, the emotion anxiety could arouse the action tendency of escape (e.g. anxiety of an assumed superior opponent in a boxing competition) or the emotion sadness could come along with the action tendency of motionlessness (Vallerand & Blanchard, 2000). Furthermore, there is always a subjective experience of an emotion. That means, for example, that researchers could ask athletes to specify which emotions they experienced during the assist in an essential soccer match and how intensive those particular emotions have been (Vallerand & Blanchard, 2000). The observable emotional behavior, that is the result of an emotion, presents another central component of an emotion (e.g. a joyfully smile after a successful action in a sportive competition; McCarthy, 2011). Deci

(1980, p. 85) tried to integrate the characterized central components in his definition of an emotion:

> An emotion is a reaction to a stimulus event (either actual or imagined). It involves change in the viscera and musculature of the person, is experienced subjectively in characteristic ways, is expressed through such means as facial changes and action tendencies, and may mediate and energize subsequent behaviors.

This working definition shall be used as the basis for this thesis.

Models to Understand the Emotion-Performance Relationship

In the following section, the fundamental ideas of theories which postulate a connection of emotions and physical performance shall be presented. Following, Lazarus's (1991b, 2000b) cognitive-motivational-relational theory (CMR Theory), Hanin's (1997) individual zones of optimal functioning model (IZOF model), Frederickson's (2001) broaden-and-build theory and the theory of challenge and threat states in athletes (TCTSA), proposed by Jones et al. (2009), will be presented.

Cognitive-Motivational-Relational (CMR) Theory of Emotion. The CMR theory of Lazarus (1991b, 2000b) postulates that for each emotion, a so-called *core theme* can be identified which describes the interaction between the individual and his environment. This core theme is, according to Lazarus (2000b), a synthesis of up to six separately appraised judgments. These appraised judgments are classified in either primary or secondary appraisals.

Within the primary appraisal process, an assessment of how far a situation or an event has personal relevance for the individual will be carried out, consisting of the three components "goal relevance," "goal congruence," and "type of ego-involvement." If a

stimulus is not relevant for a person, an emotion will not occur. If a situation matches the aims of the individual, positive emotions will arise; if the goal is contrasting, negative emotions will arise. Furthermore, it checks to what extent aspects of the "ego-identity," for example self-respect, are affected by the person-environment relationship. For example, anger arises, according to Lazarus (2000b), if a goal differing from the person-environment-relationship is estimated as a threat to self-esteem.

Within the secondary appraisal process, the individual checks the responsibility for the origin of the situation (blame or credit) and evaluates the coping potential and future expectations. The evaluation of the coping potential refers to the possibilities of the individual to eliminate or to improve aim-incongruent, person-environment-relationships or to stabilize goal-congruent person-environment-relationships. Regarding future expectations, the individual anticipates to what extent the person-environment-relationship will be changed in a positive or negative way. Table 1 gives an overview of Lazarus's (1991b) postulated core themes to discrete emotions that will play a role in further progression of this thesis.

The decisive factor for the connection of emotions and physical performance are for Lazarus (1991b, 2000a) the biologically determined "action tendencies", that come along with the individual emotions and their core themes, and which are difficult to inhibit. However, it has to be noted that action tendencies do not always translate into observable behavior, because social and cultural forces may influence their impact on actual behavior (Vallerand & Blanchard, 2000). The action tendencies of individual selected emotions which play a decisive role in the further progression of this thesis are listed in Table 2. The idea that physical performance can be increased when the

emotional state of a person and the corresponding action tendency is compatible with the physical task was already reported by Woodman et al. (2009).

Table 1.

The Core Themes of Emotions. From: Emotion and Adaptation by Richard S. Lazarus, 1991b (Modificated). New York: Oxford University Press

Emotion	Core Theme
Anger	a demeaning offence against me and mine
Anxiety	facing uncertain, existential threat
Happiness	making reasonable progress toward the realization of a goal
Sadness	having experienced an irrevocable loss

Table 2.

The Action Tendencies of Emotions. From: Emotion and Adaptation by Richard S. Lazarus, 1991b (Modificated). New York: Oxford University Press

Emotion	Action Tendency
Anger	a powerful impulse to counterattack in order to gain revenge for an affront or to repair a wounded self-esteem
Anxiety	escape or avoidance
Happiness	approach
Sadness	inaction and withdrawal

Individual Zones of Optimal Functioning (IZOF) Model. The IZOF Model of Hanin (1997) starts with the premise that neither positive nor negative emotions always lead to an increase or a decrease in performance, but that athletes differ according to their "optimal" competitive emotion. According to the model of Hanin (1997), an athlete

needs a certain level of anxiety before a competition, whereas another athlete reaches his best performance by producing happiness. This means that every athlete needs an individual emotional state before a competition to give his best performance. According to Hanin (1997), this emotional state is located within determined limits of a concrete zone. This zone is determined by the comparison of the emotional states of athletes' personally successful or unsuccessful competitions. Hanin (2000) differentiated in his model between four different categories of emotions derived from hedonic tone and functionality: pleasant and functionally optimal emotions, unpleasant and functionally optimal emotions, pleasant and dysfunctional emotions, and unpleasant and dysfunctional emotions.

Broaden-and-Built Theory. In the past, research on emotions and their effects on cognitive and physical performance has mostly focused on negative emotions (e.g. anxiety). Barbara Frederickson is one of the representatives of the so-called "positive psychology" approach and has primarily investigated positive emotions. The fundamental hypothesis of the Broaden-and-Build-Theory assumes that experiences of positive emotions broaden people's momentary thought-action repertoires, which in turn serves to build their enduring personal resources (Frederickson, 1998, 2001). Positive emotions such as joy, interest, contentment, pride or love, lead to an expansion of this perception and lead to a construction of prolonged physical, intellectual, social and psychological resources (Frederickson, 2001) which afterwards can be helpful with the coping of negative situations. Joy, for example, expands the impulse of playing and creativity; whereas interest expands the impulse of discovering and exploring (Frederickson, 2001). There is evidence that positive emotions can also have a significantly positive affect on friendship development (Waugh & Frederickson, 2006),

heightened income level (Diener, 2000), as well as on better physical health (Richman et al., 2005).

In relation to a connection between emotions and physical performance, action tendencies are, according to Frederickson (2001), well suited in forecasting the behavior in cases of negative emotions (like escape, in cases of anxiety). However, Frederickson (2001) also asserts the action tendency in cases of positive emotions is less clear or specific but rather helpful to encourage humans to explore their environments for resources and opportunities (Cohn & Frederickson, 2006). In contrast to negative emotions, which carry direct and immediate benefits in dangerous situations that threaten survival, the action tendencies triggered by positive emotions carry indirect and long-term benefits because they build enduring resources (Frederickson, 2001).

Theory of Challenge and Threat States in Athletes (TCTSA). The TCTSA of Jones et al. (2009) presents a combination and expansion of the biopsychosocial (BPS) model of challenge and threat (Blascovich & Mendes, 2000; Blascovich & Tomaka, 1996), the model of the adaptive approach to a competition (Skinner & Brewer, 2004) and other approaches that attempt to understand how athletes perceive an upcoming competition (e.g. Achievement Goal Theory; Dweck, 1986). The TCTSA addresses the question whether athletes consider a forthcoming competition as a challenge or a threat. TCTSA investigates the emotional and physiological reaction of an athlete to competition and makes assumptions as to how these two states (challenge and threat) influence sport performance. The TCTSA postulates that the athlete experiences the forthcoming competition as a challenge if he has a high self-efficacy, a feeling being in control of the situation and a focus on the approach to a goal ("approach goal"; Jones et al., 2009). However, a state of threat is associated with a low self-efficacy, a low feeling

of control in the situation and a focus on the avoidance of a goal ("avoidance goal";
Jones et al., 2009).

According to the TCTSA, positive emotions are associated in general with the
perception of a competition as a challenge and negative emotions are associated with the
perception of a competition as a threat. However, in individual cases, it is possible that
highly intensive negative emotions like anger or anxiety can be experienced as a
challenge (Jones et al., 2009). Furthermore, the TCTSA continues to assume that
athletes in a state of challenge experience their emotion as helpful, whereas athletes in a
state of threat evaluate their emotion as not helpful for their performance. In addition,
the TCTSA assumes that the cognitions, emotions as well as the neuroendocrinological
and cardiovascular reactions, which are associated with the state of challenge, are
beneficial for the athletic performance and increase its output. The other way around,
TCTSA postulates that a state of threat has a performance-reducing influence.

Classifying, Measuring and Inducing Emotions.

Regarding the classification of emotions, two basic approaches can be separated
from each other, namely dimensional and categorical models. According to the
dimensional approach, emotions are grouped on the basis of a limited number of
quantitatively varying attributes. Here, the most frequently used dimensions are the
valence of the emotion (pleasant to unpleasant or positive to negative) as well as the
activation/arousal (low to high activation/arousal). The representatives of the
dimensional approach (e.g. Watson, Clark & Tellegen, 1988) claim to find general
mechanisms that underlie all emotions (Vallerand & Blanchard, 2000). One possible
response, in a questionnaire with a dimensional approach for the emotional state of an
athlete, would be 'positive' and 'highly activated/aroused,' for example. Regarding the

categorical approach, a distinction is made amongst the variety of qualitatively different, discrete emotions. Most established are Ekman's (1992) basic emotions: happiness, surprise, anger, anxiety, contempt, sadness and disgust. According to Ekman (1992), these basic emotions are cross-cultural and accompanied by the same typical movements, especially of the facial muscles, and characterized by specific triggers as well as specific resulting action tendencies.

Emotions can be induced in experimental paradigms in a number of different ways such as films (Rottenberg, Ray & Gross, 2007) or pictures (Coombes, Cauraugh & Janelle, 2006; Coombes, Gamble, Cauraugh, & Janelle, 2008; Lang, Bradley & Cuthbert, 2005). The pictures from the IAPS (International Affective Picture System; Lang et al., 2005) are some of the most famous image materials for emotion induction. Furthermore, emotions can be induced by music (Bradley & Lang, 1999), odors (Finkelmeyer et al., 2010), imagination scripts (Woodman et al., 2009), the realization of emotional-relevant muscle movements (Strack, Martin & Stepper, 1998), or the self-generation of emotional memories (Damasio et al., 2000). The studies in this thesis used the self-generation of emotions to induce the desired emotional states. Here, participants were asked to recall memories from their past which were associated with a corresponding emotional state (e.g. happiness) and to relive this state as intensive as possible. This opportunity of emotion induction was used especially to find a method for sports practice which can be used by athletes very fast and without materials like films or pictures. The induction of an emotion by a film, for example, seems impracticable for a sprinter who wants to quickly be put into an emotional state before running.

To determine the kind of induced emotions or the emotional intensity of an induced emotion, self-reported measures (e.g. in form of ratings in Likert Scales)

dominate within sport context (McCarthy, 2011). Here, either single or multiple-item measures were conducted to report participants' single or multiple emotions and their intensity. The Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump & Smith, 1990) or the Sport Anxiety Scale (SAS; Smith, Smoll & Schutz, 1990) are examples of multiple-item measures of one single emotion. Multiple emotions are requested in the Profile of Mood States (POMS; McNair, Lorr & Droppleman, 1971), in the Positive and Negative Affect Schedule (PANAS; Watson et al., 1988) or in the Sport Emotion Questionnaire (SEQ; Jones, Lane, Bray, Uphill & Catlin, 2005). The SEQ is a sport-specific questionnaire to assess anger, anxiety, dejection, excitement and happiness as pre-competitive emotions.

The Impact of Discrete Emotions on Physical Aspects: Current State of Research

Regarding the emotion-performance relationship, the main share of sport emotion research has thus far focused on negative emotions and their effects on performance and anxiety (e.g. Hanin, 2000; Parfitt & Hardy, 1993; Tenenbaum, Edmonds, & Eccles, 2008; Woodman & Hardy, 2001). Researchers have mainly found a negative impact of anxiety on sports performance (e.g. Kleine, 1990; Woodman & Hardy, 2003). There is a lot of evidence that anxiety can impair performance in: soccer penalty kicks (Jordet, 2009; Jordet, Elferink-Gemser, Lemmink, & Visscher, 2006; Wilson, Wood, & Vine, 2009), table tennis (Williams, Vickers, & Rodrigues, 2002), handgrip dynamometer (Murphy, Woodfolk, & Budney, 1988), golf putting (Vine, Moore, & Wilson, 2011), or rock climbing (Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008; Pijpers, Oudejans, Bakker, & Beek, 2006). However, there is also evidence that a negative emotions such as anxiety does not always have a performance-decreasing effect, but that anxiety does not necessarily impair athletic performance, and, in some

circumstances, anxiety can even have a performance-enhancing effect (Hanin, 2007). Jones, Hanton, and Swain (1994) found for example that elite swimmers interpreted cognitive and somatic anxiety as being more facilitative to performance than non-elite swimmers. A positive interpretation of anxiety symptoms results from an athlete's perception of control over the environment and self, and sufficient positive belief to cope and believe that the goal can be achieved (Jones, 1995). Further, Cerin (2004) found that individuals higher in extraversion interpreted their anxiety as more facilitative than individuals lower in extraversion. Furthermore, confirmation that a negative emotion can also have a positive effect on performance derives from the emotion anger. Hanin (1997, 2000) already contended that anger can be beneficial to effort and lead to enhanced performance, and Woodman et al. (2009) found that participants' performance on a dynamometer was significantly greater in the anger condition than the happiness and emotionally neutral condition.

Although negative emotions were mostly in the focus of emotion research in sport psychology literature, there are also studies that have investigated positive emotions. Most of them show that they are beneficial for performance. Kavanagh and Hausfeld (1986) examined whether happiness produces increased performance in a physical task and found that the performance in the happiness condition was significantly enhanced compared with the sadness condition and an emotion-neutral state. Totterdell (2000) recorded data from professional cricket teams, indicating that players' happiness was positively related to cricket batting average. Perkins, Wilson, and Kerr (2001) found significant increases in performance in a hand strength task occurring when the task was experienced as pleasant excitement and the arousal was high. Hashemi, Andalib Kouraeim, Pouresmali, and Salehi Heydarabad (2011) found that

negative mood induction has destructive effects on behavioral performance and that a positive mood induction has positive effects on the performance. Frederickson and Branigan (2005) could show in two experiments that positive emotions broadened the scope of attention and thought-action repertoires compared to a neutral state. In addition, researches showed that positive emotions improve the immune system (Davidson et al., 2003), reduce inflammatory responses to stress (Steptoe, Wardle, & Marmot, 2005), and generally are connected with better mental and physical health outcomes (Tugade, Frederickson, & Feldman-Barnet, 2004). However, there are also studies (e.g. Woodman et al., 2009) who did not find a significant difference in physical performance between happiness and an emotion neutral condition. Taken together, there are already several studies investigating the emotion-performance relationship. However, to the best of my knowledge, there were no studies in the literature that have investigated discrete emotions and their influence on performance in different physical skills by using self-generated emotions as an emotion induction method.

Chapter 3

Research Approach

Outline of the Thesis

The main purpose of this thesis is to investigate the impact of discrete self-generated emotions on physical performance. These emotions will be induced prior to physical performance by the recall of autobiographical memories related to the respective emotions, which might be a very simple technique for competitive athletes to enhance their performance.

Chapter 4 includes a paper that has this focus on the influence of self-generated emotions on strength. Within this paper, three different experiments will be presented which examined the effects of different self-generated emotions on: the strength of the finger musculature (Experiment 1), the jumping height within a counter-movement jump (Experiment 2) and throwing strength (Experiment 3). In sports, the physical component speed has also a performance-limiting effect. Therefore, the paper presented in chapter 5 deals with the question as to which self-generated emotions can be performance-enhancing or performance-reducing in a sprint.

Oftentimes it happens immediately before a competition that athletes are confronted with thoughts and emotions which decrease their performance. Therefore, the paper in chapter 6 investigates the efficiency of a new intervention program for emotional regulation: the so-called wingwave method of Besser-Siegmund and Siegmund (2010). This paper investigates if emotional states, which emerged as performance-reducing in the previous chapters, can be modified by this method and in turn enhance performance. I end the thesis by discussing the combined implications from the results obtained in the studies from a theoretical and applied perspective and present future directions and study limitations.

Research Questions Addressed in Thesis

Specifically this thesis addresses three main research questions outlined in table 3.

Table 3

Research Questions Addressed in the Thesis

Research question	Outlined in
I. *How do self-generated emotions influence performance in different strength tasks?*	Chapter 4: The influence of self-generated emotions on strength
II. *How do self-generated emotions influence performance in a speed task?*	Chapter 5: The influence of self-generated emotions on speed
III. *Is the wingwave method a suitable intervention program to reduce the intensity of a performance decreasing emotion (e.g. anxiety) and thereby to enhance performance in a task where strength is required?*	Chapter 6: The wingwave method

Chapter 4

The Influence of Emotions on Strength

Rathschlag, M. & Memmert, D. (2013). The Influence of Self-generated Emotions on Physical Performance: An Investigation of Happiness, Anger, Anxiety, and Sadness. *Journal of Sport and Exercise Psychology, 35,* **197-210.**

Abstract

The present study examined the relationship between self-generated emotions and physical performance. All participants took part in five emotion induction conditions (happiness, anger, anxiety, sadness, and an emotion-neutral state) and we investigated their influence on the force of the finger musculature (Experiment 1), the jump height of a counter-movement jump (Experiment 2), and the velocity of a thrown ball (Experiment 3). All experiments showed that participants could produce significantly better physical performances when recalling anger or happiness emotions in contrast to the emotion-neutral state. Experiment 1 and 2 also revealed that physical performance in the anger and the happiness condition was significantly enhanced compared with the anxiety and the sadness condition. Results are discussed in relation to Lazarus` (1991a, 2000a) cognitive-motivational-relational (CMR) theory framework.

Keywords: Emotions, Emotion-Performance-Relationship, Physical performance, Happiness, Anger, Anxiety, Sadness

Introduction

Athletes are always searching for possibilities to improve their physical performance in training and especially in competition situations. Emotions and their regulation are a fundamental part of performance and the focus of considerable research in sports (Hanin, 2000). For example, in a weightlifting competition, where only a few kilograms decide on whether or not an athlete gets a medal, athletes need strategies to regulate their emotional level in an intended direction directly before lifting the weights to maximize their probability of success.

A primary function of emotion is the preparation for action, and recent evidence suggests that manipulating emotional states preceding or during movement leads to consistent and repeatable alterations in overt motor behavior (Coombes, Gamble, Cauraugh, & Janelle, 2008). A wide range of emotions has been investigated in sports to illuminate the emotion-performance relationship (Coombes et al., 2008; Jones & Uphill, 2011; Robazza & Bortoli, 2007; Sève, Ria, Poizat, Saury, & Durand, 2007; Woodman, Davis, Hardy, Callow, Glasscock, & Yuill-Proctor, 2009), and numerous methods have been utilized in the past to induce specific emotions: such as films (Rottenberg, Ray, & Gross, 2007), sounds (Bradley, & Lang, 1999), imagery scripts (Woodman et al., 2009), and pictures with emotional content (Lang, Bradley, & Cuthbert, 2005).

However, the weightlifting competition poses one problem: to induce a desirable emotional state directly before lifting the weights, it is very difficult to use external stimuli such as films or pictures which have been the method of choice for inducing emotions in experiments. Thus, it remains unclear whether athletes can induce a desired emotion on their own to improve performance in a competition situation. Therefore, we utilized self-generated emotions as the emotion induction method in the present

research. In studies using self-generated emotions, participants typically are asked to recall and re-experience personal emotional episodes (e.g., Damasio et al., 2000). To our knowledge, there were no studies in the literature that have investigated the emotion-performance relationship by using self-generated emotions as an emotion induction method. We investigated self-generated emotions and their influence on physical performance drawing on the theoretical framework of Lazarus's (1991a, 2000a) cognitive-motivational-relational (CMR) theory.

Lazarus's (1991a, 2000a) CMR theory suggests that the specific emotions of an athlete are each guided by a core relational theme. For example, the core relational theme of anger is "a demeaning offence against me and mine" (Lazarus, 2000a, p. 242). The core relational theme is a description of the interaction between the athlete and the environment and is a summary of different appraisal judgments which are brought together. Each core relational theme of an emotion has a biologically derived action tendency or impulse that is difficult to inhibit. The action tendency for anger is "a powerful impulse to counterattack" (Lazarus, 2000a, p. 243).

One idea of Lazarus's (1991, 2000a) CMR theory is that the core relational theme of the respective emotion and its associated action tendency will influence the performance of an athlete depending on the complex relationship between the athlete and the situation. For example, in a tennis match, anger may negatively impact performance if players are angry with themselves for a series of missed points in that their anger draws resources away from the primary task. However, if the physical skill requires a "lashing out" motion toward an aggressor or opponent, performance may be enhanced due to its close association with anger's action tendency (Lazarus, 2000b). For example, the direct extension of the arms in weightlifting could be interpreted as a

"lashing out" motion and thus, the induction of the emotion of anger may increase the performance of the weightlifter. As such, we believed that the complex emotion-performance-relationship can be explained within the framework of Lazarus' CMR theory.

Although Lazarus' CMR theory is well-respected, there is some evidence that emotions may not necessarily be associated with specific action tendencies (Fredrickson, 2001), particularly in more ecologically-valid situations that may constrain or influence the display of emotion, particularly for positive emotions (Fredrickson, 2001). Erez and Isen (2002) found that happiness was positively related to effective problem solving but that happiness was motivational only when the task had reached a certain degree of difficulty. Thus, positive emotions may provide both sufficient resources and sufficient motivation to pursue a demanding task (Fredrickson, 2001).

To the best of our knowledge, Woodman and colleagues (2009) were the first to investigate the emotion-performance-relationship within this framework and found some support for CMR theory. We found the argumentation of Woodman and colleagues (2009) for explaining their results within this framework very convincing and thus, we intended to continue their work about the emotion-performance-relationship with the aid of CMR theory. Instead of the self-generated emotions of our study, Woodman et al. (2009) utilized imagery scripts for the purpose of inducing happiness, anger, and an emotionally neutral affect. They found that participants' performance on a dynamometer was significantly greater in the anger condition than the happiness and emotionally neutral condition. The authors interpreted these results in line with Lazarus' (2000b) suggestion that anger may facilitate physical performance if the required skill is similar to the action tendency in anger (i.e., to lash out). One limitation of the Woodman et al.

(2009) study was that they only investigated the influence of emotions on one physical skill (dynamometer task) and thus, it is not clear if the effect can be generalized to other physical skills. Totterdell (2000) found support for the idea that happiness can also enhance physical performance. In his study, players from two professional cricket teams were asked to give ratings of their moods and performances three times a day for four days during a competitive match between the teams. Pooled time-series analysis showed significant associations between the players' moods and subjective performances, and the associations were independent of hassles and favorable standing in the match, and happiness was positively related to cricket batting average. Coombes et al. (2008) investigated the extent to which pleasant and unpleasant emotional states, induced via pictures from the International Affective Picture System (IAPS; Lang et al., 2005), influenced the performance of participants in a pinch grip task. The pictures from the IPAS were rated on the dimensions of arousal (ranging from calm to excited) and valence (ranging from pleasant to unpleasant) and were not categorized in different emotions. The employed pictures in the study of Coombes et al. (2008) represented three categories: erotic couples (excited and pleasant), mutilation (excited and unpleasant), and pictures with a neutral content. Researchers found that viewing pictures of both erotic couples and pictures of mutilation led to greater pinch grip force production in contrast to neutral pictures. Taken together, it seems that not only positive emotions like happiness (Totterdell, 2000) but also negative emotional states like anger (Woodman et al., 2009) or seeing mutilation pictures (Coombes et al., 2008) which might be associated with the emotion of disgust, can increase performance depending on the required physical skill.

Instead of different emotions and their valence, physical performance can also be influenced by emotional arousal. For example, physiological arousal was positively associated with performance on aerobic tasks (Parfitt, Hardy, & Pates, 1995), and strength tasks (Perkins, Wilson, & Kerr, 2001), but negatively associated in tasks that require fine motor control (Noteboom, Fleshner, & Enoka, 2001). The majority of research examining emotional arousal has focused on anxiety, and it remains unclear how other negative emotions (e.g., anger, sadness) or positive emotions (e.g., happiness) that display similar or different physiological activation (Lazarus, 2000b) affect performance. For example, the arousal of the emotions anger and anxiety is often very similar (e.g. Russell & Mehrabian, 1974) and thus, it is not clear whether these emotions might affect performance differently (Robazza & Bortoli, 2007).

The present research

The purpose of this study was to contribute to research on the emotion-performance relationship by exploring the links between different self-generated emotions and their effect on performance in different physical skills. To our knowledge, there are no studies that have investigated the influence of self-generated emotions on performance within the framework of Lazarus´s CMR theory. In this paper, we will present the results of three experiments referring to the emotion-performance relationship. In Experiment 1, we investigated this relationship in a non-sport-specific physical task of finger strength. In this experiment, participants were asked to hold two fingers together as well as possible against a mechanical force after inducing different self-generated emotions. There are well-established anatomical connections between the motor cortex and the limbic system (e.g. Mogenson, Jones, & Yim, 1980; Groenewegen, 2007), which is involved in many of our emotions. Of further relevance, the model of

the motor homunculus (Penfield & Rasmussen, 1950), which is a somatotopic representation of different body parts in the primary motor cortex, has demonstrated that the fingers represent one of the largest areas in the primary motor cortex. Thus, we believed that if different emotions influence participants' force, this effect might be most pronounced in the finger musculature.

To further examine if different emotions influence participants' force not only in a non-sport specific physical task for the fingers, we subsequently investigated the emotion-performance relationship in a sport-specific lower body movement in Experiment 2 and in a sport-specific upper body movement in Experiment 3. Participants were asked to jump as high as they can (Experiment 2) and to throw a ball with maximum velocity towards a goal (Experiment 3) after inducing self-generated emotions.

Focusing now on Experiment 1, we explored the effect of different kinds of emotions on the force of the finger musculature, by examining the following five emotion induction conditions: happiness, anger, neutral, anxiety, and sadness. First of all, we simply wanted to verify that the emotion manipulations had been successful in inducing the appropriate emotions. We hypothesized that feelings of anger (happiness, anxiety, sadness) will be significantly enhanced in the anger (happiness, anxiety, sadness) condition compared to all other conditions. Furthermore, we expected that the arousal will not differ significantly between emotions of anger, happiness, anxiety, and sadness but to the emotion-neutral condition. For the hedonic tone we expected that the values for pleasantness will be greater in happiness, compared to the emotion-neutral condition and the anger, anxiety, and sadness conditions. For physical performance we

hypothesized, in accordance with the results of Woodman et al. (2009), that participants who self-generate the emotion anger will show the highest performance on a purely physical task. Specifically, because the required skill is similar to the action tendency in anger (i.e., to clench one's fist) we hypothesized that anger will benefit performance on such a task. The core relational theme for happiness is "making reasonable progress toward the realization of a goal" (Lazarus, 2000a, p. 234), and thus approach is an action tendency in happiness (Lazarus, 1991b). Specifically, because the required skill (holding two fingers together) could be interpreted as an approach movement, and given the research of Totterdell (2000), who found that the subjective performance of cricket player is enhanced when players are happier, we believed that happiness will also facilitate performance in our task. The action tendency for anxiety is avoidance or escape (Lazarus, 2000b) and the uncertain threat "makes us feel more or less powerless" (Lazarus, 2000b, p. 57). For sadness, the action tendency is inaction and withdrawal (Lazarus, 2000b, p. 57). Consequently, we hypothesized that the emotions anxiety and sadness will decrease performance in our physical task in Experiment 1 where participants were asked to hold to finger together as well as possible against a mechanical force.

<div align="center">**Experiment 1**</div>

Method

   Participants. Thirteen male and 12 female athletes with an average age of $M =$ 24.60 years ($SD = 2.29$), and ages ranging from 22 to 29 voluntarily took part in this study. Participants were recruited from a large university in Germany, and all of them were sport students at an amateur to semi-professional level in their respective sports

and novices in the required physical task. Participants received no compensation for participation, and informed consent was obtained before commencing the study. The study was carried out in accordance with the Helsinki Declaration of 1975. None of the participants knew about the purpose of the study, the hypotheses, or CMR theory framework.

Emotion-Induction. We used a method in which five emotion conditions (happiness, anger, neutral, anxiety, sadness) were induced by recalling personal emotional episodes. In the happiness condition, for example, participants had to imagine a very happy moment in their life. For the emotion-neutral state, we suggested participants to imagine themselves brushing their teeth. This image was similar to the induction of this state via an emotion-neutral script outlining the process of brushing one's teeth (see Kavanagh & Hausfeld, 1986). All participants participated in the five emotion conditions which were counterbalanced across all participants.

Manipulation check. We used Likert scales (LS) to assess the degree to which participants experienced the different emotions. This was done to verify that the emotion manipulations were successful. Participants retrospectively rated for each emotion condition the induction of the respective emotions, valence, and arousal using a 9 point Likert scale (emotion induction: 1 = no happiness / anger / anxiety / sadness to 9 = most happiness / anger / anxiety / sadness; valence: 1 = most pleasant to 9 = most unpleasant; arousal: 1 = not arousing to 9 = most arousing).

Physical task. Strength of the finger musculature was measured via a machine (see Figure 1) that represents an objective measurement of the Bi-Digital O-Ring-Test (BDORT) developed by Omura (1985). The BDORT was originally developed as a non-invasive diagnostic procedure for medical problems in which a patient has to form a

'ring' with the thumb and the index finger (Omura, 1985). The diagnostician subjectively evaluates the patient's health according to their finger strength as the diagnostician tries to pry them apart. Our machine allows us to objectify the pulling force in the BDORT. We used this kind of measurement instead of a pinch grip task (Coombes et al., 2008) or a dynamometer (Woodman et al., 2009) because it was a part of a larger project. In this project we want to investigate a new treatment specifically designed for anxiety disorders but also for improving performance in sport-specific contexts, the so-called wingwave method developed by Besser-Siegmund and Siegmund 2001. This treatment combines elements of Eye Movement Desensitization and Reprocessing (EMDR), Neuro-linguistic programming (NLP), and the BDORT. One idea of the developer is that the patients' force of finger musculature in the BDORT is different depending on which kind of emotion they self-generate and how well patients can deal with this emotion. The aim of this paper is not to explain the wingwave method in more detail (for detailed explanations, see Besser-Siegmund, & Siegmund, 2010); we merely wanted to make clear that we chose this kind of measurement as a first step in the evaluation process of the wingwave method developed by Besser-Siegmund and Siegmund in 2001.
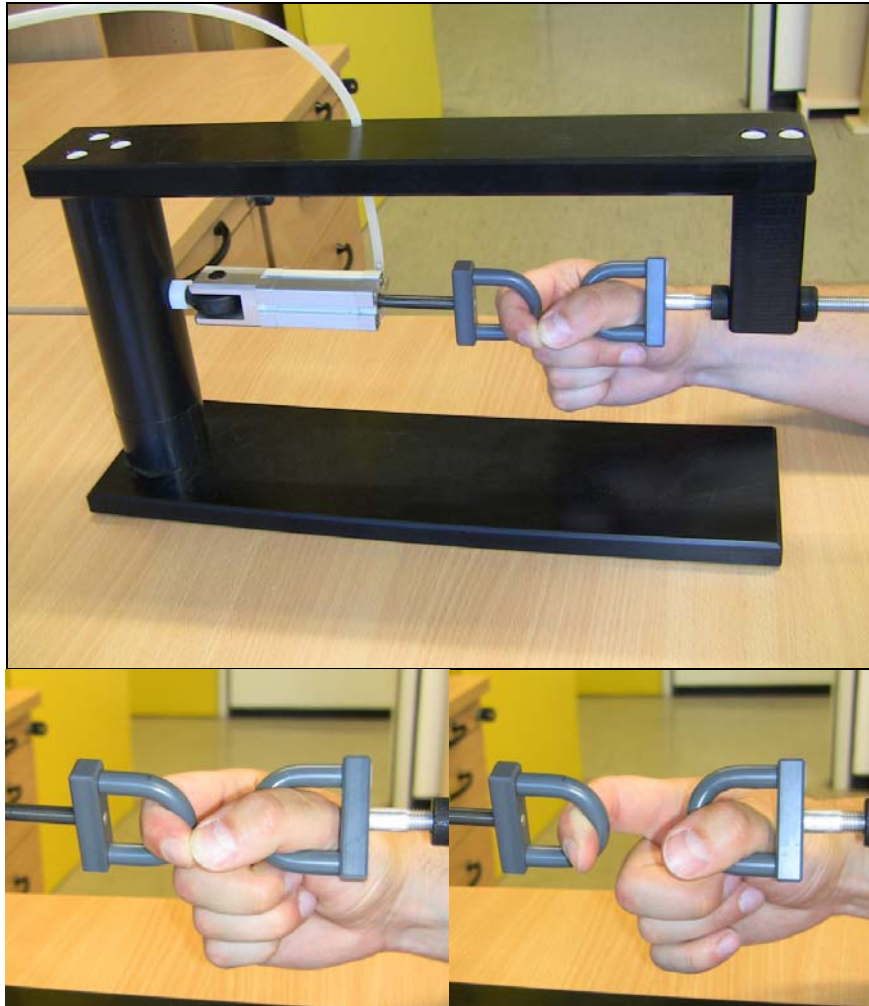
Figure 1. *Experimental setup. Top: Posture of Arm, Forearm and Especially of Index and Thumb During the Task. Bottom left: Posture of Index and Thumb Rated as "Closed Ring" Coded With "2". Bottom Right: Posture of Index and Thumb Rated as "Unclosed Ring" Coded With "1".*

Our machine for the objective measurement of the BDORT generated a pulling force that separates the index finger and the thumb when they touch each other to form a ring. A regulator controlled the strength of the pulling force. At first, the maximal strength of the participants was measured using the one repetition maximum. The one repetition

maximum was defined as the highest pulling force at which participants can still hold the ring of index and thumb together. After familiarization with the equipment, the strength of the pulling force was added in small increments (0.5 to 1.0 bar), resting 30 seconds between measurements, until the subject could no longer hold the ring of index finger and thumb together. The position of the fingers was standardized for all participants (also see Figure 1). All of the measurements in the different emotion conditions in the study were tested at 90% of participants' individual maximum voluntary contraction (MVC). The measurements were filmed by a digital camera, and the film material was observed by three raters who had to decide independently whether the ring of index finger and thumb was open or closed. We used a blind design: the rater was not informed about the respective emotion condition that participants had induced. The coding system was the following: 1.0 = "unclosed ring", 1.3 = "approximately unclosed ring", 1.7 = "approximately closed ring", 2.0 = "closed ring". After we assessed inter-rater-reliability of the three different subjective force ratings, the mean of the three rater judgments for each emotion condition (mean of the six trials per condition) was used for analysis.

Procedure. We informed participants, who attended the testing sessions individually, that the experiment was an examination of physical performance under different emotion conditions, and we provided them with instructions on how to complete the physical task. After providing demographic information and written consent, participants were familiarized with the machine for the objective measurement of the BDORT and we tested the individual MVC of the participants. Then, participants were seated at a desk, and the experimenter outlined the emotion that was to be induced during the first emotion condition and asked participants to think of a situation in which

they had experienced this emotion (e.g., happiness). When participants confirmed that they had a situation in their mind, they had one minute to self-generate the corresponding emotion. Immediately afterwards, participants put their thumb and their index finger in the machine for the objective measurement of the BDORT and performed six measurements of the force of the finger musculature (90% MVC) under the same emotion condition with breaks of 30 s in between each of the six trials. The moment in which the machine generated the pulling force was announced by an acoustic signal three seconds in advance. From that moment on, participants were asked to hold the ring of index finger and thumb together with their maximum force and go on with self-generating the emotion. After one trial, participants were asked to relax their fingers in the machine until the next acoustic signal but go on with self-generating the respective emotion in the rest intervals between the trials. Participants completed six trials under one emotion condition. Immediately after one emotion condition with six trials, participants were asked to indicate how they were feeling retrospectively on the LS. After a rest of three minutes, we measured again individuals' MVC in our task to control for fatigue failures and if necessary, the following measures of the force of the finger musculature within the next emotion condition were made at a new value of 90% of the MVC. Then, participants were asked to think of a situation in which they had experienced the next emotion (e.g., sadness), and the same procedure started again for the new emotion condition. The procedure was the same for each condition (i.e., happiness, anger, neutral, anxiety, and sadness), and we chose a resting time of three minutes between each of the conditions to minimize any carryover effect from one emotion condition to the next. The order of presentation of the emotions condition was balanced and randomized across all participants. Since our objective measurement of the

BDORT is a novel physical task, we repeated all measurements two weeks later, counterbalancing the experimental conditions between the two times of measurements (T1 and T2) to be sure that the results in our task do not differ between two times of measurements.

Data Analysis. First of all, we assessed the self-generated emotions' efficacy with respect to an induction of the respective emotions (happiness, anger, neutral, anxiety, sadness) during the physical task. Therefore, data were analyzed using 5 (emotion condition: happiness vs. anger vs. neutral vs. anxiety vs. sadness) x 2 (time of measurement: T1 vs. T2) ANOVAs with repeated measures on both factors to examine the different LS.

We then assessed the inter-rater reliability of the three different strength ratings by calculating intra-class correlation coefficients (ICC; Shrout & Fleiss, 1979) separately for each emotion condition (happiness, anger, neutral, anxiety, sadness), and for each time of measurement (first measurement and second measurement). Subsequent to this analysis, we compared the five emotion conditions. Therefore, data were analyzed using a 5 (emotion condition: happiness vs. anger vs. neutral vs. anxiety vs. sadness) x 2 (time of measurement: T1 vs. T2) ANOVA with repeated measures on the second factor.

Results

Manipulation check

Happiness, Anger, Anxiety, and Sadness. There was a significant happiness difference across emotion conditions, $F(4, 96) = 198.53$, $p < .001$, $\eta^2 = .89$). Follow-up Bonferroni corrected pairwise comparisons revealed that participants experienced significantly more happiness in the happiness condition compared with all other conditions ($p < .001$; see Table 1). Furthermore, there was an anger difference across

emotion conditions, $F(4, 96) = 187.13$, $p < .001$, $\eta^2 = .86$). Participants experienced significantly more anger in the anger condition compared with all other conditions ($p < .001$; see Table 1). We also found a significant anxiety difference across emotion conditions, $F(4, 96) = 174.76$, $p < .001$, $\eta^2 = .81$). Participants experienced significantly more anxiety in the anxiety condition compared with all other conditions ($p < .001$; see Table 1). There was also a significant sadness difference across emotion conditions, $F(4, 96) = 206.17$, $p < .001$, $\eta^2 = .91$). Participants experienced significantly more sadness in the sadness condition compared with all other conditions ($p < .001$; see Table 1).

Arousal and Pleasantness (Hedonic Tone). Analyses revealed a significant arousal difference across emotion conditions, $F(4, 96) = 17.58$, $p < .001$, $\eta^2 = .61$). Follow-up Bonferroni corrected pairwise comparisons showed that participants experienced significantly less arousal in the neutral condition in relation to all other conditions ($p < .001$; see Table 1). The happiness, the anger, the anxiety, and the sadness condition were not significantly different from each other. Also, there was no main effect for time of measurement $F(1, 24) = .340$), and we did not find a significant interaction between emotion condition and time of measurement ($F(4, 96) = .905$).

Furthermore, there was a significant hedonic tone difference across emotion conditions ($F(4, 96) = 171.53$, $p < .001$, $\eta^2 = .87$). Follow-up Bonferroni corrected pairwise comparisons revealed significant differences between the happiness and all of the other emotion conditions ($p < .001$). The anger condition showed significant differences to the neutral condition ($p < .001$) but none to the sadness and anxiety conditions. The neutral condition was significantly different to all of the other conditions ($p < .001$). The anxiety and sadness condition showed no significant difference. Participants experienced more pleasantness in the happiness condition than in the neutral

condition, the anger condition, the sadness condition, and the anxiety condition (see Table 1). Also, there was no main effect for time of measurement $F(1, 24) = .185)$, and we did not find a significant interaction between emotion condition and time of measurement ($F(4\ 96) = 1.499$). The combined results of all LS reveal that the attempts to induce the different emotions were successful.

Performance

Intra-class correlation coefficients. Inter-rater reliability coefficients were acceptable for all judges (ranging from 0.85 to 0.95 and averaging 0.92) for both times of measurements.

Physical task. The ANOVA revealed no main effect for time of measurement ($F(1,24) = .12$), but we found a main effect for emotion condition($F(4, 96) = 16.31$, $p < .001$, $\eta^2 = .41$, power $= 1.00$). Follow-up Bonferroni corrected pairwise comparisons revealed a significant difference between the anger condition and the conditions of neutral ($p < .001$), anxiety ($p < .001$), and sadness ($p < .002$), indicating that athletes in the anger condition were rated higher than in the other three conditions. There was no significant difference between the anger and the happiness condition. Furthermore, the pairwise comparisons showed that the happiness condition also leads to significantly increased ratings in relation to the conditions of neutral ($p < .001$), anxiety ($p < .013$), and sadness ($p < .004$). There were no significant differences between the neutral, the anxiety, and the sadness conditions.

Table 4. **Tab. 1.**

Likert Scale (LS) Arousal, LS Hedonic Tone, LS Happiness, LS Anger, LS Anxiety, LS Sadness, and Performance

Means (SD) for the Five Emotion Conditions in Experiment 1.

	Time of measurement 1					Time of measurement 2				
	Emotion Induction Condition					Emotion Induction Condition				
Variable	Happiness	Anger	Neutral	Anxiety	Sadness	Happiness	Anger	Neutral	Anxiety	Sadness
	M SD	M SD	M SD	M SD	M SD	M SD	M SD	M SD	M SD	M SD
Happiness	8.64 (1.51)	2.07 (1.07)	5.07 (2.33)	2.13 (1.07)	2.07 (2.07)	8.34 (1.98)	2.41 (1.40)	4.68 (3.03)	1.89 (0.77)	1.88 (1.45)
Anger	2.73 (1.36)	8.15 (2.05)	3.95 (2.41)	2.65 (1.77)	1.88 (0.66)	2.44 (1.24)	7.95 (1.86)	4.13 (2.11)	2.86 (1.68)	1.75 (0.97)
Anxiety	2.01 (1.39)	3.04 (1.66)	3.54 (2.21)	7. 88(2.23)	3.44 (1.98)	1.86 (0.95)	2.88 (1.64)	3.23 (1.98)	8.12 (1.97)	3.57 (2.01)
Sadness	1.88 (0.50)	2.36 (1.34)	2.02 (1.08)	2.89 (1.68)	8.75 (2.46)	2.23 (1.05)	2.11 (1.45)	2.33 (1.05)	3.19 (2.01)	8.43 (2.88)
Arousal	7.70 (2.13)	6.70 (2.05)	2.89 (1.45)	7.90 (2.08)	6.94 (2.14)	7.46 (2.01)	6.81 (2.32)	3.04 (1.96)	7.82 (2.16)	7.07 (2.34)
Hedonic Tone	8.01 (1.53)	2.43 (1.62)	3.88 (2.74)	1.98 (0.76)	1.88 (1.03)	8.03 (1.49)	2.56 (1.74)	3.64 (2.67)	2.42 (1.09)	1.68 (1.05)
Performance	1.65 (0.16)	1.66 (0.20)	1.42 (0.24)	1.51 (0.19)	1.48 (0.23)	1.67 (0.21)	1.71 (0.18)	1.44 (0.18)	1.51 (0.19)	1.43 (0.24)

Discussion

The aim of Experiment 1 was to examine the influence of self-generated emotions on the force of the finger musculature. Participants' physical performance was rated subjectively by three independent raters and the inter-rater reliability coefficients were acceptable for all judges. A further strength of our study was that we used a blind design and thus, the raters were not informed about the respective emotion condition that participants had induced. Furthermore, we could show that the effect of self-generated emotions in the subjective ratings of physical performance were robust between the two different times of measurements. Thus, we believe that we used a reliable task for the measurement of physical performance of the finger musculature.

Our findings partially supported our hypothesis; participants' physical performance was significantly greater in the anger condition compared with the neutral, anxiety, and sadness emotion conditions. These results are in line with Woodman et al. (2009), who found that anger leads to a significant enhanced performance on a dynamometer in the anger condition compared with a neutral condition. These results are also consistent with Lazarus's (2000b) suggestion that anger may facilitate physical performance if the required skill is similar to anger's action tendency (i.e., to lash out).

The happiness condition also leads to a significant enhanced performance compared with the neutral, anxiety, and sadness emotion conditions. The happiness and the anger emotion conditions did not differ significantly so that we could not support the results of Woodman et al. (2009) that performance in the anger condition is greater than in the happiness condition. One possible explanation for this discrepancy might be the different physical skills in the studies. Maybe performing in a dynamometer task in the study of Woodman et al. (2009) is only similar to anger's action tendency (i.e., to lash

out) and not to action tendency in happiness (i.e., to approach). Our findings that performance is enhanced in the anger and in the happiness condition could be explained in that way that our finger musculature task (holding two fingers together) might activate an action tendency for anger (i.e., to clench one' s fist) as well as an action tendency for happiness (i.e., to clench one's fist for joy). If we further interpret our physical skill as an approach movement, our results are also consistent with the suggestion that approach is another action tendency for happiness and therefore facilitates performance in physical tasks in which approach movements are required. Thus, our results are in line with the findings of Totterdell (2000), that happiness can also increase performance.

The anxiety, sadness, and the neutral emotion conditions did not differ significantly, so the findings did not support our hypothesis that anxiety and sadness lead to a significant decreased physical performance compared with the neutral condition. One possible explanation for the lack of findings is that the required skill in our task is not similar to anxiety's associated action tendency (i.e., avoidance or escape) and to sadness' action tendency (i.e., inaction and withdrawal). One study limitation in Experiment 1 was that the required skill was not very representative of sports performance, and therefore we attempted to scrutinize the findings in tasks that are more representative of real world sports performance (Experiments 2 and 3).

Experiment 2

The aim of Experiment 2 was to improve our understanding of how self-generated emotions might influence the performance in physical tasks. In Experiment 1, we used a novel task for the measurement of the subjectively rated performance of the finger musculature. We found that anger and happiness leads to a significantly increased performance in this task compared with anxiety, sadness, and a neutral emotion

condition. In Experiment 2, we investigated whether the emotion conditions have an influence on the jump height of participants performing Counter-Movement Jumps (CMJ). Accordingly to the results of Experiment 1, we hypothesized that participants in the anger and happiness emotion conditions can jump significantly higher than participants in the anxiety, sadness, and in the emotion-neutral conditions. One extension of Experiment 1 was that we were able to measure the performance not only by means of subjective ratings but also with an objective method.

Method

  Participants. Twenty-five participants (12 female) with an average age of *M* = 23.44 years (*SD* = 1.78), and ages ranging from 20 to 28 voluntarily took part in the study. The process of recruiting participants was the same as described in Experiment 1.

  Emotion-Induction. The induction of the emotions was conducted in the same manner as in Experiment 1. Again, we had five emotion conditions (happiness, anger, neutral, anxiety, sadness) which were induced by recalling personal emotional episodes.

  Manipulation check. The LS were the same as described in Experiment 1.

  Physical task. Participants performed counter-movement jumps under different emotion conditions while they were standing on a contact mat (SpeedMat, Switch) that measured the vertical jump height (in cm). A counter-movement jump is a diagnostic procedure for measuring the vertical jumping power of an athlete. The jumpers start from an upright standing position with their hands on their hips, makes a preliminary downward movement by flexing the knees and hips, then immediately extends the knees and hips again to jump vertically up off the ground. Participants were asked to jump as high as possible, and they could not see the jump height.

Procedure. The procedure was mainly the same as described in Experiment 1. We informed the participants that we were examining the jump height in counter-movement jumps under different emotion conditions. After providing demographic information and written consent, participants were familiarized with the contact mat. Then, the experimenter outlined the emotion that was to be induced during the first emotion condition and participants were asked to think of a situation in which they had experienced this emotion. After the participants' confirmation that they had a situation in their mind, they were given one minute to self-generate the corresponding emotion. Immediately afterwards, participants stepped onto the contact mat and performed six counter-movement jumps under the same emotion condition with a rest of 30 s in between each of the six trials. The moments in which the participants had to jump was announced by an acoustic signal. After each trial, participants were asked to relax until the next acoustic signal but try to stay in this emotion condition. Participants completed six trials under each emotion condition. Immediately after this period, participants were asked to indicate how they were feeling on the LS. After a break of three minutes, participants were asked to think of a situation in which they had experienced the next emotion, and the procedure outlined above started for the next emotion. The procedure was the same for each condition (i.e., happiness, anger, neutral, anxiety, and sadness). The order of presentation of the emotion conditions was balanced and randomized across participants.

Data Analysis. To assess the self-generated emotions' efficiency with respect to induction of the respective emotions (happiness, anger, neutral, anxiety, sadness) during the physical task, single-factor repeated measures ANOVAs were conducted for the different LS. Subsequent to this analysis, we compared the five emotion conditions in

relation to performance. Consequently, data were analyzed using a single-factor repeated measures ANOVA.

Results

Manipulation check

Happiness, Anger, Anxiety, and Sadness. There was a significant happiness difference across emotion conditions, $F(4, 96) = 215.74$, $p < .001$, $\eta^2 = .88$). Participants experienced significantly more happiness in the happiness condition compared with all other conditions ($p < .001$; see Table 2). Furthermore, there was an anger difference across emotion conditions, $F(4, 96) = 175.33$, $p < .001$, $\eta^2 = .84$). Participants experienced significantly more anger in the anger condition compared with all other conditions ($p < .001$; see Table 2). We also found a significant anxiety difference across emotion conditions, $F(4, 96) = 186.12$, $p < .001$, $\eta^2 = .83$). Participants experienced significantly more anxiety in the anxiety condition compared with all other conditions ($p < .001$; see Table 2). There was also a significant sadness difference across emotion conditions, $F(4, 96) = 211.85$, $p < .001$, $\eta^2 = .92$). Participants experienced significantly more sadness in the sadness condition compared with all other conditions ($p < .001$; see Table 2).

Arousal and Pleasantness (Hedonic Tone). Analyses revealed significant arousal differences across emotion conditions, $F(4, 96) = 19.36$, $p < .001$, $\eta^2 = .54$). Participants experienced significantly less arousal in the neutral condition in relation to all other conditions ($p < .001$). The happiness, the anger, the anxiety, and the sadness condition were not significantly different from each other. Furthermore, there was a significant hedonic tone difference across emotion conditions ($F(4, 96) = 190.74$, $p < .001$, $\eta^2 = .91$). Follow-up Bonferroni corrected pairwise comparisons revealed

significant differences between the happiness condition and all of the other emotion conditions ($p < .001$). The anger condition showed significant differences to the neutral condition ($p < .001$) but none to the sadness and anxiety conditions. The neutral condition was significantly different to all other conditions ($p < .001$). Furthermore, the anxiety and sadness conditions showed no significant difference.

Performance

Happiness, Anger, Neutral, Anxiety, and Sadness. We found a main effect for emotion condition ($F(4, 96) = 19.06$, $p < .001$, $\eta^2 = .45$, power $= 1.00$). Follow-up Bonferroni corrected pairwise comparisons revealed a significant difference between the happiness condition and the conditions of neutral ($p < .001$), anxiety ($p < .001$), and sadness ($p < .001$), indicating that athletes in the happiness condition could jump significantly higher than in the other three conditions. Furthermore, the pairwise comparisons showed that the anger condition led to a significantly increased vertical height in relation to the conditions of neutral *($p < .002$)*, anxiety ($p < .003$), and sadness ($p < .002$), but not to the happiness condition. No significant differences between neutral and both, the anxiety and the sadness conditions were evident.

Table 5. **Tab. 2**.

Likert Scale (LS) Arousal, LS Hedonic Tone, LS Happiness, LS Anger, LS Anxiety, LS Sadness, and Jump Height Means (SD) for the Five Emotion Conditions in Experiment 2.

	Emotion Induction Condition									
Variable	Happiness		Anger		Neutral		Anxiety		Sadness	
	M	SD	M	SD	M	SD	M	SD	M	SD
Happiness	8.00	(1.75)	2.45	(1.22)	5.88	(2.10)	2.35	(1.09)	2.21	(1.43)
Anger	1.99	(1.15)	7.86	(2.16)	3.01	(2.12)	2.69	(1.64)	1.84	(0.88)
Anxiety	1.88	(1.11)	2.75	(1.34)	2.96	(1.22)	8.23	(2.78)	3.65	(1.75)
Sadness	2.17	(0.88)	1.95	(1.14)	2.16	(1.13)	2.99	(1.56)	8.38	(2.89)
Arousal	7.19	(2.74)	6.90	(2.23)	3.05	(1.77)	7.34	(2.43)	6.75	(2.35)
Hedonic Tone	8.95	(0.99)	2.23	(1.47)	3.41	(2.62)	1.78	(0.99)	2.21	(1.23)
Jump height (cm)	32.05	(8.34)	31.68	(8.24)	31.02	(8.17)	30.81	(7.97)	30.80	(8.07)

Discussion

The aim of Experiment 2 was to examine the influence of self-generated emotions on a sport-specific lower body movement that is used in many sports. Thus, we chose a jump, and participants were tested performing counter-movement jumps (CMJ) under different emotion conditions. The findings are consistent with those of Experiment 1. That is, both anger and happiness resulted in significantly greater performance on the CMJ compared with anxiety, sadness, and the emotion-neutral condition. If we interpret a CMJ as a skill that is similar to anger's action tendency (i.e., to lash out), the anger findings are consistent with the results of Woodman et al. (2009) and Lazarus's (2000b) suggestion that anger may facilitate physical performance if the required skill is similar to anger's action tendency (i.e., to lash out). The happiness findings are in line with the

results of Totterdell (2000), that a positive emotion like happiness can also increase performance. Furthermore, to leap up into the air could be interpreted as an action tendency for happiness. If this holds true, our happiness findings are also consistent with Lazarus's (2000b) suggestion that an emotion can increase physical performance if the required skill is similar to emotion's action tendency. The happiness and the anger emotion conditions did not differ significantly, so we could not confirm the results of Woodman et al. (2009) that performance in the anger condition is greater than in the happiness condition. The anxiety, the sadness, and the emotion-neutral conditions did not differ significantly, so the findings are consistent with those of Experiment 1.

Experiment 3

Experiments 1 and 2 supported our assumption that participants are able to produce a significantly higher performance in a physical task when recalling anger or happiness emotions in contrast to recalling anxiety, sadness, or emotion-neutral states. We could find this effect for the force in the finger musculature (holding two fingers together against a pulling force) and for CMJs. In the following experiment, we investigated whether recalling emotions also has an influence on the velocity of a thrown team handball ball towards a goal. We hypothesized that participants inducing anger and happiness emotions can produce a significantly increased ball velocity in contrast to participants inducing anxiety, sadness or an emotional-neutral state.

Method

Participants. Twenty-five participants (15 men and 10 women) participated in this study. Average age of participants was $M = 21.40$ years ($SD = 2.19$), and ages were

ranged from 15 to 29. The process of recruiting participants was the same as described in Experiment 1.

Emotion Induction. The induction of the emotions was conducted in the same manner as in the Experiments 1 and 2. Again, we had five emotion conditions (happiness, anger, neutral, anxiety, sadness) that were induced by the recall of personal emotional episodes and counterbalanced across participants.

Manipulation check. The LS were the same as described in Experiment 1.

Physical task. Participants performed throws with a team handball ball towards an empty goal under different emotion conditions. Ball velocity was measured with a speed sport radar (SpeedTracX; Outer Limited Sports), with an accuracy of $\pm$ 1 m/h, which was placed in a central position behind the goal. Participants had to throw the ball into a central position of the team handball goal out of a standing position; the distance between participants and the goal was seven meters. Participants were asked to throw the ball as hard as possible, and they could not see the ball velocity on the screen after their throws.

Procedure. The procedure was mainly the same as described in the Experiments 1 and 2. After self-generation of one emotion condition (following the same procedure as in Experiment 1 and 2) participants performed six throws on the goal under the same emotion condition with a rest of 30 s in between each of the six trials and a rest of three minutes between the different emotion conditions. The moment in which they had to throw the ball was announced by an acoustic signal. After one trial, participants were asked to relax until the next acoustic signal but try to maintain their emotion. The same procedure was followed for each condition (i.e., happiness, anger, neutral, anxiety, and

sadness) and the order of presentation of the emotion conditions was balanced and randomized across participants.

Data Analysis. Data analysis was identical to the analysis in Experiment 2.

Results

Manipulation check

Happiness, Anger, Anxiety, and Sadness. There was a significant happiness difference across emotion conditions, $F(4, 96) = 235.78$, $p < .001$, $\eta^2 = .90$). Participants experienced significantly more happiness in the happiness condition compared with all other conditions ($p < .001$; see Table 3). Furthermore, there was an anger difference across emotion conditions, $F(4, 96) = 174.73$, $p < .001$, $\eta^2 = .83$). Participants experienced significantly more anger in the anger condition compared with all other conditions ($p < .001$; see Table 3). We also found a significant anxiety difference across emotion conditions, $F(4, 96) = 186.23$, $p < .001$, $\eta^2 = .85$). Participants experienced significantly more anxiety in the anxiety condition compared with all other conditions ($p < .001$; see Table 3). There was also a significant sadness difference across emotion conditions, $F(4, 96) = 217.56$, $p < .001$, $\eta^2 = .92$). Participants experienced significantly more sadness in the sadness condition compared with all other conditions ($p < .001$; see Table 3).

Arousal and Pleasantness (Hedonic Tone). Analyses revealed a significant arousal difference across emotion conditions, $F(4, 96) = 19.27$, $p < .001$). Follow-up Bonferroni corrected pairwise comparisons showed that participants experienced significantly less arousal in the neutral condition in relation to all other conditions ($p < .001$). The happiness, the anger, the anxiety, and the sadness condition were not significantly different from each other. Furthermore, there was a significant hedonic tone

difference across emotion conditions ($F(4, 96) = 205.89$, $p < .001$, $\eta^2 = .92$). Follow-up Bonferroni corrected pairwise comparisons revealed significant differences between the happiness and all of the other emotion conditions ($p < .001$). The anger condition showed significant differences to the neutral condition ($p < .001$), but none to the sadness and anxiety conditions. The neutral condition was significantly different to all of the other conditions ($p < .001$). Anxiety and sadness, however, showed no significant difference. Participants experienced more pleasantness in the happiness condition than in the neutral condition, the anger condition, the sadness condition, and the anxiety condition.

Performance

Happiness, Anger, Neutral, Anxiety, and Sadness. We found a main effect for emotion condition ($F(4, 96) = 5.63$, $p < .001$, $\eta^2 = .19$, power $= .95$). Follow-up Bonferroni corrected pairwise comparisons revealed a significant difference between the happiness condition and the neutral condition ($p < .005$), and between the anger condition and the neutral condition ($p < .037$). All other pairwise comparisons showed no significant differences. Athletes in the anger condition shot the ball with a higher velocity than the happiness condition, the sadness condition, the anxiety condition, and the neutral condition.

Table 6. **Tab.3.**

Likert Scale (LS) Arousal, LS Hedonic Tone, LS Happiness, LS Anger, LS Anxiety, LS Sadness, and Ball Velocity Means (SD) for the Emotion Conditions in Experiment 3.

Variable	Emotion Induction Condition				
	Happiness	Anger	Neutral	Anxiety	Sadness
	M SD	M SD	M SD	M SD	M SD
Happiness	8.24 (1.90)	2.36 (1.37)	4.79 (2.55)	2.10 (1.24)	2.19 (1.49)
Anger	2.54 (1.75)	8.56 (2.96)	2.90 (2.32)	2.77 (1.76)	1.96 (1.11)
Anxiety	2.45 (1.56)	3.01 (1.86)	3.32 (1.65)	8.45 (2.73)	3.80 (1.90)
Sadness	2.33 (1.39)	1.77 (1.23)	2.22 (1.34)	3.14 (1.89)	8.11 (2.85)
Arousal	7.46 (2.56)	6.84 (2.27)	3.47 (1.68)	7.83 (2.79)	7.23 (2.56)
Hedonic Tone	8.50 (1.54)	2.35 (1.49)	3.63 (3.08)	2.12 (1.16)	2.22 (1.23)
Ball velocity (m/s)	17.57 (2.82)	17.62 (3.03)	17.27 (2.81)	17.31 (2.87)	17.43 (2.92)

Discussion

The aim of Experiment 3 was to examine the influence of self-generated emotions on the ball velocity of a thrown team handball ball towards an empty goal. In this study, we found that participants inducing anger performed significantly better in contrast to the emotion-neutral state. These findings are consistent with those of Experiment 1 and 2 and the results of Woodman et al. (2009). To throw something away from oneself could be interpreted as an action tendency for anger. If that is true, our anger findings are consistent with Lazarus's (2000b) suggestion that anger can facilitate physical performance if the required skill is similar to anger's action tendency. Consistent to the results of Experiment 1 and 2, we found that happiness also leads to a significant enhanced performance compared with the emotion-neutral state. One possible explanation is that throwing a ball into goal is similar to Lazarus' (2000a) core

relational theme of happiness ("making reasonable progress toward the realization of a goal"). The happiness and the anger emotion conditions did not differ significantly, so we could not support the results of Woodman et al. (2009) that performance in the anger condition is greater than in the happiness condition. The anxiety, the sadness, and the emotion-neutral conditions did not differ significantly which makes the findings consistent with those of Experiment 1 and 2. Participants in the happiness and anger condition threw the ball with more velocity than in the anxiety and the sadness condition but the differences failed to reach significance. One possible explanation might be that the power of the performance-enhancing effect in anger and happiness in task where their action tendencies are activated is depended on the coordinative demands of the skill. Throwing a ball towards a goal probably is coordinatively more demanding than holding two fingers together (Experiment 1) or to jump (Experiment 2). Where positive effects of emotions on performance are observed, performance may be attenuated when there are high coordinative demands.

General Discussion

Although the role of emotions in sport performance has been widely recognized (Hanin, 2000; Coombes et al., 2008; Woodman et al., 2009), to our best knowledge, no studies have examined physical performance effects in different self-generated emotions within the framework of Lazarus' (1991a, 2000a) CMR theory. In all three experiments, evidence could be provided for the assumption that the induction of self-generated emotions has an influence on physical performance. All experiments showed that participants can generate a significantly higher physical performance in the anger condition and in the happiness condition compared with the neutral condition. Furthermore, Experiments 1 and 2 showed that participants' physical performance in the

anger and in the happiness condition was significantly enhanced compared with the anxiety and the sadness condition. The findings largely support Lazarus's (2000a) theoretical framework. Specifically, when the induced emotion and its action tendency are aligned with the task demands, performance increases (Woodman et al., 2009). However, one problem referring to the interpretation of our findings was, that there is some ambiguity, if our tasks were similar to specific emotion's action tendencies or not. Thus, we only present possible explanations why we believe that our tasks could have been similar to the action tendencies in the anger and the happiness emotion condition.

First of all, the combined results of all LS revealed that the attempts to induce the different emotions were successful and the range of the data in relation to the emotional state, which should be induced in the respective emotion conditions in the LS, was satisfying. Future studies could further use cutoff values for the LS in the manipulation check and eliminate participant's data in emotion conditions where cutoff values are not reached.

For the anger condition, our findings are in line with the results of Woodman et al. (2009), who found that anger significantly facilitates performance in a physical task compared with an emotion-neutral state. Woodman et al. (2009) explained their results by arguing that their task (performing a dynamometer task) was similar to anger's action tendency ("to lash out"). We conclude that our results are consistent with these findings because the required skills in our three experiments are also similar to anger's action tendency. A movement similar to clenching one's fist (Experiment 1), to vent one's anger (Experiment 2), and to throw something away (Experiment 3) are all movements which could be interpreted as action tendencies for anger. Even though we operationalized anger as an intense and unpleasant emotion (Lazarus, 1991a), we were

aware that the emotion anger is a more complex construct including the *anger in* and *anger out* coping styles (Smits & Kuppens, 2005) or whether the anger is focused on oneself or another person (Lazarus, 2000). Further studies could, for instance, investigate whether there are significant differences inducing self-generated anger on oneself or on another person in relation to physical performance.

Although Lazarus' CMR theory including specific action tendencies seems to be a good framework for the relationship between negative emotions like anger and performance, there is evidence that positive emotions like happiness may only affect performance when participant's motivation to pursue a demanding task is sufficient (Fredrickson, 2001). For the happiness condition, we found that this emotion could also facilitate the performance in our three different tasks. Thus, we believe that our tasks were motivating for participants, however we did not measure participant's personal motivation which makes this interpretation speculative. We conclude that our results in the happiness condition are also in line with Lazarus' (2000b) suggestion that an emotion can increase performance if the required skill is similar to the emotion's action tendency. The core relational theme for happiness is "making reasonable progress toward the realization of a goal" (Lazarus, 2000a, p. 234), and approach is an action tendency in happiness (Lazarus, 1991b). We believe that the required skills in Experiment 1 (holding two fingers together) could be interpreted as an approach movement and thus, the task is similar to the action tendency of approach in happiness. Furthermore we believe that our task in Experiment 1 is also similar to the movement of clenching one's fist for joy which might be also interpreted as an action tendency in happiness. In Experiment 2, we consider that performing counter-movement jumps is similar to the movement of leaping up into the air which might be also interpreted as an

action tendency in happiness and could be responsible for the increased performance in that emotion condition. The task in Experiment 3 (throwing a ball into a goal) is similar to Lazarus' (2000a, p. 234) core relational theme of happiness ("making reasonable progress toward the realization of a goal") and might have activated approach as an action tendency in happiness. Another explanation for the findings in the happiness condition for Experiment 3 might be that throwing a ball is similar to the forward motion of the arm what is a typical expression of happiness. We found that the happiness as well as the anger emotion condition could enhance physical performance in our tasks and thus, we could not confirm the results of Woodman et al. (2009) that performance in the anger condition is greater than in the happiness condition. One possible explanation might be the different physical skills in the studies. Performing in a dynamometer task as in the study of Woodman et al. (2009) might be only similar to anger's action tendency (i.e., to lash out) and not to the action tendency in happiness (i.e., to approach). For our three experiments, we have still presented explanations why we believe that our tasks might have activated action tendencies for anger as well as for happiness which could be responsible for the enhanced performance in both emotion conditions.

In their paper, Woodman et al. (2009) questioned whether any arousal-inducing emotion would result in an increased effort and therefore lead to an enhanced performance. We can now answer this question and say that performance is not the same in different arousal-inducing emotions. Although the emotion conditions of anger, happiness, anxiety, and sadness showed no significant differences in the LS for arousal in all of our experiments, the anger and the happiness emotion conditions led to a significantly enhanced performance as compared to both, the anxiety and sadness conditions in the Experiments 1 and 2. In Experiment 3, we found the same tendency but

it failed to reach significance. We propose that our skills in the experiments were more similar to the action tendencies in anger and happiness and thus, the emotion conditions of anger and happiness facilitated performance. Anxiety's action tendency can be avoidance (Lazarus, 2000b) and sadness' action tendency is inaction and withdrawal (Lazarus, 2000b). We believe that the decreased performance in our tasks in anxiety and sadness compared with anger and happiness could be explained in the way, that these action tendencies are not similar to the demands of our experiments. Another action tendency for anxiety is escape (Lazarus, 2000b). Future studies could investigate for example, whether self-generation of anxiety and the referred action tendency escape will facilitate performance of athletes in a 100 meters sprint. One hypothesis might be that athletes will benefit from induction of anxiety and its action tendency escape in sports with high demands on speed and agility.

Another possible explanation for the facilitative effect of anger and happiness compared with anxiety and sadness might be derived from theoretical models (Carver, Sutton, & Scheier, 2000; Davidson & Irwin, 1999; Lang, Bradley, & Cuthbert, 1990; Schmidt & Schulkin, 2000) that distinguish between approach-related emotions (e.g., happiness or anger) and withdrawal-related emotions (e.g., anxiety and sadness). Recent evidence (Chen & Bargh, 1999; Coombes, Cauraugh, & Janelle, 2006) demonstrates that approach/flexion movements lead to an increased physical performance when approach-related emotions (e.g., happiness and anger) are induced. If we classified all the tasks in our three experiments (holding two finger together, making a CMJ, and throwing a ball towards a goal) as approach movements, we could confirm the hypothesis that the induction of approach-related emotions such as happiness and anger will facilitate

performance in contrast to withdrawal-related emotions such as anxiety and sadness in the tasks of Experiment 1 and 2 and found the same tendency in Experiment 3.

Furthermore, we could not support our hypothesis that induction of anxiety and sadness will decrease performance in contrast to the emotion-neutral state. A possible explanation for the lack of findings resides in the induction of this state with the aid of suggesting participants to imagine themselves brushing their teeth. Although we found significant differences in the pleasantness between the neutral state and anxiety or sadness in all experiments, some participants told us that this imagination was not a neutral state. Some participants associated getting up early in the morning and being tired with the image of brushing teeth. If they had only rated in the LS for pleasantness the process of brushing their teeth separately, associated negative emotions might be overlooked which could explain the absence of significant differences between the emotion-neutral condition and the conditions of anxiety and sadness.

From a practical sport perspective the results of our experiments could be used as a routine before a physical performance. Performance or competition routines are well-established in an applied psychology context and empirical evidence for their support exists in a number of different sports (for a review, see Cotterill, 2010). They could be defined as "a sequence of task-relevant thoughts and actions which an athlete engages in systematically prior to his or her performance of a specific sports skill" (Moran, 1996, p. 150). The results of all of our experiments demonstrate that it seems to be helpful for athletes to integrate thoughts which are connected to the emotions of happiness or anger before the physical task to enhance performance.

However, it has to be noticed that the findings in our experiments can only be generalized to similar contexts, and future research should examine whether these

emotions affect performance in the natural context of sport. Thus, follow-up studies could investigate, for example, if weightlifters could also increase their performance when recalling memories related to feelings of happiness or anger briefly before lifting the weights in a natural setting. Furthermore, future studies could investigate if experience in self-generating emotions plays a role in the influence on performance. One hypothesis might be that experience in the self-generating of emotions like happiness or anger could further improve the performance. The participants in our three experiments were novices in the self-generation of emotions and also novices in performing the different physical tasks in our three experiments. Follow-up studies could furthermore investigate the role of expertise level (Ericsson, Charness, Feltovich & Hoffman, 2006) in the required tasks, in that way if experts and novices can profit both by generating different emotions or if there are significant differences. Future studies could also investigate participants' perception if they believe that a particular emotion is helpful for their performance. For example, some athletes may perceive some level of anxiety as useful and welcome it prior to the experiment and some not. Thus, it might be that our results could be explained by participant's intuitive perceptions about how they think that emotions influence performance rather than how they have in fact influenced performance. Therefore, future studies could collect data about participant's perception about the helpfulness of different emotions in relation to their performance or could manipulate the knowledge about how emotions could influence the performance. We hope that the present study will help to inform and motivate studies in the future to further delineate the complex relationship between emotional states and sport performances.

Chapter 5

The influence of emotions on speed

Rathschlag, M. & Memmert, D. (2013, submitted). Self-generated Emotions and their Influence on Sprint Performance: An Investigation of Happiness and Anxiety. *Journal of Sport and Exercise Psychology*

Abstract

The main purpose of this study was to examine the effects of self-generated emotions on sprinting times within the frameworks of Lazarus' (1991b, 2000a) cognitive-motivational-relational (CMR) theory and Frederickson's (2001) broaden-and-build theory. Using self-generated emotions as an emotion induction method, participants were asked to recall personal emotional episodes before sprinting and all participants took part in three emotion induction conditions: happiness, anxiety, and an emotion-neutral state. In Experiment 1, we measured the sprint times of 24 participants over a distance of 131 feet (40 meters) and in Experiment 2, we investigated the sprint times of 20 further participants over a distance of 75 feet (22.86 meters) in the respective emotion induction conditions. The results of both experiments indicated that the performance in the happiness condition was significantly greater compared to the anxiety condition and the emotion-neutral condition. From a practical sport perspective, it seems to be helpful for athletes to self-generate the emotion happiness before a sprint to enhance physical performance.

Introduction

Many sport interested people will remember the summer 2012 Olympic Games in London, where Usain Bolt was the undisputed champion in the 100 meter race and won the gold medal in a time of 9.63 seconds. The silver medal went to Yohan Blake (9.75 seconds) and the bronze medal was won by Justin Gatlin (9.79 seconds). The time difference which determined which athletes made it onto the podium is, however, less remembered. In fact, Tyson Gay missed the podium because of only one-hundredth of a second (9.80 seconds). This was only one of numerous examples of a sprint competition where only a few hundredths of a second decided whether an athlete was awarded a medal or not. Independent of a good physical preparation for competition situations, athletes are often searching for further possibilities to improve their performance. Two experiments will answer the question if sprinters can benefit from the regulation of their emotions directly before the competition and if this regulation can help to improve sprinters' performance.

Emotions and their regulation appear to be a fruitful area for improving performance, and for this reason, emotions have become a focus of extensive research in sports (Hanin, 2000). Illuminating the emotion-performance relationship, a wide spectrum of emotions have been investigated in studies with different designs (e.g., Coombes et al., 2008; Jones & Uphill, 2011; Mullen & Hardy, 2000; Robazza & Bortoli, 2007; Sève, Ria, Poizat, Saury, & Durand, 2007; Woodman et al., 2009). The present investigation is focused on the influence of the emotions of anxiety and happiness on sprint performance. There is already a dearth of studies in the literature which have discussed the impact of emotions on performance, however, the relationship between anxiety and performance has already received the most attention (for overviews see:

Jones, 1995; Raglin & Hanin, 2000; and Weinberg, 1990), in particular with the chocking under pressure literature (for an overview see: Hill, Hanton, Matthews, & Fleming, 2010). Researchers have mostly reported a negative impact of anxiety on sport performance (e.g. Kleine, 1990; Woodman & Hardy, 2003). There is a lot of evidence that anxiety can impair performance in soccer penalty kicks (Jordet, 2009; Jordet, Elferink-Gemser, Lemmink, & Visscher, 2006; Wilson, Wood, & Vine, 2009), table tennis (Williams, Vickers, & Rodrigues, 2002), handgrip dynamometers (Murphy, Woodfolk, & Budney, 1988), golf putting (Vine, Moore, & Wilson, 2011), or rock climbing (Nieuwenhuys, Pijpers, Oudejans, & Bakker, 2008; Pijpers, Oudejans, Bakker, & Beek, 2006). In addition, Nibbeling, Daanen, Gerritsma, Hofland, and Oudejans (2012) found several indications that efficiency in running in an aerobic task was reduced by anxiety. In addition, it has been proposed that only cognitive anxiety might impact all forms of athletic performance, whereas somatic anxiety tends to disrupt fine motor skills (Lavallee, Kremer, Moran, & Williams, 2004). However, Nicholls, Pollman, and Levy (2010) investigated 307 athletes in different sports and found that neither cognitive nor somatic anxiety could predict participants' subjective performance.

In contrast to studies which have found a negative influence on sport performance, there is also evidence that a negative emotion like anxiety does not always have a performance-decreasing effect, and that anxiety does not necessarily impair athletic performance, but in some circumstances anxiety can have a performance-enhancing effect (Hanin, 2007). Here, the assumption that the interpretation of anxiety symptoms can be either facilitative or debilitative has received some support in the emotion-performance relationship literature (Hanin, 1997; Jones & Swain, 1992). Mellalieu, Hanton, and Fletcher (2006) suggested that anxiety symptoms could be

interpreted on the one hand as positive and challenging, but on the other hand as negative and overwhelming. This idea is similar to the theory of challenge and threat states in athletes (TCTSA; Jones, Meijen, McCarthy, & Sheffield, 2009) which suggests that athletes who view upcoming competition as a challenge generally experience a performance-increasing effect, whereas those who view it as a threat normally experience a performance-decreasing effect. However, two meta-analyses found that the relationship between anxiety and physical performance is altogether relatively weak except in the negative direction (e.g. Craft, Magyar, Becker, & Feltz, 2003; Woodman & Hardy, 2003). Although a lot of studies were conducted in this research field, the results are equivocal and there are no investigations about self-generated anxiety and its influence on sprinting performance.

Most of the research on the emotion-performance relationship has corresponded up to now on negative emotions (e.g. anxiety), however, there have also been some studies investigating positive emotions and their impact on physical performance. In a study by Kavanagh and Hausfeld (1986), participants inducted into a happy mood were found to perform significantly better than participants inducted into a sad mood or participants in an emotion-neutral state. Totterdell (2000) investigated players from professional cricket teams and found that happiness was positively related to cricket batting average. Perkins, Wilson, and Kerr (2001) found significant increases in performance in a hand strength task occurring when the task was experienced as pleasant excitement and the arousal was high. Furthermore, research has shown that an induced positive state widens the scope of attention and broadens behavioral repertories (Frederickson & Branigan, 2005), speeds recovery from the cardiovascular aftereffects of negative affects (Frederickson, Mancuso, Branigan, & Tugade, 2000), and increases

immune function (Davidson et al., 2003). However, in a study of Woodman and colleagues (2009) which used imagery scripts for emotion induction, there were no significant differences between the happiness and the emotion-neutral condition in a dynamometer task in which participants were asked to kick as fast and hard as possible for a period of five seconds. In conclusion, the results on the influence of a positive affect (e.g. happiness) on physical performance indicate that a positive emotion might be able to increase physical performance in different tasks. However, there are also no studies in the literature which have investigated the influence of emotions on sprint performance.

A theory that provides an explanation for the mechanism behind the effects of emotions on physical performance is Lazarus' (1991a, 2000a) cognitive-motivational-relational (CMR) theory. Lazarus' (1991a, 2000a) CMR theory distinguishes 15 distinct emotions for which he identifies 'core relational themes'. A core relational theme is a description of the interaction between the athlete and the environment and is a summary of six different appraisal judgments which are brought together. For example, the core relational theme of happiness is "making reasonable progress toward the realization of a goal (Lazarus, 2000a, p. 242)," and for anxiety, the core relational theme is "facing uncertain, existential threat (Lazarus, 2000a, p. 242)." Furthermore, each emotion has biologically based responses which are difficult to inhibit. These responses are called 'action tendencies' (Lazarus, 1991, p. 87) and have the functional role of helping a person to cope adaptively with the emotion-arousing events. The action tendency for happiness is 'approach' (Lazarus, 2000a, p. 243) and for anxiety 'avoidance or escape' (Lazarus, 2000a, p. 243). CMR theory proposes that if an event activates a core relational theme of a specific emotion and its associated action tendency by an athlete,

the performance of the athlete can be influenced depending on the complex relationship between the athlete and the situation. The idea is that if a physical skill requires a motion which is similar to an emotion's action tendency performance, it may be enhanced, and if the motion is contrary to an emotion's action tendency, performance may be negatively impacted. To our knowledge, Woodman and colleagues (2009) were the first to investigate the emotion-performance-relationship within this framework and found that participants' performance on a dynamometer task was significantly greater in the anger condition in comparison to the emotionally neutral condition. The authors interpreted these results in line with Lazarus' CMR theory, in the way that performing in a dynamometer task is similar to the action tendency in anger (i.e., to lash out), what may have facilitated physical performance. In addition, Rathschlag and Memmert (2013) investigated the influence of self-generated emotions on the force of the finger musculature (Experiment 1), the jump height of a counter-movement jump (Experiment 2), and the velocity of a thrown ball (Experiment 3) and also found support for CMR theory. All of their experiments showed that participants could produce significantly better physical performances when recalling happiness in contrast to the emotion-neutral state. The first two experiments also revealed that physical performance in the happiness condition was significantly enhanced compared with the anxiety and sadness condition.

The present research

The present study is aimed at the investigation of the emotion-performance relationship by exploring the links between the self-generated emotions of happiness and anxiety and their effects on sprinting ability. Thus, for the first time, we investigate if the induction of a happy emotion, anxious emotion, or both, might enhance a sprinter's performance compared with an emotion-neutral state, which afterwards could give practical

implications for athletes to enhance their sprinting performance. To induce a desired emotion before a task, there have been a wide range of possibilities used in the past, such as: films (Rottenberg, Ray, & Gross, 2007), sounds (Bradley, & Lang, 1999), imagery scripts (Woodman et al., 2009), and pictures with emotional content (Lang, Bradley, & Cuthbert, 2005; Coombes, Cauraugh, & Janelle, 2006). However, in regard to the example of the sprinters, there is the problem that it is difficult to use external stimuli, such as films or pictures, which have been the methods of choice for inducing emotions in experiments directly before the beginning of the sprint. Thus, we wanted to avoid using external stimuli and preferred an 'internal' method for emotion induction which can be used by athletes on their own to induce a desired emotion. Therefore, we chose self-generated emotions for the induction of emotions, a method in which participants are normally asked to recall and re-experience personal emotional episodes (e.g., Damasio et al., 2000). There is already evidence that self-generating an emotion is an appropriate method to induce an emotional state like anxiety or happiness (e.g. Damasio et al., 2000; Rathschlag & Memmert, 2013).

Before we looked at the sprinting times in the different emotion induction conditions, we conducted a manipulation check to verify that the emotion manipulations had been successful in inducing the appropriate emotions. We hypothesized that feelings of happiness would be significantly enhanced in the happiness condition and that feelings of anxiety would be significantly enhanced in the anxiety condition compared to all other conditions. To verify further that the emotion manipulations had been successful, the dimension of arousal and hedonic tone (pleasantness) were measured, which is a typical procedure in studies where emotion are induced (e.g. Woodman et al., 2009). We expected that the arousal would not differ significantly between emotions of

happiness and anxiety but would in the emotion-neutral condition. Furthermore, we expected that the hedonic tone would be greater in the happiness condition in comparison to the emotion-neutral condition and greater in the emotion-neutral condition compared with the anxiety condition.

Given the previous promising research with the state of happiness from different research groups (e.g. Frederickson & Branigan, 2005; Kavanagh et al., 1986; Perkins et al., 2001; Totterdell, 2000) and previous results that the self-generation of happiness can improve performance (Rathschlag & Memmert, 2013), we hypothesized that participants who self-generate the emotion of happiness would benefit from this state and show a significantly reduced sprinting time compared with the emotion-neutral state. Furthermore, approach is an action tendency in happiness (Lazarus, 1991b) and we believed that if we induced happiness, this emotion would facilitate performance in the task because sprinting over a distance of 40 meters could be interpreted as an approach movement. Think of a soccer player who has made a very important goal and all of his teammates come sprinting full of happiness towards him. The action tendency for anxiety can be avoidance or escape (Lazarus, 2000b). Furthermore, a sprint over a distance of 40 meters seems to be very similar to the motion of escape. Thus, it would be expected that if anxiety was induced, the performance would also increase compared with the emotion-neutral state. To revise our hypotheses, we investigated in Experiment 1 the influence of three emotion induction conditions (happiness vs. anxiety vs. an emotion-neutral state) on sprint performance over a distance of 131 feet (40 meters). In Experiment 2, we replicated our results over a distance of 75 feet (22.86 meters) under the respective emotion induction conditions. Therefore, we followed a recent call from

Kingston, Smilek, Ristic, Friesen, and Eastwood (2003) who pointed out the necessity of replicating effects (see also Fiedler, 2011; Simmons, Nelson, & Simonsohn, 2011).

Experiment 1

Method

  Participants. Twelve male and twelve female sport students ($M = 23.10$ years, $SD = 2.22$) participated in the study. The participants were recruited by public advertisements at the local university and were all no experts in sprinting. The study was carried out in accordance with the Helsinki Declaration of 1975 and written informed consent was obtained from each participant prior to the experiment. Participants received no compensation for participation and none of the participants knew about the purpose of the study, its hypotheses, or CMR theory framework.

  Emotion-Induction. We used a method in which three emotional conditions (happiness, anxiety, and an emotion-neutral state) were induced by self-generating emotions via recalling personal emotional episodes. In the happiness condition, participants had to imagine a very happy moment in their lives and in the anxiety condition, to imagine a very anxious moment in their lives. For the emotion-neutral state, we suggested participants to imagine themselves brushing their teeth. This image was similar to the induction of this state via an emotion-neutral script outlining the process of brushing one's teeth (see Kavanagh & Hausfeld, 1986). However, we told participants that they should only imagine themselves brushing their teeth if they do not combine brushing their teeth with specific positive or negative emotions. If that was the case, we suggested participants to try to stay in no specific emotion. All participants

partook in each of the three emotional conditions which were counterbalanced across all participants.

Manipulation check. To verify that the emotion manipulations were successful, we used Likert scales (LS) to assess the degree to which participants experienced the different emotions. For each emotional condition, the induction of those respective emotions as well as valence and arousal were judged retrospectively by the participants on 9-point LS (happiness: 1 = no happiness to 9 = strongest happiness; anxiety: 1 = no anxiety to 9 = strongest anxiety; valence: 1 = most unpleasant to 9 = most pleasant; arousal: 1 = not arousing to 9 = most arousing).

Physical task. Participants performed sprints, starting from a standing position, over a distance of 40 meters under different emotional conditions. Running times for the sprints were measured with a radar system (Lichttastermesssystem; Sportronic), consisting of two light barriers positioned on the beginning and the end of the sprinting distance. Participants were asked to run the distance as fast as they could and could not see the velocity of their sprint after their trials. Participants performed the sprint twice in every condition, with a period of 180 seconds between the two trials. The mean of the two trials was used for analysis. We used 40 meter sprints instead of, for example, 100 meter sprints because every participant had to perform six sprints in our design, and the goal was to shorten the recovery phases and therefore the length of the experiment.

Procedure. We informed participants, who attended the testing sessions individually, that the experiment was an examination of physical performance under different conditions of emotion, and we provided them with instructions on how to complete the physical task. After providing demographic information and written consent before a warm-up phase of ten minutes, participants went to the starting line and

the experimenters outlined the emotion that was to be induced during the first emotion induction condition. Participants were asked to think of a situation in which they had experienced this emotion while they were standing at the starting line. After the participants' confirmation that they had a situation in mind, they were given one minute to self-generate the corresponding emotion. Immediately afterwards, announced by an acoustic signal, participants performed one sprint under this emotional condition. After 180 seconds, participants had again one minute to self-generate the respective emotion before they performed the second sprint in the same emotional condition. Immediately after each of both trials, we asked participants to complete the different LS retrospectively in relation to how they had felt prior to the sprint after the self-generation of the respective emotions. Afterwards, the mean values of the two trials were used for analysis.

We chose a resting time of ten minutes between each of the conditions to minimize any carryover effect from one emotional condition to the next. After the break of ten minutes, participants were asked to think of a situation in which they had experienced the next emotion, and the procedure, outlined above, started for the next emotion. The procedure was the same for each condition (i.e., happiness, anxiety, and the emotion-neutral state) and the order of presentation of the emotional conditions was balanced and randomized across participants.

Data Analysis. To begin with, we assessed the self-generated emotions' efficiency with respect to an induction of the respective emotions (happiness or anxiety) during the physical task. Thereafter, data was analyzed using single factor repeated measure (emotion induction: happiness vs. anxiety vs. emotion-neutral) ANOVAs to examine the different LS. For highlighting possible differences between the physical

performance in the different conditions, data was analyzed using a single factor repeated measure (emotion induction: happiness vs. anxiety vs. emotion-neutral) ANOVA.

Results

Manipulation check.

Happiness and Anxiety. Analyses revealed a significant happiness difference across emotional conditions, $F(2, 46) = 173.57$, $p < .001$, $\eta^2 = .87$). Follow-up Bonferroni correcting pairwise comparisons revealed that significantly more happiness was expressed in the happiness condition compared with the anxiety and emotion-neutral conditions ($p < .001$; see Table 1). Furthermore, participants experienced significantly more happiness in the emotion-neutral condition compared with the anxiety condition (p < .001). Moreover, there was an anxiety difference across emotional conditions, $F(2, 46) = 98.07$, $p < .001$, $\eta^2 = .79$). Participants reported significantly more anxiety in the anxiety condition compared with the happiness and emotion-neutral conditions ($p < .001$; see Table 1). The emotion-neutral and the happiness conditions did not differ significantly.

Arousal. There was a significant arousal difference across emotional conditions, $F(2, 46) = 12.07$, $p < .001$, $\eta^2 = .32$). Follow-up Bonferroni correcting pairwise comparisons showed that participants reported significantly less arousal in the neutral condition in relation to the happiness ($p < .001$) and the anxiety condition ($p < .009$). The difference between the happiness and the anxiety conditions was not significant.

Valence (Hedonic Tone). There was a significant hedonic tone difference across emotional conditions ($F(2, 46) = 77.94$, $p < .001$, $\eta^2 = .75$). Follow-up Bonferroni correcting pairwise comparisons indicated that participants reported significantly more pleasantness in the happiness condition compared to the anxiety and emotion-neutral

conditions (p < .001; see Table 1). Moreover, participants experienced more pleasantness in the emotion-neutral condition than in the anxiety condition (p < .001). The combined results of the LS revealed that the attempts to induce the different emotions were successful.

Performance.

Physical task. We found a main effect for emotion induction ($F(2, 46) = 3.42$, p < .041, $\eta^2 = .12$, power = .61). Follow-up comparisons indicated a significant difference between the happiness condition and both the emotion-neutral condition (p < .012) and anxiety condition (p < .016), indicating that participants in the happiness condition ran significantly faster compared with the emotion-neutral and anxiety conditions. The emotion-neutral and the anxiety condition did not differ significantly.

Table 7. **Tab 1.**

Likert Scale (LS) Happiness, LS Anxiety, LS Arousal, LS Hedonic Tone, and Mean Sprint Time (SD) for the Three Emotion Conditions in Experiment 1

Variable	Emotion Induction Condition		
	Happiness	Neutral	Anxiety
	M SD	M SD	M SD
Happiness	6.92 (3.34)	3.34 (1.49)	1.96 (1.06)
Anxiety	1.88 (0.72)	1.78 (1.29)	5.96 (1.78)
Arousal	6.03 (2.00)	4.03 (1.50)	5.51 (2.17)
Hedonic Tone	7.59 (1.14)	4.86 (1.26)	2.69 (1.63)
Sprint time (s)	5.75 (0.44)	5.84 (0.43)	5.83 (0.44)

Discussion

The aim of Experiment 1 was to examine for the first time the influence of the self-generated emotions of happiness and anxiety on sprint performance. Our findings partially supported our hypotheses:

Participants' sprint performances were significant enhanced in the happiness condition compared with the emotion-neutral and anxiety conditions, and thus, we found a performance-increasing effect for the emotion of happiness. These results are in line with Kavanagh and Hausfeld (1986) who also found that the induction of happiness has a positive effect on physical performance compared with an emotion-neutral state and a negative state (sadness). These results are also consistent with Lazarus's (2000b) suggestion that happiness may facilitate physical performance if the required skill is similar to happiness' action tendency (i.e. to approach). If we interpret our sprint task as an approach movement, our results are consistent with Lazarus' (2000b) suggestion and could explain the facilitation of performance in the happiness condition. In addition, the results obtained in Experiment 1 are consistent with previous findings (Rathschlag & Memmert, 2013) in which the authors found that happiness leads to a significantly enhanced physical performance compared with an emotion-neutral state in the strength of the finger musculature, in the jump height and velocity of a thrown ball.

For the emotion of anxiety, we could not confirm our hypothesis that the induction of anxiety would also have a performance-increasing effect. We believed that an anxious memory would activate anxiety's action tendency of escape and would therefore also lead to an increased sprint performance. Although the manipulation check showed that we were successful in inducing the emotion of anxiety, the results for the sprinting times showed no significant differences between the emotion of anxiety and

the emotion-neutral state. This result is in line with the findings of Nicholls et al. (2010), the meta-analyses of Craft et al. (2003) and Woodman & Hardy (2003) who found that the relationship between anxiety and performance is relatively weak. Furthermore, this result is consistent with a previous study (Rathschlag & Memmert, 2013) in which the authors also could not find significant differences between anxiety and the emotion-neutral state. Rathschlag and Memmert (2013) interpreted this finding in the way that they believed that their physical tasks did not activate anxiety's action tendency of escape. However, a sprint performance seems to be very similar to anxiety's action tendency of escape. One explanation for this result might be derived from the theory of challenge and threat states in athletes (Jones et al., 2009) which assumes that athletes who interpret the forthcoming competition and possible anxious symptoms as a challenge perform better than athletes who interpret the competition as a threat. Therefore, in Experiment 2, we also investigated whether participants interpreted the sprint task as challenging or threatening in the different emotional conditions.

In addition, there are different perceptions on how to conduct a good manipulation check for the induction of emotions (e.g. Rottenberg et al., 2007; Woodman et al., 2009). In Experiment 1, we asked participants retrospectively after the sprint to judge based on the LS how good they could induce the different emotions before performing the sprints. We already explained that we used this procedure because we did not want to interrupt the process of self-generation of an emotion prior to the sprint. However, this procedure has the disadvantage that the performance on the sprint task may influence a participants' emotional state. Therefore, in Experiment 2, we measured the different LS prior to the sprint after the self-generation and examine whether we could replicate our previous findings.

Experiment 2

The aim of Experiment 2 was to improve our understanding of how the self-generated emotions of happiness and anxiety might influence the sprint performance. We found in Experiment 1 that the induction of the emotion of happiness led to significantly improved sprinting times compared with the emotion of anxiety and an emotion-neutral state over a distance of 131 feet (40 meters). In Experiment 2, we wanted to replicate our results over a distance of 75 feet (22.86 meters) which is a typical distance for diagnosing sprint performance (e.g. NBA Combine in basketball). As described above, we measured pre-performance emotions as well as arousal and hedonic tone in this experiment prior to the task and hypothesized that the results would be the same as in Experiment 1. One further extension of Experiment 1 was that we also measured participants' ratings, if they interpreted the sprinting task as a challenge or as a threat in the different emotional conditions. We hypothesized that in the anxiety condition, we would find a correlation between high values in the LS for the judgment of the sprinting task as a challenge with fast sprinting times. On the other hand, in the anxiety condition, high values in the LS for the judgment of the sprinting task as a threat would correlate with slow sprinting times.

Furthermore, we screened the participants with the standardized State-Trait-Anxiety-Inventory (Laux, Glanzmann, Schaffner, & Spielberger, 1981). We believed that high state and trait anxiety might possibly enhance anxiety's action tendency of escape. Therefore, we hypothesized a significant correlation between the values in the STAI and the sprinting times in which high values in the STAI would come along with faster sprinting times in the anxiety condition.

Method

      Participants. A total of 20 sport students (10 women, 10 men) with a mean age of $M = 22.80$ years ($SD = 2.22$) participated in the study. All of the participants were no experts in sprinting. The process of recruiting participants was the same as described in Experiment 1.

      Emotion-Induction. The induction of the emotions was conducted in the same manner as in Experiment 1. Again, we had three emotional conditions (happiness, neutral, and anxiety) which were induced by recalling personal emotional episodes.

      Manipulation check. We used the same LS as described in Experiment 1.

      Challenge-threat scale. In addition, participants rated on 9-point LS the appraisal of the forthcoming physical task as a challenge as opposed to a threat. Therefore, participants had to rate the statements "The task seems like a challenge for me (1 = no challenge to 9 = highest challenge)," and "The task seems like a threat for me (1 = no threat to 9 = highest threat)." These two items were already used in a study by Drach-Zahavy and Erez (2002). Participants filled out all LS directly after the one minute of self-generation of an emotion prior to the sprint.

      State-Trait-Anxiety-Inventory (STAI). Participants were asked to fill out the State-Trait-Anxiety-Inventory (STAI; Laux et al., 1981) which is a self-description questionnaire including two independent scales, the applied state-anxiety-scale (STAI-G Form X1) and the trait-anxiety-scale (STAI-G Form X2), each of them consisting of 20 items.

      Physical task. The only difference to Experiment 1 consisted of the sprinting distance which was in Experiment 2 a distance of 75 feet (22.86 meters) instead of 131 feet (40 meters). Participants were also asked to run the distance as fast as they could,

and performed two sprints in every emotional condition with 180 seconds between the two trials of the same condition and a rest of ten minutes between the different emotional conditions.

Procedure. The procedure was mainly the same as described in Experiment 1. We informed the participants that we were examining the sprint performance under different emotional conditions. After providing demographic information and written consent, participants filled out the STAI. After finishing the STAI, the participants had ten minutes to warm-up and went afterwards to the starting line. Then the **e**xperimenters outlined the emotion that was to be induced during the first emotional condition and participants were asked to think of a situation in which they had experienced this emotion. Participants had again one minute to self-generate the corresponding emotion at the starting line and immediately after one minute, participants were asked to judge the manipulation of the emotion in the different LS. In addition, participants had to rate in two further LS how intensive they interpreted the forthcoming sprinting task as a 'challenge' and as a 'threat'. Immediately after completing the different LS, participants performed one sprint under the first emotional condition. After 180 seconds, participants had again one minute to self-generate the first emotion, filled out again the different LS, and performed the second sprint in the same emotion as before. After a rest of ten minutes, the same procedure started with the second emotion. The order of presentation for the emotional conditions was again balanced and randomized across participants. The mean sprinting times and values in the LS for each emotional condition were further used for analysis.

Data Analysis. Firstly, to assess the self-generated emotions' efficiency with respect to induction of the respective emotions (happiness, neutral, and anxiety), single-

factor repeated-measured ANOVAs were conducted for the different LS's. Secondly, the three emotional conditions were compared in relation to the sprinting performances. Consequently, data was analyzed using a single-factor repeated-measure ANOVA. Thirdly, we correlated the sprinting times in the anxiety condition with the values in the STAI and the LS for either 'challenge' or 'threat.'

Results

Manipulation check

Happiness and Anxiety. Analyses revealed a significant happiness difference across emotional conditions, $F(2, 38) = 64.69$, $p < .001$, $\eta^2 = .77$). Follow-up Bonferroni correcting pairwise comparisons revealed that significantly more happiness was expressed in the happiness condition compared with the anxiety and emotion-neutral conditions ($p < .001$; see Table 2). Furthermore, participants experienced significantly more happiness in the emotion-neutral condition compared to the anxiety condition (p < .001). Moreover, there was an anxiety difference across emotional conditions, $F(2, 38) = 117.83$, $p < .001$, $\eta^2 = .91$). Participants reported significantly more anxiety in the anxiety condition compared with the happiness and emotion-neutral conditions ($p < .001$; see Table 2). The emotion-neutral and the happiness conditions did not differ significantly.

Arousal. There was a significant arousal difference across emotional conditions, $F(2, 38) = 10.41$, $p < .001$, $\eta^2 = .35$). Follow-up Bonferroni correcting pairwise comparisons showed that participants reported significantly less arousal in the neutral condition in relation to the happiness ($p < .004$) and anxiety conditions ($p < .009$). The difference between the happiness and the anxiety conditions was not significant.

Valence (Hedonic Tone). There was a significant hedonic tone difference across emotional conditions, $F(2, 38) = 60.76$, $p < .001$, $\eta^2 = .76$. Follow-up Bonferroni correcting pairwise comparisons indicated that participants reported significantly more pleasantness in the happiness condition compared to the anxiety and emotion-neutral conditions ($p < .001$; see Table 2). Moreover, participants experienced more pleasantness in the emotion-neutral condition than in the anxiety condition ($p < .001$). The combined results of the LS reveal that the attempts to induce the different emotions were successful.

Performance

Physical task. We found a main effect for emotion induction ($F(2, 38) = 10.31$, $p < .001$, $\eta^2 = .51$, power $= .95$). Follow-up Bonferroni correcting pairwise comparisons indicated a significant difference between the happiness condition and the emotion-neutral condition ($p < .001$), indicating that participants in the happiness condition ran significantly faster when compared with the emotion-neutral condition (see Table 2). The emotion-neutral and the anxiety condition did not differ significantly. The happiness and the anxiety conditions also differed significantly ($p < .012$), indicating that participants in the happiness condition ran significantly faster when compared with the anxiety condition.

Correlations

STAI and Performance. There were no significant correlations between the sprinting times in the anxiety condition and both the state anxiety scale (STAI-G Form X1) and the trait anxiety scale (STAI-G Form X2).

Challenge-threat scale and Performance. There were also no significant correlations between the sprinting times in the anxiety condition and participants' judgments of the forthcoming physical task as either a 'challenge' or 'threat.'

Table 8. **Tab 2.**

Likert Scale (LS) Happiness, LS Anxiety, LS Arousal, LS Hedonic Tone, LS Challenge, LS Threat and Mean Sprint Time (SD) for the Emotion Conditions in Experiment 2.

	Emotion Induction Condition		
Variable	Happiness	Neutral	Anxiety
	M SD	M SD	M SD
Happiness	7.40 (1.09)	4.65 (2.03)	1.65 (1.63)
Anxiety	.95 (1.39)	.90 (1.21)	6.45 (1.53)
Arousal	5.75 (1.51)	3.80 (2.23)	6.05 (1.79)
Hedonic Tone	7.45 (1.70)	5.60 (1.56)	1.75 (2.09)
Challenge	3.65 (2.64)	2.85 (2.08)	3.95 (2.52)
Threat	.45 (.94)	.35 (.58)	1.90 (2.38)
Sprint time (s)	3.77 (.37)	3.81 (.35)	3.81 (.35)

Discussion

The purpose of Experiment 2 was to confirm the results presented in Experiment 1 in that the induction of the emotion of happiness leads to significantly improved sprinting times compared with the emotion of anxiety and an emotion-neutral state. Firstly, we conducted the manipulation check in Experiment 2 prior to the sprints so that we could be sure that the performance itself had no influence on participants' ratings in the LSs for the induction of the emotions. Our analysis showed that we could support the

findings from Experiment 1: Although we conducted the manipulation check prior to performance and investigated a different sprinting distance (131 feet in Experiment 1 and 75 feet in Experiment 2), the induction of the emotion of happiness also led to significantly better sprinting times compared with the emotion of anxiety and the emotion-neutral state. Thus, it seems possible that the performance-increasing effect of the emotion happiness can be generally used to improve sprinting distances. In line with the results of previous studies (Kavanagh & Hausfeld, 1986; Rathschlag & Memmert, 2013; Totterdell, 2000) and our hypothesis that our task could have activated happiness' action tendency of approach which is responsible for the facilitation of the performance in this emotional condition, our findings suggest that the emotion of happiness can improve participants' performance. In addition, consistent with the findings in Experiment 1 and previous results (Rathschlag & Memmert, 2013), we could not find significant differences between the anxiety condition and the emotion-neutral condition. We expected to find significant correlations between the sprinting times in the anxiety condition and the values in the Challenge and Threat Scale and the STAI. However, the correlations were not significant. Thus, it seems that sprinting in a state of anxiety is independent of the judgments of those tasks as either challenges or as threats and independent of participants' state and trait anxiety.

General Discussion

In the above study, we investigated in two experiments the effect of the self-generated emotions of happiness and anxiety on sprinting performance and expected that both emotions would lead to a significantly reduced sprinting time compared with the emotion-neutral condition. The results in both experiments demonstrated that the performance in the happiness condition was significantly enhanced compared with the

emotion-neutral condition but that there were no significant differences between the anxiety condition and the emotion-neutral condition. In this respect, we provided evidence for one of our hypotheses that the induction of the emotion of happiness can have a performance-increasing effect.

Firstly, the combined results of all LS revealed that the attempts to induce the different emotions were successful in both experiments. We have already mentioned that there are different concepts on how to conduct a good manipulation check (e.g. Rottenberg et al., 2007; Woodman et al., 2009). Therefore, in Experiment 1, the manipulation check of the induction of the emotions was done retrospectively and in Experiment 2, prior to physical performance. The values in the different LS did not change significantly between both experiments but showed clearly that we were successful in inducing the respective emotions. In addition, Woodman et al. (2009) questioned in their paper whether any arousal-inducing emotion would result in an increased effort and therefore lead to an enhanced performance. Although, the hedonic tone of the emotions of happiness and anxiety differed significantly in both experiments, the values in the LS for arousal did not differ between both groups. Therefore, it seems that the arousal of participants was not responsible for the different sprinting times in the emotional conditions of happiness and anxiety. This result is also in line with Rathschlag and Memmert (2013) and the findings of Woodman and colleagues (2009) who showed that self-generating of a positive emotion (happiness) and a negative emotion (anger), with no significant arousal differences, leads to significantly different physical performances in a physical task. Altogether, we believe that it is not only the arousal of the emotions which leads to an increased performance, but rather that the performance in specific physical skills is different depending on the particular self-generated emotions.

For the happiness condition, we found that this emotion could facilitate performance in the assignments of both of our experiments. We conclude that our results are in line with Lazarus' (2000b) suggestion that an emotion can increase performance if the required skill is similar to the emotion's action tendency. The core relational theme for happiness is "making reasonable progress toward the realization of a goal (Lazarus, 2000a)" and approach is an action tendency in happiness (Lazarus, 1991b). We believe that the sprint task in our experiments could be interpreted as an approach movement, and thus, the task is similar to the action tendency of 'approach' in happiness. However, we are aware that there is some ambiguity, even if a task is similar to specific emotion's action tendencies or not. Thus, we only present a possible explanation of why we believe that our task could have been similar to the action tendencies in the happiness condition. In addition, our result that a positive emotion like happiness can increase performance in physical tasks is in line with other studies (Kavanagh et al., 1986; Perkins et al., 2001; Totterdell, 2000). Furthermore, we found the same results as Rathschlag and Memmert (2013) in which the induction of happiness facilitated physical performance in different physical tasks in contrast to a neutral and an anxious state.

For the anxiety condition, our results did not support our hypothesis that the emotion of anxiety would also enhance performance in our task compared with the emotion-neutral condition. In Experiment 1, we expected that the self-generation of the emotion of anxiety would improve the sprinting times because sprinting might be interpreted as a motion which is similar to anxiety's action tendency of escape (Lazarus, 2000b). Although the manipulation check indicated that the induction of anxiety was successful, we could not find a performance-increasing effect of anxiety when we compared the sprinting times in the anxiety condition and the emotion-neutral condition.

However, this result is in line with several studies (Craft et al., 2003, Nicholls et al., 2010, Rathschlag & Memmert, 2013; Woodman & Hardy, 2003) who could also not find an effect of anxiety on physical performance.

In Experiment 2, we further investigated if we could explain the missing findings in the anxiety condition with the theory of challenge and threat states in athletes (Jones et al., 2009). However, we found no significant correlations between the sprinting times in the anxiety condition and participants' perception of the forthcoming competition as a challenge, which has in general a performance-increasing effect, or as a threat, which has normally a performance-decreasing effect (Jones et al., 2009). In addition, we could also not find significant correlations with the values in the STAI.

One possible explanation for the null findings in the anxiety condition could be found on the basis that 'escape' is in all probability not the only action tendency in anxiety. For example, the model of Cannon (1929) divides between a fight, a flight and a freeze response. The model hypothesizes that animals and humans react to anxious situations with a general discharge of the sympathetic nervous system, priming the animal or humans for fighting or fleeing. However, in the model of Cannon (1929) there is a third response to anxious situations called 'freezing.' In situations where fighting or fleeing responses are likely to be ineffective, a freeze response takes place. This response, often referred to as tonic immobility (Gallup, 1977), includes motor and vocal inhibition (Schmidt, Richey, Zvolensky, & Maner, 2008). For example, a relatively high percentage of rape victims feel paralyzed and unable to act despite no loss of consciousness during the assault (Burgess & Holmstrom, 1976; Heidt, Marx, & Forsyth, 2005). Schmidt et al. (2008) explored the responses to a threat stressor and found that perceptions of immobility in the context of the threat stressor were reported in 13% of

the sample, compared to 20% reporting a desire to flee. In our present research, participants were asked to remember any kind of anxious situation in their past and were not asked which specific situation they had thought of and what action tendencies they had felt in that situation.

Thus, future studies could ask participants to describe their specific anxious memories and associated action tendencies, or participants could be asked to generate specifically anxious situations, where they have fought, fled, or frozen, and these different anxiety conditions could be compared to sprinting times. We would hypothesize that participants who self-generate anxious situations which are connected with 'fight' or 'flight' responses would have significantly reduced sprinting times compared with emotion-neutral conditions. On the other side, we would assume that participants who self-generate anxious situations which are connected with 'freezing' or 'tonic immobility' would have a significantly increased sprinting time compared with an emotion-neutral condition. Overall, we believe that in our experiment the missing difference between the anxiety emotional condition and the emotion-neutral condition might be a result of the mixture in the anxiety condition of fight and flight responses with reduced sprinting times and 'freeze' response with increased sprint times.

A further explanation for our findings that a positive emotion like happiness can enhance physical performance might be derived from the "broaden-and-build" theory of Frederickson (2001). This theory proposes that "experiences of positive emotions broaden people's momentary thought-action repertoire, which in turn serves to build their enduring personal resources, ranging from physical and intellectual resources to social and psychological resources (Frederickson, 2001, p.218)." Furthermore, this theory would be supported by many studies which have already documented the benefits

of this positive affect (for a review, see Lyubomirsky, King, & Diener, 2005). Our main conclusion, that a positive emotion like happiness is able to enhance performance, could be interpreted in line with the report of Frederickson and Branigan (2005) who investigated thought-action repertoires in different emotional conditions. Frederickson and Branigan (2005) found that participants' thought-action urges were significantly enhanced in positive emotions like amusement and contentment compared with anxiety, anger and an emotion-neutral state, and that there were no significant differences between the anxiety and neutral conditions. One possible hypothesis for future research might be that the increased thought-action urges in a positive emotion are connected with an increased physical performance in such a positive emotional condition. Overall, it seems that the broaden-and-built theory (Frederickson, 2001) might be another reasonable framework for our findings.

With regard to the results of the experiment from a practical sport perspective, it seems to be helpful for athletes to self-generate the emotion of happiness before a sprint to enhance physical performance. However, it has to be noted that the findings in our experiment can be generalized only to similar contexts, and future research could examine whether these emotions affect performance only in sprinting or in other endurance competitions with different distances as well. Furthermore, future studies could investigate if experience in self-generating emotions plays a role in the influence on performance. One hypothesis might be that experience in the self-generating of emotions like happiness could improve future performance. Future research is needed to further examine this hypothesis and to investigate whether the induction of different self-generated emotions has an influence on performance in more physical tasks.

Chapter 6

The Wingwave Method

Rathschlag, M., & Memmert, D. (submitted). Reducing Anxiety and Enhancing Physical Performance by an Advanced Version of EMDR. *Depression and Anxiety*

Abstract

Background: The main aim of the study was to investigate the efficacy of an advanced version of EMDR for reducing anxiety.

Methods: Fifthy participants were asked at two times of measurement (T1 and T2 with a rest of four weeks) to self-generate the emotion anxiety via the recall of autobiographical memories according to their anxiety. Furthermore, the participants were randomly assigned to an experimental group (EG) and a control group (CG), whereupon the EG received an intervention of 1-2 hours with the advanced version of EMDR in order to their anxiety two weeks after T1. At T1 as well as T2 we measured the intensity of participants' anxiety with a Likert scale and collected participants' state (temporary) and trait (chronic) anxiety with the State-Trait-Anxiety-Inventory (STAI). In addition, we measured participants' physical performance in a test for the finger musculature under the induction of their anxiety.

Results: The results showed that the intensity of anxiety and the state and trait anxiety decreased significantly in the EG but not in the CG from T1 to T2. Moreover, the physical performance under the induction of participants' anxiety increased significantly in the EG from T1 to T2 and there were no significant changes in the CG.

Conclusions: The study could show that the advanced version of EMDR is an appropriate method to reduce anxiety.

Key words: EMDR, Anxiety, Treatment of anxiety, Physical performance, Wingwave

Introduction

A large part of our society is suffering from anxiety and its associated symptoms. Anxiety disorders are the most common mental illness in the United States, affecting around 40 million adults (ADAA, 2013), with these individuals spending all together billions of dollars every year in treatments and remedies (Barlow, 2002). Anxiety is also considered as an important factor influencing sport performance (e.g. Kleine, 1990). Therefore, humans need methods that can help them to choke with their anxiety. Traditional methods, like for example the cognitive-behavioral therapy (CBT), have been established as empirically supported treatments for anxiety disorders (e.g. Chambless & Ollendick, 2001), however they often require long periods of treatment: "The large majority of people who suffer from an anxiety disorder are able to reduce or eliminate their anxiety symptoms and return to normal functioning after several months of appropriate psychotherapy" (APA, 2013). Hence, researchers are always looking for new methods which can also be successful in reducing anxiety symptoms using shorter periods of time.

The purpose of this paper is to investigate an advanced version of the technique of Eye movement desensitization and reprocessing (EMDR; Shapiro, 1989) for the treatment of anxiety, the so-called wingwave method (Besser-Siegmund & Siegmund, 2010, 2013). The inventors of this method affirm that the wingwave method is appropriate in reducing anxiety symptoms in only a few hours of intervention. The wingwave method utilizes the technique of EMDR (Shapiro, 1989) as main intervention tool. EMDR was developed by Shapiro (1989) for the treatment of patients with post-traumatic stress disorder (PTSD) and has been empirically validated (Carlson, Chemtob, Rusnak, Hedlund, & Muraoka, 1997; Marcus, Marquis, & Sakai, 1997; Rothbaum,

1997; Shapiro, 1999). In EMDR treatment the patient recalls trauma-related memories and while simultaneously attending to inner thoughts and sensory stimulation from a rhythmic, bilateral source. The sensory stimulus is most typically visual (hence "eye movement"), but can be auditory, tactile or proprioceptive (Shapiro, 2001). In the first fMRI-study about EMDR, Ohtani, Matsuo, Kasai, Kato & Kato (2009) showed that performing eye movements during trauma-related recall reduces activity in the lateral prefrontal cortex (PFC) which may be a part of the biological basis for the efficacy of EMDR in PTSD. Furthermore, EMDR is not only used in the treatment of PTSD but also in the treatment of anxiety (De Jongh, van den Oord, & ten Broeke, 2002; Muris, & Merckelbach, 1997). De Jongh, & ten Broeke (2009) found that there is randomized outcome research for panic disorders and specific (i.e., spider) phobia, but not for other anxiety disorders (i.e., social phobia, OCD, and GAD).

However, in addition to the intervention with EMDR, the wingwave method uses for the diagnostic of stress triggers and for evaluating the success of the treatment a muscle test named the Bi-Digital-O-Ring-Test (BDORT) originally developed by Omura (1985). In the BDORT a subject has to form a 'ring' with the thumb and the index finger and the diagnostician tries to pry them apart. The idea of Besser-Siegmund & Siegmund (2010) is that subjects' strength of the finger musculature in the BDORT is different depending on which kind of emotion they self-generate and how good patients can deal with this emotion. Rathschlag and Memmert (2013) used an objective form of the BDORT and they found that subjects inducing self-generated emotions can generate a lower physical performance in the finger musculature when recalling anxiety and sadness in comparison to happiness or anger.

Wingwave combines BDORT and EMDR in a way that subjects only have to perform eye movements during anxiety-related recall of specific stressors when the subject cannot hold the 'ring' of their thumb and their index finger together, when the diagnostician tries to pry them apart That is, subjects' possible stress triggers will be tested with the BDORT and only the imagination of the triggers which lead to an decreased physical performance in the finger musculature will be treated with EMDR Furthermore, Besser-Siegmund & Siegmund (2010, 2013) hypothesize that after an successful intervention with EMDR the physical performance in the BDORT is enhanced when participants were asked to self-generate their anxiety or specific stressors of their anxiety again.

The present research

The purpose of this study was to contribute to research on treatment options for anxiety by exploring an advanced version of EMDR. In this study, the participants had to self-generate the emotion of anxiety by recalling an autobiographical memory. Furthermore, subjects were randomly assigned to either an experimental group (EG) or a control group (CG). Between the two times of measurement (T1 and T2), where we checked participants' intensity of anxiety and their state and trait anxiety, the EG received an intervention of 1-2 hours with respect to their anxiety with the wingwave method whereas no intervention was employed to the CG. According to the ideas of Besser-Siegmund and Siegmund (2010), we hypothesized that the wingwave method will significantly decrease anxiety from T1 to T2 in the EG but not in the CG.

Furthermore, we checked for both times of measurement the strength in the finger musculature in our objective form of the BDORT, when participants self-generated their anxiety. One assumption of the advanced version of EMDR is that

participants can deal with their anxiety after the intervention and the strength in the finger musculature will be enhanced when the anxiety will be induced once more. According to this assumption, we hypothesized that the strength in the finger musculature in the anxiety condition will increase significantly for the EG but not for the CG from T1 to T2.

Method

Participants

Twenty-two male and 28 female subjects ($M = 23.30$ years, $SD = 2.19$) with an age range between 20 to 32 years old participated in this study. They were recruited via announcements in local newspapers and at the campus of the local university. The subjects were randomly assigned to either an EG or a CG. Both groups were comparable with respect to age (EG: $M = 24.10$ years, $SD = 2.05$; CG: $M = 22.50$ years, $SD = 2.34$). The study was carried out in accordance with the Helsinki Declaration of 1975. Written informed consent was obtained from each participant prior to the experiment and the participants received no compensation for participation.

Induction of anxiety

The emotion of anxiety was induced via the recall of a personal emotional episode which was connected to this emotion. Thus, participants had to imagine themselves a very anxious moment in their lives where they could still feel this anxiety at the current time and were asked to relive this anxiety. There is already evidence that self-generating an emotion is an appropriate method to induce an emotional state like anxiety (e.g. Damasio et al., 2000; Rathschlag & Memmert, 2013). Previous results by Rathschlag and Memmert (2013) demonstrated that participants who self-generated the emotion of anxiety experienced significantly more anxiety in this condition compared

with other emotions (e.g. happiness, anger, and sadness). These finding are in line with a lot of other studies (e.g. Lench, Flores, & Bench, 2011; Lench & Levine, 2005; Stopa & Waters, 2005) and showed that anxiety can be generated in this way. In addition, participants were asked to recall the same personal emotional episode for both times of measurement.

Measurement of the intensity of anxiety

We used a Likert scale (LS) to assess the degree of which participants experienced the emotion of anxiety at the current time. Participants rated the emotional intensity of their anxiety, using a 9 point Likert scale (emotional intensity: 1 = no anxiety to 9 = most anxiety)

Measurement of State and Trait Anxiety

In addition, anxiety was recorded using the standardized State-Trait-Anxiety-Inventory (Laux, Glanzmann, Schaffner, & Spielberger, 1981). The State-Trait-Anxiety-Inventory is a self-description questionnaire including two nondependent scales, the applied state-anxiety-scale (STAI-G Form X1) and the trait-anxiety-scale (STAI-G Form X2), each of them consisting of 20 items. The scale sum values range from 20 to 80.

Physical task

We used a machine (see Figure 1, p. 31) that represents an objective measurement of the Bi-Digital O-Ring-Test (BDORT), developed by Omura (1985), to measure the strength of the finger musculature. This machine was already utilized by Rathschlag and Memmert (2013) and the authors could show that the machine is an objective and reliable measurement for the strength of the finger musculature. The machine generated a pulling force that separates the index finger and the thumb when they touch each other to form a ring and the strength of the puling force could be

controlled by a regulator. We first started to investigate participant's maximal strength using the one repetition maximum which was defined as the highest pulling force at which participants can still hold the ring of index and thumb together. Therefore, the strength of the pulling force was added in small increments (0.5 to 1.0 bar), with a resting period of 30 seconds between measurements, until the subject could no longer hold the ring of index finger and thumb together. All measurements under the emotion of anxiety were tested at 90% of participants' individual maximum voluntary contraction (MVC). To analyze the measurements, we filmed participants' hands by a digital camera and the film material was observed by three raters who had to decide independently whether the ring of index finger and thumb was open or closed. The raters were not informed about which emotion participants had to induce. The coding system was the following: 1.0 = "unclosed ring", 1.3 = "approximately unclosed ring", 1.7 = "approximately closed ring", 2.0 = "closed ring". After we assessed inter-rater-reliability of the three different subjective strength ratings, the mean of the three rater judgments (mean of the six measurements under the emotion of anxiety) was used for analysis.

Procedure

Participants were tested individually and were instructed that we propose to examine a new method for the treatment of anxiety at two different times of measurement and that they will be allocated to an EG or a CG. At T1, after providing demographic information and written consent, participants filled out the State-Trait-Anxiety-Inventory (Laux et al., 1981). Subsequently, participants were familiarized with the machine for the objective measurement of the BDORT and we tested the individual MVC of the participants. Following this, participants were asked to think of a situation in which they had experienced their anxiety. When participants confirmed that they had

a situation in their mind, they had one minute to self-generate this emotion and to indicate the intensity of anxiety on the corresponding LS. Immediately afterwards, participants put their thumb and index finger in the machine for the objective measurement of the BDORT and performed six measurements of the force of the finger musculature (90% MVC) under the emotion of anxiety, with breaks of 30 s in between each of the six trials. The moment in which the machine generated the pulling force was announced by an acoustic signal three seconds in advance. From that moment on, participants were asked to hold the ring of index finger and thumb together with their maximum force and go on with self-generating the emotion. After one trial, participants were asked to relax their fingers in the machine until the next acoustic signal but go on with self-generating their anxiety in the rest intervals between the trials. Participants completed six trials under the emotion of anxiety.

The participants had been randomly assigned to an EG or a CG. Between the two times of measurement, there was a rest of four weeks and two weeks after T1 the EG received an intervention with the wingwave method of only 1-2 hours by an qualified wingwave coach whereas the CG received no intervention. The twenty-five participants in the EG were randomly allocated to five different qualified wingwave coaches, which were comparable in relation to years of expertise with the wingwave method, and thus, each wingwave coach conducted an intervention with this method with five participants. The procedure for T2 was the same as described above for T1.

Data Analysis

First, we assessed participants' intensity of anxiety with the LS in both groups and for both times of measurement. Therefore, data were analyzed using a 2 (group: EG vs. CG) x 2 (time of measurement: T1 vs. T2) ANOVA with repeated measures on the

second factor. Second, after checking the inter-rater-reliability for the three different strength ratings, by calculating intra-class correlation coefficients (ICC; Shrout & Fleiss, 1979), we compared the EG and the CG in relation to their strength in the BDORT when inducing their anxiety for both times of measurement. The data were analyzed using a 2 (group: EG vs. CG) x 2 (time of measurement: T1 vs. T2) ANOVA with repeated measures on the second factor. Third, we compared the EG and the CG in relation to the data in the STAI-G, divided in STAI-G-State and STAI-G-Trait for both times of measurement. Hence, data were analyzed using two 2 (group: EG vs. CG) x 2 (time of measurement: T1 vs. T2) ANOVAs with repeated measures on the second factor.

Results

Intensity of Anxiety

The ANOVA did not reveal an main effect for time of measurement ($F(1, 47) = 3,844$) and for group ($F(1, 47) = .472$). However, there was a significant interaction between time of measurement and group ($F(1, 47) = 9.26$, $p < .008$, $\eta^2 = .16$). For T1, the mean values of anxiety did not differ significantly between both groups. However, the interaction indicated that the mean values of anxiety decreased in the EG from the first to the second time of measurement and the mean values of anxiety in the anxiety condition were as far as possible unchanged (see Figure 2).
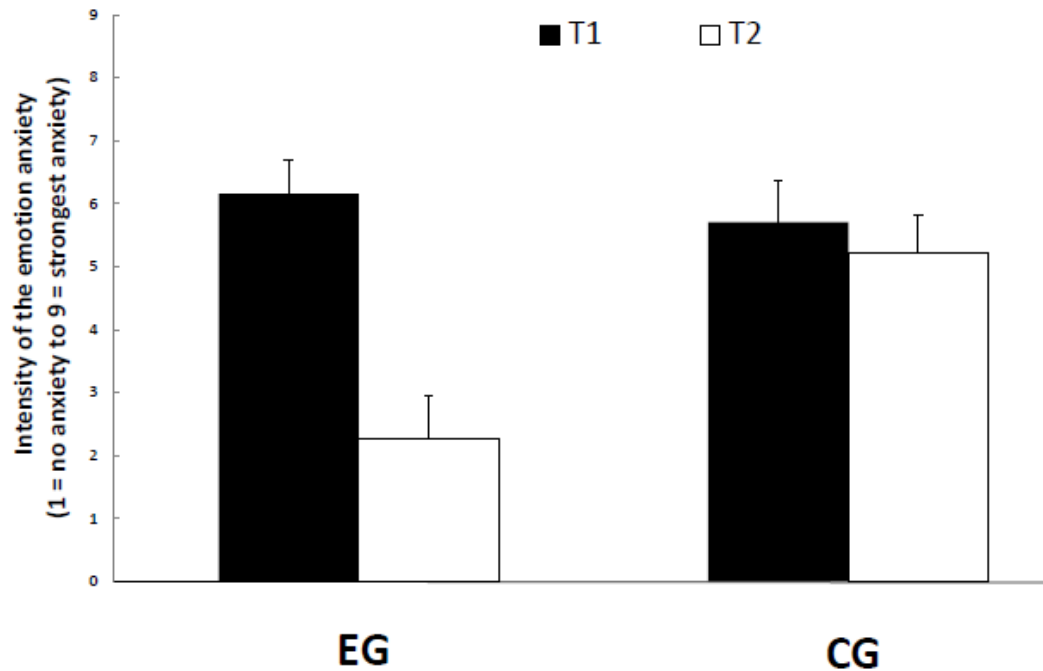
Figure 2. *Likert Scale (LS) for the Intensity of Anxiety in the Experimental Group (EG) and the Control Group (CG) for time of measurement 1 (T1) and time of measurement 2 (T2).*

Physical task

First, the inter-rater reliability coefficients were acceptable for all judges (ranging from 0.90 to 0.96 and averaging 0.93) for both times of measurement. The subsequent 2 (group: EG vs. CG) x 2 (time of measurement: T1 vs. T2) ANOVA yields a main effect for time of measurement ($F(1, 48) = 13.44$, $p < .001$, $\eta^2 = .21$) but not for group ($F(1, 48) = 3.20$). In addition, we found a significant interaction between group and time of measurement ($F(1, 48) = 12.96$, $p < .001$, $\eta^2 = .21$). The interaction indicated that the induction of anxiety led to an increased strength in the EG from T1 to T2 and the strength in the CG was as far as possible unchanged from T1 to T2 (see Figure 3).
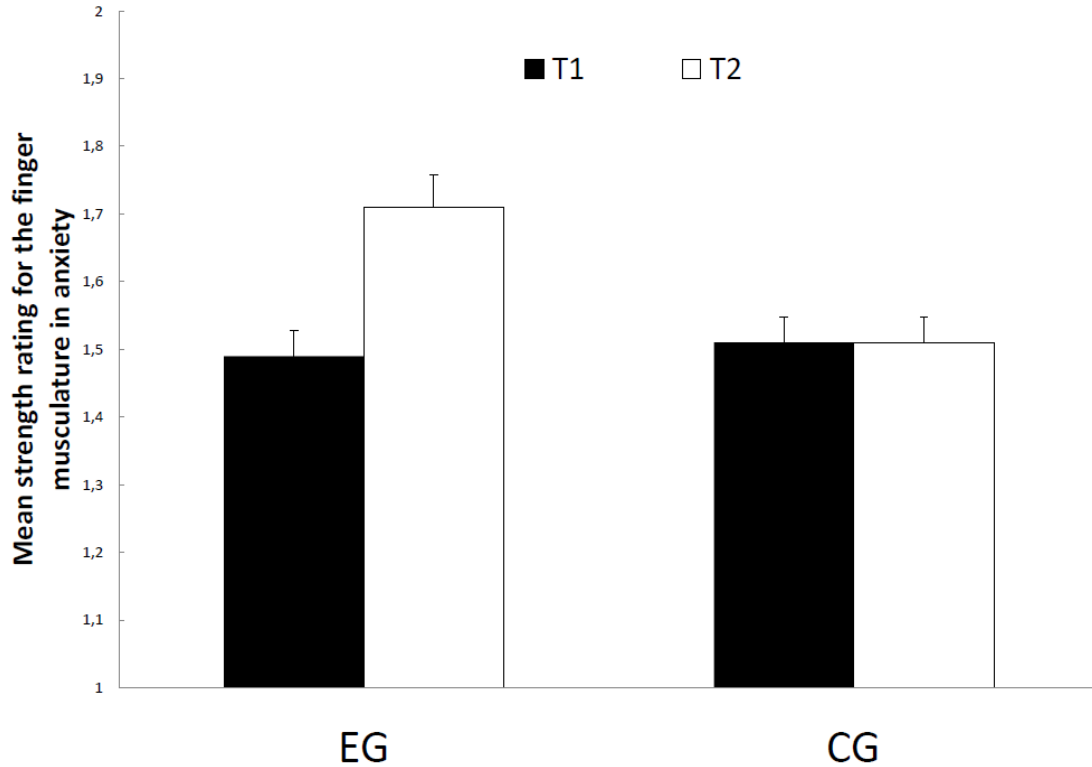
Figure 3. *Mean strength rating and standard errors for the emotion anxiety in the experimental group (EG) and in the control group (CG) for time of measurement 1 (T1) and time of measurement 2 (T2).*

STAI-G-State

The ANOVA revealed no significant main effect for group ($F(1, 48) = 1.74$) or for time of measurement ($F(1, 48) = .54$). However, we found a significant interaction between group and time of measurement ($F(1, 48) = 5.73$, $p < .022$). The mean data in the experimental group decreased from the first time of measurement to the second time of measurement while the data in the control group increased from the first time of measurement to the second time of measurement. Figure 4 shows the mean data in the

STAI-G-State questionnaire in the in the EG and the CG divided in the two times of measurement.

Figure 4. *Mean and standard errors in the STAI-G-State questionnaire for the experimental group (EG) and the control group (CG) for time of measurement 1 (T1) and time of measurement 2 (T2).*

STAI-G-Trait

The ANOVA revealed no significant main effect for group ($F(1, 48) = 1.72$) or for time of measurement ($F(1, 48) = 2.85$). The interaction between group and time of measurement ($F(1, 48) = 4.76$, $p < .035$) was significant. The mean data in the EG decreased from the T1 to T2 while the data in the CG increased from T1 to T2. Figure 5 shows the mean data in the STAI-G-Trait questionnaire in the EG and the CG divided in the two times of measurement.
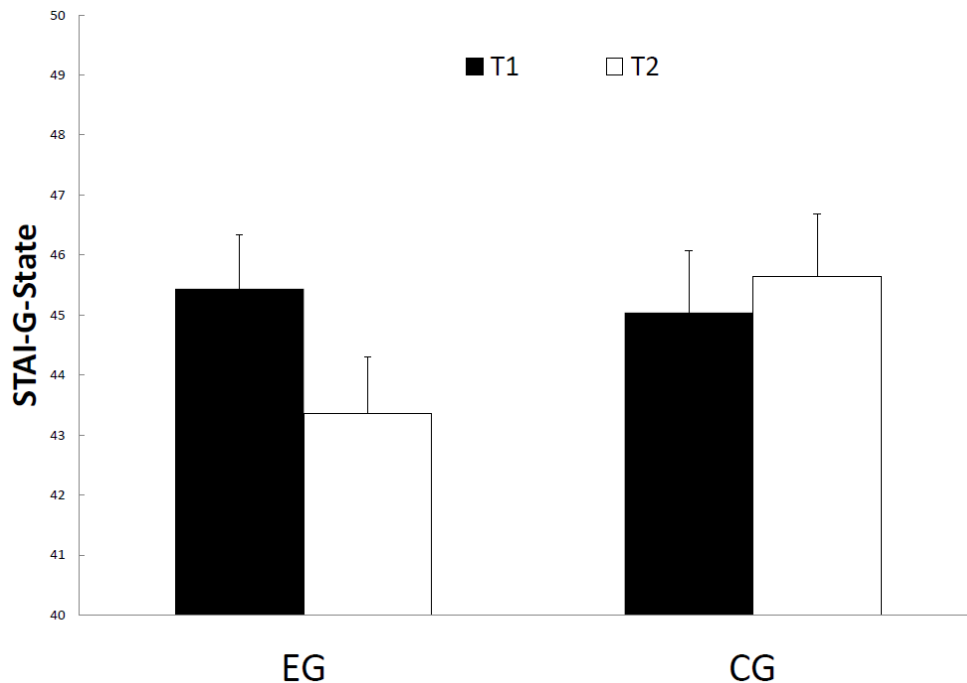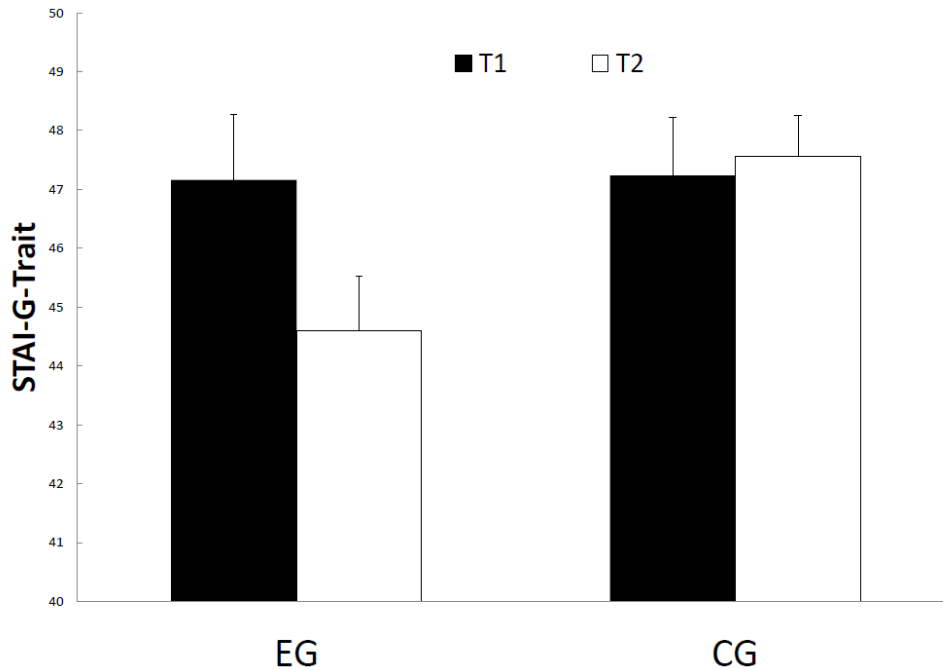
Figure 5. *Mean and standard errors in the STAI-G-Trait questionnaire for the experimental group (EG) and the control group (CG) for time of measurement 1 (T1) and time of measurement 2 (T2).*

Discussion

The main aim of the present study was to investigate for the first time the efficacy of an advanced version of EMDR according an intervention of anxiety. Between two times of measuremen, the EG received an intervention of 1-2 hours with respect to their anxiety with the wingwave method whereas no intervention was employed to the CG. All participants were asked at both times of measurement to self-generate the emotion of anxiety via the recall of an autobiographical memory. Previous studies have already demonstrated that the self-generation of an emotion is an appropriate way to induce an emotion like anxiety (e.g. Damasio et al., 2000; Rathschlag & Memmert, 2013). We investigated the intensity of anxiety, the physical performance

under the emotion of anxiety and the state and trait anxiety with the STAI (Laux et al. 1981) for both groups and for both times of measurement.

First of all, the results demonstrated that the intensity of anxiety did not differ at T1 between both groups and decreased from T1 to T2 in the EG but not in the CG. In this respect, we provided evidence for our hypothesis that the wingwave method can help to decrease the intensity of anxiety concerning to the respective anxious memories and their recall, and to make the recall more difficult. This result is in line with several studies who have found that making eye movements (EMDR) while retrieving visual images of negative autobiographical memories reduces their vividness and emotional intensity (e.g. Smits, Dijs, Pervan, Engelhard, & van den Hout, 2012). In addition, Engelhard et al. (2011) could show that eye movements (EMDR) can also reduce the vividness and emotional intensity of recurrent, intrusive visual images about potential future catastrophes ("flashforwards").

Second of all, we were interested to see if the strength in the physical task for the finger musculature, when people self-generate their anxiety, will change from T1 to T2 in the respective groups. The results provided primary evidence that the wingwave method is able to enhance participants' strength if inducing an anxious memory. Congruent to our hypothesis, data demonstrated that the strength in the EG was significantly enhanced from T1 to T2, and there were no significant differences in the CG. Thus, it seems that the wingwave method is helpful in enhancing physical strength in a task for the finger musculature when participants self-generate the emotion of anxiety. Further studies have to find out a biological explanation for this result. One possible explanation might be that the participants can deal after the intervention with their anxiety and thus, the anxious memory is afterwards not more connected to feelings

like to be paralyzed with anxiety, which might be responsible for a reduced strength before the intervention.

Third of all, we also checked participant's state and trait anxiety which were recorded with the STAI (Laux et al, 1981) and consisted of the following two nondependent scales: The state-anxiety-scale (STAI-G Form X1) and the trait-anxiety-scale (STAI-G Form X2). The results of the ANOVAS for both scales showed a significant interaction between the group and the time of measurement. The values in the EG decreased significantly from T1 to T2 in both scales and the values in the CG were unchanged from T1 to T2. Thus, the wingwave method seems to be a very powerful method to reduce state anxiety as well as trait anxiety. Similar results could be found by Graham and Robinson (2007) who found that EMDR can decrease significantly state anxiety in swimmers who had experienced a traumatic swimming event. This result is also in line with de Jongh et al. (2002) who found that EMDR is an effective treatment alternative for anxiety and can reduce this emotion. To the best of our knowledge, we could show for the first time that a technique like the wingwave method which uses EMDR as main intervention tool can not only enhance participants' state anxiety but also participants' trait anxiety.

As a first study limitation, we have to say that we investigated in the present study the possibility to reduce anxiety in general using the wingwave method. Thus, one recommendation for future research would be to investigate the effectiveness of the wingwave method in the treatment of discrete anxiety disorders, like the general anxiety disorder, phobias, or panic disorders. As a further study limitation we have to say that we only compared two groups in the present study: an EG and a CG. To compare the effectiveness of the wingwave method to CBT for example, researchers could add a

third group which gets an intervention with the CBT. A comparison of EMDR and CBT in the treatment of Panic Disorders was already done by Faretta (2012) and the results showed that both treatments are effective for the resolution of a Panic Disorder. However, EMDR treatment seems to have a faster progress in symptom reduction which is maintained over time. Another comparison could be conducted between EMDR and wingwave in the treatment of anxiety and analyses can potentially show if the wingwave method is an improved alternative to EMDR. Furthermore, future research could check, if there are time dependent effects of the method. In the present study, participants received an intervention with the wingwave method two weeks after the first time of measurement and another two weeks later, participants completed the second time of measurement. Thus, it may be interesting to find out how stable the present results are over a longer period of time.

To the best of our knowledge, the present study was the first one to investigate the effects of the wingwave method in reducing anxiety. The results from this investigation seem promising and we hope that this study will help to inform and motivate future research to further investigate this new method in the treatment of anxiety.

Chapter 7

Conclusions and Prospects

This chapter will provide a detailed synthesis of the work presented in the thesis and outline its implications for both theory and practice. The limitations of the work are discussed, as well as potential avenues for future research on emotions and their influence on physical performance.

Aims of the Thesis

The general aim of this thesis was to examine the role of self-generated emotions on performance in different physical tasks. Emotions were induced in this thesis via the recall of autobiographical memories related to the desired emotions. By adopting Lazarus's (1991, 2000) cognitive-motivational-relational theory (CMR) and Frederickson's (2001) broaden-and-built theory as the overarching theoretical framework, I attempted to highlight how emotions can influence the performance in physical tasks. Furthermore, I especially aimed to give practical implications for athletes on how they could enhance their physical performance by the help of self-generating suitable emotional states. Finally, I intended to check if the wingwave-method could help people to reduce their anxiety and to enhance their physical performance.

Summary of Key Findings and Answers to Research Questions

Specifically, I addressed three research questions. Table 9 gives an overview of the empirical answers to these questions based on the conducted studies.

Table 9.

Answers to Research Questions Addressed in the Thesis.

Research Question	Empirical Answers
I. *How do self-generated emotions influence performance in different strength tasks?*	We investigated the influence of five emotional conditions (happiness, anger, anxiety, sadness and an emotion-neutral state) on finger strength (Experiment 1), jumping power (Experiment 2), and throwing strength (Experiment 3). All experiments showed that participants produce significantly better physical performances when recalling happiness or anger emotions in contrast to the emotion-neutral state. Experiment 1 and 2 also revealed that physical performance in the happiness and the anger condition was significantly enhanced compared with the anxiety and the sadness condition.
II. *How do self-generated emotions influence performance in a speed task?*	We investigated the influence of three emotional conditions (happiness, anxiety and an emotion-neutral state) on sprinting times. The results of two experiments indicated that the performance in the happiness condition was significantly enhanced compared with the anxiety and the emotion-neutral condition.
III. *Is the wingwave method a suitable intervention program to reduce the intensity of a performance decreasing emotion (e.g. anxiety) and thereby to enhance performance in a task where strength is required?*	In an experiment with fifty participants, we could demonstrate that the intervention of only 1-2 hours with the wingwave method can significantly decrease the anxiety of participants (state and trait anxiety) compared with a control group. Furthermore, we could show that the performance in a physical strength task for the finger musculature after self-generating this anxiety was significantly enhanced after the intervention with the wingwave method compared to a control group.

Theoretical Implications of the Findings

The studies reviewed have some important theoretical implications for the research area about the emotion-performance-relationship. In the introduction, I cited McCarthy (2011, p. 50) who stated that "the existing knowledge base could not offer an adequate solution to understand emotion in performance." We started to address this shortcoming by interpreting our results about the emotion-performance relationship within the CMR theory of Lazarus' (1991, 2000) framework which seemed to be suited to improving the knowledge about how discrete emotions influence sport performance. According to Woodman et al. (2009), CMR framework seems to be a promising avenue for researchers interested in the effect of emotions on performance. At the beginning of the thesis, I argued that if the required physical skill is similar to the action tendency of an emotion, performance will increase. However, we have already indicated in chapter 4 that there is some ambiguity if our tasks were similar to specific emotion's action tendencies or not, and that we have only presented possible explanations why we believe that our tasks could have been similar to the action tendencies in the different emotional conditions. For the positive emotion of happiness we could find that this emotion significantly improved the performance in all of our experiments compared with the emotion-neutral state. Furthermore, we could show in the experiments presented in chapter 4 that the emotion of anger also has the ability, just as happiness, to significantly increase the performance in a physical task. Just as happiness, anger is often associated with approach behavior (Davidson, Jackson, & Kalin, 2000) and data indicates that anger does not follow the usual pattern of right-sided prefrontal activation observed during anxiety or sadness (see, e.g., Fox & Davidson, 1988; Harmon-Jones & Allen, 1998). If we classified all the tasks in our experiments in this thesis as approach

movements, the performance-increasing effect of the emotions of happiness and anger can be interpreted within the framework of CMR theory.

For the negative emotions of anxiety and sadness, we could find that the performance in these emotional conditions was significantly decreased in most of our experiments compared with the happiness condition which was consistent with our hypotheses. However, we were surprised that in all of our experiments there were no performance-decreasing effects of anxiety or sadness compared with the emotion-neutral states. In chapter 4, we interpreted this lack of findings within the CMR framework, as we believed that our physical tasks were not similar to the action tendencies in anxiety and sadness. However, referring to the experiments presented in chapter 5, a fast run in form of a sprint seems to be very similar to the proposed action tendency 'escape' in Lazarus' (1991, 2000) framework and thus, anxiety should have led to faster running times than at least the emotion-neutral condition. However, in agreement to the results in chapter 4, we also found in chapter 5 no significant differences between anxiety and the emotion-neutral condition in both speed experiments presented. Taking these findings together, it seems that CMR theory can help to explain a lot of our findings, however, there are also some controversial results which are difficult to explain within CMR theory.

Leaving CMR theory framework, the induction of the emotion happiness seems to have a performance increasing effect compared with an emotion-neutral state or the induction of anxiety or sadness even independent of the respective required tasks. A wide spectrum of empirical studies has already documented the adaptive value of positive effects (for a review, see Lyubomirsky, King, & Diener, 2005), and our findings could perhaps be interpreted within the "broaden-and-build" theory of Frederickson

(2001). The broaden-and-build theory encompasses the great variety of empirical results referring to the benefits of positive effects and proposes that "experiences of positive emotions broaden people's momentary thought-action repertoire, which in turn serves to build their enduring personal resources, ranging from physical and intellectual resources to social and psychological resources (Frederickson, 2001, p. 218)." Our findings that the emotion of happiness seems to have a performance-increasing effect compared with an emotion-neutral state or an anxious or sad state is in accordance with the results of Frederickson and Branigan (2005) who investigated the thought-action repertories in different emotional conditions. Frederickson and Branigan (2005) could show that participants who experienced positive emotions (amusement and contentment) within film clips had more numerous thought-action urges than people who experienced anxiety, anger or an emotion-neutral state within these clips. In addition, those participants who watched a positive film reported more frequent urges to engage in outdoor/nature activities and sport/exercise activities compared to those who viewed the neutral film. Comparing the emotion-neutral state and the negative states of anger and anxiety, Frederickson and Branigan (2005) found a tendency that the negative emotions yielded marginally smaller thought-action repertories than did the neutral condition, however the comparisons failed to reach significance. This finding is in line with our results that there are no significant differences in observable behavior in form of physical performance between anxiety and the emotion-neutral condition in all of our required task. Taken together, it seems that the broaden-and-build-theory might be a promising framework to explain the influence of different emotions on physical performance.

Although the research on the wingwave method of Besser-Siegmund and Siemund (2010) is still in its infancy, the first results indicate that this method might be able to significantly reduce anxiety and its symptoms. As described in chapter 6, the wingwave method uses EMDR as its main intervention tool, and our findings are in accordance with previous results that EMDR is an appropriate method in the treatment of anxiety (De Jongh et al., 2002; Muris & Merckelbach, 1997). The results in my thesis further concluded that this new method can also help to enhance the performance in a physical task. To the best of my knowledge, this is the first study, which shows that EMDR, implemented in the wingwave method, can help to improve physical performance.

Practical Implications of the Findings

The findings reviewed in this thesis have important applied implications for athletes and could be useful for deriving practical interventions in sports. Table 10 gives an overview of the possible practical implications from the findings in the different studies.

Table 10.

Practical Implications for the Findings Addressed in the Thesis.

Findings	**Practical Implication**
Chapter 4 *The Influence of Emotions on Strength*	The experiments presented in chapter 4 revealed that the participants significantly benefited from the self-generation of the emotion 'happiness' and the self-generation of the emotion 'anger' in our physical tasks. Therefore, it seems to be recommendable for athletes to self-generate the emotions of happiness or anger prior to these or similar specific physical tasks to enhance their performance. There was no significant difference between the performance in the happiness or the anger emotional condition. However, the induction of the happiness condition was significantly more pleasant for the participants compared with the induction of the anger condition. Therefore, it is a general recommendation for athletes to self-generate the emotion of happiness prior to the described or similar physical tasks. However, it has to be noted that the induction of the emotions of happiness or anger and their performance-enhancing effects are only the average results of all participants in the study. Although most of the participants reacted in this way, there were also participants who performed better in other conditions such as anxiety. The consequence of this is that it is probable that an individual athlete will benefit most from the induction of happiness or anger. However, the best way is to test every individual in all emotional conditions in order to find out in which emotional condition his or her performance is most increased and if the individual performance in the different emotional conditions deviates from the average results of the participants investigated in our studies.
Chapter 5 *The Influence of Emotions on Speed*	The experiments in chapter 5 has demonstrated that participants sprinted significantly faster in the happiness condition compared with the anxiety condition and the emotion-neutral condition. Therefore, it also seems generally recommendable for athletes to self-generate the emotion of happiness prior to a task in which maximum speed is required. However, it is again

	advisable to test every individual in all emotional conditions and to check if he or she deviates from the average results of the individuals who participated in this study.
Chapter 6 *The Wingwave Method*	The wingwave method seems to be an appropriate method in reducing anxiety of participants (state and trait anxiety). Therefore, it is advisable for humans, suffering from anxiety and the related symptoms, to test this new method. Furthermore, the method appears to be an eligible way to reduce the anxiety of athletes. We also showed that the method can help individuals to enhance performance in a specific physical task. Therefore, it is recommendable to investigate if the method can also increase performance in diverse physical tasks.

Limitations and Directions for Future Research

Despite the novel contribution of the findings on the emotion-performance relationship, the conducted studies are not without their limitations. Firstly, although most of the studies were in step with actual practices, they were implemented under laboratory conditions. Therefore, it is not clear whether the findings can be transferable to real world sports performance. For example, Experiment 2 presented in chapter 4 showed significant differences between emotional conditions in a counter-movement-jump. To enhance the external validity of the task and to ensure that the findings in this experiment apply not only to a certain stimulus set, for example, future studies could investigate the influence of the different self-generated emotions in real sport settings in which people have to jump. Thus, future research could address the question if high jumpers, long jumpers, or triple jumpers could also benefit from inducing emotions of happiness or anger to enhance their performance. Experiment 3 presented in chapter 4 demonstrated that participants could also increase their performance in the anger and happiness emotional conditions in a task where they had to throw a ball as fast as

possible. Therefore, it would be interesting to follow up these first results in even more representative sport scenarios. Thus, it is currently unclear if athletes (such as pitchers in baseball, javelin throwers, or shot-putters) could also benefit from inducing 'happiness' or 'anger.' Furthermore, we only measured the velocity of the thrown balls in the different emotional conditions and did not measure the precision of the thrown balls. Thus, one hypothesis might be that the velocity of the thrown balls is enhanced in both conditions of happiness and anger; however, the precision differs between both conditions in the way that a negative emotion like anger decreases the precision in contrast to a positive emotion like happiness. Furthermore, the experiments in chapter 5 showed that participants were significantly faster in the happiness condition compared with an emotion-neutral state over a distance of 40 meters (131 feet) or 22.86 meters (75 feet). Future studies could variegate the distance of running and should clarify the question if athletes could enhance their performance in short distances (e.g. 100 meters), middle distances (e.g. 800 meters), or long distances (e.g. 5000 meters) by self-generating the emotion of happiness prior to running.

Moreover, it seems necessary that future research will clarify which time for the self-generation of the performance-enhancing emotions is especially advantageous. By reason that there are, to the best of our knowledge, no directions for the time of self-generating emotions in the literature, we used in all of our studies the arbitrary time of one minute to self-generate an emotion prior to physical performance. Thus, future research should contrast different periods of time of self-generating emotions and could compare if there are significant differences in relation to physical performance.

In addition, the participants in our studies were specialized in different sports and were at different levels in their respective sports. Thus, follow-up studies could

furthermore investigate the role of expertise level (Ericsson, Charness, Feltovich & Hoffman, 2006) in the required or similar tasks to see if experts and novices could both profit by generating different emotions and if there are significant differences between both groups. Moreover, future research could investigate if participants can enhance their ability to self-generate different emotions, and therefore if such a training of inducing emotions is even more profitable to enhance physical performance.

In chapter 5 we investigated some basic ideas of a new method in the treatment of anxiety and found encouraging results for further studying this new method. We found that the method can in general help people to significantly reduce their anxiety and related representative imaginations. However, one study limitation was that we only compared our experimental group, which got an intervention with the wingwave method, with a control group and did not investigate a placebo group. Another study limitation was that we did not investigate if athletes can be helped in competitive situations to cope with their anxiety. Thus, it is advisable for researches to further investigate this method in the treatment of athletes suffering from competitive anxiety.

Concluding remarks

Research on emotions has been firmly established in the sports psychology literature over the past 40 years (McCarthy, 2011). However, the majority of sport emotion research in the past has focused on negative emotions (e.g. anxiety) and their effects on physical performance (e.g. Hanin, 2000; Parfitt & Hardy, 1993; Tenenbaum, Edmonds, & Eccles, 2008). Among other things, this thesis has shown that the investigation of positive emotions such as happiness seem to be a fruitful area for a better understanding of the emotion-performance relationship. In my opinion, this thesis supports the idea of a "positive psychology" (Seligman, & Csikszentmihalyi, 2000) by

not only focusing on negative emotions but also on positive emotions which can help people to improve their functioning. Instead of only happiness, it is recommendable to further investigate other positive emotions. Seligman (2002) have added the emotions of: optimism, resilience, hardiness, and toughness to the classification, and future research can investigate their influence on physical performance.

Overall, this thesis has broadened and extended the emotion-performance relationship literature, having theoretical and practical implications for athletes and offering some promising research areas for future investigations of emotions in the context of sport.

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Chapter 7: Conclusions and Prospects

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Curriculum Vitae

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Education

4/2002 - 10/2009	University of Giessen, Department of Psychology and Sport **Master of Arts in Sport Science (M.A.) with "sehr gut"** **(best grade)**
04/2003 - 09/2008	University of Giessen, Department of Psychology and Sport **Diploma in Psychology (Dipl.-Psych.) with "sehr gut"** **(best grade)**
10/2008-09/2011	Trainer Academy Cologne **Diploma in Training (Dipl.-Trainer) with "sehr gut"** **(best grade)**

Employment

10/20011 – Present	German Sport University Cologne, Institut of Cognitive and Team/Racket Sport Research, **Research Fellow**
10/2009-09/2011	German Sport University Cologne, Institut of Cognitive and Team/Racket Sport Research, **Teaching Stuff for Special Requirements**
04/2005 – 04/2008	University of Giessen, Department of Psychology and Sport, Psychological Methodology, **Student Assistant**
07/2005 – 08/2005	University of Giessen, Bender Institut of Neuroimaging (BION), **Trainee**

Research Experience

10/2009-Present	German Sport University Cologne, Institut of Cognitive and Team/Racket Sport Research, PhD Project with the title: "Self-generated emotions and their influence on physical performance"
10/2009-Present	German Sport University Cologne, Institut of Cognitive and Team/Racket Sport Research, Cooperative Project with the Besser-Siegmund Institut, Hamburg with the title: "Experimental research for the validation of the wingwave method"
09/2007 - 09/2008	University of Giessen, Department of Psychology and Sport, Diploma Thesis with the title: "The effect of endurance sports on the dopaminergic system: Executive function and hemodynamic activation"

Teaching Experience

10/2009 –Present	Regular Courses (average of five courses) each semester at the German Sport University Cologne in the following areas: - Sport Psychology - Team Handbal

Research Skills

- Planning, implementation and analysis of experiments
- Statistical analysis with SPSS
- Fundamentals in fMRI research
- Fundamentals in programming with Presentation

Invited Talks

11/2012	*Experimental research for the validation of the wingwave method.* International annual conference of short-time coaching, Hamburg 2012.
05/2012	*Self-generated emotions and their influence on physical performance.* Annual conference of ASP (Arbeitsgemeinschaft für Sportpsychologie), Oslo 2012.
11/2011	*Experimental research for the validation of the wingwave method.* International annual conference of short-time coaching, Hamburg 2011.
11/2010	*Experimental research for the validation of the wingwave method.* International annual conference of short-time coaching, Hamburg 2010.
05/2010	*Self-generated emotions and their influence on physical performance.* Annual conference of ASP (Arbeitsgemeinschaft für Sportpsychologie), Salzburg 2010.

Additional Skills

Since 05/2012	Healing Practitioner in Psychotherapy
01/2013-02/2013	Education: NLP Practitioner at NLP-Deutschland
11/2012	Education: Hypnosis at NLP-Deutschland
02/2011-10/2011	Education: Hypnosis at Institute of Clinical Hypnosis Cologne
09/2008	Education: Reiss-Profile-Master Sport at Reiss Profile Germany
07/2007	National A licence in team handball
06/2008	Education: Wingwave coaching at the Besser-Siegmund Institute in Hamburg