The Influence of Self-Generated Emotions on Physical Performance: An Investigation of Happiness, Anger, Anxiety, and Sadness

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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. Experiments 1 and 2 also revealed that physical performance in the anger and the happiness conditions was significantly enhanced compared with the anxiety and the sadness conditions. Results are discussed in relation to the Lazarus (1991a, 2000a) cognitive-motivational-relational (CMR) theory framework.

Keywords: emotions, emotion-performance relationship, physical performance, happiness, anger, anxiety, sadness

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 decides on whether 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 used 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 used 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 reexperience 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 by drawing on the 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 (1991a, 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 “lash 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 “lash 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’s CMR theory.

Although Lazarus’s 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) used 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 in the happiness and the emotionally neutral conditions. The authors interpreted these results in line with Lazarus’s (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 whether 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 IAPS 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 article, 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 whether 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 toward 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 with 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 with 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 would decrease performance in our physical task in Experiment 1, in which participants were asked to hold two fingers together as well as possible against a mechanical force.

**Experiment 1**

**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. For each emotion condition, participants retrospectively rated the induction of the respective emotions, valence, and arousal using a 9-point Likert scale (emotion induction: $1 = \text{no happiness/anxiety/sadness}$ to $9 = \text{most happiness/anger/anxiety/sadness}$; valence: $1 = \text{most pleasant}$ to $9 = \text{most unpleasant}$; arousal: $1 = \text{not arousing}$ to $9 = \text{most arousing}$).

**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 noninvasive 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 in 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 patient’s force of finger musculature in the BDORT is different depending on which kind of emotion they self-generate and how well.

Figure 1 — Experimental setup. Top: posture of arm, forearm, and especially of index finger and thumb during the task. Bottom left: posture of index finger and thumb rated as “closed ring” coded with “2.” Bottom right: posture of index and thumb rated as “unclosed ring” coded with a “1.”
patients can deal with this emotion. The aim of this article 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.

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 finger and thumb together. After familiarization with the equipment, the strength of the pulling force was added in small increments (0.5–1.0 bar), resting 30 s 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 filmed 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 coding system: 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 interrater 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 mind, they had 1 min to self-generate the corresponding emotion. Immediately afterward, 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 at which the machine began generating the pulling force was announced by an acoustic signal 3 s 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 3 min, we again measured 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 3 min between each of the conditions to minimize any carryover effect from one emotion condition to the next. The order of presentation of the emotion conditions was balanced and randomized across all participants.

Since our objective measurement of the BDORT is a novel physical task, we repeated all measurements 2 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)× 2 (time of measurement: T1 vs. T2) ANOVAs with repeated measures on both factors to examine the different LSs.

We then assessed the interrater reliability of the three different strength ratings by calculating intraclass 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)× 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, anger, anxiety, and sadness conditions were not significantly different from each other. In addition, 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 compared to the neutral condition ($p < .001$) but none compared to the sadness and anxiety conditions. The neutral condition was significantly different from 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, anger, sadness, and anxiety conditions (see Table 1). In addition, 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 LSs reveal that the attempts to induce the different emotions were successful.

Performance

**Intraclass Correlation Coefficients.** Interrater 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, anxiety, and sadness conditions.

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 interrater 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 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).
Table 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

<table>
<thead>
<tr>
<th>Emotion Induction Condition</th>
<th>Time of Measurement 1</th>
<th>Time of Measurement 2</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Happiness</td>
<td>Anger</td>
</tr>
<tr>
<td>Happiness</td>
<td>8.64 (1.51)</td>
<td>2.07 (1.07)</td>
</tr>
<tr>
<td>Anger</td>
<td>2.73 (1.36)</td>
<td>8.15 (2.05)</td>
</tr>
<tr>
<td>Anxiety</td>
<td>2.01 (1.39)</td>
<td>3.04 (1.66)</td>
</tr>
<tr>
<td>Sadness</td>
<td>1.88 (0.50)</td>
<td>2.36 (1.34)</td>
</tr>
<tr>
<td>Arousal</td>
<td>7.70 (2.13)</td>
<td>6.70 (2.05)</td>
</tr>
<tr>
<td>Hedonic Tone</td>
<td>8.01 (1.53)</td>
<td>2.43 (1.62)</td>
</tr>
<tr>
<td>Performance</td>
<td>1.65 (.16)</td>
<td>1.66 (.20)</td>
</tr>
</tbody>
</table>
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 countermovement jumps (CMJs). 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 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) that were induced by recalling personal emotional episodes.

**Manipulation Check**

The LSs were exactly the same as described in Experiment 1.

**Physical Task**

Participants performed countermovement jumps under different emotion conditions while they were standing on a contact mat (SpeedMat, Switch) that measured the vertical jump height (in centimeters). A countermovement jump is a diagnostic procedure for measuring the vertical jumping power of an athlete. The jumper starts from an upright standing position with hands on the hips, makes a preliminary downward movement by flexing the knees and hips, and then immediately extends the knees and hips 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 countermovement 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 mind, they were given 1 min to self-generate the corresponding emotion. Immediately afterward, participants stepped onto the contact mat and performed six countermovement 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 3 min, 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 LSs. 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, anger, anxiety, and sadness conditions 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 compared to the neutral condition ($p < .001$) but none compared to the sadness and anxiety conditions. The neutral condition was significantly different from 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.

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 CMJs 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 than in the other three conditions. Furthermore, the anxiety and the sadness conditions were evident.

**Table 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

<table>
<thead>
<tr>
<th>Variable</th>
<th>Happiness</th>
<th>Anger</th>
<th>Neutral</th>
<th>Anxiety</th>
<th>Sadness</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jump Height (cm)</td>
<td>32.05 (8.34)</td>
<td>31.68 (8.24)</td>
<td>31.02 (8.17)</td>
<td>30.81 (7.97)</td>
<td>30.80 (8.07)</td>
</tr>
</tbody>
</table>
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, sadness, and 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 toward 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. The 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 LSs were exactly the same as described in Experiment 1.

**Physical Task.** Participants performed throws with a team handball ball toward an empty goal under different emotion conditions. Ball velocity was measured with a speed sport radar (SpeedTracX; Outer Limited Sports), with an accuracy of ±1 miles per hour, 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 7 m. 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 3 min 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, anger, anxiety, and sadness conditions 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
compared to the neutral condition ($p < .001$), but none compared to the sadness and anxiety conditions. The neutral condition was significantly different from 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, anger, sadness, and anxiety conditions.

### 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.

### 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 toward 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 with 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’s (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, sadness, and emotion-neutral conditions did not differ significantly, which makes the findings consistent with those of Experiments 1 and 2. Participants in the happiness and anger conditions threw the ball with more velocity than in the anxiety and sadness conditions, 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 tasks where their action tendencies are activated is dependent upon the coordinative demands of the skill. Throwing a ball toward a goal probably is coordinatively more demanding than holding two fingers together (Experiment 1) or jumping (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’s (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 as to whether our tasks were similar to specific emotions’ 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 LSs 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 LSs, was satisfying. Future studies could further use cutoff values for the LSs in the manipulation check and eliminate participants’ 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 that 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, 2000b). 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’s 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 participants’ personal motivation, which makes this interpretation speculative. We conclude that our results in the happiness condition are also in line with Lazarus’s (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 countermovement 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’s (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 LSs for arousal in all of our experiments, the anger and the happiness emotion conditions led to a significantly enhanced performance as compared with 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 the action tendency of sadness 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-m 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 fingers together, performing a CMJ, and throwing a ball toward 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 that 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, whether 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 whether 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, to learn in that way whether experts and novices can profit by generating different emotions or whether there are significant differences. Future studies could also investigate participants’ perception of whether 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 before the experiment and some not. Thus, it might be that our results could be explained by participants’ 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 participants’ 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 current study will help to inform and motivate studies in the future to further delineate the complex relationship between emotional states and sport performances.

References


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