# The Effects of Smiling and Frowning on Perceived Affect and Exertion While Physically Active

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*Numerous studies demonstrated that deliberate control of facial expressions can influence the self-rating of affective states. The self-regulation of affect is an important part of skilled sport performances. However, no study tested the effects of facial expressions under conditions of physical activity. The aim of the present study was to examine whether deliberately adopted facial expressions have an effect on affective states and perceived exertion during physical activity. Participants' scores on the Feeling Scale (FS) and the Ratings of Perceived Exertion scale (RPE) were compared between conditions of facial expressions (smiling vs. frowning) both while cycling on a stationary bike at 50 to 60% of maximal heart rate reserve and while in a rest condition. Participants scored higher on the FS and felt less exerted when smiling compared to frowning both at rest and while physically active. The results provide initial evidence of effects of deliberately adopted facial expressions while physically active on affective states and perceived exertion. Further studies need to evaluate the applied benefits of deliberately adopted facial expressions as means of affective self-regulation while physically active.*

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*"Sometimes your joy is the source of your smile, but sometimes your smile can be the source of your joy."* These words by the Thich Nhat Hanh, in essence, reflect the mutual relation between 'mind' and 'body' that is central to theories of embodied cognition. These theories assume that bodily states play a central role in the processing of emotional and social information during the encounter as well as in the absence of external stimuli (Barsalou, Niedenthal, Barbey, & Ruppert, 2003; Niedenthal, Barsalou, Winkielmann, Krauth-Gruber, & Ric, 2005). The body's important role in information processing can at least be traced back to William James (1890) who suggested that emotions are a form of self-perception of autonomic states. Since then, the body of empirical evidence supporting the close relationship between 'mind' and 'body' has grown enormously and the interest in research on embodiment has gained increasing popularity (e.g., Niedenthal et al., 2005; Raab, Johnson, & Heekeren, 2009). Following numerous demonstrations of embodiment effects on cognition and emotion, several authors (e.g., Barsalou, 1999; Niedenthal et al., 2005) presented theoretical accounts of embodiment effects. The central idea of these accounts is that all cognitive representations and operations are grounded in their physical context.

One prediction that derives from embodiment theories is that deliberate adoptions of bodily states affect the ratings of emotions and affect (e.g., Barsalou et al., 2003; Niedenthal et al., 2005). In support of this prediction, several studies have demonstrated that the adoption of bodily postures associated with specific emotions (i.e., anger, fear, sadness, pride, happiness) increases participants' self-rated state of the corresponding emotion (e.g., Duclos et al., 1989; Flack, 2006; Flack, Laird, & Cavallaro, 1999; Stepper & Strack, 1993). Additionally, an extensive amount of research on the facial feedback hypothesis (FFH) has demonstrated that our facial expressions have a modulating effect on the self-rated state of emotions and affect (for reviews see, Adelmann & Zajonc, 1989; Izard, 1990; Laird, 1984; Manstead, 1988; McIntosh, 1996; Soussignan, 2002; Winton, 1986). Either by suppressing or exaggerating the naturally occurring facial expressions, the experienced intensity of the corresponding emotions is modulated. Moreover, there is convincing evidence that facial expressions can initiate emotional experiences even in the absence of other emotional stimuli (Flack, 2006; Schnall & Laird, 2003; for a review see McIntosh, 1996). Several modifications of the FFH have been proposed and investigated over the past decades. Winton (1986) suggested that a categorical and a dimensional version of the FFH can be distinguished. The categorical version proposes that discrete emotion specific facial expressions such as happiness, anger, or sadness can modulate or initiate the corresponding specific emotional experiences. The dimensional version only distinguishes affect on the basis of valence (i.e., positive or negative; pleasant or unpleasant). That is, a positively tuned facial expression such as a smile induces a more positive affective state, whereas a negatively tuned facial expression such as a frown induces a more negative affective state (e.g., Winton, 1986). Using unobtrusive manipulations such as holding a pen either only with the teeth (activating the muscles responsible for a smile) or only with the lips (preventing the activation of the muscles responsible for a smile) demonstrated that the mere activation of the muscles involved in the corresponding facial expression is sufficient to increase the state of positive affect (Strack, Martin, & Stepper, 1988) or decrease this state of affect (for manipulation of the muscles responsible for a frown by using golf tees, see Larsen, Kasimatis, & Frey, 1992). The proposition of the dimensional version that smiling can increase a positive affective state, whereas frowning can increase a negative affective state is commonly supported (for reviews, see Adelmann & Zajonc, 1989; Izard, 1990; Laird, 1984; Manstead, 1988; McIntosh, 1996; Winton, 1986).

The consistency in demonstrating effects of facial expressions and other bodily states on affect gives rise to the interest in possible applications of these effects. Laird (1974) recognized the potential benefits of the FFH and proposed that the change of one's facial expression can be an effective technique for emotion regulation. Numerous studies of Laird and his colleagues have demonstrated that changing the emotional expressive behaviors is effective in changing the emotional experiences (e.g., Duclos & Laird, 2001; Laird, 1974; Laird, Wagener, Halal, & Szegda, 1982; Schnall & Laird, 2003). For example, Schnall and Laird (2003) simply asked participants to repeatedly act happy, sad, or angry, including an accentuation on the adoption of the corresponding facial expression and bodily posture. Comparisons of the self-rated scores of the emotions between the base rate and post-measure indicated that participants experienced the emotions they acted out stronger at post-measures. From the manifold demonstrations of facial feedback effects, McIntosh (1996) deduced that, in parallel to investigations of the basic phenomena, it is important to establish conditions under which the facial feedback effects apply.

One condition in which facial feedback effects have not yet been investigated is during physical activity. Conditions of physical activity differ from the usually investigated conditions at rest because physical activity is accompanied by a change of bodily states due to the involved movements and the energy suppletion necessary for carrying out these movements. On the one hand, the different bodily sensations due to the movements might influence the effect of facial expressions on ratings of affect. On the other hand, the effects of facial expressions may be overruled by the bodily sensations due to physical activity because these might be more salient. Hence, it is relevant to test whether facial feedback effects exist in the context of physical activity.

The existence of facial feedback effects on affective states during physical activity is potentially valuable for sports and exercise. It is generally agreed that emotions and their regulation play a major role in performance in sports (e.g., Hanin, 2000; Jones & Uphill, 2004; Lazarus, 2000). If the deliberate adoptions of facial expressions can influence the affective state while physically active, then this might assist the regulation of emotions that are important for sports performances as well as exercise adherence (Biddle & Mutrie, 2001).

One factor that underlies performances of all physical activities and that is likely to be mediated by affective states is the experienced expended effort (Rejeski, 1985). In the context of physical activity, the perception of expended effort is commonly assessed by Borg's (1998) Ratings of Perceived Exertion scale (RPE) and referred to as *perceived exertion*. "The perception of physical exertion is a psychological construct that includes feelings of *effort, strain, discomfort,* and/ or *fatigue* experienced during both aerobic and resistance exercise" (Robertson, 2001, p. 191). Morgan and Borg (1976) showed that perceived exertion is an effective predictor of maximal performance. Furthermore, Acevedo, Gill, Goldfrab, and Boyer (1996) suggested that "affective states and the cognitive appraisal of exertion during exercise may determine whether or not an individual will persist at an activity" (p. 286).

Several authors (e.g., Acevedo, Rinehardt, & Kraemer, 1994; Hardy & Rejeski, 1989) reported a negative correlation between ratings of perceived exertion and ratings of affect, with high ratings of perceived exertion and low ratings of affect at high exercise intensities, for both, highly trained and relatively untrained participants. In addition, there are indications that frowning increases the perception of effort (Larsen et al., 1992; Stepper & Strack, 1993) and Erez and Isen (2002) found indications that positive affect facilitates expended effort and task-persistence (on cognitive tasks). Moreover, Tenenbaum and Hutchinson (2007) propose that the concept of perceived exertion as suggested by Borg (1998) represents a broader perception of various sensations that arise during physical activity, including affect. The combination of the various sensations contributes to the overall perception of exertion whereas more positive affective sensation should lead to less perceived exertion. Thus, if facial expressions influence affect during physical activity, then a facial expression leading to a more positive affective state might also reduce the perceived exertion.

To the best of our knowledge embodiment effects on affect and perceived exertion in the context of physical activity have not yet been investigated. Therefore, we examined whether the valence of affective ratings and ratings of perceived exertion are affected by deliberate adoptions of smiles and frowns during physical activity. It is hypothesized that the deliberate adoption of a smile increases the ratings of positive affect and lowers perceived exertion, whereas the deliberate adoption of a frown increases the ratings of negative affect and increases perceived exertion.

## Method

### *Participants*

Thirty four Dutch students (18 women and 16 men) voluntarily took part in the experiment. They were recruited via flyers in the university and announcements in classes. The participants were rewarded the standard fee of 7 Euros for their participation which took one hour. They had an average age of 21.91 ($SD$ = 2.55) years and a mean 'physical training experience' of 13.90 ($SD$ = 5.36) years. The participant's trained on average 7 ($SD$ = 5) hours a week. The mean resting heart rate (HRrest) of all participants was 54.82 ($SD$ = 8.83) beats per minute.

The experiment was approved by the ethical committee of the Research Institute. All participants signed an informed consent form and filled in an anamnesis questionnaire to assess possible risks of the physical activity. At the end of the experiment all participants were debriefed and thanked for their participation.

### *Materials and Procedure*

**Facial expressions.** We chose to manipulate Zygomaticus major and Corrugator supercilii activity by asking participants to smile or frown. Schnall and Laird (2003) also used an undisguised method to manipulate facial expressions by asking participants to produce the facial expression that they would have when experiencing one of the emotions (i.e., happiness, anger, sadness) that were investigated. Their study showed that only participants who were responsive to an a priori, highly disguised manipulation of facial expressions were also responsive to the undisguised manipulation. In short, the undisguised manipulation did not promote demand effects. The simple instructions to adopt facial expressions provide the advantage of quick and easy applicability, which is necessary for its later use in the applied field. Moreover, explicitly asking someone to smile might promote the adoption of a real (felt) smile that would naturally occur (Schnall & Laird, 2003). It was reported that variants of human smiles exist, depending on its function and the social context (Ekman, 1992; Ekman & Friesen, 1982). Izard (1990) argued that the facial expressions should be as analogous as possible to the naturally and spontaneously occurring facial expressions in order to maximize effects on the emotional experience. Hence, it seems reasonable that explicitly asking participants to adopt what they would think is a real smile might increase the effect on the affective ratings and perceived exertion ratings because it more likely results in the adoption of a natural facial expression. Whenever necessary, frowning was explained as bringing the eyebrows together and down. When participants were asked to smile, it was explained that several sorts of smiles exist and that for the present experiment the experimenter would be especially interested in a smile that participants would describe as a real smile. Furthermore, it was mentioned that real smiles often involve smiling with one's eyes. For both facial expressions, it was emphasized that the expressions should be as natural as possible. To control whether participants adopted and held the facial expressions they were filmed with a webcam that was hidden in the top of a turned off computer screen in front of the participants.

**Physical activity.** In the physical activity condition, a bicycle ergometer was used that was individually adjusted to the height of the participants. All participants exercised within a range of 50 to 60 percent of their maximal heart rate reserve (HRR). The HRR was calculated according to the Karvonen method (i.e., HRR = maximal heart rate (HRmax) - resting heart rate (HRrest), see Wilmore & Costill, 2004, p. 619). HRmax was estimated by subtracting the participant's age in years from 220. For the purpose of this initial study, we chose a range of moderate intensity. To control for the manipulation of the physical activity, participants' heart rates (HR) were measured using a Polar wrist HR monitor. Participants could not see their HR and were only verbally informed when they reached the required intensity and told to continue at that pace.

**Self-rated affective state.** To assess the affective valence, the Feeling Scale (Rejeski, Best, Griffith, & Kenney, 1987) was administered. The Feeling Scale (FS) is a one-item questionnaire, developed to assess affective responses during exercise. The scale assesses affect on a bipolar valence dimension, using verbal and numeric anchors ranging from +5 (*very good*) to -5 (*very bad*). The construct validity is supported by Rejeski et al. (1987) and face and content validity are supported by Hardy and Rejeski (1989). The correlation between the FS and the Self-Assessment Manikin ranges between $r = 0.51$ and 0.88. The correlation between the FS and the valence scale of the Affect Grid ranges between $r = 0.41$ and 0.59 (Van Landuyt, Ekkekakis, Hall, & Petruzzello, 2000). The FS has been widely applied in exercise related research (see Ekkekakis & Petruzello, 1999 for an overview).

**Ratings of perceived exertion.** Perceived exertion was measured with Borg's Ratings of Perceived Exertion scale (RPE). RPE is a 15-point rating scale with verbal and numeric anchors ranging from 6 (*no exertion at all*) to 20 (*maximal exertion*). The Borg 15-category scale has been validated and shows correlations with heart rate and/ or oxygen uptake, ranging from $r =$ 0.56 to 0.94. The test-retest reliability ranges from $r = 0.78$ to 0.91 (see Robertson, 2001). Results indicate that the Borg scale is an acceptable psychological instrument to measure perceived exertion during a wide range of physical activities (Robertson, 2001). RPE is widely accepted as a reliable, valid, and robust measure of perceived intensity (Borg, 1998).

**Exit interview.** A questionnaire at the end of the experiment asked a number of demographic questions, concerning age, sex, and exercise history such as type of sports, average training duration per week, and years active in sports. Participants were also asked what they believed the real purpose of the experiment was. Furthermore, participants rated how difficult they experienced the deliberate adoptions of the smiles and the frowns on a 7-point Likert Scale with verbal anchors at point 1 (*not at all*) and point 7 (*very much*).

*Setup and Procedure*

Participants were welcomed in the laboratory and told that the purpose of the experiment was to assess the influence of smiling and frowning on performance in sports. A cover story was introduced in order to minimize possible demand effects: Participants were told that the main interest of the present study is the effect of smiling and frowning on their heart rate (HR) which serves as an indication of performance. Moreover, they were told that with two questionnaires additional information would be obtained in order to control for the direct effect of facial expressions on HR. The questionnaires aimed to assess the affective state and the perceived exertion because it would be possible that these two factors have a mediating effect on the HR. Moreover, participants were told that EMG measures in the face would be conducted to control for the muscle activity necessary for the facial expressions. However, no EMG data was recorded. The bogus EMG measures were conducted in order to strengthen the impression that physiological data were of main relevance for the experiment's purpose. We expected that diverting the attention away from the psychological assessments and towards the physiological assessments would minimize participants' tendency to score in compliance with the experimenter's hypotheses on the psychological ratings.

Subsequently, participants were informed about the intensity and duration of the physical exercise and the experiment. To familiarize them with the measurements, participants filled in the FS and the RPE scale, following standardized instructions with the additional instruction to also answer the questions "how are you feeling at the moment" and "how much exertion do you perceive at the moment" while at rest (not cycling). Following the familiarization, participants strapped on the chest band to measure the HR and were seated on the bicycle ergometer. Then, the EMG electrodes were placed, one on each Zygomaticus major and Corrugator supercilii, and one on the collarbone. Pretending to adjust the EMG apparatus, the experimenter instructed participants to (a) relax the facial muscles by adopting a neutral facial expression, (b) contract the Zygomaticus major by smiling, and (c) contract the Corrugator supercilii by frowning. The bogus adjustment procedure served as a control of participants' correct adoption of the instructed facial expressions. Following the setup of the equipment, participants remained seated on the bicycle ergometer throughout the entire experiment.

The experiment followed a 2x2 within subject design with two physical activity conditions (activity and rest) that each included two facial expression conditions (smile and frown). Figure 1 illustrates the experimental design. The two activity conditions were conducted consecutively, one including a smile condition and one including a frown condition. Both activity conditions were followed by a five minutes break. The two rest conditions were also conducted consecutively, one including a smile condition and one including a frown condition. Both rest conditions were followed by a two minutes break. All participants underwent all four conditions. The activity and rest conditions were counterbalanced over all participants. The facial expression conditions were counterbalanced within the activity and rest conditions.

Figure 1.

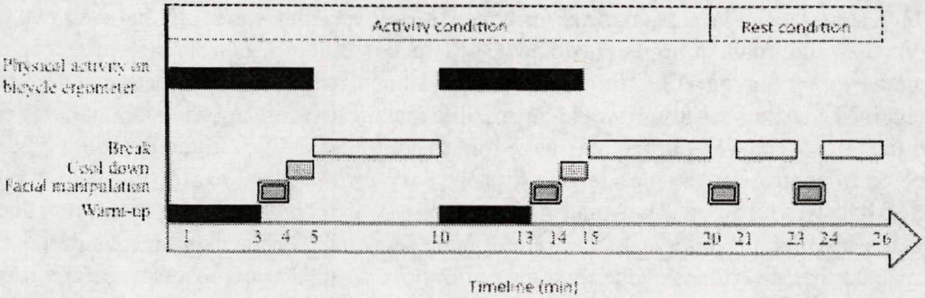


*Figure 1*. Illustration of the experimental design on the basis of an exemplary procedure for one participant. The horizontal bars show the different phases and activities throughout the experiment. The phases labels are on the y-axis. The timeline on the x-axis shows the duration, onset and offset of the different phases in minutes.

One facial expression condition lasted approximately one minute. Participants' facial expressions were manipulated three times during this minute. In each manipulation participants were required to keep on smiling or frowning for a minimum of six seconds and to continue until they had filled in the questionnaires. Before the first manipulation started, participants were informed about the procedure of the experiment, yet they were also told that they did not need to worry about remembering all the details since they would receive the specific instructions throughout the experiment. When participants were ready they adopted a smile in the smile condition (for the frown condition, the procedure was identical only replacing "smile" for "frown") and simultaneously raised their hand as a signal that the testing condition could begin. The signal was necessary to start measuring the time because the experimenter remained out of the participants' sight and could not see the participants' faces throughout all testing conditions.

The first manipulation started when participants gave the signal. Consequently, the experimenter started to take the time and encouraged participants to keep on smiling by saying: "Very good, keep smiling". The encouragement was repeated at 3 seconds with the words "Keep smiling". At 6 seconds participants were instructed to continue smiling and to fill in the FS by saying: "Keep on smiling and fill in the left questionnaire". After the completion of the FS, participants were asked to relax their face ("Relax your face, now"). FS and RPE scales were located in front of participants on a board that was attached to the bike. Both scales were printed next to each other on the same sheet of paper for practical purposes.

The second and the third manipulation started at 30 and 50 seconds, respectively, and were almost identical to the first. In contrast to the first manipulation, after the second manipulation participants did not fill in any questionnaire because this manipulation only served to increase the plausibility of the cover story that the experiments main interest is the effect of facial expressions on the physiological measures (i.e., HR and EMG). After the third manipulation, participants filled in the RPE scale instead of the FS. After completion of the RPE scale, participants were asked to relax their face again and the facial expression condition ended.

In the activity conditions participants underwent the exact same two facial expression conditions as just described with the exception that they continuously cycled at 50 to 60 percent of their maximal heart rate reserve (HRR). In addition, participants were reminded to continue cycling after each instruction to relax their face (i.e., after the completion of the FS and RPE scale and at 36 seconds). In the activity conditions, the facial expression conditions were preceded by a three minutes stepwise warm-up until the required intensity was reached. After participants' HR remained in a steady state for at least 30 seconds, the facial expression condition started and was followed by one minute of active cool-down. In total, participants cycled for five minutes per activity condition.

During the rest conditions, participants simply sat on the ergometer without cycling and underwent the two facial expression conditions. During all breaks, participants remained seated on the ergometer and filled in a Word Find (Word Search) puzzle in order to distract them from the previously filled in scores of the FS and RPE scales. The Word Find puzzle is a scattered assembly of letters in the shape of a rectangle and was of the lowest difficulty. The goal of the puzzle is to find strings of letters that form a word. Participants were explicitly informed that the puzzle (and its result) had no meaning for the experiment and that its only purpose was to prevent them from boredom while they were recovering. Subsequent to the completion of all conditions, participants filled in the exit interview and were thanked for their participation.

*Data Analysis*

To test whether the facial expressions had an influence on the state of affect and on the perceived exertion, the scores of the FS and RPE scale were analyzed, using two separate 2x2 repeated measures ANOVAs. The two within-subject factors were 'facial expression' and 'physical activity' with levels smile and frown, and rest and activity, respectively. Effect sizes were calculated as partial eta squared ($\eta p^2$). The level of significance was set at $\alpha = .05$.

## Results

**Feeling Scale.** The mean scores of the FS of all four conditions are presented in Table 1. The results of the 2 (facial expression) x 2 (physical activity) ANOVA showed a significant main effect for 'facial expression', $F(1, 33) = 25.85$, $p < .001$, $\eta p^2 = .44$. The mean FS score of the two *smile* conditions (activity and rest) was 3.15 ($SD = .91$) and the mean FS score of the two *frown* conditions (activity and rest) was 2.32 ($SD = 1.35$). The results indicated that participants felt better while they were smiling than while they were frowning. Furthermore, there was a significant main effect for 'physical activity', $F(1, 33) = 12.21$, $p = .001$, $\eta p^2 = .27$. The mean FS score of the two *activity* conditions (smile and frown) was 2.51 ($SD = 1.12$) and the mean FS score of the two *rest* conditions (smile and frown) was 2.96 ($SD = 1.10$). The results indicated that participants felt better when they were at rest (just sitting on the bike) than when they were active (cycling). No interaction effect was found $F(1, 33) = .22$, $p = .64$, $\eta p^2 = .01$.

**Ratings of Perceived Exertion.** The mean scores of the RPE scale of all four conditions are also presented in Table 1. To test whether facial expression and physical activity had an influence on perceived exertion we conducted a 2x2 ANOVA. The results showed a significant main effect for 'facial expression', $F(1, 33) = 14.72$, $p = .001$, $\eta p^2 = .31$. The mean RPE score of the two *smile* conditions was 9.13 ($SD = 1.09$) and the mean RPE score of the two *frown* conditions was 9.71 ($SD = 1.36$). The results indicated that participants perceived less exertion when smiling than when frowning. Furthermore, there was a significant main effect for 'physical activity', $F(1, 33) = 190.16$, $p < .001$, $\eta p^2 = .85$. The mean RPE score of the two *activity* conditions was 11.79 ($SD = 1.87$) and the mean RPE score of the two *rest* conditions was 7.04 ($SD = 1.09$). The results showed that participants perceived less exertion while just sitting on the bike than while they were cycling. No interaction effect was found $F(1, 33) = .13$, $p = .72$, $\eta p^2 = .00$.

Table 1

*Mean scores and standard deviations of the FS and RPE scale per physical activity and facial expression condition.*

| Scale | Condition | | | |
|---|---|---|---|---|
| | Rest | | Activity | |
| | Smile | Frown | Smile | Frown |
| FS | 3.38 (0.95) | 2.53 (1.48) | 2.91 (1.03) | 2.12 (1.34) |
| RPE | 6.74 (0.79) | 7.35 (1.63) | 11.53 (1.96) | 12.06 (1.87) |

*Note*. FS = Feeling Scale; RPE = Ratings of Perceived Exertion Scale. N = 34.

**Manipulation Check and Exit Interview.** Participants' compliance with the facial manipulation instructions was checked in a random sample of 10 participants, resulting in 40 facial expression conditions with 3 facial manipulation instructions each (i.e., a total of 120 trials). Two raters watched the films recorded by the hidden webcam and judged independently whether a smile or a frown was recognizable and whether that was the correct expression in the corresponding condition. The accurate facial expressions were adopted in all except one trial, and the inter-rater agreement was above 99%.

According to the data of the exit interview only 1 out of the 34 participants guessed the real purpose of the experiment (i.e., "investigating whether smiling or frowning influences affect and whether this promotes performance"). Excluding the participant's data from the analyses did not yield different results.

In addition, the mean difficulty rating for smiling was 2.94 ($SD = 1.50$). The mean difficulty rating for frowning was 3.59 ($SD = 1.74$). A paired sample *t*-test of the difficulty ratings for smiling and frowning revealed that there was no significant difference in difficulty ratings, $t(1,33) = 1.72, p = .096$).

## Discussion

The present study investigated whether facial feedback effects are present during physical activity. Therefore, the effects of deliberately smiling and frowning on affective states and perceived exertion were tested while at rest and while physically active. It was hypothesized that deliberately adopted smiles would increase positive affect and decrease perceived exertion. Moreover, it was hypothesized that deliberately adopted frowns would increase negative affect and increase perceived exertion. The current results support the hypotheses. Participants reported to feel more positively when deliberately smiling than when frowning. Participants also reported to perceive less exertion in the smiling condition when compared to the frowning condition. The more positive effects of smiling as opposed to frowning were present at rest and under conditions of physical activity. Hence, the study provides initial evidence for the existence of facial feedback effects during physical activity.

The study expands the conditions under which the facial feedback effects apply, complying with requests stated elsewhere (McIntosh, 1996). Moreover, the facial feedback effects on affect are in line with reviews on the FFH (Adelmann & Zajonc, 1989; Izard, 1990; Laird, 1984; Manstead, 1988; McIntosh, 1996). The results also support the prediction, deriving from theories of embodiment effects (Niedenthal et al., 2005), that bodily states can modulate the emotional experience. In line with the study by Schnall and Laird (2003), the present study also showed that explicitly asking participants to produce an emotional expressive facial expression can result in a change of the corresponding affective states while physically active. In combination with the effects on affect, the effect of facial expressions on perceived exertion provides an indication for the hypothesis that a more positive affect might reduce the perception of exertion (Hardy & Rejeski, 1989). Moreover, the results are in line with participants' reports of more perceived effort due to frowning (Larsen et al., 1992; Stepper & Strack, 1993). Laguna and Dobbert (2002) showed that runners wearing sunglasses while performing at bright daylight perceived less exertion, felt more positive, and performed better than runners without sunglasses. Laguna and Dobbert (2002) argued that the differences are caused by impaired vision due to blinding by the light, which is a source of distraction. Alternatively, the sunglasses could also have prevented runners from squinting (due to the bright light), which is a facial expression that involves Corrugator supercilii activity and is very similar to frowning. Thus, it is possible that the differences were caused by more Corrugator activity (i.e., frowning), due to blinding by the light.

In the present paper, we provide initial evidence for the existence of facial feedback effects during physical activity. However, solely based on the present study we cannot conclude whether the increase in affect and the decrease in perceived exertion are either due to more smiling or less frowning, because no control condition was included in the present design. It is possible that the effects are due to differences in the amount of Corrugator supercilii activity, which is reduced by smiling. Yet, other studies (e.g., Larsen et al., 1992; Strack et al., 1988) demonstrated that activity of either the Zygomaticus major or the Corrugator supercilii alone is sufficient to significantly change ratings of affect as compared to control conditions. Hence, it is likely that both smiling (i.e., Zygomaticus activity) and frowning (i.e., Corrugator activity) independently contribute to changes in affect and perceived exertion. Moreover, in line with Darwin (1872/1965) who considered the contraction of the Corrugator supercilii as "the expression of the 'perception of something difficult ... either in thought or action'" (p. 223; cf. Stepper & Strack, 1993, p. 216), we suggest that a significant amount of Corrugator supercilii activity is naturally present in facial expressions during physical activity, given that physical exercise is often demanding.

Following the conclusion that facial feedback effects exist while physically active, questions about these effects under more ecologically valid situations arise, such as those including physical activity of longer durations and exercises with various intensities. Physical activity itself seems to have a distinguished effect on affect that strongly depends on the exercise intensity (Ekkekakis, Hall, & Petruzzello, 2008). At high exercise intensities, the bodily sensations due to the physical activity might become so salient (Rejeski, 1985) that they overrule the effects of facial expressions. Additionally, it seems that psychological factors such as self-efficacy moderate the effect of exercise intensities on affect (Ekkekakis, 2003). A similar moderating effect seems to exist for RPE measures, with the tendency to be less dependent on psychological factors at higher intensities (Hall, Ekkekakis, & Petruzzello, 2005). Hence, to further examine the effects of facial expressions on affect and perceived exertion, future studies should investigate the influence of specific exercise durations and intensities as well as possible psychological moderators.

Given the results of the exit interview, there are no indications for demand effects as a possible explanation for the differences in affect and perceived exertion between the smile and frown conditions. By introducing the cover story about the interest in heart rate, and diverting participants' attention to the physiological measures of the experiment, we minimized participants ' tendency to score the scales in compliance with the actual hypotheses of the experiment. In fact, only one participant guessed the actual purpose of the experiment. In addition, the effect of facial expressions on perceived exertion is even less likely due to demand effects. The relation between facial expressions and a measurement of the general amount of exertion that one is experiencing is much more obscure and indirect than the relation between facial expressions and affect. Last but not least, the alternative explanation that the facial feedback effects are due to differences in the difficulty of adopting either a smile or a frown can be dismissed based on the results of the exit interview that showed that participants experienced no significant differences. Hence, the results of the present study support the conclusion that facial feedback effects also exist while physically active.

To conclude, the present study showed that facial feedback effects occur during physical activity. The effects of smiling and frowning on ratings of affect and perceived exertion motivate further studies about facial feedback effects in sports and exercise. The present study is a first step towards the investigation of the facial feedback effects on affect and perceived exertion while physically active. Yet, further research is needed to substantiate our initial findings. For example, future research has to show whether these effects also occur at various intensities that are relevant to different fields of sports and exercise in order to provide more evidence to legitimize the statement that sometimes your success is the source of your smile and sometimes the smile is the source of your success.

## References

Acevedo, E. O., Gill, D. L., Goldfarb, A. H., & Boyer, B. T. (1996). Affect and perceived exertion during a two-hour run. *International Journal of Sport Psychology, 27*, 286-292.

Acevedo, E. O., Rinehardt, K. F., & Kraemer, R. R. (1994). Perceived exertion and affect at varying intensities of running. *Research Quarterly for Exercise and Sport, 4*, 372-376.

Adelmann, P. K., & Zajonc, R. (1989). Facial efference and the experience of emotion. *Annual Review of Psychology, 40*, 249-280.

Barsalou, L. W. (1999). Perceptual symbol system. *Behavioral and Brain Sciences, 22*, 577-660.

Barsalou, L. W., Niedenthal, P. M., Barbey, A. K., & Ruppert, J. A. (2003). Social embodiment. In B. H. Ross (Ed.), *The psychology of learning and motivation*, Vol. 43 (pp. 43-92). San Diego, CA: Academic Press.

Biddle, S. J. H., & Mutrie, N. (Eds.). (2001). *Psychology of physical activity: Determinants, well-being and interventions*. London, UK: Routledge.

Borg, G. (1998). *Borg's perceived exertion and pain scales*. Champaign, IL: Human Kinetics.

Cacioppo, J. T., Priester, J. R., & Bernston, G. G. (1993). Rudimentary determination of attitudes: II. Arm flexion and extension have differential effects on attitudes. *Journal of Personality and Social Psychology, 65*, 5-17.

Darwin, C. R. (1965). *The expression of emotions in man and animals*. Chicago: University of Chicago Press. (Original work published 1872)

Duclos, S. E., & Laird, J. D. (2001). The deliberate control of emotional experience through control of expressions. *Cognition and Emotion*, *15*, 27-56. doi:10.1080/02699993004200088

Duclos, S. E., Laird, J. D., Schneider, E., Sexter, M., Stern, L., & Van Lighten, O. (1989). Emotion-specific effects of facial expressions and postures on emotional experience. *Journal of Personality and Social Psychology, 57*, 100-108.

Ekkekakis, P. (2003). Pleasure and displeasure from the body: Perspectives from exercise. *Cognition and Emotion, 17*, 213-239. doi:10.1080/02699930244000282

Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2008). The relationship between exercise intensity and affective responses demystified: To crack the 40-year-old nut, replace the 40-year-old nutcracker. *Annals of Behavioral Medicine, 35*, 136-149. doi:10.1007/s12160-008-9025-z

Ekkekakis, P., & Petruzzello, S. J. (1999). Acute aerobic exercise and affect. Current status, problems and prospects regarding dose-response. *Sports Medicine, 28*, 337-374.

Ekman, P. (1992). Facial expressions of emotion: An old controversy and new findings. *Philosophical Transaction of the Royal Society of London: Biological Sciences, 335*, 63-69.

Ekman, P., & Friesen, W. V. (1982). Felt, false, and miserable smiles. *Journal of Nonverbal Behavior, 6*, 238-252.

Erez, A., & Isen, A. M. (2002). The influence of positive affect on the components of expectancy motivation. *Journal of Applied Psychology, 87*, 1055-1067. doi:10.1037//0021-9010.87.6.1055

Flack, W. F. (2006). Peripheral feedback effects of facial expressions, bodily postures, and vocal expressions on emotional feelings. *Cognition and Emotion, 20*, 177-195. doi:10.1080/02699930500359617

Flack, W. F., Laird, J. D., & Cavallaro, L. A. (1999). Separate and combined effects of facial expressions and bodily postures on emotional feelings. *European Journal of Social Psychology, 29*, 203-217. doi: 10.1002/(SICI)1099-0992(199903/05)29:2/3<203::AID-EJSP924>3.0.CO;2-8

Hall, E. E., Ekkekakis, P., & Petruzzello, S. J. (2005). Is the relationship of RPE to psychological factors intensity-dependent. *Medicine and Science in Sports and Exercise, 37*, 1365-1373. doi:10.1249/01.mss.0000174897.25739.3c

Hanin, Y. L. (2000). *Emotions in Sport*. Leeds, UK: Human Kinetics.

Hardy, C. J., & Rejeski, W. J. (1989). Not what, but how one feels: The measurement of affect during exercise. *Journal of Sport and Exercise Psychology, 11*, 304-317.

Izard, C. E. (1990). Facial expressions and the regulation of emotions. *Journal of Personality and Social Psychology, 58*, 487-498.

James, W. (1890). *The principles of psychology*. New York: Holt.

Jones, M. V., & Uphill, M. A. (2004). Emotion in sport: Antecedents and performance consequences. In D. Lavellee, J. Thatcher, M. V. Jones (Eds.), *Coping and emotion in sport* (pp. 9-28). New York: Nova Science Publishers.

Laguna, P. L., & Dobbert, K. (2002). The effect of wearing sunglasses on performance, exercise-induced feeling states, and perceived exertion in runners. *International Journal of Sport Psychology, 33*, 355-371.

Laird, J. D. (1974). Self-attribution of emotion: The effects of expressive behavior on the quality of emotional experience. *Journal of Personality and Social Psychology, 29*, 475-186.

Laird, J. D. (1984). The real role of facial response in the experience of emotion: A reply to Tourangeau and Ellsworth, and others. *Journal of Personality and Social Psychology, 47*, 909-917.

Laird, J. D., Wagener, J. J., Halal, M., & Szegda, M. (1982). Remembering what you feel: Effects of emotion on memory. *Journal of Personality and Social Psychology, 42*, 646-657.

Larsen, R. J., Kasimatis, M., & Frey, K. (1992). Facilitating the furrowed brow: An unobtrusive test of the facial feedback hypothesis applied to unpleasant affect. *Cognition and Emotion, 6,* 321-338.

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

Manstead, A. S. R. (1988). The role of facial movement in emotion. In H. L. Wagner (Ed.), *Social psychophysiology: Theory and clinical applications* (pp. 105-129). New York: Wiley.

McIntosh, D. N. (1996). Facial feedback hypotheses: Evidence, implications, and directions. *Motivation and Emotion,* 2, 121-147.

Morgan, W. P., & Borg, G. (1976). Perception of effort in the prescription of physical activity. In T. T. Craig (Ed.), *The mental health aspects of sports, exercise, and recreation.* Chicago, IL: American Medical Association.

Niedenthal, P. M., Barsalou, L. W., Winkielman, P., Krauth-Gruber, S., & Ric, F. (2005). Embodiment in attitudes, social perception, and emotion. *Personality and Social Psychology Review, 9*, 184-211.

Raab, M., Johnson, J., & Heekeren, H. (Eds.) (2009). Mind and motion: The bidirectional link between thought and action, Vol. 174. *Progress in Brain Research*. Amsterdam: Elsevier.

Rejeski, W. J. (1985). Perceived exertion: An active or passive process? *Journal of Sport Psychology, 7*, 371-378.

Rejeski, W. J., Best, D., Griffith, P., & Kenney, E. (1987). Sex-role orientation and the response of men to exercise stress. *Research Quarterly, 58*, 260-264.

Robertson, R. J. (2001). Development of the perceived exertion knowledge base: An interdisciplinary process. *International Journal of Sport Psychology, 32*, 189-196.

Schnall, S., & Laird, J. D. (2003). Keep smiling: Enduring effects of facial expressions and postures on emotional experience and memory. *Cognition and Emotion, 17*, 787-797. doi:10.1080/02699930244000183

Soussignan, R. (2002). Duchenne smile, emotional experience, and automatic reactivity: A test of the facial feedback hypothesis. *Emotion,* 2, 52-74. doi:10.1037//1528-3542.2.1.52

Stepper, S., & Strack, F. (1993). Proprioceptive determinants of emotions and nonemotional feelings. *Journal of Personality and Social Psychology, 64*, 211-220.

Strack, F., Martin, L. L., & Stepper, S. (1988). Inhibiting and facilitating conditions of the human smile: A non-obtrusive test of the facial feedback hypothesis. *Journal of Personality and Social Psychology, 54*, 768-777.

Tenenbaum, G., & Hutchinson, J. C. (2007). A social-cognitive perspective of perceived and sustained effort. In G. Tenenbaum, & R. C. Eklund (Eds.), *Handbook of sport psychology (3rd ed.)*. (pp. 560-577). Hoboken, NJ: Wiley & Sons.

Thich Nhat Hanh (n.d.). *Quote from Thich Nhat Hanh*. Retrieved from http://thinkexist.com/quotation/sometimes_your_joy_is_the_source_of_your_smile/9460.html

Van Landuyt, L. M., Ekkekakis, P., Hall, E. E., & Petruzzello, S. J. (2000). Throwing the mountains into the lakes: On the perils of nomothetic conceptions of the exercise-affect relationship. *Journal of Sports and Exercise Psychology, 22*, 208-234.

Wilmore, J. H., & Costill, D. L. (2004). *Physiology of sport and exercise (3rd ed.)*. Leeds UK Human Kinetics.

Winton, W. M. (1986). The role of facial response in self-reports of emotion: A critique of Laird. *Journal of Personality and Social Psychology, 50*, 808-812.