

The rewarding effect of flow experience on performance in a marathon race

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A B S T R A C T

Objectives: This research aimed to shed light on the relationship between flow experience and performance in sports using a marathon race as an example. We hypothesized that flow influences the marathon race performance by an indirect rewarding effect. We assumed that the positive quality of flow experience rewards the pre race running activity and thereby enhances training behavior which again leads to high race performance. A methodological issue of the this was to compare the retrospective with the experience sampling measure of flow.

Design: Three studies with marathon runners ($N_s = 109, 112, 65$ for Studies 1, 2, and 3, respectively) were conducted.

Method: They measured flow experience four times during a marathon race either retrospectively (Studies 1 and 2) or using an experience sampling method during the race (Study 3). Additionally race performance and future running motivation (Studies 1, 2, and 3), pre race training behavior (Studies 2 and 3) and flow experience in training (Study 3) were measured.

Results: The results confirmed the hypothesis showing that flow during a marathon race is related to future running motivation, but is not directly linked to race performance. Instead, race performance was predicted by pre race training behavior (Studies 2 and 3) which again was fostered by flow during the training (Study 3). The descriptive flow courses of the retrospective and the experience sampling flow measures were comparable but also showed important differences.

Conclusions: We critically discuss the practical implications of the rewarding effect of flow on performance and the advantages of the retrospective and experience sampling measure of flow.

Keywords:

Flow experience
Performance in sports
Marathon race

Flow experience is a "subjective state that people report when they are completely involved in something to the point of forgetting time, fatigue, and everything else but the activity itself" (Csikszentmihalyi & Rathunde, 1992, p. 59). A large number of studies found that flow experience is associated with high performance in various domains of human live (e.g., Campion & McClelland, 1991; Jackson & Roberts, 1992; Jackson, Thomas, Marsh, & Smethurst, 2001; Martin & Cutler, 2002; Nakamura, 1991; Schiefele & Rheinberg, 1997). For example, flow is positively associated with performance in learning settings (e.g., Engeser, Rheinberg, Vollmeyer, & Bischoff, 2005; Schüler, 2007; Schiefele & Rheinberg, 1997) and artistic and scientific creativity (e.g., Perry, 1999; Sawyer, 1992). Interestingly, in the domain of sport the relationship between flow and performance is not as consistent. Some studies found significant associations between flow and sport performance (e.g., Jackson & Roberts, 1992; McInman & Grove, 1991; Jackson, Kimiecik, Ford, & Marsh, 1998; Jackson et al., 2001), whereas others did not (e.g., Janson, Archer, & Norlander, 2005; Stoll & Lau, 2005).

This research aimed to shed light on the relationship between flow and performance in sports by discussing the mechanism of how flow influences performance.

How flow facilitates performance

The mechanisms how flow influences performances are based on the characteristics constituting the flow experience. The defining feature of this multifaceted phenomenon is the intrinsically rewarding experiential involvement in moment to moment activity that is accompanied by a positive experience quality (Csikszentmihalyi, 1990; Csikszentmihalyi, Abuhamdeh, & Nakamura, 2005). This main feature is responsible for further features as the merging of action and awareness, the altered sense of time and the sense of control: The involvement in an activity can become so deep that individuals are no longer aware that they are separate from their action and thus it feels as if action and awareness have merged. The absorption by the action leaves no room for self reflective processes and fosters an altered sense of time. Thus, it often seems that time passes faster. Additionally, during flow individuals do not worry about failure and instead experience

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a high sense of control. As the most important conditions of flow experience Csikszentmihalyi et al. (2005) proposed the perceived balance of the challenge of a task and the own skills and a clear set of goals that, combined with an unambiguous feedback about how well one is doing, directs the activity and provide the information what exactly has to be done next.

The multifaceted character of flow brings along that different features may influence performance by different mechanisms. On the one hand the flow literature proposed that some flow characteristics directly influence performance because they are performance enhancing in their nature (e.g., Engeser et al., 2005; Jackson & Roberts, 1992; Jackson et al., 2001). For example, high concentration and a sense of control have often been cited as facilitators of performance (e.g., Eklund, 1994, 1996; Williams & Krane, 1997). Therefore, flow is a functional state itself that facilitates performance directly. On the other hand an indirect influence on performance has been suggested. This mechanism is based on the rewarding effect of the positive experience that accompanies the deep involvement during flow. According to Csikszentmihalyi and colleagues (e.g., Csikszentmihalyi et al., 2005) this positive experience is a powerful motivating force. "When individuals are fully involved in an activity, they tend to find the activity enjoyable and intrinsically rewarding" (Csikszentmihalyi et al., 2005, p. 602). Because activities that have been rewarded are more likely to be performed again, flow has effects on the future motivation. In order to continue experiencing flow, individuals have to perform the activity again and find greater challenges that enhance their skills over time. This again results in an enhancement of competence and greater performance (e.g., Wong & Csikszentmihalyi, 1991). Thus, the positive experience quality of flow causes an indirect effect on performance by first influencing the motivation to perform the activity again that in a second step enhances performance.

Present research

In this research we analyze how flow influences performance in a marathon race. First hints about this mechanism come from previous studies testing the relationship between flow during a marathon race and the race performance. Stoll and Lau (2005) conducted two sophisticated studies with marathon runners who were asked about their flow experience during a marathon race directly after crossing the finishing line. In the first study the authors tested whether the flow experience predicted the running time (performance). In a second study the de facto running time was additionally controlled for by taking the intended running time into account. In both studies the flow experience during the marathon race was unrelated to race performance, indicating that flow did not directly foster performance in a marathon race. Because other studies suggest direct associations between flow and sport performance (Jackson & Roberts, 1992; Jackson et al., 2001), we were inspired to think about the special characteristic of a marathon race that may unlink flow during the race from race performance. We speculated that the potentially performance enhancing flow characteristics that are responsible for the direct link between flow and performance do not determine performance in a marathon race as strongly as in other sports. For example, high concentration and a high sense of control may not enhance the running speed in long distance runners to the same degree as it enhances performance in sports in which precise springiness requires concentration and control (e.g., basketball shots). Based on these considerations and Stoll and Lau's (2005) results we expected no direct relationship between flow during a race and race performance. Instead, we assumed that the indirect effect of flow on performance works very well for a marathon race: The positive experience quality of flow rewards the pre race running activity

and thereby enhances the training behavior prior to a race. The link to performance is provided by basic knowledge of sport's science that the race performance is mainly determined by the amount of training behavior. To sum up, we suggest a mediation model that is based on the rewarding character of flow as proposed by Csikszentmihalyi (e.g., Csikszentmihalyi et al., 2005).

We conducted three studies with marathon runners which have the same basic structure. Data were collected at three time periods: prior to the race the intended running time was assessed as an important control variable (see Stoll & Lau, 2005). Flow experience during the race was measured either retrospectively (Studies 1 and 2) or simultaneously (Study 3). After the race we measured the performance and the future running motivation. The studies extend each other by adding further variables that are necessary to test different parts of the mediation hypothesis. Study 1 is designed to show that flow during a marathon race influences future running motivation. Additionally, we tested whether flow during the race is directly associated to race performance. Study 2 aimed at replicating the results of Study 1 and additionally proving another link in the mediation model by showing that the pre race training behavior indeed is associated with high race performance. Finally, Study 3 is designed to test the whole mediation hypothesis that flow in the training enhances the pre race training behavior which again predicts good race performance.

In order to optimize the measurement of flow during a marathon race and therewith to enhance the quality of flow research in this domain, this research has the methodological issue to compare the *flow retrospective measure* with the *flow experience sampling measure*. Measuring flow after the flow evoking event (retrospective measure) has been criticized by some authors mainly for conceptual reasons (see Rheinberg, 2008). Because during flow individuals are assumed to be totally involved in the action, there should be no room left in their awareness for introspection. This makes it difficult to report about flow experience afterwards. Additionally, memory effects can decrease the validity of retrospective measures. Thus, flow is recommended to be measured directly during the performance of an activity (Rheinberg, 2008; Csikszentmihalyi & Larson, 1987). This is usually realized by the experience sampling method (ESM; Csikszentmihalyi, Larson, & Prescott, 1977) in which samples of experiences were registered by providing the participants with a beeper that signals at random intervals when participants had to fill in a questionnaire about their current experience. The ESM has been used in several studies and revealed results convincingly supporting its validity (e.g., Csikszentmihalyi & Csikszentmihalyi, 1991; Csikszentmihalyi & LeFevre, 1989; Delle Fave & Bassi, 2000; Schallberger & Pfister, 2001). Apart from the advantages of the flow experience sampling measure, there are at least two disadvantages compared to the flow retrospective measure. First, when asking individuals about their flow experience during the potentially flow evoking activity, the activity must be interrupted. This risks the danger of disturbing flow. Second, the flow experience sampling measure is a highly sophisticated issue connected with high time and even financial costs for the researcher. Because there are pros and cons for each method (see also Jackson & Marsh, 1996) this research aims at examining the courses of flow during a marathon race and weighting the advantages and disadvantages of the flow experience sampling vs. retrospective measure.

In order to reliably measure flow we considered the special characteristics of a marathon race. A marathon race is not characterized by a constant level of physiological and psychological effort, but by strong variations of required effort that mainly depend on variations in the availability of energy. Especially the race period around kilometer 30 is critical due to a change over from one main source of energy (glucose from muscles and liver) to another

(transformation of fat resources) which is often accompanied by temporary energy deficits. In colloquial language of marathon runners this energy deficit is called "the wall", because it is experienced as a severe barrier that feels hard to overcome. To meet the strong variations of difficulties during a marathon race we measured flow experience four times, at kilometer 10, 20, 30 and 40.

Study 1

In Study 1 we explored the course of flow during a marathon race. Additionally we tested the hypothesis that flow during a marathon race predicts future running motivation, but that it is unrelated to race performance.

Method

Participants and procedure

Thirty six female and 78 male marathon runners were recruited at a marathon exhibition prior to a race to participate in a study on *Experiences in a Marathon race*. Here, they directly answered a few questions concerning their age, sex, starting number and their intended race performance by filling out a first brief questionnaire. They received a second questionnaire that they were asked to fill in when they arrived at home directly after the marathon race and to mail it back immediately. All but two male participants who filled in the first part sent back the second questionnaire. Thus, the final study sample comprised 112 participants (mean age 37.00, SD 7.61, range: 18–62). They were asked to remember the race as vividly as possible and try to re-experience the race periods at about kilometer 10, 20, 30 and 40 again. Participants reported their flow experience for each of the four race periods and finished the questionnaire with answering questions about their future running motivation. The real race performance was objectively assessed by the marathon organizer.

Measures

The marathon runners stated their intended race performance by writing down their intended running time (e.g., 3:30:00) prior to the race. Using this operationalization of race performance, higher values in the intended running time indicate lower intended race performance. The Flow Short Scale (Flow Kurz Skala; Rheinberg, Vollmeyer, & Engeser, 2003) has been proven to measure the multifaceted flow phenomenon reliable and valid (e.g., Engeser & Rheinberg, submitted for publication; Engeser et al., 2005; Rheinberg et al., 2003). In this research it was used to assess the flow experience at the race periods around kilometer 10, 20, 30 and 40 retrospectively. Participants were instructed to successively imagine each race period as vividly as possible. A description of prominent landmarks (i.e., sights, bridges, and famous places) helped them to imagine the periods and they were asked to give an answer that referred to that specific period. Example of items are "I am totally absorbed in what I am doing.", "I do not recognize that time is going by", "I feel that everything is under control" and "I have no difficulty concentrating". Average scores of flow experience for each of the four race periods were computed (Cronbach's Alphas between .84 and .91). To get an overall flow score of the marathon race the mean of these four flow scores was computed. The future running motivation was measured with the three items "I am looking forward to the next running training", "I can hardly wait to start running again", and "I am already planning my future training". The items were rated concerning how much the participants agree with them using a 7 point scale (1: not at all 7: very much). The future running motivation measure was reliable with an internal consistency of .76 (Cronbach's Alpha). The running time was measured objectively by the marathon organizers. Again, higher values in running time indicate lower race performance.

Results

Preliminary analyses and descriptive statistics

Preliminary analyses revealed that men had a significantly higher intended race performance (running time in minutes: $M = 231.99$, $SD = 28.35$) than women ($M = 256.63$, $SD = 35.01$), $t(110) = 3.98$, $p < .01$ and were also faster in the marathon race (men: $M = 241.25$, $SD = 32.23$; women: $M = 259.79$, $SD = 36.34$), $t(110) = 2.73$, $p < .01$. Because these sex differences did not influence any of the results reported below, and no other sex or age effects were found they will not be mentioned further. Pearson correlation analyses revealed that the mean flow experience ($M = 4.88$, $SD = .89$) during the race was correlated with the future running motivation ($M = 4.27$, $SD = 1.53$), $r = .35$, $p < .01$, but not with the running time ($M = 247.21$, $SD = 34.55$), $r = .12$, ns. The intended running time ($M = 239.91$, $SD = 32.61$), and the real running time were highly related with $r = .83$, $p < .001$, indicating that the intended running time must be considered as a control variable when running time is predicted.

The prediction of future running motivation and performance

The correlation analyses reported above already showed a positive association between flow experience and future running motivation. To predict the running time, flow during the race and the intended running time were entered simultaneously into a multiple regression equation. Flow during the race did not predict the running time, $\beta = .08$, ns, $b = 3.22$, $se_b = 2.08$, whereas the intended running time revealed to be a significant predictor, $\beta = .82$, $p < .001$, $b = .87$, $se_b = .06$; $R^2 = .69$, $F(2, 109) = 119.73$, $p < .001$.

Examination of the course of flow during the race

An analysis of variance with a four step repeated measure factor (flow at kilometer 10, 20, 30, 40) revealed significant changes of flow during the race periods, $F(3, 333) = 63.43$, $p < .001$. Flow decreased from kilometer 10 ($M = 5.54$, $SD = 0.87$) to kilometer 20 ($M = 5.18$, $SD = 1.01$) and had a strong decrease up to kilometer 30 ($M = 4.43$, $SD = 1.24$) and a slight decrease around kilometer 40 ($M = 4.38$, $SD = 1.26$). The detached line in Fig. 1 illustrates the course of flow in this study.

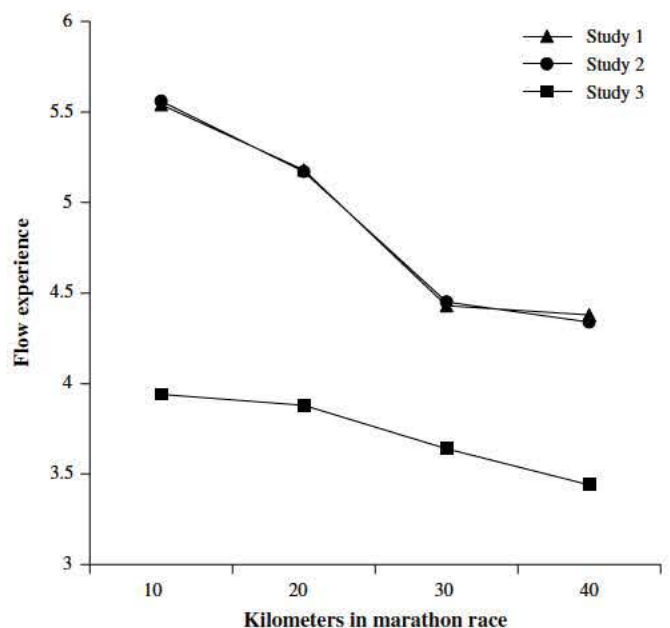


Fig. 1. Flow courses of the retrospective flow measures (Studies 1, 2) and the experience-sampling flow measure (Study 3). Note: the flow courses of Studies 1 and 2 were so similar that the lines partly overlap.

Brief discussion

The study showed that a high flow experience during the marathon race lead to a high motivation to continue the running activity in the future. This supports parts of our mediation assumption that flow rewarded the performed activity and therefore enhances future running motivation. As expected, flow during the race was not directly associated to race performance. Further, the high correlation of $r = .82$ between the intended running time and the real race performance indicates that marathon runners are very realistic goal setters. Interpreting the intended running time as a realistic rating about ones training level, the high correlation is a first hint that prior race factors may influence the running performance strongly.

The four flow measures during the race allow analyzing the time course of flow during a marathon race. Results show that the time course is in line with the variations of physiological energy. The flow experience is the highest at kilometer 10 when the energy that can be provided is in balance with the energetic requirements of the run and it decreased slightly up to kilometer 20. As expected the strongest decrease of flow took part at the critical energy crisis at about kilometer 30. Afterwards flow just decreased slightly up to kilometer 40.

Study 2

Study 2 aimed at replicating the result of Study 1 suggesting that flow is related to future running motivation but not to race performance. The additional measure of the pre race training behavior allowed testing an important link within our assumed mediation model in which we hypothesized that race performance is predicted by the pre race training behavior. Additionally, Study 2 was designed to enhance confidence in the flow retrospective measure by confirming the flow course of Study 1.

Method

Participants and procedure

One hundred and nine marathon runners (19 women, 90 men) with a mean age of 36.30 years (SD 7.70, range: 20–68) participated. The procedure of data collection was similar to the data collection in Study 1. In the first questionnaire, which was filled in at home prior to the race, participants indicated their age, sex, starting number and their intended race performance. In addition to Study 1, we asked for the pre race training behavior. The second questionnaire was filled in at home directly after the race and contained the same retrospective flow measures as in Study 1, referring to the race periods at kilometer 10, 20, 30 and 40. Additionally, participants answered questions concerning their future running motivation. Again, the race performance was objectively assessed by the marathon organizer.

Measures

The intended race performance, the real race performance and flow during the race (Cronbach's Alphas for the four race periods between .82 and .90) were measured exactly as in Study 1. The assessment of future running motivation contained the three items of Study 1 plus three additional items ("I do not feel motivated for the running training", "Currently I am not thinking about the running training", "At the moment, I feel no desire to future trainings"). Participants could again rate their agreement using a 7 point scale (1: not at all 7: very much). After recoding the three additional items, all six items were aggregated to a mean future running motivation score. The internal consistence was sufficiently high with Cronbach's Alpha .76. To assess pre race training

behavior, participants were asked how many kilometers they had run on average each week (for the last 3 months) ahead of the marathon race.

Results

Preliminary analyses and descriptive statistics

As in Study 1, men intended to be faster ($M = 223.21$, $SD = 26.26$) and actually were faster in the marathon race ($M = 225.04$, $SD = 30.85$) than women (intended running time: $M = 236.89$, $SD = 19.84$, $t(107) = 2.14$, $p < .05$; real running time: $M = 244.70$, $SD = 28.67$, $t(108) = 2.43$, $p < .05$). Neither the sex differences nor age influenced the analyses reported below. The correlation coefficients in Table 1 show that as in Study 1 the mean flow experience during the race was positively correlated with the future running motivation, $r = .22$, $p < .05$. Additionally, the correlation between flow and running time was marginally significant, $r = .21$, $p < .10$. Again, the intended running time and the real running time were highly related with $r = .77$, $p < .001$, suggesting that the intended running time should be considered as a control variable. Pre race training behavior was positively associated with the future running motivation, $r = .33$, $p < .01$ and was negatively associated with running time ($r = -.34$, $p < .01$) and flow experience during the race ($r = -.25$, $p < .05$).

The prediction of future running motivation and performance

To predict future running motivation the variables' flow experience, pre race training behavior and intended running time were entered simultaneously into the regression equation (due to significant correlations with the dependent measure). Flow experience remained a significant positive predictor of the future running motivation, $\beta = .18$, $p < .05$, $b = .22$, $se_b = .13$, this time even when controlling for pre race training behavior ($\beta = .25$, $p < .01$, $b = .01$, $se_b = .01$) and for the intended running time ($\beta = .08$, ns , $b = .004$, $se_b = .005$), $R^2 = .13$, $F(3, 101) = 5.12$, $p < .01$.

In order to predict running time, the intended running time, the pre race training motivation and flow experience during the race were entered simultaneously into the regression analysis. Again, flow during the race was not related ($\beta = .08$, ns , $b = 2.84$, $se_b = 2.31$) whereas the intended running time was related to the actual running time, $\beta = .74$, $p < .001$, $b = .89$, $se_b = .08$. As expected, the pre race training behavior, $\beta = .23$, $p < .05$, $b = .80$, $se_b = .09$, predicted the running performance, $R^2 = .61$, $F(3, 101) = 52.57$, $p < .001$.

Examination of the course of flow during the race

An analysis of variance with flow at kilometer 10, 20, 30, 40 as the four steps of the repeated measure factor revealed significant variations in the flow course, $F(3, 312) = 60.86$, $p < .001$. The flow course was so similar to the flow course of Study 1 that the lines that symbolize the flow courses in Fig. 1 are partly covered by each other (see dotted lines in Fig. 1). Again, flow decreased from kilometer 10 ($M = 5.55$, $SD = 0.77$) to kilometer 20 ($M = 5.15$, $SD = 1.00$). Then it had an extremely strong decrease up to

Table 1
Descriptive statistics and Pearson correlation (two-tailed) among variables of Study 2

	2	3	4	5	M	SD
1. Intended running time	-.37**	-.19*	-.20*	.77***	225.60	25.71
2. Pre-race training behavior		-.25*	.32**	-.34**	52.03	24.56
3. Flow during race			.22*	-.21 ⁺	4.88	.87
4. Future running motivation				-.14	5.42	1.19
5. Running time					228.23	31.23

⁺ $p < .10$; * $p < .05$; ** $p < .01$; *** $p < .001$.

kilometer 30 ($M = 4.45$, $SD = 1.19$) and then decreased only slightly up to kilometer 40 ($M = 4.34$, $SD = 1.29$).

Brief discussion

Studies 1 and 2 suggested that flow experience during a marathon race is associated with the future running motivation but not with race performance. By finding a relation between training behavior and race performance we verified an important link in our assumed mediation model. Study 2 also confirmed the flow course of Study 1 by revealing a slight decrease from kilometer 10 to 20 and a deep decrease at kilometer 30. The very similar flow courses of marathon runners who took part at different marathon races at different times exclude the explanation that external factors were responsible for the flow variation and thus strengthen the confidence in the flow measure.

Study 3

Study 3 measured flow during the training, pre race training behavior and race performance and therefore allowed testing the whole mediation model. We hypothesized that flow during training enhances pre race training behavior which again leads to high performance in the marathon race. By additionally measuring the intended running time and flow during the race, we could compare the results of Study 3 with the results of Studies 1 and 2. An important methodological aspect that differentiated Study 3 from the former studies is the experience sampling method to assess flow. Instead of asking participants retrospectively for their flow experience, flow was measured by directly asking the athletes at the kilometer marks 10, 20, 30 and 40 for their current flow experience. Therefore the marathon runners are awaited at the kilometer marks by assistants of the researcher. These assistants joined them for a short distance and asked them to rate their current flow state by reading the flow items and noting the answers. Because the flow data have been assessed under very similar conditions (the same performance situation, similar participants, and same time periods) and with the same questionnaire (Flow Short Scale), a direct comparison on a descriptive level between the flow retrospective measure (Studies 1 and 2) and the flow experience sampling measure can be made.

Method

Participants and procedure

Sixty five male marathon runners took part in a study on *Experiences of Long Distance Runners*. The study sample is restricted to male marathon runners, because we also measured physiological indicators that were not of interest for this research.¹ Participants were between 20 and 68 years of age ($M = 43.7$, $SD = 9.67$). As in Study 2 the first questionnaire prior to the race was to assess participants' age, the starting number, the intended running performance and the pre race training behavior. In addition, flow experience during the training period was measured once by asking participants to rate their flow experience retrospectively with regard to a typical training situation. Participants were then informed in detail about the measures taking place during the race. During the marathon race, at the kilometers 10, 20, 30 and 40 the participants were interviewed about their

flow experience by assistants of the researcher while continuing running.² After the marathon race, the runners rated their future running motivation.

Measures

Intended race performance, real race performance, pre race training behavior and future running motivation were assessed in the same way as in Study 2. The Flow Short Scale (Rheinberg et al., 2003) was administered once to assess the flow experience during training. Participants were instructed to imagine a typical training within the last 10 weeks excluding the last week. We excluded the last week prior to a race because marathon runners typically reduce the amount of training in the last week in order to be physically recovered for the race. Again, a mean flow score across all items was computed (Cronbach's Alpha = .71). In order to measure flow during the race with the experience sampling method, participants' run was not interrupted, but the helpers awaited the runners at the check marks of kilometer 10, 20, 30 and 40, accompanied them and noted their answers to each flow item of the Flow Short Scale (Rheinberg et al., 2003). Again, all flow scores were reliable with Cronbach's Alphas between .74 and .81. As before, the flow scores for each race period were aggregated to a mean score of that period and a general flow score for the race was computed (mean of flow scores of all race periods).

Results

Preliminary analyses and descriptive statistics

Preliminary analyses revealed that the age of the participants did not influence the results reported below. All significant correlations replicated the relationships found in Studies 1 and 2 (see Table 2). Thus, flow during the race is positively correlated with future running motivation, $r = .27$, $p < .05$. This relationship remained stable when regressing future running motivation on flow during the race while controlling for the running time, $\beta = .28$, $p < .05$, $b = .31$, $se_b = .14$ (overall model: $F(2, 62) = 2.61$, $p = .08$, $R^2 = .08$). The intended running time is highly correlated to the real running time, $r = .87$, $p < .001$. As in Study 2, the pre race training behavior is related to the intended running time, $r = .40$, $p < .01$. The correlation coefficients in Table 2 also show that all necessary relationships to test the hypothesized mediation model are given. Thus, flow experience in the training is associated with the pre race training motivation, $r = .24$, $p < .05$ and with the running time, $r = .29$, $p < .05$. The pre race training behavior is associated with the running time, $r = .45$, $p < .01$.

Testing the mediation model

To test the mediation hypothesis that flow in training enhances pre race training behavior which in turn enhances running performance, we followed a procedure proposed by Baron and Kenny (1986). As documented in the correlation analyses reported above, all preconditions to test a mediation effect (significant relationships between predictor, mediator and criterion) are fulfilled. To test the mediation effect, we conducted a multiple regression analysis in which running time was simultaneously regressed on flow in training and pre race training behavior. The overall model was significant, $F(2, 62) = 9.77$, $p < .001$, $R^2 = .24$, and pre race training behavior was still a predictor of running time, $\beta = .40$, $p < .001$, $b = .50$, $se_b = .17$. As expected, the relationship between flow in training and running time was no longer

¹ The physiological measures were cortisol measures. Because the variation of the cortisol level is different for men and women, we chose only male participants.

² Cortisol in saliva was assessed by taking a probe of saliva at the race periods of kilometer 10, 20, 30, 40. Because the probes were taken after the participants were interviewed about their flow experience they could not have influenced the measures relevant for this study.

Table 2
Descriptive statistics and Pearson correlation (two-tailed) among variables of Study 3

	2	3	4	5	6	M	SD
1. Intended running time	-.40**	-.28*	-.08	.08	.87***	222.54	30.04
2. Pre-race training behavior		.24*	.27*	.13	-.45**	42.08	19.91
3. Flow in training			.37**	.13	-.29*	3.84	.41
4. Flow during race				.27*	-.13	3.72	.47
5. Future running motivation					.05	4.21	.52
6. Running time						222.66	28.89

* $p < .05$; ** $p < .01$; *** $p < .001$.

significant with β .16, ns (b 13.76, se_b 8.01). Thus, the beta weight dropped from β .29, $p < .05$ in a regression analysis testing the direct relationship between flow in training and running time (b 20.58, se_b 8.46, $F(1, 63)$ 5.91, $p < .05$, R^2 .10) to a non significant beta weight of β .16, indicating that the pre race training behavior partially mediated the relationship between flow in training and the running time.

Examination of the course of flow during the race

A repeated measure analysis of variance (repeated measure factor: flow at kilometer 10, 20, 30, 40) showed significant changes of flow among the marathon race ($F(3, 192)$ 26.04, $p < .001$). Flow decreased from kilometer 10 (M 3.94, SD 0.40) to kilometer 20 (M 3.88, SD .54) and had a strong decrease at kilometer 30 (M 3.64, SD .62), followed by a slight decrease up to kilometer 40 (M 3.44, SD .66) (see solid line in Fig. 1). Fig. 1 allows to descriptively compare the flow time courses measured by the retrospective flow measures and the flow experience sampling measure. Two main differences can be seen. First, the flow mean scores of the experience sampling measure were lower than the retrospective ratings of flow. Second, the flow time course showed less intense variation. Although the nature of the flow course was similar in the way that they all show the sharp decline at kilometer 30, the flow experience sampling measure revealed a less strong drop of flow at kilometer 30 and in contrast to the retrospective measures a slighter decrease up to kilometer 40.

Brief discussion

Although flow during the race was measured directly during the running activity instead of retrospectively, Study 3 could fully replicate the results of Studies 1 and 2. Again, flow during the race was related to future running motivation and uncorrelated to the race performance. As in Study 2, the pre race training behavior predicted race performance, supporting an important link in our mediation model. The added value of Study 3 was the test of the mediation model as a whole. A regression analysis approach revealed a partial mediation indicating that flow in training enhanced pre race training behavior which again is responsible for high race performance. The mediation approach is partly limited because we could not test the causal relationship between flow and training behavior, because in Study 3 both variables referred to the same date. However, the result that flow experience measured during the race predicted future running motivation indicates a causal relationship. This is in favor of our assumption that flow influences training motivation and not vice versa.

General discussion

The aim of this study was to examine the relationship between flow and running performance in a marathon race. We examined whether flow influences performance directly or whether flow enhances training motivation prior to the race which then

enhances race performance. The results of our three studies strongly support the indirect effect of flow on performance. In none of the studies flow during the race was directly associated with race performance. Instead, flow was associated with a high future running motivation. This supports our assumption that flow functions as a reward of the running activity, which leads to the desire to perform the activity again. Studies 2 and 3 showed that indeed the pre race training behavior was a strong predictor of race performance. The missing link between flow during training and the pre race training behavior was provided by Study 3 which tested the whole mediation model. As expected, experiencing flow during training enhanced the training behavior which in turn resulted in high race performance.

One methodological aim of this research was to answer the question whether the flow retrospective and the flow experience sampling measures are comparable. The results suggest two answers. In favor of comparability we found that both measures revealed comparable results concerning the hypothesis. Also the descriptive flow courses (Fig. 1) support the comparability argument suggesting that marathon runners can cognitively reconstruct the flow course during different race periods with its main characteristic of a strong decrease at kilometer 30. On the other hand, we found two differences that suggest a critical consideration of the retrospective measure. First, the retrospectively measured flow scores were consistently higher than the flow scores measured by the experience sampling method. Second, they showed more variation, for example a stronger decrease of flow during the critical race period at kilometer 30. This suggests that the marathon runners overestimated the amount as well as the variation of flow when rating flow retrospectively. To sum up, there are arguments in favor as well as against the comparability. We recommend that the decision whether to use the more economic flow retrospective measure or the more sophisticated flow experience sampling measure depends on the focus of the research question. When the research question focuses on the relationship between flow and other measures or just on the simple nature of flow courses, the very economic retrospective measure might be sufficient. But when aiming to make assumptions about the absolute level of flow experience or when very precise measures of flow courses are required, the flow experience sampling measure is recommended.

The present findings inspired us to discuss its practical implications. Our results could be of interest for the domain of performance promotion in professional sports as well as for health promotion in health related or leisure time sports. For serious sports, where the focus is on performance, our theorizing suggests that high performance can be reached by facilitating flow experience in the training (for flow enhancing strategies in sport see, e.g., Jackson & Wrigley, 2004; Lindsay, Maynard, & Owen, 2005; Nicholls, Poltnan, & Holt, 2005), which positively rewards the sport activity. In the long run this should result in more intense training which in turn will foster performance. However, the assumption of a linear relationship between the intensity of training and performance in a competition might be too simplified from an athletic training point of view. For example, overtraining can lead to physical and mental stress impairing performance, whereas a decrease in the intensity prior to a competition may be a useful recovery strategy increasing performance (e.g., Beckmann & Kellmann, 2004; Kellmann & Kallus, 2001). Thus, in practical coaching settings multiple aspects of training behavior (e.g., variation of training intensities, kind of training, and recovery processes) should be taken into consideration in order to successfully link training behavior to better performance.

A current research question in health psychology is how to motivate individuals to maintain exercise behavior in order to gain the beneficial health effects connected to long term exercising (e.g., Rothman, 2000; Schwarzer, 1999, 2001). Based on this study's

results, flow experience may contribute to the long term maintenance of exercising by positively rewarding the sport activity and thus enhancing the probability to perform it again. With this, two kinds of well being could be reached simultaneously, the immediate positive experience quality connected to flow and the beneficial health effects in the long run.

References

- Baron, R. M., & Kenny, D. A. (1986). The mediator-moderator variable distinction in social psychological research: conceptual, strategic and statistical considerations. *Journal of Personality and Social Psychology*, 51, 1173–1182.
- Beckmann, J., & Kellmann, M. (2004). Self-regulation and recovery: approaching an understanding of the process of recovery from stress. *Psychological Reports*, 95, 1135–1153.
- Campion, M., & McClelland, C. (1991). Interdisciplinary examination of the costs and benefits of enlarged jobs: a job design quasi-experiment. *Journal of Applied Psychology*, 76, 196–199.
- Csikszentmihalyi, M. (1990). *Flow. The psychology of optimal experience*. Harper Collins.
- Csikszentmihalyi, M., Abuhamdeh, S., & Nakamura, J. (2005). Flow. In A. J. Elliot, & C. S. Dweck (Eds.), *Handbook of competence and motivation* (pp. 598–608). New York, NY, US: Guilford Publications, Inc.
- Csikszentmihalyi, M., & Csikszentmihalyi, I. S. (1991). *Die aussergewöhnliche Erfahrung im Alltag. Die Psychologie des Flow-Erlebens. [Extraordinary experience in everyday life. Psychology of flow experience]*. Stuttgart, Germany: Klett-Cotta.
- Csikszentmihalyi, M., & Larson, R. (1987). Validity and reliability of the Experience Sampling Method. *Journal of Nervous and Mental Disease*, 175, 529–536.
- Csikszentmihalyi, M., Larson, R., & Prescott, S. (1977). The ecology of adolescence activity and experience. *Journal of Youth and Adolescence*, 6, 281–294.
- Csikszentmihalyi, M., & LeFevre, J. (1989). Optimal experience in work and leisure. *Journal of Personality and Social Psychology*, 56, 815–822.
- Csikszentmihalyi, M., & Rathunde, K. (1992). The measurement of flow in everyday life: toward a theory of emergent motivation. In R. Dienstbier, & J. E. Jacobs (Eds.), *Nebraska Symposium on motivation, 1992, 40, Developmental Perspectives on motivation* (pp. 57–97). Lincoln and London: University of Nebraska Press.
- Delle Fave, A., & Bassi, M. (2000). The quality of experience in adolescents' daily lives: developmental perspectives. *Genetic, Social, and General Psychology Monographs*, 126, 347–367.
- Eklund, R. C. (1994). A season long investigation of competitive cognition in collegiate wrestlers'. *Research Quarterly for Exercise and Sport*, 65, 169–183.
- Eklund, R. C. (1996). Preparing to compete: a season-long investigation with collegiate wrestlers'. *The Sport Psychologist*, 10, 111–131.
- Engeser, S., & Rheinberg, F. Flow, performance and moderators of challenge-skill-balance, submitted for publication.
- Engeser, S., Rheinberg, F., Vollmeyer, R., & Bischoff, J. (2005). Motivation, Flow-Erleben und Lernleistung in universitären Lernsettings. [Motivation, flow experience, and performance in learning settings at university]. *Zeitschrift für Pädagogische Psychologie*, 19, 159–172.
- Jackson, S. A., Kimiecik, J., Ford, S., & Marsh, H. W. (1998). Psychological correlates of flow in sport. *Journal of Sport & Exercise Psychology*, 20, 358–378.
- Jackson, S. A., & Marsh, H. W. (1996). Development and validation of a scale to measure optimal experience: the Flow State Scale. *Journal of Sport & Exercise Psychology*, 18, 17–35.
- Jackson, S. A., & Roberts, G. C. (1992). Positive performance states of athletes: Toward a conceptual understanding of peak performance. *The Sport Psychologist*, 6, 156–171.
- Jackson, S. A., Thomas, P. R., Marsh, H. W., & Smethurst, C. J. (2001). Relationship between flow, self-concept, psychological skills, and performance. *Journal of Applied Sport Psychology*, 13, 129–153.
- Jackson, S. A., & Wrigley, W. J. (2004). Optimal experience in sport: current issues and future directions. In J. Summers, & T. Morris (Eds.), *Sport psychology: theory, applications and issues* (2nd ed.). (pp. 423–451) Milton: John Wiley & Sons Australia.
- Janson, L., Archer, T., & Norlander, T. (2005). Achievement of timing in the highest competitive level: the necessity of a "driving conviction". *Athletic Insight: Online Journal of Sport Psychology*, 7(2).
- Kellmann, M., & Kallus, K. W. (2001). *Recovery-stress questionnaire for athletes: user manual*. Champaign, IL: Human Kinetics.
- Lindsay, P., Maynard, L., & Owen, T. (2005). Effects of hypnosis on flow states and cycling performance. *The Sport Psychologist*, 19(2), 164–177.
- Martin, J. J., & Cutler, K. (2002). An exploratory study of flow and motivation in theatre actors. *Journal of Applied Sport Psychology*, 14, 344–352.
- McInman, A. D., & Grove, J. R. (1991). Peak moments in sport: a literature review. *Quest*, 43, 333–351.
- Nakamura, J. (1991). Optimales Erleben und die Nutzung der Begabung. In M. Csikszentmihalyi, & I. S. Csikszentmihalyi (Eds.), *Die außergewöhnliche Erfahrung im Alltag. Die Psychologie des Flow-Erlebens [The extraordinary experience in everyday life. The psychology of flow experience]* (pp. 326–334). Stuttgart, Germany: Klett-Cotta.
- Nicholls, A. R., Poltman, R. C. J., & Holt, N. (2005). The effects of individualized imagery interventions on golf performance and flow states. *Athletic Insight: Online Journal of Sport Psychology*, 7(1).
- Perry, S. K. (1999). *Writing in flow*. Cincinnati: Writer's Digest Books.
- Rheinberg, F. (2008). Intrinsic motivation and flow-experience. In H. Heckhausen, & J. Heckhausen (Eds.), *Motivation and action* (pp. 323–348). Cambridge, UK: Cambridge University Press.
- Rheinberg, F., Vollmeyer, R., & Engeser, S. (2003). Die Erfassung des Flow-Erlebens. In J. Stiensmeier-Pelster, & F. Rheinberg (Eds.), *Diagnostik von Motivation und Selbstkonzept [Diagnosis of motivation and self-concept]* (pp. 261–279). Göttingen: Hogrefe.
- Rothman, A. J. (2000). Toward a theory-based analysis of behavioral maintenance. *Health Psychology*, 19(1), 64–69.
- Sawyer, K. (1992). Improvisational creativity: an analysis of jazz performance. *Creativity Research Journal*, 5, 253–263.
- Schallberger, U., & Pfister, R. (2001). Flow-Erleben in Arbeit und Freizeit. Eine Untersuchung zum Paradox der Arbeit mit der Experience Sampling Method. [Flow experiences in work and leisure. An experience sampling study about the paradox of work]. *Zeitschrift für Arbeits- und Organisationspsychologie*, 45, 176–187.
- Schiefele, U., & Rheinberg, F. (1997). Motivation and knowledge acquisition: searching for mediating processes. In M. L. Maehr, & P. P. Pintrich (Eds.), *Advances in motivation and achievement, vol. 10* (pp. 251–301). Greenwich, CT: JAI Press.
- Schüler, J. (2007). Arousal of flow-experience in a learning setting and its effects on exam-performance and affect. *Zeitschrift für Pädagogische Psychologie*, 21, 217–227.
- Schwarzer, R. (1999). Self-regulatory processes in the adoption and maintenance of health behaviour. *Journal of Health Psychology*, 4(2), 115–127.
- Schwarzer, R. (2001). Social-cognitive factors in changing health-related behaviour. *Current Directions in Psychological Science*, 10, 47–51.
- Stoll, O., & Lau, A. (2005). Flow-Erleben beim Marathonlauf – Zusammenhänge mit Anforderungspassung und Leistung. [Experiencing "flow" during a marathon. Associations with the fit between demand and ability]. *Zeitschrift für Sportpsychologie*, 12(3), 75–82.
- Williams, J. M., & Krane, V. (1997). Psychological characteristics of peak performance. In J. M. Williams (Ed.), *Applied sport psychology: personal growth to peak performance*, 3 (pp. 158–170). Mountain View, CA: Mayfield.
- Wong, M. M., & Csikszentmihalyi, M. (1991). Motivation and academic achievement: the effects of personality traits and the quality of experience. *Journal of Personality*, 59(3), 539–574.