

Effects of a Mindfulness Intervention on Sports-Anxiety, Pessimism, and Flow in Competitive Cyclists

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Background: This study investigated whether mindfulness training increases athletes' mindfulness and flow experience and decreases sport-specific anxiety and sport-specific pessimism. **Methods:** Cyclists were assigned to an eight-week mindfulness intervention, which incorporated a mindful spin-bike training component, or a wait-list control condition. Participants completed baseline and post-test measures of mindfulness, flow, sport-anxiety, and sport-related pessimistic attributions. **Results:** Analyses of covariance showed significant positive effects on mindfulness, flow, and pessimism for the 27 cyclists in the mindfulness intervention condition compared with the 20 cyclists in the control condition. Changes in mindfulness experienced by the intervention participants were positively associated with changes in flow. **Conclusions:** Results suggest that mindfulness-based interventions tailored to specific athletic pursuits can be effective in facilitating flow experiences.

Keywords: anxiety, athletes, cyclists, flow, mindfulness, pessimism

INTRODUCTION

Mindfulness consists of open and sustained awareness and non-interference of judgement with sensory experience (Brown & Ryan, 2003; Brown, Ryan, & Creswell, 2007). The present research examined whether eight weeks of mindfulness training—tailored for competitive athletes—facilitates flow. We predicted that greater mindfulness impacts flow directly as well as through

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inhibition of anxiety and pessimism which in turn may also impact flow. Mindfulness may be especially pertinent for athletes, such as competitive cyclists, for whom flow experience during sport may be beneficial and who may be prone to distraction by sport-related anxiety and pessimism (e.g. Jackson & Csikszentmihalyi, 1999).

Flow

Flow experience consists of a feeling of enhanced physical and psychological functioning, a sense of freedom stemming from absence of negative thought and self-conscious evaluation (Jackson, 2000) and autotelic experience (Nakamura & Csikszentmihalyi, 2005), which is linked to or may accompany peak performance (Jackson & Csikszentmihalyi, 1999; Jackson & Roberts, 1992; Schüler & Brunner, 2009). The ability to be absorbed in the present moment task is the catalyst that creates the opportunity to experience a flow state (Csikszentmihalyi, 1978).

As well as being linked to peak performance, flow experience may be important in competitive sport in facilitating an optimal subjective psychological state involving positive sport experiences, intrinsic motivation, and persistence (Jackson, 2000; Kimiecik & Stein, 1992). Seligman and Csikszentmihalyi (2000) argued that the enjoyment felt when breaking through new limits leads to personal growth and happiness. Flow may contribute to the quality of sport experience through “endowing momentary experience with value” (Nakamura & Csikszentmihalyi, 2005, p. 102).

Cognitive processes involving attention and awareness are at the core of the flow experience in athletes (Swann, Keegan, Piggott, & Crust, 2012). Csikszentmihalyi (1978) explained that flow experiences “are made possible by an unusually intense concentration of attention on a limited stimulus field” (p. 342). Awareness of the present is a core aspect of both mindfulness and flow (Swann et al., 2012). Flow can be defined by nine characteristics or dimensions (Csikszentmihalyi, 1990). Three of these dimensions, challenge–skill balance, clear proximal goals, and unambiguous feedback, are pre-cursors of flow (Nakamura & Csikszentmihalyi, 2005). When fulfilled, these three precursor *flow conditions* may facilitate the subjective experience of being in a flow state (Hunter & Csikszentmihalyi, 2000), which may be defined by the six *flow characteristics*: Concentration on the task at hand, action-awareness merging, loss of self-consciousness, sense of control, transformation of time, and autotelic experience (Nakamura & Csikszentmihalyi, 2005).

Mindfulness and Flow

Mindfulness may create a basis for the experience of flow (Aherne, Moran, & Lonsdale, 2011; Briegel-Jones, Knowles, Eubank, Giannoulatos, & Elliot, 2013;

Kaufman, Glass, & Arnkoff, 2009). Mindfulness involves awareness of and purposeful attention to one's present-moment experiences, in a non-judgemental and accepting way (Bishop et al., 2004; Brown & Ryan, 2003; Kabat-Zinn, 2003, 2009). A high level of mindfulness is associated with a greater frequency of the key flow dimensions of challenge–skill balance, clear goals, concentration, merging of action and awareness, and loss of self-consciousness (Kee & Wang, 2008). Research by Cathcart, McGregor, and Groundwater (2014) found that elite athletes with a high level of dispositional mindfulness have a propensity to experience flow. This research suggests that mindfulness may be a catalyst for flow. Intervention studies intended to increase mindfulness can provide further information as to whether there is a causal connection between mindfulness training and flow.

Mindfulness-based interventions focus on the enhancement of non-judgemental attention to the present moment (Brown & Ryan, 2003). In studies not directly related to sports, such interventions have benefits ranging from reductions in anxiety and depression (Cayoun, 2011; Grossman, Niemann, Schmidt, & Walach, 2004; Hofmann, Sawyer, Witt, & Oh, 2010; Hölzel et al., 2011; Kabat-Zinn, 2003) to increasing the production of the enzyme telomerase (Schutte & Malouff, 2014). Some evidence for the causal role of mindfulness in the mindfulness–flow relationship comes from research with athletes and suggests that mindfulness interventions may increase flow experience (Aherne et al., 2011; Briegel-Jones et al., 2013; Kaufman et al., 2009).

In addition to promoting flow, mindfulness may decrease the likelihood of experiencing anxiety. In reviews of the mindfulness and sports literature, Birrer, Röthlin, and Morgan (2012) and Gardner and Moore (2012) suggested that increases in mindfulness may lead to modified relationships with internal experiences such as anxiety. Athletes with enhanced mindfulness might still experience anxiety, but the subjective meaning of the anxiety may be different. One of the purposes of the present study was to examine the impact of mindfulness training on the experience of athletes' anxiety.

Anxiety and Flow

Some flow experts suggest that flow may be difficult to achieve when one is anxious because anxiety can invoke a negative self-conscious focus that disrupts concentrated attention (Csikszentmihalyi, 1990; Jackson & Csikszentmihalyi, 1999). Fullagar, Knight, and Sovern (2013) reported an association between greater performance anxiety and less experience of flow among musicians. Jackson, Kimiecik, Ford, and Marsh (1998) found associations between high performance anxiety and lower frequency of the key flow dimensions of challenge–skill balance, unambiguous feedback, clear goals, concentration, and sense of control. Some flow literature suggests that the cognitive rather than the physiological component of anxiety may be the factor that is most responsible for the negative impact of anxiety on flow (Jackson & Wrigley, 2004).

Pessimism and Flow

Similar to anxiety, pessimistic feelings may also interfere with the frequency and intensity of flow (Catley & Duda, 1997). As proposed by Abramson, Seligman, and Teasdale (1978), pessimistic and optimistic attribution styles relate to the thoughts used by a person to habitually explain the causes of outcomes. A pessimistic attribution style entails thought processes related to failure that focus attention on thoughts of permanence (e.g. “it has happened in the past and it will happen again”); universality (e.g. “it happens to me no matter what race I go to”); and internal causes (e.g. “it is because I am simply not good enough”). Individuals with a pessimistic attribution attribute success to temporary, specific, and external causes (Buchanan & Seligman, 1995).

A pessimistic attribution style can contribute to the experience of anxiety (Moran, 2012; Schleider, Vélez, Krause, & Gillham, 2014) as well as directly impeding the experience of flow by directing attention away from present-moment experience towards anticipated failure. Pessimism can also impede the fulfilment of flow conditions by focusing attention on negative self-concepts such as perceived low ability and reduced self-confidence (i.e. competence), impeding the matching of skills with challenges and a sense of control over the task (i.e. autonomy), which can negatively impact on intrinsic motivation and persistence (Kowal & Fortier, 1999). The present study set out to examine the impact of mindfulness training on athletes’ pessimism.

Mindfulness Training

Mindfulness training has the potential to change relatively enduring characteristics (Cayoun, 2011; Kabat-Zinn, 1982, 2009). Eight-week mindfulness training in attentional and emotional regulation skills has been found to increase dispositional mindfulness (Kabat-Zinn, 1982, 2009) as well as impact other characteristics in beneficial ways (Geschwind, Peeters, Drukker, Van Os, & Wichers, 2011; Kabat-Zinn, 1982, 2009; Segal, Williams, & Teasdale, 2002; Williams, Teasdale, Segal, & Kabat-Zinn, 2007). As mindfulness training has been shown to have broad benefits, mindfulness training may increase the propensity to experience flow and decrease sport-anxiety and pessimism among cyclists.

Aims of the Study

In the present study we examined the impact of a mindfulness-based intervention on mindfulness, flow, sport-anxiety, and sport-related pessimistic attributions in competitive cyclists. Further, we explored the relationship between changes in mindfulness in the intervention group cyclists and changes in their experiences of flow, anxiety, and pessimism. Mindfulness training may be especially relevant to endurance athletes such as cyclists because these athletes tend to experience pro-

longed exposure to sensations of discomfort or pain. Mindfulness may result in a reduction in cognitive and emotional automatic response inhibiting attention saliency of pain and discomfort (Kabat-Zinn, 1982; Zeidan, Grant, Brown, McHaffie, & Coghill, 2012). We propose that mindfulness training that incorporates practice of mindfulness in relation to an athlete's sport may help athletes assimilate mindfulness skills more readily. Mindfulness training may help athletes develop skills such as refocusing and acceptance, which in turn may lead to reinterpretation of inner experience and increased flow.

We hypothesised that:

- 1 Participants in the mindfulness-based intervention group would show greater increases in mindfulness compared to wait-list control participants.
- 2 Participants in the mindfulness-based intervention group would show greater increases in global experience of flow, flow conditions (challenge – skill balance, clear goals, unambiguous feedback), and flow characteristics (action awareness merging, concentration on task at hand, sense of control, and loss of self-consciousness and autotelic experience) compared to wait-list control participants.
- 3 Participants in the mindfulness-based intervention would show greater decreases in sport-anxiety and sport-related pessimism, relative to wait-list control participants.
- 4 Greater increases in mindfulness would be associated with greater increases in the frequency of flow and decreases in anxiety and pessimism in mindfulness intervention participants.

METHODS

Participants

We recruited cyclists from the New England region of Australia after the study was approved by the university ethics committee. Inclusion criteria for the study were that the cyclists be actively competing in mountain biking or road cycling at club level and be 16 years of age or older. The single exclusion criterion was involvement in formal mindfulness-meditation practice as the study was seeking participants who were predominantly naïve to mindfulness practice, so as to better assess the intervention's efficacy in enhancing mindfulness and promoting flow. Participant recruitment started on 14 January 2013 and closed on 14 February 2013. Baseline pre-intervention measures for all participants were completed on 6 March 2013. The eight-week intervention commenced on 6 March 2013 and was completed on 24 April 2013.

From the potential eligibility list of 150 riders (the number of members on club lists from which the cyclists were recruited), 60 cyclists gave their informed

consent to participate in the study. Two females and five males from the wait-list control and three males from the intervention condition withdrew from the study. Three cyclists from the control condition were excluded from the data analysis due to their disclosure of significant mindfulness experience. This resulted in a total of 47 competitive cyclists being included in the final analyses. Twenty-seven were in the mindfulness intervention condition and 20 were in the wait-list control condition. See Figure 1 for progression of participants through the study and reasons for dropout.

The cyclists were members of road cycling ($n = 30$) and mountain bike ($n = 17$) clubs. The total sample comprised five female and 42 male riders. One female and 19 male riders were in the control condition and four female and 23 male riders were in the mindfulness intervention condition. Mindfulness intervention participants' ages ranged from 16 to 57 years ($M = 38.96$, $SD = 12.4$), and control participants' ages ranged from 22 to 67 years ($M = 40.65$, $SD = 10.88$).

Among the control participants, eight riders (40%) spent on average 1–5 hours training each week, eight trained 5–10 hours on average, one rider trained 10–15 hours, and one trained 15–20 hours. All control group riders indicated that they competed at least once a week. In the mindfulness intervention group, 12 riders (44.4%) spent on average 1–5 hours training each week, 13 (48.1%) trained 5–10 hours on average, one rider trained 10–15 hours, and one trained 15–20 hours/week. Twenty-five riders (92.6%) in the intervention group indicated that on average they competed at least once a week and two riders competed 6–10 times/month.

Procedure

The cyclists were stratified by gender and cycling discipline (i.e. road or mountain biking) and then randomly allocated to either the mindful-meditation or wait-list control condition. They were randomly assigned by one of the researchers through the flip of a coin (Schulz & Grimes, 2002). This study used a pre-baseline random allocation procedure in response to a high percentage of participants requesting a week's notification so that possible changes to work and training schedules could be made to facilitate their likelihood of being able to meet the study requirements. Participants and researchers were not blind to participants' condition.

After allocation to conditions, riders were sent an email that contained participation instructions one week prior to the study commencement. Wait-list control participants accessed the baseline survey electronically. The survey contained the mindfulness, sport-anxiety, pessimistic attribution style, and flow scales and questions relating to participants' training and racing. Riders allocated to the intervention condition completed a pen-and-paper version of the same baseline survey completed by the control participants before receiving any intervention material. Control group cyclists received no further contact until they were asked

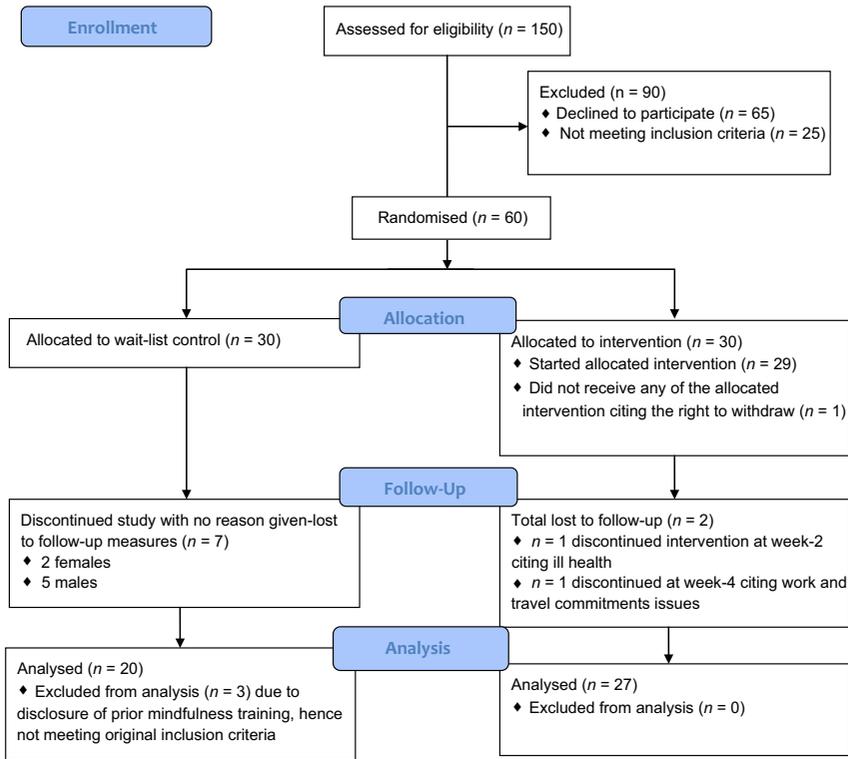


FIGURE 1. Progression of participants through study.
 Note: Chart based on Schulz, Altman, and Moher (2010).

to complete the post-test questionnaire eight weeks later. The mindfulness intervention group cyclists participated in the mindfulness workshops, home-meditation based on the modified mindfulness-integrated cognitive behavior therapy program (MiCBT) (Cayoun, 2011) material, and mindful spin-bike training sessions. At the end of the eight-week period, all participants were asked to complete the post-test survey. Control group cyclists were offered the mindfulness-training intervention after completion of the study.

Measures

Participants completed the following measures at baseline and at post-test. We evaluated *Flow in Sport* using the 36-item Dispositional Flow Scale-2 (DFS-2; Jackson & Eklund, 2002). This scale measures the frequency with which a person typically experiences the occurrence of flow in sport or a physical activity. The scale comprises nine separate flow dimensions, with each subscale contain-

ing four items, that are assessed on a 5-point Likert scale, ranging from 1 (*never*) to 5 (*always*), with higher scores indicating greater frequency of flow. Flow scores can be calculated on a dimensional and global level (i.e. total score) and expressed as either a global sum or as an item mean score for each dimension. A mean score is typically used as it can be evaluated against the scale's anchor descriptors; thus scores in this study ranged from 1 to 5 for each dimension and composite subscales. Jackson and Eklund (2004) recommend that the transformation of time subscale is excluded when calculating the composite scores as it has only a modest association with global flow, so for the present study we excluded this subscale.

We combined the dimensions measuring the foundations of the flow experience (i.e. challenge–skill balance, unambiguous feedback and clear goals) to provide a measure of flow conditions. Following the recommendations of Jackson and Eklund (2004), in line with the conceptualisation of the characteristics that denote the experiential state of being in flow (Nakamura & Csikszentmihalyi, 2005), we computed a flow characteristics scale comprising the five dimensions of action awareness merging, concentration on task at hand, sense of control, and loss of self-consciousness and autotelic experience.

The internal consistency of each of the DFS-2 subscales in previous research has been adequate to high, with Cronbach's alphas ranging from .78 to .86 (Jackson & Eklund, 2002). In the present study, internal consistencies of the DFS-2 subscales were high as indicated by Cronbach's alphas ranging from .88 to .92 at baseline. The global score (eight flow dimensions) had a Cronbach's alpha of .92, inflow-experience (i.e. five flow dimensions) had a Cronbach's of .89, and the three-dimension flow-conditions scale had a Cronbach's alpha of .88.

We assessed *Sport Anxiety* using the Sports Anxiety Scale-2 (SAS-2; Smith, Smoll, Cumming, & Grossbard, 2006). An advantage of this scale is that it provides a total sport-performance anxiety score as well subscale scores, providing insight into different aspects of sport anxiety. The scale consists of 15 items that measure sport performance anxiety on three dimensions: somatic anxiety, worry, and concentration disruption (five items each), with items assessed on a 4-point Likert scale, ranging from 1 (*not at all*) to 4 (*very much*). Scores can range from 15 to 60, with higher scores representing greater sport performance anxiety. Internal consistency of the SAS-2 subscales of somatic anxiety, worry, and concentration disruption in previous research has been adequate to high, with Cronbach's alphas of .76, .90, and .85, respectively, and high for the total SAS-2 score, with a Cronbach's alpha of .87 (Smith et al., 2006). In the present study, internal consistencies of the SAS-2 subscales were high, with Cronbach's alphas of .88, .92 and .83 at baseline, and high for the total SAS-2 score, with a Cronbach's alpha of .92 at baseline.

We assessed *Mindfulness* using the Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006). The scale measures an individual's general tendency to be mindful in daily life. The FFMQ

consists of 39 items assessing five facets of mindfulness: observing, describing, acting with awareness, non-judging of inner experience, and non-reactivity to inner experience, with items for each subscale being assessed on a 5-point Likert scale, ranging from 1 (*never or very rarely true*) to 5 (*very often or always true*). For the total measure, scores can range from 39 to 195, with higher scores representing higher levels of mindfulness. In previous research the FFMQ had adequate to high internal consistency with coefficient alphas ranging from .75 to .91 (Baer et al., 2008). In the present study, the five facets of the FFMQ and the total FFMQ score showed high internal consistency, with Cronbach's alphas above .85 at baseline.

We assessed *Sport-related Pessimism* using the short form of the Sport Attribution Style Scale (SASS; Hanrahan, Grove, & Hattie, 1989). This scale consists of 10 items that describe five positive and five negative hypothetical events in sport (Hanrahan & Grove, 1990). Respondents are asked to vividly imagine themselves involved in each of the situations and to write down the single most likely cause if that event had happened to them. Causal attributions according to the five causal dimensions of internality, stability, globality, controllability, and intentionality are then rated by the respondent using a 7-point Likert scale that differs in anchoring descriptors for each causal dimension. For example, for the causal dimension of internality item response ranges from 1 (*totally due to other people or circumstances*) to 7 (*totally due to me*). As specified by Hanrahan and Grove (1990), in this study the pessimism composite score was calculated separately for positive (i.e. reverse scored) and negative scores on the dimensions of internality, stability, and globality, and then summed. Scores can range from 30 to 210, with higher scores representing greater use of a pessimistic explanation style.

In previous research internal consistency of the subscales was adequate with coefficient alphas of .74 and .72 for positive and negative events, respectively (Hanrahan & Grove, 1990). In the present study, the internal consistency of the pessimism composite score had a Cronbach's alpha of .81 at baseline.

Intervention

Mindfulness intervention group cyclists participated in an eight-week mindfulness-training program consisting of regular weekly workshop sessions, home-meditation training, and group stationary cycle mindful-spinning sessions. The mindful-spinning sessions were intended to help participants assimilate mindfulness skills into their sports practice. Figure 2 summarises the content and progression through the program. The mindfulness-training protocol was based on the mindfulness-integrated cognitive behavior therapy program (MiCBT; Cayoun, 2011). The weekly workshop sessions focused on the presentation of information related to mindfulness-meditation practice and the discussion of home-meditation and mindful spin-cycling experience. Information each week focused on core concepts relating to mindfulness and meditation practice and

difficulties that may occur while meditating, as well as strategies for increasing adherence to practice and ease of meditation at home and in workshop sessions. In addition, mindfulness concepts were discussed in relation to how they could be best assimilated into weekly guided mindful spin-bike practice.

The home-meditation sessions involved the use of CDs provided by the MiCBT program. The CDs contained guided mindful meditation instructions for practices such as mindfulness of breath and a progressive range of body scan meditations. Participants were asked to complete weekly body sensation interoception forms as part of MiCBT training (Cayoun, 2011). Completion of these forms was intended to encourage participants to reflect on awareness of body sensations and to provide an indication of mindfulness acquisition progress. Participants were asked to practice—and keep records of adherence in a workbook supplied—the assigned 30 minutes per day home-meditation .

Mindful-spinning was implemented via weekly indoor stationary cycling sessions, conducted in a group setting on fixed-drive spin-bikes with tension adjustment capabilities. This training provided a guided setting in which the cyclists were encouraged to observe any physical sensations and related thoughts in a non-judgemental and non-reactive manner. Mindful-spinning was designed to help the participants practice and assimilate the mindfulness-acceptance skills they had gained in the workshop sessions into their daily cycle routine and competition environment. In addition, mindful-spinning served as a generalised anchor to help facilitate the skill of refocusing attention (i.e. an associative focus of attention on cadence or the sensation of spinning the legs in an accepting, observant, and non-judgmental way) when distractions occurred.

Fidelity of the Intervention. The protocol followed a number of Dane and Schneider's (1998) suggestions for maintaining the integrity of a treatment protocol. To maintain the fidelity of the MiCBT treatment protocol (Cayoun, 2011), the first author of the current study undertook supervised training in MiCBT foundation skills and conducted the workshops and mindful-spinning sessions. In addition, the same guided mindful meditation CD based on the MiCBT protocol was given to each participant.

Participation in workshop sessions was recorded. In addition, in their weekly workbooks participants were asked to complete a record of minutes meditated immediately after each home-meditation session. The main purpose of the interoception forms was to encourage reflection on awareness of body sensations, but these forms also provided some information regarding adherence to mindfulness training through representing internalisation of aspects of mindfulness (Cayoun, 2011).

The mean number of sessions attended was 6.33 ($SD = 1.86$; range was 2–8). The mean number of minutes spent meditating as recorded in the workbooks was 547 ($SD = 416$). Visual inspection of the introspection forms provided a rough estimate of internalisation of aspects of mindfulness. The amount of

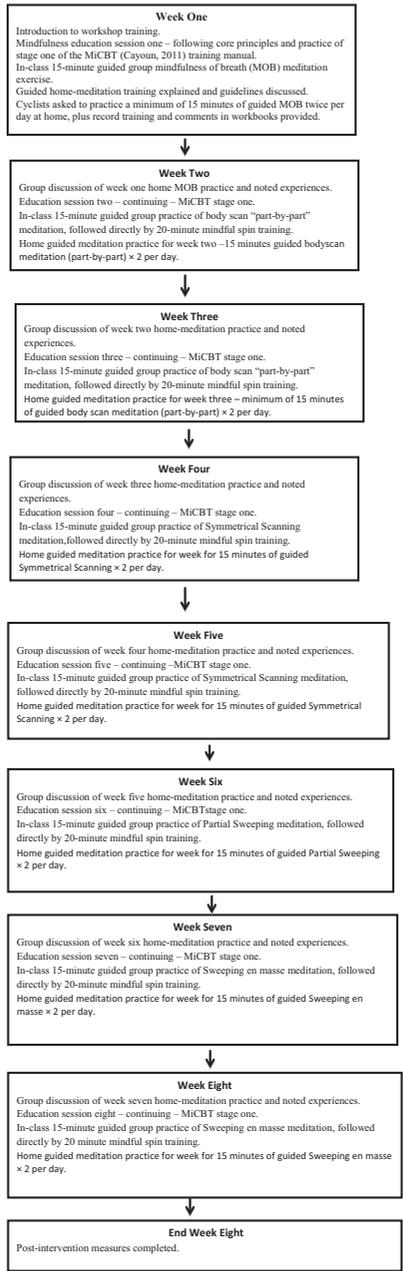


FIGURE 2. Summary of content and progress through the eight-week mindfulness training program.

shaded area of the back and front of the body silhouettes indicating awareness of body sensation during the first week of the program was on average 22 per cent across participants. At week 4 it was 46 per cent and by the last week of the program it was 70 per cent.

Overview of Analyses

Tabachnick and Fidell (2013) recommended using Analysis of Covariance (ANCOVA) to examine the results of a between-groups design with pre- and post-test measures as this approach takes into account ceiling and floor effects. If hypothesised outcomes are conceptually distinct, as in the present study, alpha inflation stemming from multiple analyses may not be a concern, and univariate rather than multivariate analysis may be preferable (Huberty & Morris, 1989). Thus, we used ANCOVAs to examine differences at post-test between the mindfulness intervention cyclists and control group cyclists holding constant baseline scores. Follow-up *t*-tests then examined significance of changes from baseline to post-test. Correlations between changes in major variables for participants in the intervention group examined the association of change in one variable with change in other variables.

RESULTS

Effect of the Mindfulness Intervention

Table 1 shows the means and standard deviations of the key study variables for the cyclists in the mindfulness training condition and control condition. There was a significant difference between groups on pre-test mindfulness, $t(45) = 2.35$, $p = .023$, 95% CI [1.22, 15.95], $d = .68$, with control group participants scoring higher; there was no significant difference found between groups at pre-test on any other key study variables.

Cyclists in the mindfulness training condition showed greater increases in mindfulness than the control cyclists, as shown by an ANCOVA in which group membership was the independent variable, baseline mindfulness was the covariate, and post-test mindfulness was the dependent variable, $F(1, 44) = 4.05$, $p = .049$, partial $\eta^2 = .09$. The increase in mindfulness from baseline to post-test in the intervention group cyclists had a moderate to large effect size, $t(26) = -3.96$, $p < .001$, 95% CI [-15.68, -5.43], $d = .75$.

In an ANCOVA in which group membership was the independent variable, pre-test global flow was the covariate and post-test global flow was the dependent variable, cyclists in the mindfulness training condition showed greater increases in the frequency of global flow relative to control cyclists, $F(1, 44) = 4.20$, $p = .046$, partial $\eta^2 = .09$. The effect size of the increase in

TABLE 1
Mindfulness Training and Control Group Means and Standard Deviations Pre and Post

Variables	Mindfulness condition (n = 27)				Control condition (n = 20)			
	Pre		Post		Pre		Post	
	M	SD	M	SD	M	SD	M	SD
Mindfulness	117.81	10.27	128.37	12.53	126.40	14.83	127.35	17.23
Flow conditions	3.51	.42	3.79	.41	3.69	.56	3.65	.44
Flow characteristics	3.46	.47	3.68	.41	3.64	.36	3.64	.36
Global flow	3.48	.42	3.72	.40	3.66	.39	3.64	.41
Anxiety total	31.37	7.90	27.11	6.41	29.00	6.97	27.50	8.39
Pessimism	110.11	10.76	106.03	15.21	115.05	12.47	117.25	13.96

Note: Mindfulness = FFMQ scale total; Flow conditions = 3-dimension composite of pre flow conditions; Flow characteristics = 5-dimension composite of flow frequency; Global flow = 8-dimension model; Anxiety total = SAS-2 total for sport-specific anxiety; pessimism = SASQ pessimistic attribution style.

global flow for the intervention group was moderate, $t(26) = -3.31, p = .003, 95\% \text{ CI} [-.38, -.10], d = .63$.

An ANCOVA in which baseline flow condition was the covariate showed that cyclists in the mindfulness training condition showed greater increases in the frequency of flow conditions compared to control cyclists, $F(1, 44) = 6.20, p = .017, \text{ partial } \eta^2 = .12$, and this increase was moderate to large, $t(26) = -3.51, p = .002, 95\% \text{ CI} [-.45, -.12], d = .67$. An ANCOVA in which baseline flow characteristic was the covariate showed that cyclists in the mindfulness training condition did not show significantly greater increases in experienced flow characteristics relative to control cyclists, $F(1, 44) = 2.26, p = .14, \text{ partial } \eta^2 = .05$. Even though there was no significant difference between groups, the increase in the frequency of flow characteristics experienced among the intervention group cyclists was significant, $t(26) = -2.48, p = .009, 95\% \text{ CI} [-.64, -.06]$, indicating a moderate effect size, $d = .54$.

Controlling for baseline pessimism levels in an ANCOVA, cyclists in the mindfulness training condition showed a less pessimistic attribution style at post-test, relative to control cyclists, $F(1, 44) = 4.40, p = .042, \text{ partial } \eta^2 = .091$. The decrease in pessimism between pre- and post-test among the intervention group cyclists was not significant, $t(26) = 1.73, p = .096, 95\% \text{ CI} [-.77, 8.92], d = .34$.

An ANCOVA controlling for baseline anxiety levels showed that the intervention group cyclists were not significantly less anxious than the control cyclists at post-test, $F(1, 44) = 1.18, p = .284, \text{ partial } \eta^2 = .026$. However, the decrease in anxiety among the intervention group cyclists was significant from pre- to post-test $t(26) = 3.12, p = .004, 95\% \text{ CI} [1.49, 7.02]$, with a medium effect size, $d = .61$.

Changes in Mindfulness, Flow, Anxiety, and Pessimism in the Intervention Group

Change scores in mindfulness, flow, anxiety, and pessimism for the mindfulness intervention participants were calculated by subtracting the pre-test scores from the post-scores. Table 2 shows the correlations between these change scores. A greater increase in mindfulness was significantly correlated with an increase in global flow and an increase in the two higher-order factors of flow conditions and flow characteristics. A greater increase in mindfulness was also significantly correlated with a greater decrease in anxiety concentration.

DISCUSSION

Cyclists participating in a mindfulness intervention showed greater increases in mindfulness and flow than control group participants. Greater increases in mindfulness in intervention participants between baseline and post-test were related to greater increases in flow. These outcomes of the eight-week cyclist-specific mindfulness-training program extend the promising findings of the effects of mindfulness training on flow in other types of athletes (Aherne et al., 2011; Briegel-Jones et al., 2013).

Mindfulness and flow increases among the cyclists in the mindfulness-training condition had moderate to large effect sizes. These substantial effect sizes may in part be due to the inclusion of a cycling-specific mindful-spin component in the intervention. The inclusion of a mindful-spin component permitted riders to practice mindfulness techniques while they were experiencing sensations (e.g. discomfort) and thoughts (e.g. distressing cognitions regarding discomfort) central to their sport in a guided setting in which they were encouraged to observe naturally occurring events non-judgementally and non-reactively.

The findings are consistent with components of flow theory relating to the ability to narrowly focus attention to facilitate the fulfilment of preconditions of flow and the ability to sustain attention to remain in a flow state (Nakamura & Csikszentmihalyi, 2005). The findings, along with previous empirical research findings (Kawabata & Mallett, 2011), suggest a sequential relationship among flow factors, in which attention enables preconditions of flow which then facilitate the characteristics that define the experience of being in a flow state.

The mindfulness intervention variably impacted on sport-anxiety and sport-related pessimistic attributions. Cyclists in the mindfulness condition were no less anxious at post-test than control participants. However, cyclists in the mindfulness training condition showed fewer pessimistic attributions at post-test than wait-list control cyclists. However, the change in pessimism from pre- to post-test among intervention group cyclists did not reach significance. Birrer et al. (2012) and Gardner and Moore (2012) suggested that

TABLE 2
Intercorrelations, Means, and Standard Deviations for Change Scores (pre-to-post) for all Main Dispositional Variables and SAS-2 Subscales for the Mindfulness Training Group (n = 27)

Measures	1	2	3	4	5	6	7	8	9	M	SD
1. Mindfulness		.47*	.73**	.67**	-.37	-.24	-.27	-.40*	.08	10.56	13.84
2. Flow conditions			.75**	.90**	-.33	-.10	-.35	-.36	-.04	.28	.42
3. Flow characteristics				.96**	-.29	.01	-.27	-.43*	.01	.21	.39
4. Global flow					-.33	-.04	-.32	-.43*	-.01	.24	.37
5. Anxiety total						.79**	.85**	.87**	.34	-4.26	6.99
6. Anxiety somatic							.51**	.52**	.21	-2.00	2.53
7. Anxiety worry								.63**	.38	-1.37	2.78
8. Anxiety concentration									.27	-.89	3.01
9. Pessimism										-4.07	12.24

Note: Mindfulness = FFMQ scale total; Flow conditions = 3-dimension composite of pre flow conditions; Flow characteristics = Characteristics defining an flow experience = 5-dimension composite of flow frequency; Global flow = 8-dimension model; Anxiety total = SAS-2 total for sport-specific anxiety; Anxiety somatic = SAS-2 somatic anxiety subscale; Anxiety worry = SAS-2 worry anxiety subscale; Anxiety somatic = SAS-2 somatic anxiety subscale; Anxiety concentration = SAS-2 anxiety concentration disruption subscale; pessimism = SASQ pessimistic attribution style.

* Indicates a statistically significant correlation ($p < .05$, two tailed).

** Indicates a statistically significant correlation ($p < .01$, two tailed).

increases in mindfulness may modify the nature of the experience of emotions and cognitions such as anxiety and pessimism rather than lessen them. Additional research with larger cohorts of athletes engaged in different sports as well as different approaches to assessment of anxiety and pessimism may help to clarify these matters. The anxiety concentration aspect of anxiety in relation to mindfulness and flow may be an especially good focus for future investigation.

The results of this study should be interpreted with some caution given several limitations. First, the sample size was small. Based on previous mindfulness intervention research, medium to large effect sizes were expected and a power analysis indicated that the sample was large enough to detect these, and a number of effect sizes found were indeed medium to large. Nevertheless, a larger sample may identify additional significant changes stemming from mindfulness training. Second, the assessment of some relevant constructs is difficult. As Jackson and Marsh (1996) and Csikszentmihalyi (1992) pointed out, the subjective experience of flow can be quite difficult to assess. Valid and reliable measures of flow were used in this study, but they may not have adequately captured the ephemeral experience of flow.

Third, more participants withdrew from the control group than the intervention group. Fourth, the present study used a wait-list control design; thus, there is a lack of clarity regarding the extent to which regular weekly contact may have contributed to the benefits obtained by the intervention group cyclists. In future research a control condition with a distractor task unrelated to mindfulness training might provide additional elements of study control.

The results of the study have practical implications for athletes and coaches. Together with findings of previous research, the results suggest that training athletes in mindfulness skills increases their mindfulness. Increasing athletes' mindfulness has implications for athletes' experience during sporting events as well as aspects of their life outside of sport. Further, the results of the study indicate that sport-specific mindfulness training increases athletes' experience of flow, a state beneficial for athletes (Jackson, 2000; Kimiecik & Stein, 1992).

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