The effect of mindfulness training on attention and performance in national-level swimmers

The Effect of Mindfulness Training on Attention and Performance in National-Level Swimmers: An Exploratory Investigation

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Abstract

This quasi-experimental intervention study investigated the impact of mindfulness training on attention and performance in swimmers. Following an 8-week intervention with six national-level university swimmers (*M* = 20 years), single case analysis of pre- and post- measurements for three of six participants showed large improvements in mindfulness and attention efficiency. Two participants showed a small increase in one of mindfulness or attention efficiency, and one showed no changes. Four participants improved performance times compared to season-best, and five participants improved self-rated performance. Athletes and coach positively evaluated mindfulness training. This study, with strong ecological validity, shows improvements in mindfulness, attention, and performance, consistent with theory that proposes attention as a mechanism for mindfulness based performance changes. Mindfulness training can be an effective and practical intervention. Further applied research is required utilising designs to determine causality and further test the proposed mechanisms through which mindfulness may influence performance.

Keywords: mindfulness, intervention, attention mechanisms, social validation, swimming

The ability to direct and control attention is a critical component of success in any area of skilled performance (Moran, 2011). Understanding the processes and limitations of attentional processing has been a dominant focus for cognitive psychology, and theories and concepts that underpin attention control have been widely applied in the sport psychology literature (see Moran, 2011 for a review). In sport, techniques to enhance attention such as goal setting, pre-performance routines, trigger words, and imagery are common features of psychological skills developed to support optimal performance.

Recent developments in applying *mindfulness* have particular relevance for self-regulated, present-moment attention required in athletic performance (Gardner & Moore, 2004). Mindfulness can be defined as "the awareness that emerges through paying attention on purpose, in the present moment, and nonjudgmentally to the unfolding of experience moment by moment" (Kabat-Zinn, 2003, p.145). The ability to maintain present moment focus has been identified as an effective strategy to achieve peak performance and flow in sport, and mindfulness develops a non-judgemental, accepting dimension to flow experiences (Aherne, Moran, & Lonsdale, 2011). Acceptance-based approaches to sport performance enhancement reflect the 'third wave' of cognitive-behavioural therapy in psychology (e.g., acceptance and commitment therapy; Hayes, Strosahl, & Wilson, 1999), emphasising acceptance rather than control. Acceptance is considered advantageous because accepting internal experiences, and persisting despite self-regulatory disruption, can maintain focus on the task rather than the self (Moore, 2009). In contrast, attempts to control thoughts and emotions may be counterproductive and have paradoxical effects on attention (e.g., scanning for discomfort). Self-focused ironic processing can lead to impaired sport performance (e.g., Beilock, Afremow, Rabe, & Carr, 2001). Thus, it is not the presence or absence of negative cognitions

and emotions which is key, but the extent to which the performer can accept these and remain engaged with the task.

Mindfulness is proposed to be underpinned by three fundamental components (axioms) - intention, attention, and attitude (openness and non-judgmental) - which lead to a significant and transformational shift in perspective, termed *reperceiving* (Shapiro, Carlson, Astin, & Freedman, 2006). Reperceiving is described by Shapiro et al. (2006) as a meta-mechanism which overarches four additional direct mechanisms: self-regulation; values clarification; cognitive, emotional, and behavioural flexibility; and exposure. The fundamental component of *attention* in achieving mindfulness requires one to observe the operations of moment to moment internal and external experience (through meditation inspired activities) to develop present-moment awareness. This ability to self-regulate attention is developed through practicing attending to one object for long periods (vigilance/sustained attention), shifting attention between objects (task switching), and inhibiting secondary elaborative processing of thoughts and feelings (cognitive inhibition; Shapiro et al., 2006). It has been suggested that mindfulness training could enhance working memory capacity (e.g., Chiesa, Calati, & Serretti, 2011) and that meditation training improves brain efficiency, possibly via improved sustained attention and impulse control (Kozasa et al., 2012).

Although meditation features in developing mindfulness (due to its origins in Buddhist meditative tradition), the intention of mindfulness meditation is to consciously attend to specific thoughts and feelings that arise in awareness and observe them non-judgmentally (i.e., zoning-in). This differs from basic meditation that typically involves emptying the mind of thoughts (i.e., zoning out). Similarly, although mindfulness-based training techniques have demonstrated efficacy in reducing stress and worry, highly relevant to athletic performers, the

techniques differ from relaxation or arousal regulation techniques because mindfulness encourages acceptance of internal and external experiences (Moore, 2009). Given a function of pre-performance routines is to optimise attention (e.g., Moran, 2011) the use of mindfulness techniques could augment these, particularly during focusing stages.

A small number of studies have demonstrated positive performance effects from mindfulness training interventions. For example, Gardner and Moore (2004) found performance improvement using a Mindfulness Acceptance Commitment (MAC) training protocol in single-case studies with an inter-collegiate male swimmer and a masters-level female weightlifter. A single nine-week case study of an adolescent springboard diver showed that competition scores improved by up to 14% on 3-m dives, following a MAC protocol (Schwanhausser, 2009). Furthermore a season-long study with elite young golfers demonstrated that all seven participants improved their national ranking (Bernier, Thienot, Codron, & Fournier, 2009). Whilst prolonged study across a season has advantages, other factors that could have contributed to the performance changes, such as physical maturation and the quality of golf coaching, were not assessed. Aherne et al. (2011) adopted a reliable protocol, using CD-guided mindfulness training with thirteen athletes, randomly assigned to experimental and control groups. The experimental group (n = 6) undertook six weeks of mindfulness training and reported greater flow than before the program and in comparison to the control group. Whilst Aherne et al. (2011) review literature in which flow is associated with peak performance, no direct assessment of performance changes were made in that study.

However, not all studies have found evidence of mindfulness improving performance. A four-week practitioner-led Mindful Sport Performance Enhancement (MSPE) protocol showed no immediate performance benefit for recreational archers, golfers (n = 32; Kaufman,

Glass, & Arnkoff, 2009) and runners (n = 25; De Petrillo, Kaufman, Glass, & Arnkoff, 2009), Although a one-year follow up with the runners indicated significant improvements in best mile-times for runners (n=13; Thompson, Kaufman, De Petrillo, Glass, & Arnkoff, 2011), these results should be treated cautiously. Average mile-times across a small group, with a wide range of times, and the potential, as recreational runners, to make significant improvements easily could lead to false-positive interpretation of results.

Empirical studies into mindfulness training in sport are few, and the evidence equivocal, so further research is required to examine the potential impact on performance, and address limitations identified in previous research, by using high level athletes, multiple data sources, and consideration of mediating variables. Given mindfulness training is proposed to enhance self-regulation of attention, and through this benefit sports performance, the current study assessed changes in attention, and in particular measures related to working memory and efficiency. Furthermore, the current study used mixed methods to reduce over-reliance on single source, self-report data and benefit from triangulating data to enhance confidence in conclusions. This counters some of the existing limitations in determining the efficacy of mindfulness training in sport.

This study investigated the impact of an eight-week mindfulness training intervention on attention and performance in six national-level swimmers. Given the study was exploratory, and conducted in ecological setting with limited experimental control, analysis of single cases was chosen to determine changes. The research aimed to contribute to the literature by assessing whether increases in mindfulness would correspond with improved attention and performance. It was hypothesised that a mindfulness training program would lead to participants experiencing: (i) increased mindfulness; (ii) improved attention; (iii) increased

attention efficiency; (iv) improved performance times; and (v) higher self and coach ratings of performance.

Method

Design

This study was conducted in an ecologically valid context, and assessed changes from pre- to post-intervention through analysing responses of six single-subject cases. Intervention impact was assessed by comparing pre-existing performance data and baseline measures on mindfulness and attention with post-intervention scores, and in addition social validation interviews (Page & Thelwell, 2013). Using multiple cases increased the confidence in determining impact when changes emerge consistently across cases. Constraints placed on design, by participant availability and competitive scheduling, prevented either more extensive baseline testing or application of staggered baseline. However the authors considered the strong ecological validity achieved by working with high standard athletes and real competitive performance data countered these limitations from an applied practitioner perspective. The study received approval from the relevant Institutional ethics committee.

Participants

Six swimmers (2 males, 4 females; *M* age = 20.00 years, SD = 1.40 years, range 18-22 years) from a United Kingdom (UK) University 'High Performance Programme' all competing at national level volunteered and provided informed consent to participate.

Measures and Training

Mindfulness. The Cognitive and Affective Mindfulness Scale – Revised (CAMS-R; Feldman, Hayes, Kumar, Greerson, & Laurenceau, 2007), developed using university students, assesses mindful approach to thoughts and feelings via 12 items rated on a Likert scale from 1

(*rarely/not at all*) to 4 (*almost always*) with high scores indicating greater mindfulness. The CAMS-R has shown acceptable internal consistency (alpha = .81) (Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) and has been used previously in sports based research investigations (Aherne et al., 2011).

Attention test. The 'elevator counting with reversal' sub-test of the Test of Everyday Attention (TEA; Robertson, Ward, Ridgeway, & Nimmo-Smith, 1996) was used to measure auditory-verbal working memory component of attention. Participants listened via headphones to a fixed-speed presentation of three different tones, and were required to mentally follow the progress of an imaginary elevator, based on the different tones, indicating whether the elevator was going up, down, or was at a floor. Each test, lasting approximately 5 minutes, commences with three example trials which had to be completed successfully, or repeated, before a series of ten trials with progressive difficulty and duration. This published, psychometric test has shown, through factor analysis, to load the same component of attention as Paced Auditory Serial Addition Test. To avoid practice effects, it offers three versions that show good reliability (r = 0.66). This test of a fundamental component of attention has been used in previous applied cognitive psychology research within a physical performance context (Leach & Ansell, 2008). Additional advantages of the chosen test are that it does not use word stimuli or require mathematical operations meaning it is suitable to use with different nationalities, and may be less influenced by educational attainment or specific ability limitations such as dyslexia or dyscalculia, than other widely used tests.

Mental effort. The Rating Scale for Mental Effort (RSME; Zijlstra, 1993) assesses self-reported effort. Participants indicate effort level on a vertical scale with verbal anchors ranging from 0 (not at all effortful) to 150 (very effortful). The RSME has demonstrated

reliability in work settings (r = 0.78), and in the laboratory (r = 0.88) and has been shown to correlate with physiological indices of effort (Zijlstra, 1993). The scale has been applied in previous sport psychology research (e.g., Wilson, Smith, & Holmes, 2006).

Performance time. Competitive performance times were reported as a percentage of the participant's season's best for their primary event, for three competitions during the intervention period and five competitions prior to the intervention period.

Performance criteria rating. Self- and coach-assessed performance used performance criteria to rate performance (Wilson & Richards, 2011). Prior to the intervention each participant identified in discussion with the coach up to five key performance indicators (KPIs). KPIs were individual specific and related to technical and tactical components of performance, for example, *Dive entry and breakout*, and *First 50m pace*. Performance was assessed by combining ratings for all KPIs made on a Likert scale including verbal anchors (10, *the best ever done*, to 1, *the worst ever done*). Participants and coach rated KPIs independently and within two hours following the competition to minimise the risk of retrospective recall bias.

Social validation. In accordance with recommendations (Page & Thelwell, 2013), individual, semi-structured social validation interviews were conducted with each participant and the coach, to determine the satisfaction with the mindfulness training and its impact on performance. Interviews, lasting 30-45mins, were audio-recorded and transcribed. Additionally, each participant rated how beneficial the mindfulness training was to their performance on a 1-10 scale with verbal anchors: 0 (no benefit at all); 5 (moderately beneficial); and 10 (extremely beneficial).

Training. Each participant received a one page written explanation of mindfulness including information about the strong experience and expertise of Jon Kabat-Zinn the author of the CD "Guided Meditation Practices" (Williams, Teasdale, Segal, & Kabat-Zinn, 2007). This commercially available CD, used in recent experimental work (Aherne et al., 2011), enabled the intervention to be delivered in a standardised and reliable format and excluded the influence of practitioner-led intervention, which would restrict opportunities for replication studies. Training comprised four exercises, each lasting 10-30 minutes: "Breath"; "Breath and Body"; "Standing Yoga"; and "Body Scan". Adherence to training was monitored via a simple weekly log, collected each week. Participants also received a courtesy call (week 1) and subsequent weekly emails to answer questions and promote commitment to training.

Procedure

Baseline Phase

Participants completed paper and pencil mindfulness tests (15 mins approx.) and then the attention test auditory-verbal working memory test in a quiet room wearing headphones, followed immediately by rating subjective effort (RSME). All tests were conducted with the researcher present to ensure the protocols were followed precisely. After a 15-minute lapse the attention test (alternate version to avoid practice effects) and effort rating were repeated.

Intervention Phase

Following instruction participants commenced mindfulness training, keeping a weekly log to determine adherence and receiving prompts and support from the researcher. They attended further testing sessions through the intervention period, completing the attention test and effort rating on weeks 3, 5, and 7, and mindfulness tests on week 5.

Post-Intervention Phase

Participants completed mindfulness and attention tests, effort rating, and took part in a social validation interview in the week following the intervention being completed. Participants required no amendments to summary transcripts provided for review and comments, to enable 'member checking' (Lincoln & Guba, 1985).

Swimming Performance

Performance times for each participant were collected from published results for swim meets before the study began. Participants competed at weeks 4, 5, and 8, and race times together with self and coach ratings of KPIs were collected following each event.

Analysis

All measurements were completed except for one attention test by Participant 4 (third measurement during intervention) who was unavailable. Only the second attention test during baseline was included in analysis as the first test was a familiarization trial. Attention scores were 'scaled' for the relevant age group following the published manual (Robertson et al., 1996) and attention efficiency was determined by dividing scaled attention scores by self-rated effort. To improve graphical presentation and facilitate visual inspection attention efficiency scores (ranging between 0.03-0.3) were subject to square root transformation before plotting. Performance times were presented as proportion of pre-intervention season's best, so an upward trend would represent improvement, aiding consistency of presentation with the other plotted measures in this study. Performance criteria ratings for each participant were compared over time and visually assessed for correspondence with the coach ratings for that performer.

Analysis for all data variables was performed through a combination of visual inspection, descriptive statistics, together with content analysis of the social validation

transcripts. A similar range of analysis techniques has been utilised in single-case design studies (e.g., Neil, Hanton, & Mellalieu, 2013).

Visual inspection of mindfulness, attention, effort, and attention efficiency were undertaken, based on recommendations by Hrycaiko and Martin (1996), to identify if a treatment effect had occurred: (a) baseline performance was stable or in a direction opposite to that predicted for the treatment; (b) effect is replicated within and across participants; (c) there are few overlapping data points between the baseline and intervention periods; (d) the effect occurs soon after the introduction of the intervention; and (e) the effect is large compared to the baseline. Quotations from social validation interviews were used to interpret findings from visual inspection of numerical data and contribute to understanding experiences of mindfulness training experience, whilst individual Likert rankings were reported to determine overall perceived impact of training.

Results

Mindfulness and Training. Five participants reported 100%, and one participant 75%, adherence with the mindfulness training program. Visual inspection showed three participants (Participants 1, 3, and 5) had increased mindfulness following the intervention, with Participant 6 showing very minor improvement as measured by the CAMS-R. Participant 1 had the lowest pre-intervention score and most marked improvement across the intervention (see Figure 1). Participants 2 and 4 showed no improvement in their CAMS-R scores.

****Figure 1 near here****

Attention, Effort, & Attention Efficiency. Visual analysis of the attention scores indicated a ceiling effect, therefore a more meaningful analysis of the impact of the intervention was provided by attention efficiency, derived from attention and effort. Four

participants (1, 2, 3, and 5) showed improved attention efficiency over the study period (see Figure 2) although these were minor for Participant 2. Participant 5 showed the greatest improvement, particularly for the high post-intervention test score. Neither Participants 4 nor 6 showed improvements across the study.

****Figure 2 near here****

Performance times. Four participants (1, 2, 3, and 4) had improved performance times for their primary event during the intervention period. Participants 2 and 3 had significant improvements and swam faster than their pre-intervention season's best for all three competitions in the intervention period (i.e., no overlapping data points) (top panel, Figure 3). The average improvement in performance time for intervention period compared to pre-intervention season's best was 1.5% for Participant 3 and 1.1% for Participant 2, representing substantial progress for races typically lasting 60 to 70 seconds. Participants 1 and 4 (see middle panel, Figure 3) had improved performance times, although both had one overlapping data point (for the final competition). On average during the intervention period Participant 1's performance time was 0.4% better than the pre-intervention season's best, whilst Participant 4's equivalent average was in line with the season's best. Participants 5 and 6 (see bottom panel, Figure 3) had several overlapping data points and neither swam faster than their pre-intervention season's best during the study period. On average, Participant 6 swam consistently faster during the intervention period than pre-intervention, whilst Participant 5's average times were slower during the intervention period. This participant reported an illness preceding the final event which had adversely affected performance. Excluding this competition, Participants 5's average times during the intervention were in line those from pre-intervention.

****Figure 3 near here****

Performance criteria ratings. The performance criteria ratings made by the coach were consistent with those of the athletes, lending support to this metric. For simplicity only athlete ratings are presented for the three competitions that occurred during the intervention (denoted as Intervention Competitions 1-3) in Figure 4. Five participants had improved rated performance, with the most marked increases being shown for Participants 3, 4, and 5, and a more moderate improvement for Participants 2 and 6. The reduction in rated performance for Participant 1 is driven by the poorer average score for Intervention Competition 3. Four participants rated their highest average score for Intervention Competition 2 and then reported a lower score for Intervention Competition 3.

****Figure 4 near here****

Social Validation

The participants and coach reported strongly positive appraisals of the intervention and its effects. The benefit of mindfulness training to swimming performance was rated on a 10-point scale (0, *not at all beneficial*; 5, *moderately beneficial*; and 10, *extremely beneficial*). Two (Participants 4 and 5) rated training as eight, two rated training as seven (Participants 2 and 3), and two rated it as six (Participants 1 and 6). The coach reported that performances of five participants (all except Participant 6) exceeded his expectations for the three competitions in the intervention phase. Furthermore, the coach subjectively reported that overall performance criteria ratings for four athletes improved compared to what he had observed in the pre-intervention period.

During the interview participants reported specific effects of the intervention which analysis grouped under three key themes. Firstly, increased relaxation, particularly around

competitions, was reported by five participants (e.g., Participant 1: "I felt more, sort of, relaxed. I wasn't tense or worrying about the result, which I'd kind of gotten into the habit of"). Secondly, improved focus or concentration was reported by Participants 1, 3, 4, and 5. For example, Participant 1 reported being more focused on breathing rather than chatting to other swimmers following the intervention whilst Participant 5 stated "I was able to concentrate more on what I was actually doing in training" from week 3 or 4 of the intervention. Thirdly, a shift in attention towards swimming processes (e.g., technique) and away from performance times was reported by Participants 1, 2, and 3. For example, Participant 3 reported: "I think (in) these meets I've been more focused on how I've raced it rather than the outcome at the end". All participants reported that the program was flexible and easy to fit around other commitments. Five participants reported that the intervention was about the right duration. All participants reported that they intend to continue using mindfulness training and would recommend it to other athletes.

The coach was unanimously positive in his perceptions of the intervention effects. Changes noted throughout the intervention, and post intervention, included improved focus, greater composure, increased confidence, and a greater ability to deal with negative situations.

Discussion

The aim of the present study was to examine the effect of an eight-week mindfulness training program on six national-level swimmers' attention and performance. The hypotheses, that athletes who underwent training would experience increased mindfulness, increased attention efficiency, improved performance times, and improved self- and coach-rated performance evaluations, were largely supported. This exploratory study contributes to the literature by demonstrating increases in mindfulness and associated performance benefits

following the intervention. Importantly results showed improvement in attention, tested using a measure of auditory-verbal working memory, which supports the proposal that attention is a mechanism through which mindfulness enhances performance.

Four participants improved attention efficiency (three strongly), five participants improved self-evaluated performance criteria ratings, and four participants improved performance times compared to pre-intervention season-best. Although data from just six single cases has limitations, and possible covariates must be considered especially with regard to performance (see study limitations), results support the proposition that mindfulness may improve attention efficiency. Improvements in efficiency of the working memory component of attention could facilitate participants' ability to self-regulate attention (e.g., sustained attention, switching, and cognitive inhibition) consistent with the *reperceiving* mechanism proposed by Shapiro et al. (2006).

Social validation interviews showed all six athletes rated mindfulness training as beneficial to performance. Performance times, across primary and non-primary events, swam by five athletes exceeded the coach's expectations. Analysis of individual cases shows theoretically consistent patterns of change, supporting the efficacy of mindfulness training. Participants 1 and 3 had relatively large improvements in mindfulness, attention efficiency, performance times, and performance criteria ratings, and both exceeded coach expectations. Participant 5 had improved mindfulness, attention efficiency, and performance criteria ratings. Whilst Participant 5 did not improve performance times, other positive impacts were reported through social validation interviews. These three cases provide support that the intervention had a positive effect and demonstrate theoretical consistency between an increase in mindfulness, improvement in attention, and improvement in performance.

A different picture is evident for Participants 2 and 4. Although both had improved performance times and performance criteria ratings, neither had a meaningful increase in self-reported mindfulness and only Participant 2 showed minor improvement in attention efficiency. This may suggest that mindfulness was not a major contributory factor to observed changes for these individuals, perhaps in part due to higher baseline mindfulness levels relative to other participants (see study limitations for other possible explanations for change).

The findings from this study are consistent with existing literature (Gardner & Moore, 2004; Schwanhausser, 2009) showing performance improvement following mindfulness intervention. In addition the current study provides a new contribution to the research by measuring changes in function of attention, a potential mechanism through which mindfulness may impact on performance. Self- and coach-rated performance criteria together with social validation provides confirmatory support to the competitive performance times, providing a more robust suite of outcome measures than in previous research.

The intervention used in the current study replicated that used by Aherne et al. (2011), and was identical across all participants. This use of a CD–based intervention recognises the importance of using a standardised protocol that can be easily replicated, and enables viable comparisons with future research to facilitate the development of a coherent body of evidence on mindfulness. Importantly, this method avoids the potential significant variation in practitioner-led mindfulness training programs (e.g., Gardner & Moore, 2004; Schwanhausser, 2009; Thompson et al., 2011), which risks confusing the impact (or lack) of an intervention with the therapeutic relationship. Further confidence in findings of the current study was provided by assessing adherence to mindfulness training and social validation data.

Study Limitations and Future Research Directions

The lack of prolonged baseline data for attention efficiency and performance criteria ratings were limitations in this study. It would have been preferable for the intervention phase to have commenced when baseline-dependent variables were stable, or in the opposite direction to that predicted for the treatment. This would provide more confidence in attributing change in the dependent variables to the intervention (Hrycaiko & Martin, 1996). However this was prevented in this study due to participant availability, and furthermore stability in one of the dependent variables, performance times, could not have been expected. The study limitations must also acknowledge that attempts to measure performance changes with KPIs, whilst providing more comprehensive assessment, may have inadvertently provided attentional cues for performers. A further limitation, learning effects on the test of attention, could have been further reduced with more opportunity for baseline measurement.

The potential for other contributory factors to have affected performance, as reported by the coach, represent limitations to the strength of conclusions that can be made. Three competitions during the intervention period were in the 'racing phase' of the season, with training designed for swimmers to peak and deliver best performances. Secondly, facility constraints meant that training sessions in a competition-size 50m pool could not take place until partway through the pre-intervention period. However the pre-intervention period was a very important part of the season, including Olympic trials, and participants' motivation to perform was high. Furthermore participants were all national standard therefore performance improvements seen in the intervention period for Participants 1 to 4 were relatively large.

With respect to all of these limitations the opportunities to spend longer were constrained by the time available and the need to conduct research aligned to the performers' competition schedules. Despite the limitations inevitably experienced in conducting field-

based applied research, the study design offers a strong contribution to the developing research in this area because of strong ecological validity and participation of high performance athletes.

Where possible future single-case design research should use multiple baseline to offset the potential effect of confounding variables and afford greater confidence that observed outcome changes were due to the intervention. Furthermore research should assess not just performance changes but the mechanisms through which mindfulness operates, such as attention. The current study provides initial support for attention as a mechanism. Although the TEA (Robertson et al., 1996), was developed for determining cognitive impairment in clinical settings, the psychometric validation work included both clinical and normal populations and the test has been applied to detect functional changes in military personnel during field exercises (Leach and Ansell, 2008). Further investigations using alternative and or additional attention measures would contribute to examining this mechanism for mindfulness. Future research could include attention measures in performance settings, although this may prove difficult in practice, and measurements of state anxiety. This could provide a link to research into choking-susceptible athletes (e.g., Mesagno & Marchant, 2013), and would allow assessment of whether improved mindfulness is beneficial to such performers. Further research is also necessary into how reperceiving might facilitate a more adaptive and flexible response to the environment in contrast to the more rigid patterns of reflexivity that can lead to cognitive fusion and ironic processing (Shapiro et al., 2006).

Whilst the athletes in the current study were short distance swimmers whose performance may have benefited from improved pre-race focus, longer distance events are associated with greater opportunities to experience distractions linked to pain and suffering

during performances so may offer different opportunities for mindfulness to have an impact on performance. Therefore research could be extended to longer, endurance sports settings. Finally, alternative research design could investigate the dose effect of mindfulness-based interventions, to determine how much training is enough to elicit a positive effect.

Implications for Practitioners and Conclusions

This study gives promising evidence for practitioners, coaches, and performers. The CD-based intervention can be used flexibly by athletes at times to suit training, can be used at a rate to suit individual skill development, and does not require intensive, time consuming, or costly practitioner input compared to fully practitioner-led programs. The total mindfulness training time was 90 minutes per week over eight weeks. This is relatively short when improved performance times and participant ratings of beneficial impact indicate a good return on invested time. These exploratory findings lend support to using a CD, and brief guided support from a practitioner, to develop mindfulness and potentially benefit components of performance. The acceptance by athletes of this intervention was strong with five of the six participants indicating they would fully recommend mindfulness training to other athletes, whilst the remaining participant would recommend it for some athletes or circumstances.

In conclusion, the current study adds to the existing literature by illustrating that mindfulness training can enhance performance times and performance criteria ratings in a real-world sport setting. Crucially, this study also contributes to the literature by demonstrating increases in attention efficiency, adding support to the theoretical proposals that mindfulness enhances performance through self-regulated attention mechanisms related to working memory and efficiency. Further research is needed to test the mechanisms through which mindfulness may benefit sport performance.

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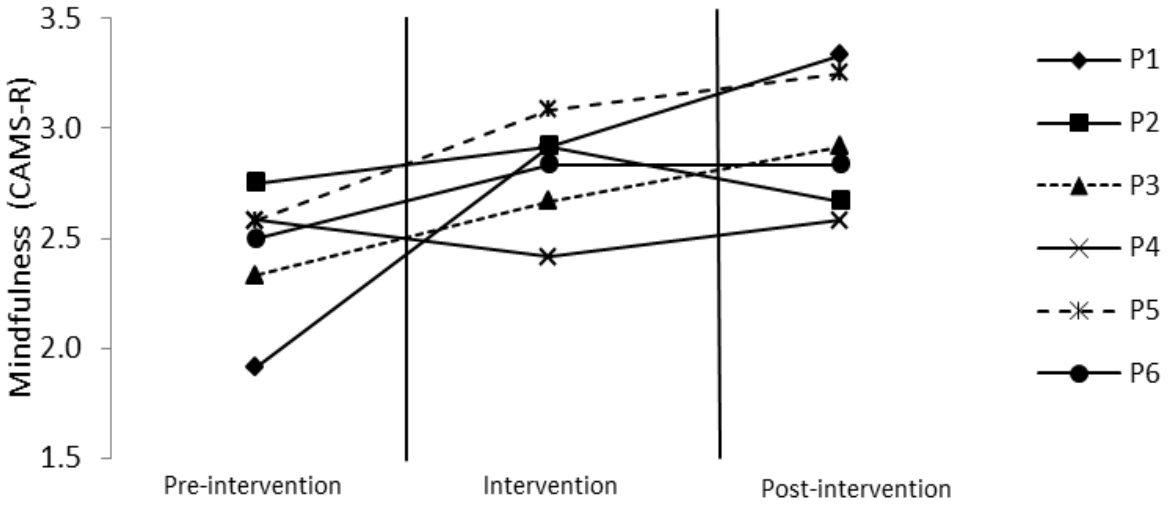

Figure 1 - Changes in mindfulness, as measured by mean scores from The Cognitive and Affective Mindfulness Scale – Revised (CAMS-R) across the phases of the study for the six participants (P1-P6).

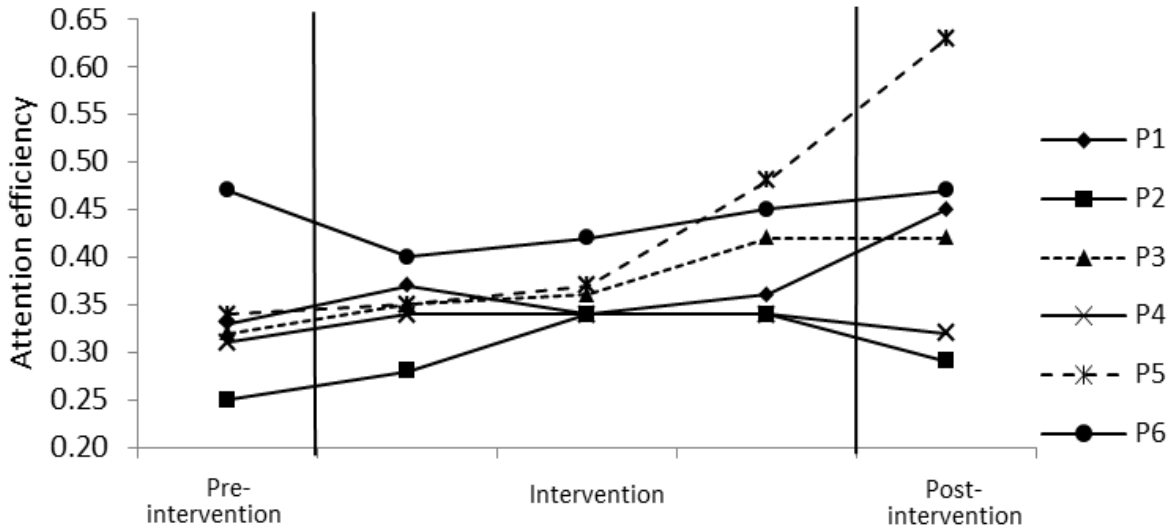

Figure 2 - Mean attention efficiency scores for the six participants (P1-P6). Efficiency calculated as attention score divided by self-reported mental effort.

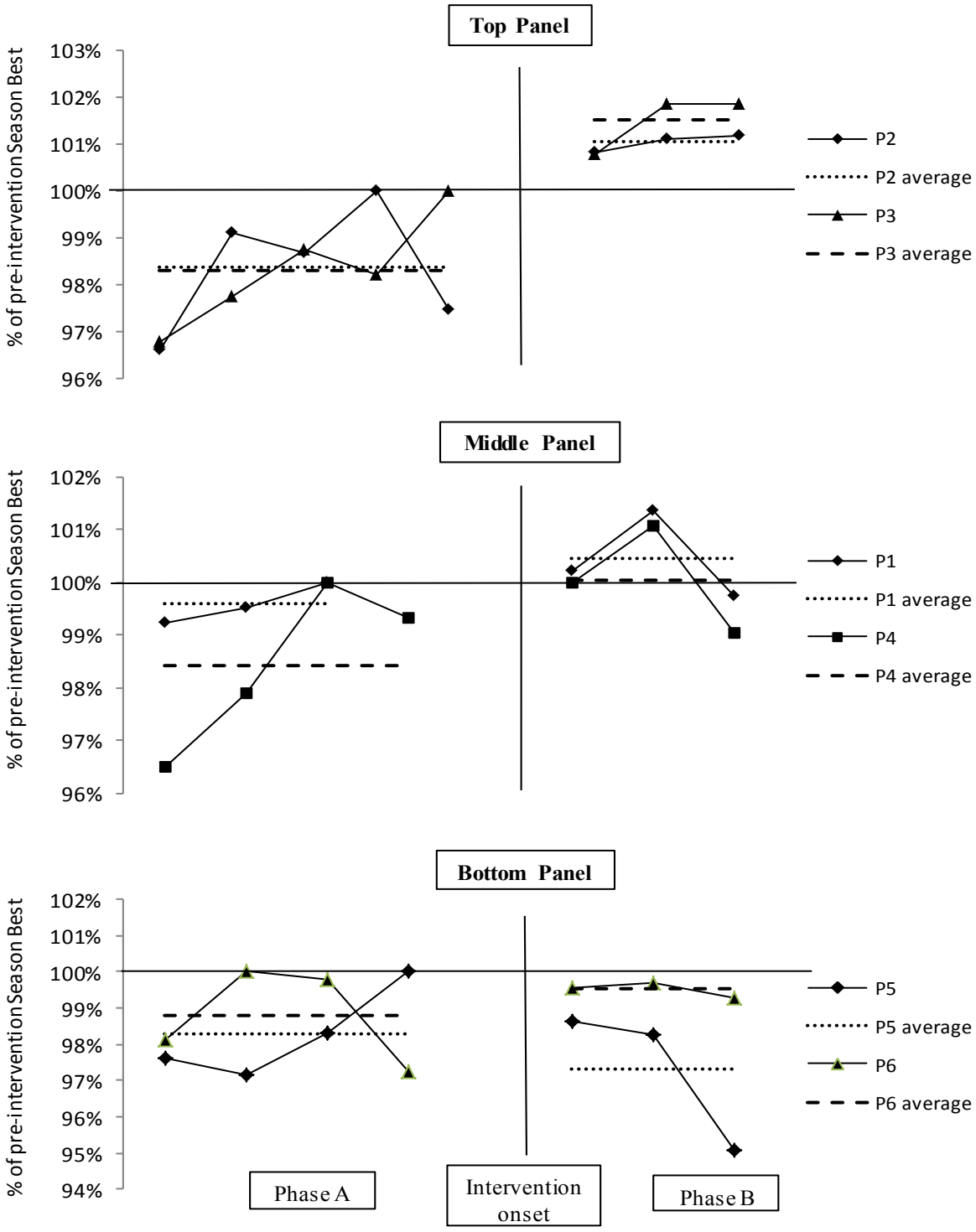

Figure 3 - Performance times expressed as a proportion of pre-intervention season-best for the six participants (P1-P6).
Phase A shows pre-intervention performances and Phase B shows performances during the 8-week intervention period.

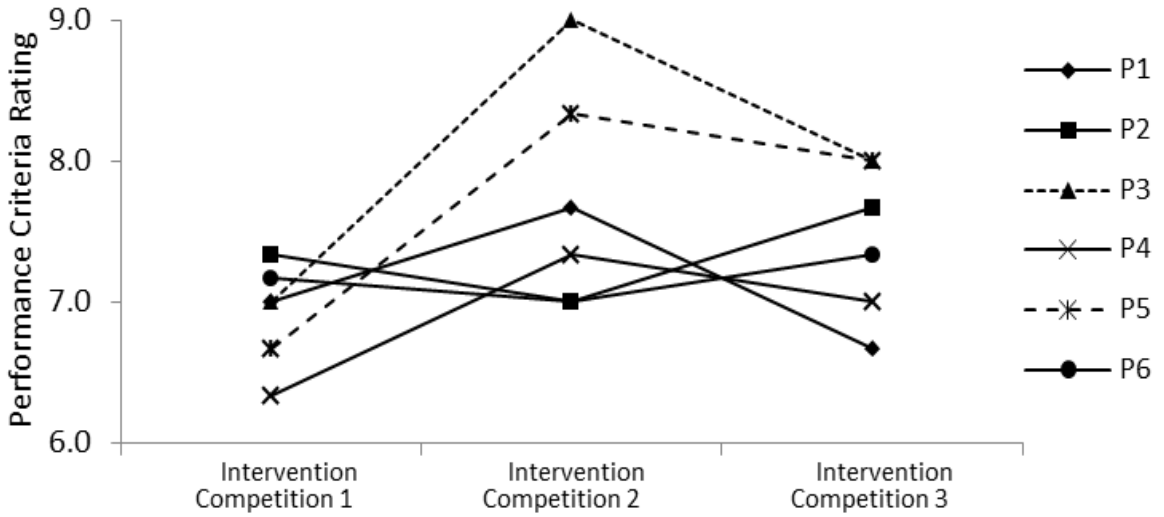

Figure 4 - Mean self-reported performance criteria ratings for the six participants (P1-P6) for the three competitions during the intervention period.