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The effects of mindfulness training on beginners’ skill acquisition in dart throwing: A randomized controlled trial

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The Effects of Mindfulness Training on Beginners' Skill Acquisition in Dart Throwing: A Randomized Controlled Trial
Abstract

Objectives: The present study was into whether or not mindfulness training, based on the mindfulness-acceptance-commitment approach (MAC), can improve beginners' skill acquisition of dart throwing.

Design: Randomised controlled trial.

Methods: A total of 43 first-year college students who had not played darts professionally prior to the study were randomly assigned to either an attention control group (n = 21) or a mindfulness training group (n = 22) during an eight-week dart training program. Dart throwing and psychological variables were assessed at pre-intervention, post-intervention, and two-week follow-up.

Results: Two-way repeated measures ANOVA revealed that the mindfulness group, but not the attention control group had significant improvements in mindfulness, experiential acceptance, and flow at post-intervention and follow-up. Although both groups improved dart throwing performance after the intervention, the improvement of the mindfulness group was statistically higher in comparison to that of the attention control group.

Conclusions: It was concluded that the MAC approach could improve the performance and adaptive sport experience of beginners in dart throwing.

Keywords: Experiential acceptance; flow; mindfulness intervention; motor skill learning; sport performance.
The effects of mindfulness training on beginners’ skill acquisition in dart throwing: A randomized controlled trial

The acquisition of motor skills is fundamental in the domain of sport where the evaluation criteria or the key to success is heavily relied on athletes’ ability to reproduce their sport skills (Williams & Hodges, 2004). Athletes start as beginners to acquire new skills through self-controlled learning and deliberate practice before becoming accomplished in their sports. Mindfulness is described as paying attention and awareness to the present moment with a non-judgmental and non-reactive attitude (Brown & Ryan, 2003; Kabat-Zinn, 2003), and might be able to facilitate an effective motor skill learning (Ferrari, 1996). Mindfulness enables individuals to avoid simply learning through automatic repetition (i.e., processing given information without being aware of alternative options) by increasing their sensitivity to skill acquisition (Langer, 2000). Recent research supports the effects of mindfulness on basic skill performance (e.g., finger movement and postural balance; Kee, Chaturvedi, Wang, & Chen, 2013; Kee, Chatzisarants, Kong, Chow, & Chen, 2012). We, therefore, speculated that mindfulness training would be useful for enhancing sport beginners’ learning experience.

The aim of this study was to test the effects of mindfulness training (i.e., mindfulness-acceptance-commitment; Gardner & Moore, 2007) on the dart throwing performance and psychological effects of dart beginners.

Mindfulness has been integrated into cognitive behavioural training in the sport context, with the aim of improving athletes’ performance, mental status, and general well-being (Gardner & Moore, 2012). Compared to traditional cognitive behavioural training (e.g., psychological skill training), which builds on the rationale of controlling or changing the contents of performers’ undesirable psychological events in order to
achieve the optimal psychological states (e.g., the states of peak performance), mindfulness training is an alternative approach for individuals to experience their psychological events (i.e., learning experiences). In a state of mindfulness, individuals apply an accepting and non-judging approach to act and think rather than trying to change or control those experiences (Gardner & Moore, 2007). Therefore, mindfulness training encourages individuals to pay attention to the present moment, which helps disengage distractions from their ruminative states. In other words, mindfulness training may help individuals avoid ineffective or counterproductive psychological states (Gardner & Moore, 2007).

The benefits of mindfulness training to human learning experience have been explained by recent studies in cognitive psychology and neuroscience (Chiesa, Calati, & Serretti, 2011; Peabody, in press). Theoretically, it has been proposed that mindfulness training (e.g., mindfulness meditation) can enhance attention control, emotion regulation, and self-awareness (for reviews, see Hölzel Lazar et al., 2011; Tang, Hölzel, & Posner, 2015). With regard to the empirical evidence on the mechanisms of attention control and self-awareness, it has been demonstrated that both long- and short- term mindfulness training can cause a structural change of grey matter (Hölzel Carmody et al., 2011) and white matter (Tang et al., 2007) in the brain. These neurological effects are proposed to indicate motor learning (Sampaio-Baptista et al., 2013; Wei, Zhang, Jiang, & Luo, 2011). As such, mindfulness training might well be useful for mastering new sport skills because of its neurological effects related to motor learning, as well as the psychological effects, such as attention control.

The mindfulness-acceptance-commitment approach (MAC; Gardner & Moore, 2007) is one of the most popular mindfulness training programs in sport. The MAC
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includes key concepts and practices skills from two widely-recognized mindfulness-based training programs: the mindfulness-based cognitive therapy (Segal, Williams, & Teasdale, 2002) and the acceptance and commitment therapy (Hayes, Strosahl, & Wilson, 1999). In MAC, mindfulness training skills, acceptance, value, and commitment from these two training programs have been fully integrated and reconstituted with behaviour-change strategies in sport contexts. The aim of MAC is to help performers develop skills of non-judging mindful attention and awareness, and experiential acceptance of internal experiences, while focusing on contextually appropriate behavioural responses, in order to promote both competitive in-the-moment behaviours as well as in the pursuit of valued goals (Moore, 2009).

Several functions of MAC are suggested to be useful to motor skill learning, such as task-focused attention, experiential acceptance (i.e., willingness to experience internal events such as bodily sensation, emotions, thoughts, and memories), and commitment (Gardner & Moore, 2007; Wulf, Shea, & Lewithwaite, 2010). Task-focused attention allows learners to focus on the external motor movements rather than their internal self-referenced thoughts. This is viewed as an effective motor learning principle (Wulf et al., 2010). In addition, openness to new experience with a nonjudgmental attitude has been explicitly encouraged in the MAC training (Gardner & Moore, 2007). Individuals, using this experiential acceptance approach, may easily detect the inconsistencies and incoherencies in the earlier stages of motor skill learning (i.e., the cognitive and associative stages in the three-stage model; Fitts, 1964; Fitts & Posner, 1973).

Furthermore, commitment to motor learning goals is important. In MAC, value-driven behaviours, rather than emotion-driven behaviors, are cultivated in order to promote individuals consistent commitment to their goals (Gardner & Moore, 2007).
Research has shown that mindfulness training can improve athletes’ mental status in sport, such as an increase in experiential acceptance, general well-being, and flow (i.e., complete absorption in what one does; Csikszentmihalyi, 1990) as well as the reduction of anxiety, worries, and the risk of burnout (e.g., Aherne, Moran, & Lonsdale, 2011; Gardner & Moore, 2012; Thompson, Kaufman, De Petrillo, Glass, & Arnkoff, 2011). Among all the proposed psychological variables, flow is an immediate and critical outcome of MAC that can facilitate athletes’ adaptive behaviours in competitive sport (Bernier, Thienot, Codron, & Fournier, 2009; Gardner & Moore, 2007, 2012). Most importantly, flow experiences also correspond to the description of the autonomous stage of motor skill learning (Fitts, 1964; Fitts & Posner, 1973), in which athletes perform their skills without the need to consciously think about what they are doing (Magill, 2004).

Although there has been some evidence on the link between mindfulness and athletes’ experience in sport, the application of MAC to sport novices and its prolonged effects on motor skill acquisition has not been researched. Although MAC training has been shown to have an acute enhancing effect on athletes’ performance in various sports (e.g., field hockey, volleyball, and diving; Gardner & Moore, 2012; Schwanhausser, 2009; Wolanin & Schwanhausser, 2010), causal inference could not be made from previous studies as they were generally conducted using small sample case studies among elite or collegiate players without randomisation control (Birrer, Röthlin, & Morgan, 2012). Therefore, generalisability of previous findings was restricted to elite athletes, but not to athletes at all levels (e.g., sport novices or recreational level players). Nonetheless, investigating the role of mindfulness training in improving beginner players’ experience, mental status, and sport performance is highly useful for understanding how
mindfulness could be applied to learning, improvement, and skill acquisition in sport training.

The aim of the present study was to examine the effectiveness of MAC training on beginners’ mindfulness, experiential acceptance, flow, and dart throwing performance. It was hypothesised that mindfulness, experiential acceptance, flow, and dart throwing performance in the mindfulness training group would be significantly higher than the attention control group immediately-after and two-weeks after the intervention. In addition, it was hypothesised that the mindfulness training group, instead of the attention control group, would significantly improve mindfulness, experiential acceptance, and flow at the post-test and the improvement would be maintained two-weeks later.

Methods

Participants

Ethics clearance was granted by the research ethics committee of the Hong Kong Sports Institute. A total of 43 first-year college students who were enrolled in a sport psychology program at a sport university in China participated voluntarily in the study (response rate = 87.76 %; $M_{age} = 19.23; SD = 1.27$). Participants were all right-handed, had normal or corrected-to-normal vision, did not have any mindfulness training, and had not played darts professionally prior to the study. Players were self-selecting based on their being unskilled at playing darts. Written informed consent was provided to participants before inclusion and the confidentiality and anonymity of their participation were assured.

Intervention Protocols
Mindfulness training in the current study was based on the MAC protocol (Gardner & Moore, 2007; see the online supplementary material Appendix A), but initial evidence from two single-case studies in China demonstrated that Chinese athletes had different interpretations toward the concepts of value and commitment in MAC, because social-oriented value and commitment were deemed as more appropriate than personal-oriented value and commitment in the Chinese culture (Bu, 2013; Zhang, 2013). As such, to facilitate better understanding of these two important concepts, the cultivation of a new awareness and discovery of social-oriented insights, meanings, and values of life were integrated into the MAC modules (Si et al., 2014). The adaptation is essential because the delivery of MAC training is likely to be more effective if the interpretation of values and commitments in MAC is in line with the indigenous cultural values and beliefs (Si, Lo, & Zhang, in press). This adapted MAC protocol has already been demonstrated to be effective in improving mindfulness, experiential acceptance, and training performance of a sample of six national level elite Chinese synchronized swimmers (Si et al., in press).

Measures

Participants completed a 15-min questionnaire and dart throwing tests at pre-intervention (Week 1), post-intervention (Week 8), and follow-up (Week 10).

Mindfulness was measured using the Chinese version of Five Facet Mindfulness Questionnaire (FFMQ; Baer, Smith, Hopkins, Krietemeyer, & Toney, 2006) developed in a recent study (Deng, Liu, Rodriguez, & Xia, 2011) with supporting evidence regarding the factorial validity of the measure in a Chinese population. Using a five-point Likert scale (1 = never or very rarely true; 5 = very often or always true), participants rated 39 items from five dimensions, including: observe (e.g., “I notice the smells and aromas of
things."), describe (e.g., “I can usually describe how I feel at the moment in considerable detail.”), act with awareness (e.g., reverse-worded “I rush through activities without being really attentive to them.”), non-judgment (e.g., reverse-worded “I tell myself that I shouldn’t be thinking the way I’m thinking.”), and non-react (e.g., “When I have distressing thoughts or images, I just notice them and let them go.”). There was acceptable internal consistency reliability of the FFMQ across three assessments ($\alpha = .71$ to .94).

Experiential acceptance was measured by the Chinese version (Zhang, Chung, Si, & Liu, 2014) of Acceptance and Action Questionnaire-II (AAQ-II; Bond et al., 2011). The measure has seven items (e.g., “My painful experiences and memories make it difficult for me to live a life that I would value.”) and data from previous studies supported its factorial validity (Bond et al., 2011; Zhang et al., 2014). Responses were made on 7-point Likert scale (1 = never true; 7 = always true). This single-dimension scale produced satisfactory internal consistency during our three assessments ($\alpha = .82$ to .93).

Flow was assessed by the Chinese version (Liu, 2010) of Short Dispositional Flow Scale (SDFS; Jackson, Martin, & Eklund, 2008), in which both versions demonstrated satisfactory factorial validity. Participants rated the seven items (e.g., “When participating in my sport, I know clearly what I want to do.”) of SDFS on a 5-point Likert scale (1 = never; 5 = always). The internal consistency reliability of SDFS was satisfactory across our three assessments ($\alpha = .66$ to .82).

The dart throwing performance was measured approximately five minutes after participants completed the self-report measures of mindfulness, experiential acceptance, and flow at each of the three assessments (pre-intervention, post-intervention, and
follow-up). Two dartboards that were made-up of ten concentric circles were used, rather than the traditional style. The position of the dartboards was set according to international standards, where the bullseye was 1.73 meters from the floor and the throwing line was 2.37 meters away from the dartboard. The score for each throw was given by how close the dart hit the bullseye, ranging on a scale from 10 (bullseye) to 0 (outside the dartboard). Participants were asked to throw three darts in each round, and their performance of dart throwing was the total score they obtained in five consecutive rounds.

**Procedure**

All participants took part in an eight-week dart training program instructed by a professional dart playing coach. In the first two weeks, the basic knowledge and skills of dart throwing were introduced to the participants. In the subsequent weeks (Week 3 to Week 8), participants were given two 30 minutes sessions of dart throwing practice every week. Mindfulness training began in Week 2, in which participants were randomly divided into a mindfulness group ($n=22$, 10 males and 12 females) or an attention control group ($n=21$, 6 males and 15 females), based on a simple randomisation (i.e., use of random number tables). From Week 2 to Week 8, the mindfulness group received MAC mindfulness training while the attention control group received sport psychology lectures.

In accordance with the guidelines of Gardner and Moore (2007), the mindfulness group was given homework to practice mindfulness a minimum of three times per week. Similarly, the attention control group was required to revise the learning materials of the previous lecture three times per week. The sport psychology lecture intervention for the attention control group was an introductory course of sport and exercise psychology.
(see the online supplementary material Appendix B). Topics included history, research, theories, talent identification, and athletes’ lifespan development. MAC training was delivered to the mindfulness group by one instructor, and the sport psychology lecture of the attention control group was conducted by another independent instructor. They were both qualified sport psychology consultants and had more than one year experience in mindfulness practice. With a single-blinded design, these two instructors understood about the research purpose, but they did not have any mutual interference during the intervention period and were not allowed to disclose the study hypotheses, study design, or methodology to the participants. A session was given in each of the weeks, and the duration was 80 to 90 minutes for each group, and the amount of time and level of interaction that the instructors had with the participants was consistent between the two groups.

**Data Analysis**

Two-way repeated measures analyses of variance (ANOVA) were conducted to test the effect of time (within-subject independent variable: levels = pre-intervention, post-intervention, and follow-up) and group (between-subject independent variable: levels = mindfulness group and attention control group) on mindfulness, experiential acceptance, flow, and dart throwing performance respectively. Post-hoc paired sample *t*-tests were further used to investigate whether there was any within-group difference between three assessments of each group.

**Results**

In preliminary data screening, no missing data were observed and there were no significant between-group differences on any study variables at pre-intervention (*p* > .05). See Table 1 for the means, standard deviations, skewness, kurtosis, and internal
consistencies (Cronbach’s \( \alpha \)) of the study variables of each group across three assessments.

Two-way repeated measure ANOVA of mindfulness revealed a significant time by group interaction effect, \( F(2, 40) = 6.59, p = .003, \eta^2 = .25 \) and a significant between-group difference, \( F(1, 41) = 27.79, p < .001, \eta^2 = .40 \). Furthermore, within-group difference of mindfulness scores across time was significant, \( F(2, 40) = 8.28, p = .001, \eta^2 = .29 \). Post-hoc independent sample t-tests indicated that the mindfulness scores of mindfulness group were significantly higher than attention control group at both post-intervention and follow-up (see Table 2). Post-hoc paired sample t-tests indicated that, in mindfulness group, the mindfulness scores were significantly higher in post-intervention and follow-up, as compared to that of pre-intervention. Unexpectedly, mindfulness group significantly decreased their mindfulness scores from post-intervention to follow-up, but the follow-up mindfulness scores were still significantly better than the pre-intervention mindfulness scores. No significant differences of mindfulness scores were observed across three assessments in the attention control group (see Table 3).

No significant time by group interaction was found from the ANOVA of experiential acceptance, \( F(2, 40) = 2.48, p = .097, \eta^2 = .11 \), but between-group difference was significant, \( F(1, 41) = 10.50, p = .002, \eta^2 = .20 \). In addition, within-group difference of experiential acceptance across time was not significant, \( F(2, 40) = 2.24, p = .120, \eta^2 = .10 \). Post-hoc independent sample t-tests indicated that the experiential acceptance of mindfulness group were significantly higher than attention control group at both post-intervention and follow-up. Post-hoc paired sample t-tests indicated that the experiential acceptance of mindfulness group were significantly higher during post-
intervention and follow-up, in comparison to that of pre-intervention. No significant differences of experiential acceptance were observed across three assessments in the attention control group.

Repeated measure ANOVA of flow revealed a significant time by group interaction effect, $F(2, 40) = 6.07, p = .005, \eta^2 = .23$ and a significant between-group difference, $F(1, 41) = 20.89, p < .001, \eta^2 = .34$. Furthermore, within-group difference of flow across time was significant, $F(2, 40) = 5.20, p = .010, \eta^2 = .21$. Post-hoc independent sample t-tests indicated that the flow of mindfulness group were significantly higher than attention control group at both post-intervention and follow-up.

Post-hoc paired sample t-tests indicated that the flow of mindfulness group was significantly higher in post-intervention and follow-up, as compared to that of pre-intervention. No significant differences were found across three assessments of flow in the attention control group.

Repeated measure ANOVA of dart throwing performance revealed a significant time by group interaction effect of the, $F(2, 40) = 6.83, p = .003, \eta^2 = .26$ and a significant between-group difference, $F(1, 41) = 20.43, p < .001, \eta^2 = .33$. Furthermore, within-group difference of dart throwing across time was significant, $F(2, 40) = 35.51, p < .001, \eta^2 = .64$. Post-hoc independent sample t-tests indicated that the dart throwing performance of mindfulness group were significantly higher than attention control group at both post-intervention and follow-up. Post-hoc paired sample t-tests indicated that both mindfulness and attention control group significantly increased dart throwing performance at post-intervention. Interestingly, from post-intervention to follow-up, mindfulness group had no significant improvement, whereas the attention control group had significant decrease in dart throwing performance.
Discussion

The current study provides preliminary evidence for the effectiveness of MAC training on the skill acquisition of dart throwing for beginners, who never played darts professionally prior to the experiment. Compared with the attention control group, beginners in dart throwing who completed the mindfulness training significantly improved their dart throwing performance, mindfulness, experiential acceptance, and flow at the post-intervention test and follow-up. From post-intervention to two-week follow-up, mindfulness group reported no significant changes on experiential acceptance, flow, and dart throwing performance, while the attention control group significantly decreased their dart throwing performance, indicating the positive effects of mindfulness training sustained two weeks after the intervention.

Individuals with high levels of mindfulness have an advantage in learning new motor skills (Kee & Liu, 2011). The current study extended the findings of mindfulness in previous studies about basic motor skill learning (Kee et al., 2012, 2013) to sport skill acquisition. It also corroborated the findings of a recent report that supported the effectiveness of mindfulness training on performance of some motor skills (e.g., darts, golf putting, and sinusoid tests; Meeûs, Boen, & De Cuyper, 2010). Notably, in our study, the dart throwing performance of the attention control group, instead of the mindfulness group, was impaired in the two-week follow-up which might imply that MAC training could be useful for preserving a new skill obtained by sport novices. Overall, the mindfulness group performed better than the control group in dart throwing. This may mean that although sport novices improve along with their practice, MAC training is likely to make the improvement better and more sustainable, and these patterns are
likely to be associated with increases in psychological variables such as experiential acceptance and flow.

The current findings support the existing literature of the effectiveness of mindfulness training on salutary psychological variables with regard to mindfulness, experiential acceptance and flow (e.g., Aherne et al., 2011; Gardner & Moore, 2012; Schwanhausser, 2009; Thompson et al., 2011). Although the mindfulness group had increased mindfulness scores after the mindfulness training, the score slightly dropped by follow-up. Although the score was still significantly higher than the baseline, we believed that poor adherence to home-based mindfulness practice following the termination of the intervention was the main reason (Rosenzweig et al., 2010). This finding further emphasized the importance of behavioural persistence, commitment, self-initiated training following the termination of mindfulness intervention (Morgan, Graham, Hayes-Skelton, Orsillo, & Roemer 2014). Nevertheless, it seemed that the slight decrease of mindfulness alone did not influence the dart throwing performance of mindfulness group.

Mindfulness has been linked to significant and positive relations with experiential acceptance and flow in previous correlational and intervention studies (e.g., Aherne et al., 2011; Kee & Wang, 2008; Thompson et al., 2011; Zhang et al., 2014). As shown in our study, the mindfulness group had consistently reported higher experiential acceptance, flow, and performed better dart throwing than the attention control group. As such, these findings provide further support on our theoretical proposition that mindfulness training can facilitate experiential acceptance and flow experiences which can in turn help novices acquire new skills in sport (Ferrari, 1996; Gardner & Moore, 2007; Langer, 2000). As an important component in MAC training, exceptional
acceptance facilitates learners’ earlier stage of skill acquisition enabling them to accept
the inconsistencies and incoherencies encountered (Langer, 2000). Given that flow
experience is consistent with the characteristic of autonomous stage of motor skill
learning (i.e., knowing what to do without conscious attention control; Csikszentmihalyi,
1990; Ferrari, 1996), it may suggest that flow is one of the key indicators of effective
performing motor tasks during later stage of skill acquisition (Singer, Lidor, & Cauraugh,

Despite its merits, the present study is not without limitations. Firstly, the two-
week follow-up duration might not be adequate for testing the long-term effects of
mindfulness training across the entire learning progress of sport participants. Also, our
sample size was relatively small and the findings might be tentative. Future research
should include a longer follow-up with a larger sample, and longitudinally assess the
uptake of mindfulness and sport training over a prolonged period (Twisk & Proper, 2004).
Secondly, psychological factors were measured on self-report inventories and
responses could therefore be subjected to social desirability, memory bias, and mere-
measurement effects (Chan & Hagger, 2012; Podsakoff, MacKenzie, & Podsakoff,
2012); future research may consider further including biomarkers in outcome measures
as supplements of an objective indicator of the mental status, for example, heart rate
variability (Mankus, Aldao, Kerns, Mayville, & Mennin, 2013) and saliva secretory
immunoglobulin A (SIgA; Taylor, Turner, Gleeson, & Hough, 2015). Thirdly, the present
study could not examine the independent effects of each key component of mindfulness
and acceptance training provided by MAC because the intervention was delivered as a
whole package. Future studies may adopt a cluster randomised controlled trial to partial
out the effects of separate elements of MAC. Fourthly, the single-blinded design may
raise issues about whether the expectations of the instructors might lead participants to behave or respond to the assessment according to the study hypothesis. Although we tried to minimise this problem by having trained the experimenters not to disclose the hypothesis and design of the study, future studies should adopt a double-blinded design. Fifthly, we did not evaluate how well participants applied the skills of MAC for dart throwing. It was because the evaluation immediately before dart throwing could possibly interfere participants’ performance. Retrospective assessment of home-based MAC training was possible, but the responses would be subjected to memory loss and self-reported bias. Future studies may consider using the experience sampling method (Csikszentmihalyi & Larson, 1987), diary self-monitoring method (Burke, Wang, & Sevick, 2011), or qualitative interview for a more comprehensive measure of participants’ behavioural adherence to the mindfulness and acceptance training.

Conclusion

In summary, the present study provided initial evidence supporting the application of MAC-based mindfulness and acceptance training in dart learning for beginners. Mindfulness and acceptance training not only appeared to be adaptive to beginners’ sport experience and performance, but it also seemed to reduce the deterioration of the acquired skill level of sport after the end of sport training. The importance of preserving the habit of regular mindfulness practice after the completion of mindfulness intervention (e.g., MAC) is highlighted.
References


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Table 1
Descriptive statistics, distributions, and reliability indices of the study variables across pre-intervention, post-intervention, and follow-up

<table>
<thead>
<tr>
<th>Measures</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M</td>
<td>SD</td>
<td>Skew</td>
</tr>
<tr>
<td>Mindfulness</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness group</td>
<td>3.14</td>
<td>.32</td>
<td>.56</td>
</tr>
<tr>
<td>Attention control group</td>
<td>3.11</td>
<td>.22</td>
<td>.97</td>
</tr>
<tr>
<td>Experiential acceptance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness group</td>
<td>5.16</td>
<td>1.06</td>
<td>-.60</td>
</tr>
<tr>
<td>Attention control group</td>
<td>5.17</td>
<td>.85</td>
<td>-.25</td>
</tr>
<tr>
<td>Flow</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness group</td>
<td>3.51</td>
<td>.49</td>
<td>.33</td>
</tr>
<tr>
<td>Attention control group</td>
<td>3.43</td>
<td>.45</td>
<td>-.48</td>
</tr>
<tr>
<td>Dart throwing performance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness group</td>
<td>4.83</td>
<td>1.34</td>
<td>-.22</td>
</tr>
<tr>
<td>Attention control group</td>
<td>4.70</td>
<td>1.15</td>
<td>.18</td>
</tr>
</tbody>
</table>

Note. M = Mean; SD = Standard Deviation; α = Cronbach’s Alpha; Skew = Skewness; Kur = Kurtosis. Average score of each item/dart throwing is presented.
Table 2

Summaries of between-group independent sample t-test comparisons

<table>
<thead>
<tr>
<th>Measures</th>
<th>Pre-intervention</th>
<th>Post-intervention</th>
<th>Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>t value</td>
<td>p value</td>
<td>t value</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness</td>
<td>.30</td>
<td>.766</td>
<td>4.82</td>
</tr>
<tr>
<td>Experiential acceptance</td>
<td>-.048</td>
<td>.962</td>
<td>3.19</td>
</tr>
<tr>
<td>Flow</td>
<td>.57</td>
<td>.572</td>
<td>4.90</td>
</tr>
<tr>
<td>Dart throwing performance</td>
<td>.07</td>
<td>.945</td>
<td>6.04</td>
</tr>
</tbody>
</table>

*Note. CI= confidence interval. The degree of freedom of all t-test comparisons equal to 41.*
Table 3

Summaries of within-group paired sample t-test comparisons among pre-intervention, post-intervention, and follow-up

<table>
<thead>
<tr>
<th>Measures</th>
<th>Pre-intervention vs Post-intervention</th>
<th>Pre-intervention vs Follow-up</th>
<th>Post-intervention vs Follow-up</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>M Diff</td>
<td>t</td>
<td>df</td>
</tr>
<tr>
<td>Mindfulness Group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness</td>
<td>-23.86</td>
<td>-4.45**</td>
<td>21</td>
</tr>
<tr>
<td>Experiential acceptance</td>
<td>-5.91</td>
<td>-2.77*</td>
<td>21</td>
</tr>
<tr>
<td>Flow</td>
<td>-4.55</td>
<td>-5.04**</td>
<td>21</td>
</tr>
<tr>
<td>Dart throwing performance</td>
<td>-31.14</td>
<td>-8.00**</td>
<td>21</td>
</tr>
<tr>
<td>Attention control group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mindfulness</td>
<td>-1.62</td>
<td>-.54</td>
<td>20</td>
</tr>
<tr>
<td>Experiential acceptance</td>
<td>-.05</td>
<td>.03</td>
<td>20</td>
</tr>
<tr>
<td>Flow</td>
<td>.48</td>
<td>.43</td>
<td>20</td>
</tr>
<tr>
<td>Dart throwing performance</td>
<td>-16.71</td>
<td>-4.11**</td>
<td>20</td>
</tr>
</tbody>
</table>

Note. M Diff = Mean Difference; df = degree of freedom; *p < .05, **p < .01, at two-tailed significance.
• Mindfulness training can facilitate the skill acquisition of dart throwing beginners.

• Mindfulness training can help prevent the decline of beginners’ performance once they stop practicing their skills.

• Continued practice of mindfulness is required to maintain its benefits.
Appendix A (Supplementary Online Material)

*Outline of the Intervention Protocol for Mindfulness Group*

<table>
<thead>
<tr>
<th>Theme of each week</th>
<th>Contents</th>
</tr>
</thead>
</table>
| **Week 2:** Preparing the participants with psychoeducation | 1. Introducing the entire structure of the mindfulness training program  
2. Theoretical rationale and specific aims of the program  
3. A story on the application of mindfulness of an athlete  
4. The practice of brief centering exercise and group sharing  
5. Homework (brief centering exercise) |
| **Week 3:** Introducing mindfulness | 1. Introducing the definition of mindfulness (*as it is and here and now*)  
2. Introducing Eastern mind and heart in mindfulness  
3. The practice of exercises of mindfulness breathing, mindfulness walking and mindfulness fruit eating and group sharing  
4. Homework (mindfulness breathing, mindfulness walking and mindfulness fruit eating) |
| **Week 4:** Introducing cognitive defusion | 1. Introducing the concept of cognitive defusion  
2. From ruminated self-orientation to task-orientation  
3. The practice of mindfulness exercises such as forgetting-self behaviour exercise and group sharing  
4. Homework (forgetting-self behaviour exercise) |
| **Week 5:** Introducing acceptance | 1. Strengthen participants’ understanding of acceptance and avoidance of experiences in dart throwing  
2. Emphasizing the attitudes of accepting and non-judging towards |
experiences in dart throwing

3. The practice of coexistence exercise I and II and group sharing
4. Homework (coexistence exercise)

Week 6:

1. Introducing the concept of value (personal- and social- oriented values)
2. Introducing the concept of insight (a new understanding of values and value-driven behaviours)
3. The relationship between social-oriented values and insight
4. A storytelling and sharing approach to help participants develop insight
5. Homework (previous mindfulness exercises)

Week 7:

1. Introducing the concept of commitment
2. The importance of commitment to dart throwing training and beyond
3. Linking commitment with insight, value-driven behaviour and social-oriented value
4. Homework (previous mindfulness exercises)

Week 8:

1. Summarizing the aims of all sessions to get an overall understanding of the program: Combing mindfulness, acceptance, and commitment
2. Reviewing and practicing some key mindfulness exercises
3. Maintaining and enhancing the application of the mindfulness-acceptance-commitment approach
Appendix B (Supplementary Online Material)

Outline of Intervention Protocol for Attention Control Group

<table>
<thead>
<tr>
<th>Theme of each week</th>
<th>Contents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Week 2:</td>
<td>1. Sport psychology in sports context</td>
</tr>
<tr>
<td>What is sport and</td>
<td>2. Exercise psychology in the context physical activity and exercise</td>
</tr>
<tr>
<td>exercise psychology</td>
<td>3. Sport and exercise psychology in the context of physical education</td>
</tr>
<tr>
<td></td>
<td>4. Homework (review lecture notes)</td>
</tr>
<tr>
<td>Week 3:</td>
<td>1. The beginning of sport psychology in 19th century</td>
</tr>
<tr>
<td>History of sport and exercise psychology</td>
<td>2. Coleman Griffith as American First Sport Psychologist</td>
</tr>
<tr>
<td></td>
<td>3. History of International Society of Sport Psychology (ISSP)</td>
</tr>
<tr>
<td></td>
<td>4. History of Asian South Pacific Association of Sport Psychology (ASPASP)</td>
</tr>
<tr>
<td></td>
<td>5. History of Chinese sport and exercise psychology</td>
</tr>
<tr>
<td></td>
<td>6. Homework (review lecture notes)</td>
</tr>
<tr>
<td>Week 4:</td>
<td>1. Four different levels of research (describe, interpretation, predict and intervention)</td>
</tr>
<tr>
<td>Research methods and paradigms in sport and exercise psychology</td>
<td>2. Two different orientations of research (theoretical and practical)</td>
</tr>
<tr>
<td></td>
<td>3. Quantitative and qualitative research</td>
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<tr>
<td></td>
<td>4. Introducing five main journals in sport and exercise psychology (JSEP, PSE, IJSEP, JASP, and TSP)</td>
</tr>
<tr>
<td></td>
<td>5. Homework (review lecture notes)</td>
</tr>
<tr>
<td>Week 5:</td>
<td>1. Theories of sport psychology in athletic excellent performance</td>
</tr>
<tr>
<td>Theories and concepts of sport and exercise psychology</td>
<td>2. Motivation theories in the context of sport, exercise and physical education (e.g., SDT)</td>
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<td>-----------------------------------------------------</td>
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<tr>
<td></td>
<td>3. The relations and changing mechanisms between physical activity and mental health</td>
</tr>
<tr>
<td></td>
<td>4. Homework (review lecture notes)</td>
</tr>
<tr>
<td><strong>Week 6:</strong></td>
<td>1. What is personality?</td>
</tr>
<tr>
<td>Personality theories and concepts linking with sport</td>
<td>2. Psychodynamic theory</td>
</tr>
<tr>
<td></td>
<td>3. Trait theory of personality in sport</td>
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<td></td>
<td>4. Theory of the Big Five personality in sport</td>
</tr>
<tr>
<td></td>
<td>5. Homework (review lecture notes)</td>
</tr>
<tr>
<td><strong>Week 7:</strong></td>
<td>1. Significance of talent identification in sports</td>
</tr>
<tr>
<td>Talent identification of athletes</td>
<td>2. Personality characteristics of athletes and talent identification</td>
</tr>
<tr>
<td></td>
<td>3. Progress and updates of talent identification</td>
</tr>
<tr>
<td></td>
<td>4. Homework (review lecture notes)</td>
</tr>
<tr>
<td><strong>Week 8:</strong></td>
<td>1. Importance of athletic life-long development</td>
</tr>
<tr>
<td>The life-long development of athletes</td>
<td>2. The relation between sport performance and life-long development</td>
</tr>
<tr>
<td></td>
<td>3. Interactive and whole-person development</td>
</tr>
<tr>
<td></td>
<td>4. Emphasizing longitudinal research</td>
</tr>
<tr>
<td></td>
<td>5. Homework (encouraging continued lecture notes review)</td>
</tr>
</tbody>
</table>