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Interactive Effect of Dispositional Mindfulness and Type of Attention Instruction on Movement-Specific Reinvestment Components and Basketball Shooting Performance Under Psychological Pressure

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ABSTRACT

Objective: This study aimed to investigate the interactive effects of dispositional mindfulness and type of attention instruction on movement-specific reinvestment components and basketball shooting performance under psychological pressure.

Methods and Materials: A total of 80 Bachelor's degree students from the University of Babol, Iraq, were purposefully and conveniently selected and randomly divided into four groups of 20: 1) The high dispositional mindfulness with external focus group (HDMEAG), 2) The high dispositional mindfulness with internal focus group (HDMIAG), 3) The low dispositional mindfulness with external focus group (LDMEAG), 4) The low dispositional mindfulness with internal focus group (LDMIAG). Data were collected using the Brown and Ryan Mindfulness Scale, the movement-specific reinvestment Scale, and the Basketball Shooting Test (mid-range shot). Paired t-tests were used to examine within-group effects, and ANCOVA was used for between-group comparisons.

Findings: The results showed that both high and low dispositional mindfulness and internal and external attention improved movement self-consciousness, conscious motor processing, and basketball shooting performance ($P \leq 0.05$). The findings also indicated that the interaction between high dispositional mindfulness and external attention resulted in the best performance in basketball shooting, movement self-consciousness, and conscious motor processing compared to the other groups ($P \leq 0.05$).

Conclusion: Overall, the combination of high dispositional mindfulness and external attentional focus appears to be the most optimal state for enhanced athletic performance, whereas low dispositional mindfulness coupled with internal attentional focus may lead to performance decrements and heightened engagement in movement-specific reinvestment.

Keywords: *Mindfulness, Attention, Psychological Pressure, Movement-Specific Reinvestment, Basketball*

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1. Introduction

Many athletes, despite having high physical fitness and skill, are unable to perform at their best in competitions due to psychological pressure (1). This pressure can reduce their ability to control emotions (1, 2). As a result, their cognitive performance declines, and their concentration is disrupted (3). Therefore, psychologists seek interventions that concurrently influence the cognitive, emotional, and motor domains of athletes. One of these methods is mindfulness training.

Mindfulness is defined as purposeful, present-moment, and nonjudgmental awareness. This kind of awareness is not automatic; it requires intentional and consistent practice (4). There are three important features of mindfulness: a) Intention – practicing with a purpose, such as self-regulation or self-exploration. b) Attention – being continuously aware of both internal and external experiences in the present moment. c) Attitude – approaching this awareness with an open, accepting, and nonjudgmental mindset (5).

As research has progressed, mindfulness has also been conceptualized as both state and trait. State mindfulness refers to clear, nonjudgmental, flexible, and present-moment awareness (6). In contrast, trait or dispositional mindfulness refers to an individual's enduring tendency to experience current events with awareness and acceptance (7). Research has shown that mindfulness practice can improve dispositional mindfulness (8) and enhance several cognitive abilities, including sustained attention, experiential acceptance, emotional self-regulation, cognitive flexibility, reduced attachment, and decreased rumination. These capacities are all beneficial for psychological adjustment (9).

Since dispositional mindfulness is closely linked to an individual's cognitive state of awareness, researchers have examined how dispositional mindfulness influences motor control and performance. For example, Kee et al. (2012) found that the main effect of a mindfulness intervention on a balance task was not statistically significant. However, there was an interaction between dispositional mindfulness and the induced mindfulness condition. Specifically, within the intervention group, individuals with high dispositional mindfulness performed better than those with low dispositional mindfulness (10). Chiu et al. (2019) demonstrated that individuals with high dispositional mindfulness can sustain attention for a more extended period and are less likely to experience disruption during motor tasks when engaging in irrelevant self-talk. They also found that individuals with low dispositional mindfulness showed impaired performance when using irrelevant self-talk during such tasks. (11). In a recent study, Liu et al. (2022) advanced the argument that prior research has integrated mindfulness and psychological interventions within a laboratory setting (12), in the absence of external pressure, defined as the presence of observers (10-12). Liu et al. (2022) (12) hypothesized that if participants performed motor tasks in the presence of others, the results would differ. They reported that individuals with low dispositional mindfulness who engaged in irrelevant self-talk showed poorer performance in bimanual coordination tasks under pressure. Theoretically, dispositional mindfulness refers to an individual's cognitive tendency to be aware of environmental stimuli and to maintain attention to the task at hand. Therefore, individuals with high dispositional mindfulness tend to perform better in specific motor tasks compared to those with low dispositional mindfulness (7).

Research findings suggest a connection between mindfulness and attention. To perform a motor task successfully, individuals must focus their attention on key elements. These include body posture, the position and angle of equipment, the distance, size, and direction of target objects, and the timing of movement execution (13). Schmidt et al. (2018)(14) stated that attention enables performers to effectively allocate cognitive resources and efficiently process relevant information to carry out a motor task successfully. Researchers and coaches believe that the direction of attentional focus can have an almost immediate effect on performance. The process of directing attention is known as attentional focusing, which refers to organizing available resources in order to channel them toward specific sources of information (15). One key dimension of attentional focus is the distinction between internal focus and external focus. Internal focus refers to situations in which an individual directs attention to their body parts or movements during task execution. In contrast, external focus involves directing attention toward the effects or outcomes of the movement on the environment (16). Wulf and Lewthwaite (2016) proposed the OPTIMAL theory of motor learning (Optimizing Performance Through Intrinsic Motivation and Attention for Learning). This theory highlights three key factors that significantly influence the acquisition and learning of motor skills (17). The first factor is the adoption of an external focus of attention, which refers to directing attention toward the intended effect of the movement (e.g., the outcome of an action). This focus has been shown to enhance motor learning more effectively than an internal focus, which involves attention to one's own movements or body parts. The second factor is autonomy support or self-control, considered a motivational variable. Giving learners the opportunity to make choices during practice increases their motivation and engagement, thereby enhancing learning. The third factor is enhanced expectancies, meaning that increasing learners' confidence and positive expectations can facilitate the learning process. Recent evidence suggests that when learners experience enhanced expectancies, their ability to learn motor skills improves. Therefore, according to this theory and supporting research, the external focus of attention is regarded as a critical attentional factor that improves both the performance and learning of new motor tasks (17). Wulf and Prinz (2001) also introduced the Constrained Action Hypothesis to explain the advantages of an external focus of attention over an internal focus. According to this hypothesis, when individuals are instructed to adopt an internal focus, they attempt to consciously control their movements, which constrains the motor system. This conscious interference disrupts the automatic control processes that typically govern skilled motor performance, leading to less efficient and less effective movement execution (18). Possible explanations for why an external focus of attention leads to better outcomes include the reduction of conscious motor control, which results in less noise in the motor system. Additionally, it facilitates more efficient underlying mechanisms of motor performance, such as improved electromyographic (EMG) activity (19). Previously, Wolf and Prinz's (2001) common coding hypothesis argued for the superiority of external focus of attention, stating that we need to align the afferent and efferent information coding systems during motor performance (18). Specifically, Wolf and Su (2007) proposed that both perception and action are based on exteroceptive events (external focus), which generate afferent and efferent codes and share a common abstract representation (20).

Athletes are not always able to perform at their best under pressure (21). This issue is also true in other fields (22, 23). The effect varies across different conditions and individuals, and despite poor performance in some athletes, others show acceptable or even better-than-usual performance (24). Therefore, some researchers consider individual differences as a cause of this phenomenon and introduce reinvestment as the underlying factor (25). This approach and the reinvestment hypothesis, proposed by Masters (1992), align with theories such as the limited capacity hypothesis and automaticity. It argues that focusing attention on skill execution or movement technique represents a form of self-focus or internal focus of attention, which disrupts performance under pressure in well-learned skills (26). Masters and Maxwell (2004) defined reinvestment as the use of explicit, rule-based knowledge by working memory to consciously control the execution of movements in progress (27). In this context, Masters et al. (1993) suggested that performance breakdown may be caused by some athletes' tendency to consciously review explicit knowledge related to the task (28). Masters and Maxwell (2004) stated in their research that high reinvestors use more explicit knowledge to control their movements under pressure compared to low reinvestors (27). Knierad et al. (2010) also showed that reinvestment is associated with performance disruption in both motor and cognitive skills (21). For some athletes, the importance of understanding pressure situations in sports can lead to harmful effects on performance due to attentional disruptions (29). Specifically, an athlete's ability to focus on task-relevant information during execution can be compromised by increased anxiety levels (30). Closed motor skills, such as basketball free throws, which are performed automatically, may become vulnerable when performed under pressure (31). Three theoretical models have been proposed to explain the relationship between anxiety and performance deterioration under pressure. First, the Distraction Model suggests that performance decline in high-pressure situations is due to attention being diverted to irrelevant external stimuli rather than task-relevant information (32). The second model, known as the Self-Focus (or Self-Monitoring) Model (33), is based on evidence that internal focus of attention during pressure situations disrupts the execution of well-learned motor skills (30), likely because such skills are encoded to operate automatically, without conscious contr. (26). Finally, Nieuwenhuys and Oudejans (2012) integrated both distraction and self-focus accounts. According to their model, increased levels of cognitive anxiety may lead to performance impairments through either distraction (e.g., attention to task-irrelevant stimuli) or self-focus (i.e., fixation on internal sensations or thoughts). However, these mechanisms are not necessarily mutually exclusive (34). Oudejans et al. (2011) found that both self-focus and distraction negatively affect performance under pressure, but distraction—such as worrying about the outcome—is more commonly the cause of performance decline .Therefore, enhancing an individual's ability to focus on task-relevant information in the present moment, while effectively managing anxiety, may help prevent performance decrements in high-pressure situations (35).

Based on the aforementioned discussions, it is assumed that mindfulness and the type of attention of the individual provide the athlete with the opportunity to accept his/her emotions and incompatible cognitions and to direct his/her attention in a desirable way when under pressure. Therefore, since mental capabilities, as a complement to physical and skill fitness, define a successful athlete, the importance of this issue requires that researchers in the field of improving the cognitive, emotional, and motor capacities of athletes use appropriate approaches in addition to motor skills training. Therefore, the purpose of this study is to investigate the interactive effect of dispositional mindfulness and the type of attention instruction in conditions under psychological pressure on the movement-specific reinvestment components and basketball shooting performance . Considering the purpose and background of the study, the research hypotheses are as follows:

1. Dispositional mindfulness (high vs. low) and attentional focus (internal vs. external) affect basketball free-throw performance in the absence of psychological pressure.
2. Dispositional mindfulness (high vs. low) and attentional focus (internal vs. external) affect basketball free-throw performance under psychological pressure.
3. Dispositional mindfulness (high vs. low) and attentional focus (internal vs. external) influence conscious motor processing and movement self-consciousness.
4. There is a significant difference in the effect of dispositional mindfulness (high vs. low) and attentional focus (internal vs. external) on basketball free-throw performance in the absence of psychological pressure.
5. There is a significant difference in the effect of dispositional mindfulness (high vs. low) and attentional focus (internal vs. external) on basketball free-throw performance under psychological pressure.
6. There is a significant difference in the effect of dispositional mindfulness (high vs. low) and attentional focus (internal vs. external) on conscious motor processing and movement self-consciousness.

2. Methods and Materials

2.1 Study Design and Participants

The present study employed a semi-experimental design using a pre-test and post-test framework. The statistical population consisted of undergraduate students (aged 18 to 24) at Babol University in Iraq who were physically healthy, had no prior experience in basketball, and provided informed consent to participate in the study. From this population, 80 students were selected using purposive and convenience sampling methods. These participants were then randomly assigned to four groups of 20, as follows:

1) the high dispositional mindfulness with external focus group (HDMEAG).

2) the high dispositional mindfulness with internal focus group (HDMIAG).

3) the low dispositional mindfulness with external focus group (LDMEAG).

4) the low dispositional mindfulness with internal focus group (LDMIAG).

2.2 Data Collection

The Brown and Ryan Mindfulness Scale: The Brown and Ryan Mindfulness Scale (2003) was used to assess participants' dispositional mindfulness. This 15-item scale measures attentional focus. Each item is rated on a 6-point scale ranging from 1 (almost always) to 6 (almost never). The total scale score is calculated by summing all 15 items, with higher scores indicating higher levels of dispositional mindfulness. Deng and colleagues (2012) reported an internal consistency of 0.88 for this scale (36).

Movement-Specific Reinvestment Scale: To assess movement-specific reinvestment in motor skills, the movement-specific meinvestment Scale was used. This scale comprises two factors with a total of 10 items. Five items relate to the Movement Self-Consciousness factor, which measures the extent of an individual's concern with the style or technique of their movement execution. The other five items pertain to the Conscious Motor Processing factor, which assesses the degree of conscious monitoring during movement execution. All items are rated on a six-point Likert scale, ranging from "strongly disagree" to "strongly agree". Masters et al. (2005) reported a Cronbach's alpha ranging from 0.70 to 0.78 for the movement self consciousness factor and from 0.65 to 0.71 for the conscious motor processing factor (37). In the research by Laborde et al. (2015), the internal consistency for the movement self consciousness factor was 0.71 and for the conscious motor processing factor was 0.69 (25). In the study by Soleimani-Rad et al. (2017), the Cronbach's alpha coefficient for conscious motor processing was reported to be 0.80 and movement self consciousness was reported to be 0.73. In addition, the internal consistency for conscious motor processing was reported as 0.70, and for movement self consciousness as 0.79 (38).

Basketball shooting test (mid-range shot): A mid-range shot was used to assess performance. The Wickfield and Smith (2009) (39) scoring system was used to evaluate mid-range shot performance as follows: 1) The ball does not hit the basket or backboard and goes out = 0 points, 2) The ball hits the backboard and then goes out = 1 point, 3) The ball hits the rim and then goes out = 2 points, 4) The ball hits the backboard and then scores = 3 points, 5) The ball hits the rim and then scores = 4 points, 6) The ball scores directly = 5 points. Therefore, the maximum score for each mid-range shot is 5 and the minimum score is 0. As indicated in previous studies, the optimal shooting distance is specified (40), and the mid-range shooting distance is 460 centimeters from the backboard. According to the rules of the International Basketball Federation (FIBA), a size 7 ball was used for men.

First, the investigator provided the undergraduate students with the Personal Specifications Questionnaire to record the subjects' age, height and weight, health status, and basketball playing or training history. They then completed the Brown and Ryan Mindfulness Scale. After reviewing the personal specification questionnaire and the mindfulness scale scores, students who had no history of playing basketball, were physically healthy, between the ages of 18 and 24, and provided informed consent to participate in the research were selected, 80 individuals were selected based on the mindfulness scale (40 individuals with high dispositional mindfulness and 40 individuals with low dispositional mindfulness) as a sample and then divided into four groups of 20 each, including 1) HDMEA group 2) HDMIA group 3) LDMEA group 4) LDMIA group. In a preliminary session, the research procedures and training instructions were explained to the participants. Following this briefing, participants completed the movement-specific seinvestment Scale. Subsequently, a basketball shooting pretest was administered. Each participant performed mid-range shots from five court positions located at angles of 0°, 45°, 90°, 135°, and 180° relative to the basket. At each position, five shots were taken, resulting in a total of 25 shots. The total score was recorded as the participant’s pretest performance. As identified in previous studies (40), the optimal distance for mid-range shooting was set at 460 cm from the backboard. In accordance with the regulations of the International Basketball Federation (FIBA), a size 7 basketball was used for male participants. The pretest was conducted over two consecutive days. On the first day, participants performed mid-range shots from various angles without any spectators present. On the second day, to induce psychological pressure and stress, female spectators were present during the shooting task.

Following the pretest phase, participants in the experimental groups engaged in their designated training protocols for a duration of eight weeks, with three sessions per week. Each session began with a 5–10 minute warm-up, followed by two trial shots from each of the five designated angles (0°, 45°, 90°, 135°, and 180°). After the warm-up, participants performed ten main shooting trials at each angle, based on their assigned instructional focus.

The instruction for the internal focus groups involved directing attention to the elbow angle and wrist movement during the shooting motion. In contrast, the external focus groups were instructed to focus on the front edge of the basketball rim during shot execution. Twenty-four hours after the final training session, post-test assessments were conducted. Similar to the pretest phase, participants completed the movement-specific seinvestment Scale and performed the basketball shooting task under both non-pressure (no spectators) and pressure (presence of spectators) conditions.

2.3 Data Analysis

In the present study, the Shapiro-Wilk test, Levene's F test, and analysis of variance were used to test for normality of data distribution, homogeneity of variances, and homogeneity of regression slopes. The paired t-test was used to examine within-group effects, while analysis of covariance was used for between-group comparisons. SPSS software version 26 was used for data analysis, and a significance level of 0.05 was considered for all statistical methods.

3. Results

The descriptive statistics of the research participants, including age, height, and weight, are as follows for the HDMEAG group (20.45±1.57, 174.00±4.08, 75.78±8.22), the HDMIA group (21.21±15.78, 172.00±3.82, 73.46±6.64), the LDMEAG group (21.55±1.64, 172.00±4.48, 74.51±5.03), and the LDMIAG group (20.90±1.33, 175.25±4.35, 77.37±6.66). Table 1 shows the descriptive statistics of the research variables.

Table 1. Descriptive statistics of research variables by group

Group	Variable	Pre-test	Post-test
		Mean (SD)	Mean (SD)
HDMEAG	Pressure-free performance (Score)	34.25 (5.61)	60.50 (8.97)
	Performance under pressure(Score)	32.00 (4.53)	54.30 (6.75)
	Movement Self Consciousness	24.85 (1.63)	11.25 (1.73)
	Conscious Motor Processing	26.30 (3.10)	13.80 (2.76)
HDMIAG	Pressure-free performance (Score)	32.45 (7.40)	53.10 (7.07)
	Performance under pressure(Score)	30.55 (6.21)	45.80 (3.93)
	Movement Self Consciousness	25.35 (1.53)	16.05 (2.78)
	Conscious Motor Processing	26.30 (2.93)	16.80 (1.64)
LDMEAG	Pressure-free performance (Score)	33.25 (8.49)	46.45 (7.69)
	Performance under pressure(Score)	30.15 (6.24)	39.95 (5.42)
	Movement Self Consciousness	25.05 (2.09)	19.25 (1.48)
	Conscious Motor Processing	26.80 (2.78)	21.95 (1.64)
LDMIAG	Pressure-free performance (Score)	31.60 (6.12)	38.50 (5.38)
	Performance under pressure(Score)	29.65 (3.92)	34.90 (4.44)
	Movement Self Consciousness	24.10 (2.90)	24.40 (2.91)
	Conscious Motor Processing	24.55 (3.05)	24.90 (2.61)

HDMEAG: High Dispositional Mindfulness with External Focus Group; HDMIAG: High Dispositional Mindfulness with Internal Focus Group; LDMEAG: Low Dispositional Mindfulness with External Focus Group; LDMIAG: Low Dispositional Mindfulness with Internal Focus Group.

Based on the calculated Sig values for the Shapiro-Wilk test, F-test, and analysis of variance, all of which were greater than 0.05, it was determined that the assumptions of normality of data distribution, homogeneity of variances, and homogeneity of regression slopes were met. Therefore, paired t-tests and analysis of covariance were used to examine the within-group and between-group effects. The results of the paired t-test indicated (Table 2) that high dispositional mindfulness (HDM), low dispositional mindfulness (LDM), internal focus (IF), and external focus (EF) all led to improvements in basketball shooting performance under both pressure and non-pressure conditions ($P \leq 0.05$). In addition, The paired t-test results (Table 2) also revealed that movement self-consciousness and conscious motor processing—both components of movement-specific reinvestment —significantly decreased in the high dispositional mindfulness group, low dispositional mindfulness group, internal focus group, and external focus group ($P \leq 0.05$).

Table 2. The results of the paired t test to investigate the within-group effect of the research variables

Group	Variable	Difference of means (post-pre)	t	Sig
HDMG	Pressure-free performance	23.45	16.69	0.001*
	Performance under pressure	18.77	14.63	0.001*
	Movement Self Consciousness	11.45-	20.99-	0.001*
	Conscious Motor Processing	11.15-	15.90-	0.001*
LDMG	Pressure-free performance	10.05	14.07	0.001*
	Performance under pressure	7.52	13.48	0.001*
	Movement Self Consciousness	2.75-	-4.68	0.001*
	Conscious Motor Processing	2.25	-387	0.001*
EFG	Pressure-free performance	19.72	15.05	0.001*
	Performance under pressure	16.05	11.97	0.001*
	Movement Self Consciousness	-9.70	-13.89	0.001*
	Conscious Motor Processing	-8.67	-9.96	0.001*
IFG	Pressure-free performance	13.78	8.52	0.001*
	Performance under pressure	10.25	8.82	0.001*
	Movement Self Consciousness	-4.50	5.10-	0.001*
	Conscious Motor Processing	-4.72	-5.02	0.001*

*Significance at $P \leq 0.05$ level; HDMG: High Dispositional Mindfulness Group; LDMG: Low Dispositional Mindfulness Group; EFG: External Focus Group; IFG: Internal Focus Group

The results of the ANCOVA (Table 3) showed that, after controlling for the pre-test scores, there were significant differences among the experimental groups in post-test basketball shooting performance (under both pressure and non-pressure conditions), movement self-consciousness, and conscious motor processing (P ≤ 0.05). The Bonferroni post-hoc test was employed for the purpose of conducting pairwise group comparisons, and the results are presented in Table 4.

Table 3. ANCOVA test results for post-test comparison of research variables

Variable	Source	Sum of Squares	df	Mean of Squares	F	Sig	Effect size
Pressure-free performance	Pre-test	1489.54	1	1489.54	41.98	0.001*	0.36
	Group	4583.72	3	1527.90	43.06	0.001*	0.63
	Error	2661.21	75	35.483			
Performance under pressure	Pre-test	417.40	1	417.40	18.69	0.001*	0.20
	Group	3641.94	3	1213.98	54.36	0.001*	0.68
	Error	1674.75	75	22.33			
Movement Self-Consciousness	Pre-test	66.91	1	66.91	14.74	0.001*	0.16
	Group	1894.73	3	631.58	139.18	0.001*	0.85
	Error	340.34	75	4.54			
Conscious Motor Processing	Pre-test	3.37	1	3.37	0.68	0.413	0.01
	Group	1475.54	3	491.84	98.69	0.001*	0.80
	Error	373.78	75	4.98			

*Significance at P≥0.05 level

The results of the Bonferroni post hoc test (Table 4) indicated that the combination of high dispositional mindfulness and external focus showed the best performance in basketball shooting (under both pressure and non-pressure conditions), as well as in reducing movement self-consciousness and conscious motor processing, compared to the other groups (P ≤ 0.05). Conversely, the combination of low dispositional mindfulness and internal focus demonstrated the poorest performance across these same variables relative to the other groups (P ≤ 0.05).

Table 4. Bonferroni post hoc test results for comparing pairs of groups

Variable	Group1	Group1	Difference of means (post-pre)	Sig
Pressure-free performance	HDMEAG	HDMIAG	-6.26	0.009*
		LDMEAG	-13.42	0.001*
		LDMIAG	-20.32	0.001*
	HDMIAG	LDMEAG	7.16	0.002*
		LDMIAG	14.06	0.001*
	LDMEAG	LDMIAG	6.91	0.003*
Performance under pressure	HDMEAG	HDMIAG	-7.86	0.001*
		LDMEAG	-13.54	0.001*
		LDMIAG	-18.37	0.001*
	HDMIAG	LDMEAG	-5.67	0.002*
		LDMIAG	-10.50	0.001*
	LDMEAG	LDMIAG	-4.83	0.011*
Movement Self Consciousness	HDMEAG	HDMIAG	4.58	0.001*
		LDMEAG	7.91	0.001*
		LDMIAG	13.48	0.001*
	HDMIAG	LDMEAG	3.33	0.001*
		LDMIAG	8.91	0.001*
	LDMEAG	LDMIAG	5.57	0.001*
Conscious Motor Processing	HDMEAG	HDMIAG	2.98	0.001*
		LDMEAG	8.11	0.001*
		LDMIAG	11.22	0.001*
	HDMIAG	LDMEAG	5.25	0.001*
		LDMIAG	8.25	0.001*
	LDMEAG	LDMIAG	3.11	0.001*

*Significance at P≥0.05 level; HDMEAG: High Dispositional Mindfulness with External Focus Group; HDMIAG: High Dispositional Mindfulness with Internal Focus Group; LDMEAG: Low Dispositional Mindfulness with External Focus Group; LDMIAG: Low Dispositional Mindfulness with Internal Focus Group

4. Discussion and Conclusion

The aim of the present study was to investigate the interactive effect of dispositional mindfulness and the type of attentional focus instruction under psychological pressure on the components of movement-specific reinvestment and basketball free-throw performance. The findings indicated that individuals with higher levels of dispositional mindfulness achieved significantly better scores in basketball free-throw performance compared to those with lower levels of dispositional mindfulness. Moreover, they scored lower on the components of movement-specific reinvestment, namely conscious motor processing and movement self-consciousness. The results also showed that an external focus of attention, compared to an internal focus, led to better shooting performance and lower scores on movement-specific reinvestment components. Furthermore, the interaction effects revealed that individuals with high dispositional mindfulness who adopted an external attentional focus demonstrated the best performance and the lowest scores in movement-specific reinvestment. In contrast, those with low dispositional mindfulness who adopted an internal focus of attention showed the poorest performance and the highest reinvestment scores.

Several studies have examined the effect of trait mindfulness on basketball shooting performance and the components of movement-specific reinvestment, including movement self-consciousness and conscious motor processing. Notable among these are the works of Kee et al. (2012) (10), Chiu et al. (2019) (11), Liu et al. (2022) (12), and Brown & Ryan (2003) (7). Feng et al. (2022) found that individuals with higher mindfulness performed better in mid-range basketball shooting, especially during retention tests (41). Similarly, Gooding and Gardner (2009) reported that mindfulness scores significantly predicted the free-throw percentage in games (42). Josephson et al. (2020) observed that aspects of mindfulness had a positive relationship with shooting performance in biathlon competitions (43). Beyond performance outcomes, Koop and Jooste (2023) stated that elite female basketball players with higher mindfulness demonstrated fewer irrational performance beliefs and greater tolerance of uncertainty (44). Some studies have shown that when athletes engage in movement reinvestment during sports skill execution under pressure in laboratory environments, their performance deteriorates (45-47). However, these laboratory-based findings may not directly apply to real sports competitions, where pressure is usually much higher (48, 49). Moreover, findings from some field studies indicate that overthinking (movement reinvestment) leads to poorer performance in sports (50-52).

The results indicate that movement self-consciousness (but not conscious motor processing) likely impairs rowing performance during competitions due to the presence of spectators and recording cameras (52). It was also shown that movement self-consciousness (rather than conscious motor processing) disrupted backhand and topspin strokes in table tennis when performed in front of spectators and cameras (53). The positive association between higher dispositional mindfulness and improved basketball performance aligns with existing literature that emphasizes the role of mindfulness in enhancing attentional control and emotion regulation. Mindfulness enables athletes to focus on the task at hand while minimizing distractions caused by internal thoughts or external pressures (54). This is consistent with studies demonstrating how mindfulness can enhance concentration and reduce anxiety in sport contexts (55). Research also suggests that mindfulness can increase self-efficacy and confidence, leading to improved performance outcomes (56). However, some research indicates that excessive self-focus can sometimes lead to performance decrements, particularly under high-pressure situations (57). Furthermore, certain studies have shown that mindfulness may not always benefit performance, especially when athletes are experiencing high levels of stress or anxiety (58). These findings suggest that mindfulness may enhance basketball performance by improving shooting accuracy, reducing anxiety, and promoting adaptive responses to pressure situations. High dispositional mindfulness increase self-consciousness, enabling individuals to better perceive their movements and make necessary adjustments. This approach can help reduce movement self-consciousness during performance, leading to more natural and confident execution. Therefore, mindfulness can serve as a valuable tool for improving basketball performance and managing competition-related stress (59).

Regarding the effects of internal and external focus of attention on basketball shooting performance and the components of movement-specific reinvestment (i.e., movement self-consciousness and conscious motor processing), findings indicate that external focus leads to superior performance compared to internal focus. This result supports existing literature suggesting that external focus enhances motor performance by promoting automaticity and reducing cognitive load (60). Consistent research shows that an external attentional focus can improve motor learning and retention (61). However, contrasting evidence suggests that in certain scenarios—such as complex tasks requiring fine motor skills—internal focus may benefit some athletes (62). Moreover, some studies indicate that a blended focus (combining internal and external cues) may be more effective than relying solely on one strategy (63). At times, internal focus can lead to "paralysis by analysis", where excessive movement control hinders performance. This occurs because athletes become overly self-conscious of their actions, resulting in increased muscular tension and disrupted motor control (64). Research consistently demonstrates that adopting an external attentional focus enhances motor performance and learning across various tasks, skill levels, and age groups (60). Specifically, external focus has been shown to improve motor performance, including greater accuracy in basketball free throws (19). This approach also leads to more automatic movements, characterized by increased fluidity and consistency (65). These findings support the Constrained Action Hypothesis proposed by Wulf and Prinz (2001), suggesting that adopting an internal focus interferes with automatic motor control by promoting conscious movement regulation (18). In contrast, an external focus reduces conscious interference, minimizes motor system "noise" (19), and enhances movement efficiency at neuromuscular levels. Moreover, the Common Coding Theory (Wulf & Prinz, 2001) explains external focus superiority by aligning afferent and efferent codes, as both perception and action are encoded in terms of distal environmental effects (18). Wulf and Su (2007) emphasized that externally-focused instructions promote a shared representational system between perception and movement outcomes (20).

One possible explanation for the effect of external focus of attention on movement-specific reinvestment is that athletes, by concentrating on external cues, can reduce their movement self-consciousness and the tendency to overthink their actions. This allows for more natural and efficient motor processing, as the brain is not preoccupied with internal control mechanisms. Overall, external focus is more beneficial for enhancing performance because it helps athletes perform more naturally and effectively by decreasing self-consciousness and conscious motor processing.

The interactional results suggest that individuals with higher dispositional mindfulness who adopted an external focus of attention achieved the best performance outcomes. This indicates that high levels of mindfulness may enhance the benefits of an external focus, allowing athletes to engage more fully in the task while minimizing unnecessary cognitive processing. Conversely, individuals with low dispositional mindfulness who utilized an internal focus exhibited the poorest performance, highlighting their increased susceptibility to distraction and overthinking during execution. Supporting studies suggest that mindfulness can enhance the effectiveness of attentional focus strategies, leading to improved performance outcomes (66). However, conflicting research shows that individual differences in personality traits, such as conscientiousness, may influence the effectiveness of attentional and mindfulness-based strategies (67). Both mindfulness and external focus can improve basketball shooting performance, particularly under pressure. Mindfulness helps athletes reduce anxiety and stay present-focused, while external focus directs attention to external targets (e.g., the basketball hoop), thereby increasing accuracy. These approaches contribute to performance enhancement by automating movements and reducing excessive movement reinvestment. Practicing these techniques can help athletes better utilize their capacities (68).

Overall, the combination of high dispositional mindfulness and an external focus of attention appears to be the most optimal condition for athletic performance, whereas low dispositional mindfulness paired with an internal focus may lead to performance decrements and heightened movement-specific reinvestment. The findings of this study suggest that mindfulness—particularly when integrated with an external focus—can enhance athletic performance and buffer the adverse effects of psychological pressure on motor execution. This underscores the importance of incorporating mental training techniques that foster mindfulness and promote effective attentional strategies into athletic training programs.

Authors' Contributions

All authors equally contributed to this study.

Declaration

In order to correct and improve the academic writing of our paper, we have used the language model ChatGPT.

Transparency Statement

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Declaration of Interest

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Ethical Considerations

The study protocol adhered to the principles outlined in the Helsinki Declaration, which provides guidelines for ethical research involving human participants.

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