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The effects of attentional strategies on dart throwing and gaze behavior indexes in novices: The moderating effect of anxiety

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Abstract

Background: Researchers have always been interested in the focus of attention and the quiet eye. However, the effect of distance of attentional strategy in different anxiety conditions has remained unclear.

Aim: The purpose of this study was to determine the effect of attentional strategies on gaze behavior and the performance of dart throwing in novices under anxiety conditions.

Materials and Methods: The participants were 42 female, Alzahra University students, aged 18-35 years. Participants with high trait anxiety (score higher than 24) were excluded using the Sports Competition Anxiety Test through a state anxiety questionnaire. Participants were randomly divided into two groups of high and low-trait anxiety. They performed the dart-throwing task counterbalanced in four different attention strategies (distal external attention, proximal external attention, internal attention, and control). The participants in the high-anxiety group were told that if they performed each throw correctly, they would receive a cash prize, and the low-anxiety group performed the throwing without anxiety and any instruction. At the same time as dart throwing, gaze behavior data was recorded with an eye tracker device. After the anxiety manipulation, the individual's anxiety was measured with Competitive State Anxiety Inventory-2.

Results: The results showed that the low-anxiety group performed better than the high-anxiety group (P=0.01). Also, external attention had a lower radial error in both high and low-anxiety groups. No significant difference was found in the average duration and number of fixations between different attentional strategies and groups. The comparison of the mean showed that in the low anxiety group, the fixation duration in the external attention strategy was longer, and in the high anxiety group, the fixation duration in the external attention and control strategies was longer than other strategies.

Conclusion: The present study supported the preplanning hypothesis, attentional control theory, and inhibition hypothesis, but was inconsistent with the restricted action hypothesis. These results showed the importance of the effect of anxiety on gaze behavior and performance in directing future research.

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1. Introduction

Competitive sports inherently induce anxiety, often accompanied by heightened arousal. Both amateur and professional athletes experience anxiety, manifesting in symptoms such as sweating, increased heart rate, disrupted gaze behavior, and impaired memory. These symptoms can negatively impact athletic performance by reducing concentration and perception [1, 2]. Anxiety can disrupt visual search patterns and overall performance. Research on visual search patterns has shown that anxiety leads to an increased number of fixations and a decreased duration of fixations in novice individuals. Moreover, high anxiety levels prolong the time taken and reduce the velocity of detecting cues associated with pre-specified targets [1]. Under high-anxiety conditions, athletes may perform either better or worse than expected, potentially making numerous errors in pressured environments. Jarvis (2006) distinguished between state and trait anxiety. Trait anxiety refers to a personality trait. Individuals with high trait anxiety tend to be anxious regardless of the situation. Eysenck's personality theory (1966) assumes that some individuals are generally more anxious than others due to genetic predispositions to react more strongly to potential threats in their environment [2].

Sports psychologists have long been interested in arousal, anxiety, and stress and their impact on performance [3]. The processing efficiency theory of Eysenck and Calvo (1992) proposes that anxiety is a negative state resulting from perceived threat [4]. Furthermore, the attentional control theory, based on Eysenck and Calvo's (1992) processing efficiency theory, suggests that anxious individuals perceive neutral stimuli as threatening and that anxiety disrupts attentional control, even when there are no threat-relevant and task-irrelevant stimuli [5].

In coaching, varying focus of attention (FOA) on key aspects of the movement or the outcome of the movement has been emphasized to improve skill acquisition and performance [6]. Numerous studies have shown that when attention is directed to the effects of movement (e.g., external FOA), positive performance benefits are observed, whereas conscious control of body movements through internal FOA leads to decreased performance levels [7].

Researchers have demonstrated the impact of different types of attentional focus on gaze behavior and Quiet Eye duration [8]. However, some studies have yielded contradictory results regarding the effects of attentional focus. For example, Niźnikowski et al. (2022) found no difference between distal and proximal external focus in novice table tennis players in the backhand [9]. Banks et al. (2020) investigated the performance of rowers under control, proximal external, and distal external focus conditions. Results showed no significant difference in performance between proximal and control conditions, but participants performed better in the distal condition [10].

In this regard, the inhibitory hypothesis of Klostermann et al. (2014) suggested that longer quiet eye durations, by inhibiting additional movement variations, lead to optimal changes in the preparation and execution phases of a movement [11].

On the other hand, over the past two decades, researchers have conducted numerous empirical investigations into the visual control of movement in aiming tasks [12]. The quiet eye (QE) is a perceptual cue and a gaze behavior marker before the onset of a movement or motor response; In other words, it is the final fixation of the eye on a

point and an indicator of the time required to program force, direction, and speed for the response [13].

A consistent finding is that the final visual fixation (longer than 100 milliseconds, within one degree of visual angle) prior to the execution of an action is displayed for a longer duration by more skilled performers. Longer final fixations are associated with more successful performance outcomes, commonly referred to in the literature as the "quiet eye".

Research findings highlighting the performance benefits of QE have been consistently demonstrated in sports [14]. Researchers have also investigated interventions to increase QE duration. Asadi et al. (2022) examined attentional strategies in combination with cognitive load. Results showed that external focus and low cognitive load led to better accuracy in novice dart throwers. However, the specific distance of the external focus of attention was not specified in this study [15].

Querfurth et al. (2016) examined the interaction between attentional focus and quiet eye duration in dart throwing. Neither internal nor external focus conditions showed better performance. Results indicated no significant differences in dart-throwing performance (radial error). However, in the internal focus condition, quiet eye (QE) duration was significantly longer, indicating an interaction between attentional focus and QE [16].

In addition to attentional focus, quiet eye duration can be influenced by other factors such as anxiety. Anxiety is an unpleasant psychological experience that is commonly experienced by individuals in various situations. Anxiety is influenced by various factors and can be experienced temporarily or long-term. Although anxiety is associated with restlessness and confusion, it can be beneficial in some situations. Athletes experience anxiety at varying levels during training and competition.

For example, Behan and Wilson (2008) [17], and Eysenck and Wilson (2016) [18] assessed anxiety-related changes in quiet eye duration and throwing accuracy in a simulated archery task performed under high and low anxiety conditions. Results showed that quiet eye duration was significantly reduced under high anxiety conditions. Furthermore, accurate performance was also associated with longer quiet eye durations, which was not true for inaccurate performances. It has been shown that anxiety-related changes in visual orientation may compromise performance. As expected, throwing accuracy was strongly influenced by the length of the quiet eye duration, with shorter durations associated with decreased performance [17, 18].

Additionally, Simpson et al. (2022) investigated the effects of attentional strategies on novice dart throwing, quiet eye duration, and pupillary response. They found no significant differences in dart-throwing accuracy and quiet eye duration among novice participants with internal focus (IF), external focus (EF), and control (CT) conditions [19].

Since psychological factors such as anxiety affect performance, and the distance of attentional focus is also an important factor in the outcomes of this area, the question arises as to whether anxiety causes a change in the distance of attentional focus. And under anxiety conditions, which type of attentional focus strategy leads to better performance?

2. Materials and Methods

2.1. Participation

Seventy female students from Alzahra University (aged 18-35 years, right-handed, with normal or corrected-to-normal vision) were recruited through available sampling and voluntarily participated in the initial test at the sports laboratory of the Faculty of Physical Education, Alzahra University. Forty-two participants met the inclusion criteria for the study. The sample size was estimated based on G*Power (version 1.3) calculations with F= 2.3, α= 0.05, power= 0.95, number of groups= 2, and test type= repeated measures ANOVA. Participants were randomly assigned to two groups: high anxiety and low anxiety. The attentional conditions were counterbalanced between groups including distal external, proximal external, internal, and control (no strategy) attentional strategies. Gaze behavior and dart-throwing performance in novice individuals with high and low anxiety were measured. An informed consent form was used before the test. Table 1 presents the research design.

Table 1. The research design includes four strategies and two types of anxiety conditions.

		Proximal external attention	Distal external attention	Internal attention	Control
Anxiety	High	Proximal / High	Distal / High	Internal / High	No attention
	low	Proximal / low	Distal / low	Internal / low	No attention

2.2. Apparatus

ADHD Rating Scales. The Adult Conners' ADHD Rating Scales (CAARS-S:SV) self-report version was used to assess Attention Deficit Hyperactivity Disorder (ADHD). This version is suitable for adults over 18 and consists of 30 questions divided into three sections: inattention, hyperactivity, and an overall ADHD index [20].

Revised Competitive State Anxiety Inventory (CSAI-2R). This questionnaire is a modified version of the Competitive State Anxiety Inventory-2, originally developed by Martens et al. (1990) [21]. The CSAI-2R consists of 17 items, divided into three subscales: somatic anxiety (7 items), cognitive anxiety (5 items), and self-confidence (5 items). Each item is rated on a 4-point Likert scale ranging from 1 (not at all) to 4 (very much). The total score for each subscale is calculated by summing the item scores. Cox et al. (2003) demonstrated the satisfactory construct validity of the revised CSAI-2R [22]. Mostafayi Far (2016) conducted a validation study on the Persian version of the CSAI-2R. Confirmatory factor analysis results indicated a good fit (CFI= 0.85) for the Persian version of the CSAI-2R, supporting its construct validity [23].

State-Trait Anxiety Inventory (STAI). This inventory consists of 15 statements (excluding statements 1, 4, 7, 10, and 13, which are not scored) with a three-point Likert scale (1= rarely, 2= sometimes, 3= often) for answering questions 2, 3, 5, 8, 9, 12, 14, and 15. The score range is from 10 to 30. Martens reported a reliability coefficient of 0.77 [24]. The validity and Cronbach's alpha coefficient of this inventory have been reported as 0.79 [25].

Eye-movement apparatus. An eye-tracking device, model (SMI) manufactured by Pupil Labs in Germany, was used. This device can measure alertness, attention level, concentration, fixation count, fixation duration, and saccadic eye movements, which are the primary components of visual search behavior, at a speed of 60 Hz with an accuracy of 0.4 degrees. In this research, all efforts to measure gaze behavior (fixation count, fixation duration, fixation location,

fixation onset, and offset) were made using this device.

Dartboard. A "Deluxe" model 18012-BL bristle dartboard was used to assess performance (throwing accuracy). The radial error was used to evaluate throwing accuracy, and the duration of the throw was used to evaluate performance efficiency. The following formula was used to measure throwing accuracy:

$$\text{MRE} = (\text{RE}) = \text{Radidal Error } = \sqrt{x^2 + y^2}$$

Each throw was defined using the recorded radial error x and y (cm). Any throw that did not hit the dartboard (outside the dartboard) was calculated with a radial error of 23 cm. Throws that fell off the board after hitting were considered as a throw, and the radial error was calculated [8].

2.3. Procedure

Participants were randomly divided into two groups (high and low anxiety) and performed different attentional strategies within their respective groups. The attentional conditions were counterbalanced between groups. Participants were informed about the general goals and procedures of the research. They were also informed that they could withdraw from the study at any time if they wished. Participants completed a consent form, a demographic questionnaire, and the State-Trait Anxiety Inventory (SCAT) before the experiment. Inclusion criteria for the study were normal or corrected-to-normal vision, right-handedness (self-reported), physical health, female gender, and no trait anxiety. Exclusion criteria were high trait anxiety (scores above 24 on the State-Trait Anxiety Inventory) and Attention Deficit Hyperactivity Disorder (ADHD) (scores above 13 on the Conners' Adult ADHD Rating Scales). The experiment was conducted in the laboratory of the Faculty of Physical Education, Alzahra University. Participants were divided into two groups: high anxiety (N=21) and low anxiety (N=21). Each group performed the dart-throwing task in four 15-trial blocks under different attentional focus conditions (distal-external, proximal-external, internal, and control) in a counterbalanced order. Initially, participants wore eye-tracking glasses and stood 3.72 m away from the dartboard, which was positioned at a height of 1.73 m. They performed three practice throws on the first day. A five-point calibration was conducted before the start of each block. For the high-anxiety group, after calibrating the eye-tracking glasses, a cash prize was announced. They were told that "for each dart that hits the center of the target, they will receive 50,000 Tomans, and if any individual scores higher than the rest of the group members in the throws, they will receive an additional 400,000 Tomans and two extra points will be added to one of their course grades". However, the low-anxiety group was told that all throws were for research purposes [26]. Subsequently, the experimenter provided instructions on anxiety before each trial. Anxiety in individuals in the high-anxiety group was manipulated using a competitive ranking structure and a cash prize. The anxiety of each participant was measured before and after the experiment using the Revised Competitive State Anxiety Inventory. Immediately after inducing anxiety, attentional strategies were applied. Three strategies, adapted from the research of [27], were used as follows [28]:

- **Distal external attention.** Attention was focused on the center of the target, and participants were instructed to aim for the bullseye. The experimenter

provided this instruction to the participant in each trial.

- **Proximal external attention.** Attention was focused on the flight of the dart, and participants were instructed to focus on both the path of the dart and the target. The experimenter provided this instruction to the participant in each trial.
- **Internal attention.** The participant focused their attention on the muscles of their hand and fingers. The experimenter provided this instruction to the participant in each trial.
- **Control.** No attentional strategy.

In all four sessions, to confirm that participants' attention was directed as intended, a researcher-created questionnaire based on previous studies was used. After each block, participants were asked, "What were the instructions?" and "How well could you follow the instructions?" The questions were answered on a 7-point Likert scale [29]. Each day, participants performed the same number of throws in a counterbalanced order for each of the four attentional strategies, under both high and low anxiety conditions, and gaze behavior and performance indicators were measure.

2.4. Statistic

A mixed-design analysis of variance (ANOVA) with repeated measures (2 (groups) × 4 (conditions)) was used for both QE duration and performance and if the interaction was significant, independent samples t-tests and Bonferroni post hoc tests were used to locate the exact location of the interactions. Data analysis was performed using SPSS version 16, and tables and graphs were created using Excel.

3. Results

3.1. Performance accuracy

An independent samples t-test was initially conducted to compare the two groups of high and low anxiety. The results indicated no significant difference between the two groups (P>0.05). A repeated measures ANOVA (2 (groups)×4 (conditions)) was performed on performance, revealing significant main effects of group, condition, and a significant group × condition interaction (P<0.05; Table 2).

Table 2. The result of different focus of attention and anxiety on performance

Source of changes	Sum of squares	df	Mean square	F	sig	η^2_p
Groups	166.635	1	166.635	7.517	0.014	0.307
Conditions	177.26	3	59.08	3.180	0.031	0.180
Conditions × Groups	294.256	3	98.085	5.127	0.029	0.269

The results of the repeated measures ANOVA demonstrated a significant interaction between group × condition ($F(3,13)= 5.13$, P=.03, $\eta^2p= 0.27$) and there is a significant main effects of group ($F(1,52)= 7.18$, P=0.014, $\eta^2p=0.31$), condition ($F(3, 18)= 3.18$, P= 0.031, $\eta^2p= 0.18$). Bonferroni post hoc tests revealed significant differences between distal external attention and proximal external attention, internal, and control conditions in the high-anxiety group (P<0.05). Similarly, in the low-anxiety group, there were significant differences between distal external attention and proximal (P<0.05), distal external attention and internal (P<0.05), and distal external attention and control (P<0.05). Additionally, there were

significant differences between proximal external attention and internal (P<0.05), and proximal external attention and control (P<0.05). Furthermore, there was a significant difference between internal and control attentional strategies (P<0.05). Moreover, independent samples t-tests between the high and low anxiety groups in the distal external attention condition (t= -5.70, P= 0.007), proximal external attention condition (t= -7.75, P= 0.004), and internal attention condition (t= 6.70, P= 0.004) indicated significant differences in all attentional strategies between high and low anxiety groups.

Comparisons of means showed that the radial error in the distal external attention condition was higher in the high-anxiety condition compared to the low-anxiety condition. Similarly, the radial error was higher in the proximal external attention condition for the high-anxiety group compared to the low-anxiety group. The radial error in the proximal external attention condition was also higher in the high-anxiety group compared to the low-anxiety condition. The radial error in the control attention condition was also higher in the high-anxiety group compared to the low-anxiety condition (Figure 1).

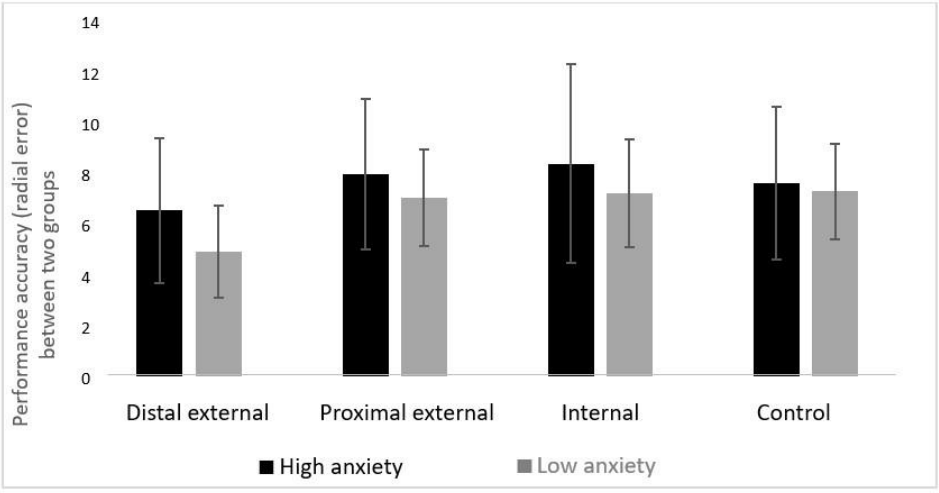

Figure 1. Comparison of accuracy of dart throwing performance in high anxiety and low anxiety groups between four experimental conditions

3.2. Fixation duration

The results of the analysis of variance with a 2 (groups) × 4 (conditions) design showed no significant difference in the mean total fixation duration between the main effects of different attentional strategies, the main effect of the group, and the interaction (group × condition) (P> 0.05).

3.3. Fixation number

The results of the analysis of variance with a 2 (groups) × 4 (conditions) design showed no significant difference in the mean total number of fixations between the main effects of different attentional strategies, the main effect of the group, and the interaction (group × condition) (P>0.05).

3.4. Quite eye

A repeated measures ANOVA (2 (groups)× 4 (conditions)) was conducted. The results showed a there is no significant interaction (P> 0.05). However, there is significant main effect of condition (F(3,120)= 7.31, P=.021, η^2p= 0.249) and group (F(1, 4)= 5.376, P= 0.03, η^2p= 0.149). To investigate the main effect of the group, an independent samples t-test was performed. The results

indicated significant differences between the two groups in the distal external attention condition (t= 3.12, *P*=0.01), proximal external attention condition (t= 4.01, *P*= 0.003), and internal attention condition (t= 3.31, *P*=0.012). Comparisons of means revealed that the duration of QE behavior was shorter in the high-anxiety group compared to the low-anxiety group (Figure 2).

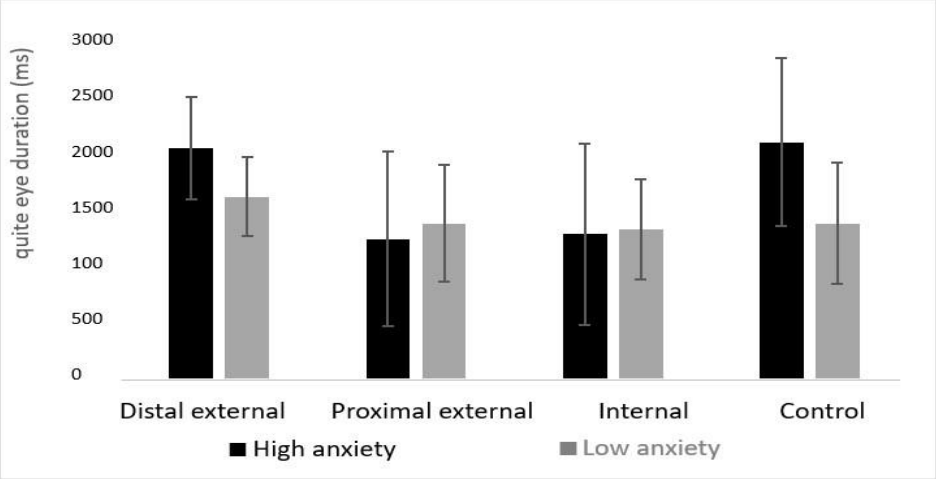

Figure 2. Quite eye duration between two groups in different attentional strategies

Table 3. The result of different focus of attention and anxiety on quiet eye

Source of changes	Sum of squares	df	Mean square	Error degree of freedom	F	Level of significance	Effect size
Groups	112727.31	3	37575.77	120	7.031	0.021	0.249
Conditions	600.92	1	600.92	40	5.376	0.03	0.149
Conditions × Groups	1641505.73	3	182359.53	33	0.59	0.06	0.07

Additionally, Bonferroni post hoc tests showed significant differences between conditions. In the low-anxiety group, there were significant differences between distal external attention and proximal, internal, and control conditions (*P*<0.05). In the high-anxiety group, there was no significant difference between distal external attention and control (*P*>0.05) but there were significant differences between distal external attention and proximal and internal attention conditions. Additionally, there was no significant difference in the duration of static eye behavior between proximal and internal attention strategies in the high-anxiety group (*P*>0.05). However, the high-anxiety group showed significant differences between control and proximal and internal attention strategies (*P*< 0.05).

Comparisons of means revealed that the duration of static eye behavior in distal external attention and control conditions was longer in the high-anxiety condition compared to the low-anxiety condition. Conversely, the duration of static eye behavior in proximal external attention and internal attention conditions was shorter in the high-anxiety condition compared to the low-anxiety condition (Figure 2).

To assess whether participants were able to follow the specified attentional strategies, a researcher-made questionnaire was used. Participants were asked to respond to three questions, which are

examined separately below.

Question 1. Please specify to what extent (%) were you able to follow the specified attentional condition.

Results of the repeated measures ANOVA showed no significant main effects of group, attentional strategy, or group × attentional strategy interaction (P> 0.05). This indicates that both groups were able to focus their attention on the different attentional strategies and there was no significant difference between them. A comparison of means showed that participants were able to follow the attentional strategy instructions more than 50% of the time.

Question 2. To what extent were you able to follow the given instructions? In this question, the lower the score, the better the participant was able to follow the instructions. The results of the analysis of variance showed no significant differences between groups and the interaction between group and evaluation condition. However, according to Table 3, there was a significant difference between conditions.

Comparison of means showed that participants in both groups were able to follow the attentional strategy in distal external (M= 1.75, SD= 0.75), internal (M= 1.76, SD= 0.5), and control (M= 1.78, SD= 0.1) conditions, but they were unable to follow the instructions in proximal external attention (M= 1.72, SD= 0.03).

4. Discussion

The present study aimed to compare the effects of distal external, proximal external, and internal focus of attention on the accuracy of performance (radial error) and gaze behavior (fixation duration, fixation number, and QE) in novice dart throwers with the moderating role of anxiety. Various training methods are used to improve performance in sports skills, but it must be acknowledged that skills are not always performed in an environment without any distractions or at an expert level. Instead, changing performance conditions, such as competition, can lead to anxiety.

Results showed that adopting a distal external focus of attention, both in high and low anxiety conditions, led to a better dart-throwing performance in novice participants compared to proximal external, internal, and control conditions.

Previous studies have widely confirmed that an external focus of attention significantly enhances motor performance compared to an internal focus [30]. Researchers believe that coaches and sports teachers should direct athletes' attention to specific aspects of movement through verbal instructions to achieve better performance and learning [31].

Niźnikowski et al. (2022) found that a distal-external focus of attention facilitated both short-term and long-term learning and performance. However, they did not observe a difference between distal and proximal-external focus. In their study, participants were asked to hit a ball into three small targets on a table tennis ball to score as many points as possible. The skill level of the participants (novice) and the performance environment (closed and open: backhand, aiming) were similar to the present study, but the task type (dart throwing vs. table tennis) was different. The results of Nikofski et al. (2022) were compared with the results of the low anxiety condition in the present study and were consistent with the results of the present study in the low anxiety condition [9].

Also, Memarmoghaddam, Ali Asghari Toyeh, and Mohammadi (2022) conducted the performance of novice dart throwers was better in the external focus condition

compared to the internal and no instruction conditions, which is consistent with the present study, but he did not specify the distance of the focus of attention. Since in dart throwing, the external focus of attention includes the moment the dart is released and the location from where the athlete stands to the center of the target, it must be precisely specified from what distance the participant directs their attention externally [32].

In this regard, Wulf's constrained action hypothesis [33] is proposed, which states that internal focus leads to conscious awareness of movement and reduces automaticity and motor performance in skilled individuals.

In the present study, contrary to this theory, novice individuals had better performance with an external focus compared to an internal focus, whereas the theory states that for effectiveness and efficiency, and consequently, improved performance, novice individuals should use an internal focus.

Homanian et al. (2020) showed that the external focus condition was better than the internal focus condition, and in the condition of low perceptual load, the radial error was lower. The results were consistent with the present study. The study showed that in low-anxiety conditions in the dart throwing skill for novice individuals, a task load similar to anxiety is one of the performance-impairing variables [34].

However, Law and Wong (2021) concluded that novice dart throwers with an internal focus had poorer motor effectiveness (lower accuracy in dart throwing skill) and efficiency (longer throwing time) compared to the control group. In the present study, no difference was found between the internal strategy and no strategy. The reasons for the inconsistency may include the limited number of instructions applied, the method of measuring dart performance (throwing accuracy and throwing time), and conscious motor processing (internal focus instruction) [35].

Asadi et al. (2020) was consistent with the present study; it showed that an external focus of attention in high-load conditions led to better dart-throwing performance in novice individuals than an internal focus. However, another result of this study was that in low-load conditions, there was no significant difference between the effectiveness of external and internal focus of attention, which was not consistent with the results of the present study. The reason for the difference can be attributed to the different cognitive secondary task variables compared to the present study, and the different external focus instruction compared to the present study [36].

In manipulating anxiety, the study by Nabizade et al. (2022) manipulated the presence and absence of an audience; performance in both groups (far and near) decreased in the presence of an audience compared to the absence of an audience, but the decrease in performance was less in the group with a far external focus of attention during dart throwing [37]. Despite the similarity of the task, the results of the aforementioned study were not consistent with the present study. The method of inducing anxiety (audience presence) and the field environment were the differentiating factors and reasons for the inconsistent results with the present study. In this regard, the attentional control theory can be mentioned, which suggests that during anxiety, the efficiency of information processing decreases and potentially leads to decreased performance [38]. In other words, increased anxiety

reduces the impact of goal-directed attention in favor of greater attention to salient and threatening stimuli. However, less than optimal attention does not necessarily lead to decreased performance because with greater effort, performance may be maintained, and the present study supports this theory [38].

Since attention is a complex, voluntary, and selective process with limited capacity, overt attention can be measured by head or eye movements, and covert attention is a change in attention that is not observable and is purely mental. In sports-related research, it has been consistently shown that the collection of relevant visual information is necessary for the effective performance of various tasks.

The present study aimed to investigate the effect of attentional instructions on gaze behavior and fixation duration in novice participants under both high and low anxiety conditions. The results showed that the duration of fixation, mean fixation duration, and fixation count were longer in the far external focus condition, despite low and high anxiety.

In this regard, Simpson et al. (2022), in examining attentional focus instructions in three groups with external, internal, and control focus on dart throwing accuracy, showed that there was no significant difference in performance and fixation duration between external, internal, and no instruction focus conditions in novice dart throwers. This study was similar in terms of skill level and type of skill (novice in darts) but did not examine the distances of attentional focus (far and near) and measured participants' learning, while the present study measured performance. Also, unlike the present study, a between-groups design was used, and on the day of data collection (transfer and retention phase), no instructions were given to the participants, whereas in the present study, participants received instructions in all trials. The reasons for the inconsistency with the present study were [19].

In this regard, the inhibition hypothesis of Klostermann et al. (2014) showed that a longer fixation duration with the inhibition of additional movement changes leads to optimal changes in the preparation and execution phases of movement [11]. The present results supported this hypothesis, and previous research has shown that a longer fixation duration is associated with better performance in experts, but in the present study, the participants were novices.

On the other hand, in the study by Asadi et al. (2022), no difference was found in fixation duration between high and low cognitive loads. However, external focus led to a longer fixation duration compared to internal focus in dart throwing [15]. In the present study, the distances of external focus of attention were examined, but the results in the external focus of attention, regardless of the distance, were consistent with the results of the aforementioned study.

Based on the pre-programming hypothesis [39], a longer fixation duration allows for accurate information processing and fine-tuning of motor functions (i.e., force, direction, and speed) according to the relevant aspects of the task. Therefore, according to the results of the present study, the far external focus strategy probably led to a longer duration that requires more accurate information processing and resulted in optimal and better performance compared to other strategies, and in this regard, the results support the pre-programming hypothesis.

Memarmoghaddam et al. (2022) showed that the external focus condition, compared to the internal focus condition,

led to a longer fixation duration in dart throwing, which is consistent with the results of the present study. However, in that study, the type of external strategy included focusing on the center of the target, maximum score, and the movement of the dart in the air [32]; whereas in the present study, the distances of external focus included far external strategy (center of the target), near external (flight of the dart), and internal (arm muscles), and no strategy (throwing), while all participants focused on all four strategies.

Based on the pre-programming hypothesis [39], a fixation duration allows for accurate information processing and preparation of motor cortex settings, therefore, in the present study, more efficient movement was observed with a longer fixation duration in the far external focus. Also, in line with the constrained action hypothesis, the results of the present study showed that in both high and low anxiety, the far external focus instruction led to a longer fixation duration, thus supporting the hypothesis that directing attention to the outcome and effects of movement (EF) enhances performance by promoting automatic, reflexive, and unconscious processes of motor control. In contrast, it is believed that an IF engages conscious cognitive control processes that interfere with the self-organizing tendencies of the motor system, and consequently disrupts optimal motor control [33, 40].

Based on the results of the study, novice adults in dart throwing should use a far external focus. of attention for better performance during performance. On the other hand, not providing attentional instructions in high-anxiety conditions shows results similar to the far external instruction. Therefore, it is likely that not providing any attentional instructions in high-anxiety conditions can be beneficial because it does not force the individual to direct attention and gives the individual a sense of choice.

In this regard, Wulf (2016) stated that instructions that give the participant a sense of choice lead to better learning in stressful conditions compared to instructions that provide how to perform and control [41]. However, in low-anxiety conditions, giving far external instructions that lead to the best final movement outcome is suggested. In other words, coaches and sports teachers are recommended to use a far external focus strategy (center of the target) when teaching dart throwing. Also, novice individuals should be kept away from anxiety-provoking environments during training because it leads to decreased performance and consequently discourages novice individuals during learning. The limitations of the present study include the level of motivation, sleep, and nutritional status of the participants, sample size, gender, and method of inducing anxiety. It is suggested that in future studies, anxiety be induced more realistically (e.g., presence of an audience). Also, comparing different skill levels with age groups of children and adolescents or even the elderly, along with measuring working memory capacity and attention span, is suggested.

5. Conclusion

This study investigates how different ways of focusing attention can affect the performance of novice dart throwers and how anxiety influences this relationship. We know that how we concentrate during tasks can impact how well we perform. For this research, we looked at different focus strategies: distal-external focus, where the player concentrates on the target they are

aiming for, in proximal-external focus, attention is focused on the flight of the dart, and internal focus, where they focused their attention on their muscles and fingers. We found that when novice dart players used a distal-external focus strategy, their accuracy improved significantly. However, this benefit was reduced when players experienced high levels of anxiety. Those who focused internally and proximal-externally on their own movements did worse when feeling anxious. We also noticed that QE changed based on their focus strategy and anxiety level.

These findings are important because they highlight how mental strategies can be just as crucial as physical skills when it comes to sports performance. For people new to dart throwing or similar sports, understanding that the way they concentrate can either help or hinder their performance adds an essential layer to their training. This research suggests that coaches and players might benefit from focusing not only on physical practice but also on mental techniques to manage anxiety and improve concentration. Overall, these insights can enhance training approaches, making sports like darts more enjoyable and successful for beginners.

Highlights

- Distal-external focus improves dart-throwing accuracy in novice players.
- Gaze behavior correlates with attentional strategies used during throws.
- Anxiety levels moderate the effectiveness of attentional strategies in novices.
- Gaze fixation on targets enhances performance, especially with lower anxiety.

Conflict of interest

The authors declared no conflicts of interest.

Authors' contributions

The authors contributed to the original idea, study design.

Conceptualization: B and C, Methodology: B and C, Investigation: all authors, Data collection: B, Original Draft: A and C, Review & Editing: A, and C, Supervision, B, C.

Ethical considerations

The authors have completely considered ethical issues, including informed consent, plagiarism, data fabrication, misconduct, and/or falsification, double publication and/or redundancy, submission, etc.

The ethics code (IR.SSRC.REC.1402.074) was obtained from the Research Institute of Physical Education and Sports Sciences.

Data availability

The dataset generated and analyzed during the current study is available from the corresponding author on reasonable request.

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