

## Examining the effects of attention and concentration levels on reaction time in fencing

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### Abstract

**Background and Study Aim** Attention and concentration, fundamental psychological skills, are crucial in situations where the opponent moves rapidly and incessantly. Reaction time is also of paramount importance in winning a game in fencing, which requires both offensive and defensive actions. Understanding the factors that affect reaction time is essential for improving performance. This study aimed to investigate the impact of disruptions in attention and concentration on reaction time in fencing.

**Material and Methods** Thirty-four healthy male and female fencers participated in two testing sessions. In the initial session, participants filled out a personal information form and took the d2 Attention Test to determine their attention levels. They also completed items representing the concentration disruption subscale of the Sport Anxiety Scale-2 (SAS-2) to measure concentration levels. In the second session, participants underwent the Favero Electronic Fencing Target (EFT-1) test to measure their reaction times. To analyze the obtained data, SPSS 20 was used. The Pearson correlation coefficient between attention, concentration disruption, and participants' reaction times was calculated. Then, linear regression analysis was employed to test whether attention and concentration scores could predict the reaction times.

**Results** The findings indicated that there is a significant positive relationship between E ( $r = .603, p < .01$ ), E% ( $r = .628, p < .01$ ), E1 ( $r = .584, p < .01$ ), E2 ( $r = .533, p < .01$ ), and reaction time. Additionally, a significant negative relationship was revealed between concentration performance and reaction times ( $r = -.456, p < .01$ ). A significant positive correlation was observed between fencers' concentration disruption and reaction times ( $r = .416, p < .05$ ).

**Conclusions** Our study results emphasize the importance of attention and concentration in disciplines that require quick reactions. These cognitive factors need to be considered in the development of sports performance.

**Keywords:** fencing, reaction time, attention, concentration.

### Introduction

Fencing is an open-skill sport in which fast body movements, effective game strategies, and cognitive skills are used effectively [1]. In fencing, reaction time plays an important role in developing deceptive strategies against the opponent, attacking as soon as possible, and defending by anticipating the opponent's attack. The response to a visual, auditory, and tactile stimulus of athletes determines their reaction time [2]. Reaction time is one of the key factors in achieving peak performance in fencing, as it is closely related to decision-making and action [3]. Since it is accepted that reaction time directly affects performance in fencing, research has been conducted on various training methods to improve reaction time [4, 5]. Factors such as concentration and attention are known may affect reaction time.

Concentration, a basic psychological skill, is crucial to maintaining mental toughness, especially in situations where the rival moves quickly and continuously. According to Moran, concentration is

defined as the mental effort one is willing to spend on the most important thing in any subject [6]. An athlete with a high level of concentration tries to compete in the best possible way to reach the goal, learns new skills faster and in a shorter time, increases self-confidence, keeps stress and anxiety under control at high levels of experience, and focuses on factors that are within the control [7]. Therefore, the high concentration levels of athletes before and during the competition may have a positive effect on their performance. The study by Mahardhika et al. [8] investigated the effect of concentration on football-playing skills and showed that there is a significant relationship between concentration and football performance. Donie et al. [9] examined the effect of concentration, eye coordination, and agility on badminton playing skills and showed that the badminton playing skills of athletes with high concentration were affected positively.

Attention is one of the most researched topics in the field of sports as it covers almost all aspects of perception, cognition, and action [10]. Attention is related to the process by which certain relevant information is processed while other information

is ignored [11]. High attention levels are required of athletes so that responses to stimuli can be provided efficiently. Athletes need to pay attention to resources under control while aiming to improve their performance effectively [12]. The studies point out the importance of attentional resources for succeeding in sports [13, 14, 15]. Hijazi [16] investigated the relationship between attention, visual perception, and sports performance in fencing and found that there is a significant relationship between high attention levels and the sports performance of fencers. The effect of attention on sports performance in football was investigated by Fetean et al. [17] and it was found that the attention-test program increased the performance of football players. A study conducted by Gutierrez-Davila et al. [18] on the effect of attention on offensive and defensive actions in fencing showed that attention processes play an important role in fencer performance in real competitions and positively affect success.

In light of this information, the present study aimed to investigate the relationship between attention, concentration, and reaction time of fencers. It was hypothesised that attention levels have a positive effect on reaction times in fencers. It was also expected that there is a significant positive relationship between concentration and reaction times.

## Materials and Methods

### Participants

34 healthy male and female fencers met the inclusion criteria and were selected for this study. The inclusion criteria were as follows (tabl. 1): (a) aged 18–25 years; (b) free of any acute or chronic neuromuscular diseases; (c) not having visual impairment; (d) not being a smoker and/or an alcohol user; (e) not using drugs; (f) body mass index (BMI) less than 30. The experimental

procedures, including possible risks, were verbally explained to the participants after which they signed informed consent. Following the approval by the Committee for Scientific Research and Ethics of the Faculty of Sport Sciences at the Girne American University with 2022-2023/01 reference number, the research commenced and all data was collected by the Declaration of Helsinki.

### Research Design

The test protocol consisted of two sessions (Figure 1). In the first test session, the personal information form, d2 attention test, and items representing the concentration disruption subscale of the Sport Anxiety Scale-2 (SAS-2) were applied for the psychometric evaluations. In the second test session which is 24 hours after the first test session, the warming up (running 12 minutes, dynamic stretching exercises, and standardized specific warm-up exercises for fencing) and the Favero Electronic Fencing Target (EFT-1) test to measure reaction time were performed.

### Personal Information Form

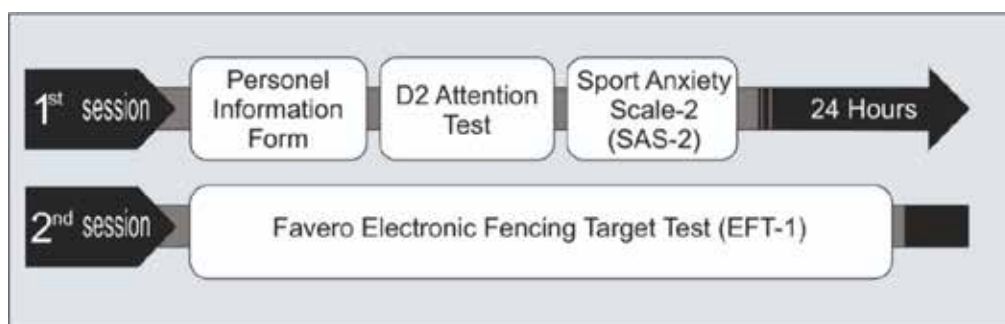
To determine the characteristics of the participants, a form prepared by the researchers containing information on age, training experience year, weight, height, and gender was applied.

### D2 Attention Test

The d2 attention test, developed by Brickenkamp and Rump in 1962 [19] and revised over the years was used [20]. The purpose of this test is to evaluate the continuous attention and visual screening ability of participants [21]. In this test, which is used to determine the structure of attention and concentration, participants are asked to constantly focus on selecting a stimulus [20]. The first page of the test contains an application line and a section where performance results are recorded. On the next page, there is a standardized test. The test page consists of 14 lines and each of these lines contains

**Table 1.** Descriptive statistics of the participants

Characteristics	Mean	SD	Min	Max
Age (year)	19.94	2.424	18	25
Fencing Experience (year)	7.35	2.984	3	17



**Figure 1.** Schematic representation of the experimental setup

47 marked letters. There are a total of 16 different letters in each line, including the letters “p” and “d” and the one two three, and four signs above/below these letters. In the test participants must scan the lines and mark the letter the two-dotted “d” letters by ignoring non-relevant letters. Participants are given 20 seconds for each line. This test may applied individually or as a group. This test may applied individually or as a group [20, 21]. In our research, participants were gathered in the meeting room and the d2 test was applied as a group at a time.

**Total Number of Items Processed (TN):** The quantitative performance measurement for all processed items that are related and non-related.

**Total Error (E):** Indicates errors unmarked (E1) and mismarked letters (E2).

**Error% (% E):** It is a variable measures that the qualitative value of performance. Refers to the error rate across all items processed. The accuracy of the subject, the nature of the work, and the increase in the degree of attention depend on the decrease in the error rate.

**Error 1 (E1):** The number of mistakes due to omission.

**Error 2 (E2):** Errors of commission.

**Total Norm-Error (TN-E):** It is the score obtained by subtracting errors from the total number of items scanned. TN-E is a total performance score. TN-E shows normal distribution, it has a high level of reliability and provides a measure of the relationship between performance’s accuracy and speed. In addition, TN-E focuses more on the quantitative part of performance and gives less importance to the qualitative part. In exceptional cases, if the quantitative and qualitative scores are (total score and error percentage) extremely high, TN-E, tends to indicate total performance more. Overestimations can be avoided by taking error scores or examining the concentration performance score.

**Concentration Performance (CP):** It is obtained by taking away E2 from the number of relevant items marked as true. Unlike TN-E, CP is not affected by marking all letters or skipping random test sections. This index is excellent for the accuracy of performance and coordination of speed.

**Fluctuation Rate (FR):** It indicates the difference between the line including the maximum number of items and the line including the minimum number of items. FR is one of the less reliable measurements of the test. Excessively high FR scores may create inconsistency in the speed of work and may be associated with low motivation [22].

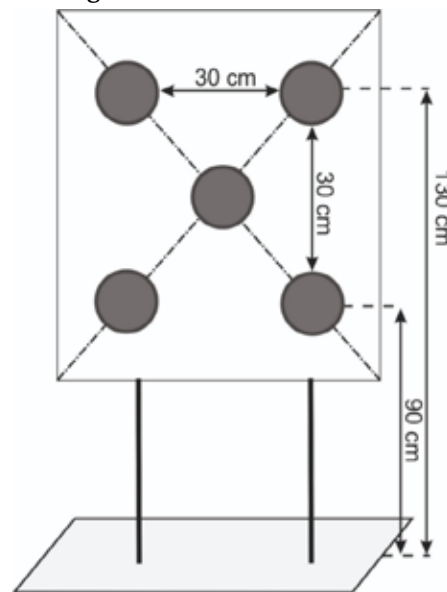
**Sport Anxiety Scale-2**

The Sport Anxiety Scale-2 (SAS-2) was developed by Smith et al. [23] and was also revised by Smith et al. [24]. This scale has 3 subscales (somatic anxiety, worry, and concentration disruption) and consists of 15 items, 5 items each. This study used only the

concentration disruption subscale of the SAS-2. Participants are asked to mark the number closest to them (1-not at all, 2-a little bit, 3-pretty much, 4 very much) to indicate how they felt before/ during competitions and games. At the beginning of the study, the participants were asked about doubts about understanding the statements. The implementation of this questionnaire was carried out by the relevant rules and regulations.

**Favero Electronic Fencing Target Test (EFT-1)**

An electronic fencing target (Favero EFT-1) manufactured by Favero Electronic was used. There are five targets on the device, each equipped with an LED light. Two of the targets located at the bottom of the device are 90 cm above the ground, the other two are 130 cm above the ground, and the distance is 30 cm between these four targets. The fifth target is located in the middle of the device, at the point where the diagonals intersect.



**Figure 2.** Electronic fencing target (Favero EFT-1) device.

The device has nine different programs however, this study was conducted using programme 1. All programs consist of 10 pokes and the minimum duration of these pokes is 0.01 seconds and the maximum duration is 1.30 seconds. If a target was missed or a poke sequence was not performed correctly, the poke is assumed to have been completed at maximum time and is considered 1.30 seconds. In addition, the fencers were not allowed to repeat the pokes they missed in the tests. Therefore, a clear determination of the speed and accuracy of the pokes made has been provided. In this program, the fencers were asked to poke randomly appearing red lights with the tip of the foil using their dominant hand. The turning red light to green at the end of the poking indicates the accuracy of the poke. During this test, the digital screen on the top of the device showed and recorded the duration of the poke. At the end of the test, the device showed the

average duration of the 10 pokes and the duration of the fastest one. In this study, we used the average duration of the 10 pokes.

#### Statistical Analysis

In order to analyze the obtained data set, we first calculated the Pearson correlation coefficient between attention, concentration disruption, and the reaction times of the participants. Then we tested whether attention and concentration scores may have an account for predicting the reaction times employing linear regression analysis.

### Results

The correlation analyses were shown in Table 2 to determine the relationship between the d2 attention test and reaction times.

Correlation analyses were conducted to explore the relationship between d2 attention test scores and reaction times among fencers (Table 2). The results reveal significant positive correlations between various error metrics from the d2 test and reaction times. Additionally, a significant inverse relationship was found between concentration performance scores and reaction times.

The correlation between concentration disruption and reaction times among fencers is outlined in Table 3. A significant positive correlation was observed, suggesting that an increase in concentration disruption correlates with longer reaction times. This finding highlights the impact of concentration levels on the speed of fencers' responses.

Table 4 showcases the predictive power of the d2 attention test for fencers' reaction times. It reveals that error rates and concentration significantly affect reaction speeds, with detailed metrics like Total Error and Concentration Performance directly correlating with performance. The Adjusted R<sup>2</sup> value underscores the proportion of reaction time variability explained by these attentional factors. The predictive power of the regression model of fencers' d2 attention test and concentration level for reaction time was 32%.

Table 5 presents the regression analysis on the impact of concentration disruption on fencers' reaction times. The analysis indicates that concentration disruption inversely affects reaction times, with the Adjusted R<sup>2</sup> value revealing that this factor alone explains 15% of the variation in reaction speeds.

**Table 2.** The relationship between the d2 attention test and reaction times of fencers

Measurement	Reaction Time
Total Number of Items Processed (TN)	-.124
Total Error (E)	.603**
Error Percentage (%E)	.628**
Error Type 1 (E1)	.584**
Error Type 2 (E2)	.533**
Total Norm-Error (TN-E)	-.278
Concentration Performance (CP)	-.456**
Fluctuation Rate (FR)	-.120

Note: \*\* $p < .01$

**Table 3.** The relationship between concentration disruption and reaction times of fencers

Measurement	Reaction Time
Concentration Disruption	.416*

Note: \* $p < .05$

**Table 4.** Predictive abilities of d2 attention test for reaction time

Variable	B	Beta	t	R	Adjusted R <sup>2</sup>
Constant	85.763		3.659		
Total Error (E)	-.607	-.986	-.076		
Error Percentage (E%)	.567	.167	.224	.651	.321
Error Type 1 (E1)	.765	1.103	.094		
Error Type 2 (E2)	1.298	.356	.163		
Concentration Performance (CP)	-.063	-.173	-.606		

Note: B: Unstandardized regression coefficient; Beta: Standardized regression coefficient; t: Test statistic for the regression coefficient; R: Correlation coefficient; Adjusted R<sup>2</sup>: Adjusted R-squared, measures the proportion of variation explained by the model, adjusted for the number of predictors.

**Table 5.** Predictive abilities of concentration disruption for reaction time

Variable	B	Beta	t	R	Adjusted R <sup>2</sup>
Constant	113.299		9.995		
Concentration Disruption	-3.259	-.416	-2.586	.416	.147

Note: B: Unstandardized regression coefficient; Beta: Standardized regression coefficient; t: Test statistic for the regression coefficient; R: Correlation coefficient; Adjusted R<sup>2</sup>: Adjusted R-squared, measures the proportion of variation explained by the model, adjusted for the number of predictors.

## Discussion

Fencers are believed to possess superior ability in selecting the correct motor response due to the physical nature of fencing as a reactive sport. In our study, it was observed that there was a significant positive correlation between the error numbers, error percentage and reaction time and that fewer errors in attention tests may be associated with faster reaction times. In addition, a significant negative relationship was found between concentration and reaction times. Therefore, high concentration shortens reaction time. Additionally, it revealed a significant positive correlation between concentration disruption and reaction times among fencers. This suggests that slower reaction times are associated with higher levels of concentration disruption.

The study results indicate that reaction times are linked to levels of attention and concentration, which is in line with Gutierrez-Davila et al. [18] research on the impact of attention on offensive and defensive actions in fencing. Their study demonstrated that attentional processes play a crucial role in fencers' performance in actual competitions and have a positive impact on their success.

Solanky et al. [25] found a significant correlation between reaction times and attention and concentration levels in their study of national gymnastics and hockey players, which is consistent with our findings. It is important to note that these studies highlight the importance of attention and concentration levels in reaction time in athletes. Similarly, Subramanyam et al. [26] reported a statistically significant relationship between attention control and reaction time in athletes at a sports training centre. Schmidt and Lee [27] concluded that reaction time is associated with the ability to make quick and accurate decisions based on sensory information.

In a recent study, Kıyıcı [28] investigated the attention and reaction levels of athletes across various sports. The results showed significant differences between sports in terms of the importance of attention and reaction time, with fencing being particularly noteworthy. These findings support the notion that attention levels are closely related to reaction times.

Podrigalo et al. [29]. found that the reaction speed of taekwondo athletes increased with age

and training experience. Balko and Simonek [30] conducted research on the detection of differences in simple and selective reaction time during visual stimulation between elite, sub-elite, and beginner fencers. The findings indicate a significant difference in reaction time between beginners and elite fencers during different movement tasks, such as direct strike and lunge.

It is important to note that shorter reaction times were associated with higher levels of attention and concentration. The study conducted by Solanky et al. [25] found a significant relationship between reaction times and attention and concentration levels in national gymnastics and hockey players. These findings highlight the significance of attention and concentration levels concerning athletes' reaction time. Dereceli [31] investigated the concentration and mental endurance of professional basketball players and found that guards demonstrated better concentration abilities than players in other positions.

Athletic performance can be affected by reaction time which can help the athlete react to each situation better and reduce the risk of injuries. Furthermore, there is a close relationship between attention and reaction time. That is to say, the higher levels of attention result in a shorter reaction time, and the opposite is also true [32]. All these findings show, how our research can complement each other in understanding and improving the factors that influence athlete performance.

## Conclusions

During the process of recognising the goals of individuals, the periods of arousal, perception, attention, and reaction are directly related to each other. In this context, as a result of our research aimed to determine the relationship of concentration, attention, and reaction time in fencing sport. These results show that a significant relationship was found between concentration levels and reaction time. There was also a significant relationship between attention levels and reaction time. This suggests that high levels of concentration and attention can have a direct effect on performance by improving reaction times. These effects of concentration and attention are important elements to consider in training strategies and performance enhancement studies. The results of this study once again confirm

the importance of attention, concentration, and reaction time in the field of sports science and may make an important contribution to research aimed at better understanding the role of these cognitive characteristics in sports performance.

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