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# A Single-Session Eye Movement Desensitization and Reprocessing (EMDR) Therapy Reduces Anxiety and Improves Self-confidence in Athletes with Post-traumatic Stress Associated with Injury

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## Abstract

**Background:** Stress and anxiety related to post-injury trauma in athletes is a latent problem in sport. The use of eye movement desensitization and reprocessing (EMDR) allows sports psychologists to intervene with their athletes more effectively to help them into their recovery and achieve peak sport performance.
**Objectives:** Analyze the EMDR therapy effect in the psychophysiological responses of four athletes with stress related to a traumatic event during sports practice.
**Methods:** Four athletes (22.25 ± 1.71 years; 11.5 ± 2.65 years of experience) participated an idiographic single-case, multiple-probe study. The Sport Psychology Department of the institution approved the study for its application, which also followed the statement of the declaration of Helsinki. The participants had been medically cleared to practice their sport after sustaining a severe injury, but they expressed significant difficulty in performing optimally yet. The Competitive State Anxiety Inventory-2RD was applied to measure the anxiety and self-confidence levels before, after and two weeks later EMDR therapy intervention. Eye movement desensitization and reprocessing standard protocol therapy was carried out to identify the dysfunctional memories to be reprocessed, address the abnormal behaviors as trauma consequences, and develop the behavioral changes to manage the trauma. Heart rate variability parameters used as biofeedback were monitored during the EMDR protocol to associate with moments of stress and relief. Data analysis was performed using the smallest worthwhile change (SWC) of Hopkins to compare the results in the different moments of the protocol and study.
**Results:** All four athletes reported likely and most likely beneficial changes (according to the SWC) in their levels of anxiety and self-confidence after the intervention with the EMRD therapy as well as at two weeks afterward. Heart rate variability (HRV) parameters linked with parasympathetic activity were reduced and the sympathetic parameters increased their levels when the intervention protocol induced stressor memories, observing an opposite behavior when EMDR phases let the athlete be relaxed or getting relief.
**Conclusions:** Eye movement desensitization and reprocessing is a therapy is effective to manage a sport injury related psychologic trauma. Furthermore both, LnRMSSD and LnSS parameters of the HRV can be used as a biofeedback strategy for a better efficacy of EMDR-based treatment.

*Keywords:* Psychological Intervention, Posttraumatic Stress Disorder, Psychophysiological Responses, Heart Rate Variability, Sport Injury, Sport Performance, EMDR

## 1. Background

Sport can lead to endless experiences for those who practice it. When these are perceived as negative and occur with great intensity (e.g., injuries, failures, etc.), the athlete can be emotionally affected and even develop psychological effects related to a trauma because of a stressful situation which can trigger a post-traumatic stress disorder (PSTD) (1). Post-traumatic stress disorder is a chronic condition that includes psychophysiological symptoms such as hyperarousal, dysregulation of the autonomic nervous system, mood states and negative cognitions, associated with intrusive re-experiencing of the traumatic event (2). The literature refers that it is common for subjects suffering from this condition to orient their behaviors to avoid stimuli that evoke feelings or memories related to the traumatic event (3, 4).

Related to PTSD in sport, some authors identify that,

athletes who had experienced a traumatic event such an injury, may have great difficulties to perform at their best level, suffering high levels of cognitive and somatic anxiety, while affecting their level of self-confidence (5, 6). Sport psychologists require efficient tools and techniques to intervene with athletes with problem behaviors associated with PTSD symptoms. The scientific evidence suggest that cognitive behavior therapy (CBT) is the most efficient and proved approach to threat the PTSD (3). In the last decade, within the CBT alternatives, there has been increasing evidence on the use of treatments such as eye movement desensitization and reprocessing (EMDR) therapy (7), which is based on the generation of a coherent narrative from the athlete's experience of the trauma, exposing them in a controlled way (inside their mind) to the situation to reduce their distress about those memories (6). Eye movement desensitization and reprocessing therapy is based on the accelerated information processing model. Its aim is integrating the psychological information associated with the trauma and redirecting it to an adaptive resolution that allows the patient to cope with the situation in a functional manner (7-10).

The use of EMDR in athletes has been reported in the literature as a treatment model to attenuate PTSD symptoms associated to an injury (1, 11), as well as to reduce negative symptoms related to stress disorders (6, 12, 13), maltreatment in sport (14), and to strengthen coping skills for managing negative emotions (15) and overcoming mental blocks that affect performance (5, 16). In addition, the efficacy of the use of this treatment has been reported for the accomplishment of peak athletic performance (17). According to research evidence, the application of EMDR therapy allows psychologists to effectively treat various problems that athletes may face during their careers.

The application of EMDR treatment involves a retrospective of the stressful experience. This process generates an emotional response related to the type of memory recalled, causing psychological and physiological reactions that are reflected with changes in the autonomic nervous system (ANS) (18). It has been documented in several studies that the ANS responds to emotion processing and can be measured through heart rate variability (HRV) parameters (18-22). In a review, Balzarotti et al. (19), point out that high baseline HRV parameters are related to an assertive emotional response to the experience of a stressful situation, whereas when subjects present inadequate emotional responses, low baseline HRV indices are observed. In the same line, Hauschildt et al. (20), found that when subjects diagnosed with PTSD are exposed to visualizations and narratives of affective scenes, their HRV parameters such as rMSSD (the square root of the differences between consecutive RR intervals), high frequency (HF)-HRV and low frequency (LF)-HRV decrease, increasing the response of sympathetic activity to stressful memories. This is consistent with the reported by Green et al. (21), who identified a negative correlation between increased PSTD-related symptoms and LF-HRV. Accordingly, it can be inferred that reduced levels of these HRV parameters may be associated with PTSD (23). Regarding the athlete population, according to the literature review for this manuscript, no specific research has been conducted to analyze HRV responses in athletes with PTSD.

## 2. Objectives

Following the conclusions of the recent literature reviews by Miller-Aron et al. (6) and Yang et al. (1), there is a high incidence of problems related to post-traumatic stress disorder or stressful events among elite athletes, which generates the need to intervene to help them to adequately manage their emotions and behavioral responses through more effective techniques or therapies. Therefore, the present study aimed to analyze the EMDR therapy effect in the psychophysiological responses of four athletes with stress related to a traumatic event during sports practice.

## 3. Methods

An idiographic single-case, multiple-probe study was carried out with four athletes (22.25 ± 1.71 years; 11.5 ± 2.65 years of experience) who practiced handball (two men), volleyball (one woman) and pole vault (one man), all with international competition level before suffering their injuries. This kind of studies are characterized by a baseline assessment, intervention and baseline review after intervention (24). The participants shared the characteristic of having suffered a severe injury in the two years prior to the research which forced them to undergo surgery to recover from it (e.g., anterior cruciate ligament, shoulder dislocation). At the time of the EMDR intervention, the athletes had been medically discharged to play their sport for approximately 10 to 12 months before, competed at national level and train in their university teams at least five sessions per week. In addition, all the participants reported having previously received psychological support, however, they expressed significant difficulty to performing optimally as a result of fear and catastrophic thoughts associated with the previous injury experience.

### 3.1. Procedure

The study was approved by the Sport Psychology Department of the Autonomous University of Nuevo Leon

and followed the ethical guidelines and the recommendations of the Helsinki declaration on the treatment of the subjects and the data obtained (25). First, the researchers obtained permission to disseminate information about the project to the university's sports medicine department (in charge of the rehabilitation of athletes representing the institution). Subjects referred themselves to researchers to participate in the study. Those who met the inclusion characteristics were invited by researchers to participate in the study. The application protocol was explained to them, and they signed the voluntary participation consent.

Subsequently, they were interviewed one by one by the psychologist trained in EMDR intervention to determine the specific situation to be worked on during the EMDR therapy. After that, they responded the Competitive State Anxiety Inventory-2RD (CSAI-2RD) from a retrospective perspective to the traumatic event. One session of intervention using the EMDR technique was carried out individually. Previous research showed positive results after a single-session therapy using rational emotive behavior therapy (26, 27) which is based on CBT approach. During the time of the intervention (30 to 50 minutes depending on the course of the procedure and the need for trauma reprocessing in some cases), in a seated position, the HRV was recorded in 5-minute intervals. At the end of the EMDR application, athletes were asked to answer again the CSAI-2RD thinking to perform in a hypothetic competitive situation. Two weeks after the EMDR intervention, the precompetitive anxiety inventory was applied again to examine the maintaining of positive cognitions and behaviors to a competitive situation.

### 3.2. Instruments

#### 3.2.1. Competitive State Anxiety Inventory-2RD

With the aim of identifying the levels of precompetitive state anxiety derived from the traumatic event experienced by the participants, the Competitive State Anxiety Inventory-2RD designed by Cox et al. (28) and validated in the Mexican context (29), was used in its intensity and direction dimensions under a retrospective or memory application (30). The CSAI-2RD in its intensity dimension identifies 3 factors (somatic anxiety, cognitive anxiety and self-confidence) through its 17 items that answer the question "how do you feel now just before the competition?" with a four-point Likert-type response scale (1 = not at all ... 4 = very much). The score for each factor is obtained by adding the punctuation of the items that comprise it. Regarding the direction dimension, the same factors are divided into identical 17 items answered under the question "do you think that this feeling will harm or help you in the execution of your competition routines?", which is answered using a scale ranging from -3 (it will harm me) to 3 (it will benefit me), identifying through this, how much it affects or benefits the intensity of cognitive and somatic anxiety levels as well as self-confidence in the athletes' performance (29).

#### 3.2.2. Heart Rate Variability

HR measurements were performed using the polar team 2 in the RR (beat-to-beat) option. Data were analyzed with the Kubios HRV analysis software version 2.0, to perform the evaluation of the time and frequency domain parameters, as well as the Poincaré diagram parameters. For the study, the following parameters were used according to the suggestions of the task force (31): (I) rMSSD for its accuracy in reflecting the parasympathetic activity of the ANS; (II) HF-HRV (0.15 - 0.40 Hz); (III) LF-HRV (0.04 - 0.15 Hz); (IV) stress score (SS) for its ability to determine the level of activation of the sympathetic branch of the ANS (32). Heart rate variability measurements were performed during the EMDR application protocol with the athlete in sitting position. The RR recording was divided into 5-minute intervals for the duration of the protocol application (30 to 50 minutes).

#### 3.2.3. Eye Movement Desensitization and Reprocessing Therapy

To apply the EMDR standard protocol, the procedure recommended by Shapiro (8) was followed. The application of the EMDR therapy was performed in the three moments: Past, present, and future. The first one works on identify dysfunctional stored pathogenic memories to be reprocessed. In the present setting, EMDR treatment addresses the abnormal behaviors caused by the trauma. For the final stage, therapy targets the development of the respective behavioral alternatives to possible avoidance behavior, and the anxiety related to a possible traumatic episode in the future. To achieve a successful therapy, the EMDR standard protocol (Table 1) are ideally structured in eight treatment phases (the presented phases was adjusted according to the nature of the treatment with the study participants).

### 3.3. Data Analysis

Data for CSAI-2RD were presented by means ± SD of each time taken both intensity and direction. All HRV parameters were log-transformed *100 (LnrMSSD, LnSS, LnHF-HRV and LnLF-HRV, respectively). For intrasubject analysis we used magnitude-based inferences using the smallest worthwhile change (SWC) of Hopkins et al. (33) to compare somatic anxiety, cognitive anxiety and self-confidence from CSAI-2RD scales (intensity and direction) between the three times, as well as HRV parameters between time intervals during EMDR intervention. Quantitative chances

**Table 1.** The Standard Protocol of the Eye Movement Desensitization and Reprocessing Therapy

| Phase | Description of the Process for Each Phase |
|---|---|
| I | History and treatment planning: The precise traumatic event was recorded. |
| II | Preparation: Athletes received all the information about the method to be applied (all of them had experience with relaxation and visualization techniques). |
| III | Assessment: Dysfunctional stressful memory is activated in a controlled manner through the fractional activation of partial networks in its affective, sensory and cognitive components. |
| IV | Desensitization: This is the main phase of the treatment. The therapist guides the eye movements to apply bilateral stimulation and connects with the memory for processing the work individually. It is common to achieve a notable relief feeling by the changing affective and sensory thoughts and impressions. |
| V | Installation: After phases 3 and 4, a strengthening of the positive cognition is sustainably installed by bilateral stimulation. |
| VI | Body scan: Was employed to search for potentially persisting sensory negative memory. When was necessary, it was reprocessed by applying more bilateral stimulation. |
| VII | Closure: Afterwards, the experience is discussed at length with the therapist. The need of reprocessing material that could surfaced during the session is also discussed with the patient. |
| VIII | Re-evaluation: Patient feedback about changes after previous sessions is conversed. |

of beneficial/better or detrimental/poorer effect were assessed qualitatively as follows: < 1%, most likely not; > 1% to 5%, very unlikely; > 5% to 25%, unlikely; > 25% to 75%, possible; > 75% to 95%, likely; > 95% to 99%, very likely; and > 99%, almost certain. If the chances of having beneficial/better or detrimental/poorer performances were both > 5%, the true difference was assessed as unclear.

## 4. Results

The results of the application of the CSAI-2RD in its intensity and direction scale for each subject in the three applications are shown in Figure 1. The analysis of magnitude-based change (33) displayed in Table 2 showed that the intensity and direction levels for somatic anxiety for three athletes had a positive change at the post-intervention measure, and only two for the 2-week post-intervention time. While the intensity of cognitive anxiety had a positive change for all participants at the post-intervention measure, but for athlete 3 it worsened at the 2-week-post moment. Regarding the direction of cognitive anxiety, only athlete 4 has a better perception at the post-intervention measure, but all participants show an improvement at the 2-week-post time. Finally, self-confidence for the dimension intensity increases for three of the athletes at the post-intervention time, but an increase is observed by all four athletes at the 2-week-post measure. Regarding the direction, all participants had an improvement at the post-intervention time and only for athlete 2 this perception decreases at the 2-week-post time.

With respect to the behavior of HRV during the EMDR session applied to each of the subjects (Figure 2), it was possible to observe changes in the evaluated parameters, which were corroborated by means of SWC (Table 3).

## 5. Discussion

The main objective of our study was to analyze the changes in the levels of anxiety and self-confidence perceived after an EMDR therapy intervention in athletes who had suffered a moderate-severe injury. The results confirm that both cognitive and somatic anxiety levels decrease. Opposite, self-confidence increases from probably to very probably in accordance with the qualitative inference proposed by Hopkins et al. (33). In addition, the secondary objective was to analyze the changes in different HRV parameters during the EMDR application protocol. According to the results, the behavior of the HRV was very specific and individualized in each of the evaluated subjects. As expected, changes were presented by means of the SWC analysis proposed by Hopkins et al. (33). In the four observed parameters, the moments associated with an increase in psychological stress coincided with a decrease in parameters associated with parasympathetic activity. Also, an increase in those linked to sympathetic activation was noted, while in the periods of relaxation during the application of the EMDR technique, the opposite behavior was observed.

The application of EMDR therapy has been shown to reduce symptoms associated with PSTD and other trauma-related mental disorders such as injury (1, 6), as well as possible blocks associated with these traumas (5) and poor sports performance (17). Also, the increased levels of pre-competitive anxiety related to a stressor can be improved through the use of EMDR (34). This evidence supports the behavior observed in the anxiety levels of the participants in our study caused by the psychological trauma associated with a sports injury.

After a single-session EMDR intervention, athletes reported in the post-treatment and two-week post-treatment measurements a "likely beneficial" and "most likely beneficial" decrease in both symptoms of somatic and cognitive anxiety. In the same line, the perception of self-confidence for both, intensity and direction values of the CSAI-2RD increased. According to the literature, EMDR is considered a feasibly effective treatment to manage this type of problems (1). Has a mechanism to evoke repeated reprocessing of the information associated with the traumatic memory from a controlled perspective through the acceleration of nerve conduction, helping to adaptively reduce the

**Table 2.** Intraindividual Smallest Worthwhile Changes of CSAI-2RD Variables Pre, Post and Two Weeks Post EMDR Intervention [a, b]

| | Intensity | | | Direction | | |
|---|---|---|---|---|---|---|
| | Pre to Post | Post to 2 w Post | Qualitative Assessment | Pre to Post | Post to 2 w Post | Qualitative Assessment |
| **Athlete 1** | | | | | | |
| Somatic anxiety | 0/0/100 | 0/0/100 | Most likely | 100/0/0 | 99/1/0 | Most likely |
| Cognitive anxiety | 0/0/100 | 1/49/50 | Most likely | 1/49/50 | 100/0/0 | Most likely |
| Self confidence | 100/0/0 | 9/83/9 | Most likely | 100/0/0 | 9/83/9 | Most likely |
| **Athlete 2** | | | | | | |
| Somatic anxiety | 0/0/100 | 9/83/9 | Most likely | 100/0/0 | 1/49/50 | Most likely |
| Cognitive anxiety | 0/9/91 | 9/83/9 | Likely | 0/0/100 | 99/1/0 | Most likely |
| Self confidence | 99/1/0 | 9/83/9 | Very likely | 100/0/0 | 0/0/100 | Most likely |
| **Athlete 3** | | | | | | |
| Somatic anxiety | 1/49/50 | 100/0/0 | Most likely | 1/49/50 | 100/0/0 | Most likely |
| Cognitive anxiety | 0/9/91 | 100/0/0 | Most likely | 0/0/100 | 100/0/0 | Most likely |
| Self confidence | 9/83/9 | 9/83/9 | Likely | 100/0/0 | 0/9/91 | Most likely |
| **Athlete 4** | | | | | | |
| Somatic anxiety | 0/0/100 | 50/49/1 | Most likely | 100/0/0 | 50/59/1 | Most likely |
| Cognitive anxiety | 0/0/100 | 0/9/91 | Most likely | 100/0/0 | 99/1/0 | Most likely |
| Self confidence | 100/0/0 | 1/49/50 | Most likely | 99/1/0 | 50/49/1 | Very likely |

[a] Pre: CSAI-2RD application before EMDR intervention; Post: CSAI-2RD application after EMDR intervention; 2 w Post: CSAI-2RD application two weeks after EMDR intervention.
[b] Values are expressed as %.

**Table 3.** Intraindividual Smallest Worthwhile Changes of Heart Rate Variability at Five Minutes Intervals Time During EMDR Intervention [a, b]

| Interval Time | 1 - 2 | 2 - 3 | 3 - 4 | 4 - 5 | 5 - 6 | 6 - 7 | 7 - 8 | 8 - 9 | 9 - 10 | 10 - 11 | Qualitative Assessment |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Athlete 1** | | | | | | | | | | | |
| LnrMSSD | 21/76/3 | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | 0/9/91 | 100/0/0 | 100/0/0 | 0/0/100 | Most likely |
| LnSS | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 99/1/0 | 41/58/1 | 0/0/100 | 0/5/95 | 0/0/100 | 100/0/0 | Most likely |
| LnLF-HRV | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | 0/0/100 | 100/0/0 | 0/0/100 | 0/0/100 | Most likely |
| LnHF-HRV | 0/0/100 | 0/0/100 | 100/0/0 | 0/0/100 | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | Most likely |
| **Athlete 2** | | | | | | | | | | | |
| LnrMSSD | 100/0/0 | 0/0/100 | 0/0/100 | 100/0/0 | 0/0/100 | 53/47/0 | 100/0/0 | 100/0/0 | 0/0/100 | - | Most likely |
| LnSS | 100/0/0 | 100/0/0 | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | 0/1/99 | 0/0/100 | 0/0/100 | - | Most likely |
| LnLF-HRV | 100/0/0 | 0/0/100 | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 12/82/6 | - | Most likely |
| LnHF-HRV | 100/0/0 | 0/0/100 | 100/0/0 | 100/0/0 | 100/0/0 | 0/0/100 | 23/74/3 | 100/0/0 | 0/1/99 | - | Most likely |
| **Athlete 3** | | | | | | | | | | | |
| LnrMSSD | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | - | - | - | - | - | Most likely |
| LnSS | 100/0/0 | 0/6/94 | 0/0/100 | 100/0/0 | 0/0/100 | - | - | - | - | - | Most likely |
| LnLF-HRV | 100/0/0 | 100/0/0 | 100/0/0 | 100/0/0 | 0/0/100 | - | - | - | - | - | Most likely |
| LnHF-HRV | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 100/0/0 | - | - | - | - | - | Most likely |
| **Athlete 4** | | | | | | | | | | | |
| LnrMSSD | 0/0/100 | 0/0/100 | 0/0/100 | 100/0/0 | 100/0/0 | 100/0/0 | 0/0/100 | 100/0/0 | - | - | Most likely |
| LnSS | 0/0/100 | 100/0/0 | 0/0/100 | 100/0/0 | 0/0/100 | 0/0/100 | 0/0/100 | 100/0/0 | - | - | Most likely |
| LnLF-HRV | 1/58/41 | 0/0/100 | 0/0/100 | 100/0/0 | 100/0/0 | 100/0/0 | 0/0/100 | 100/0/0 | - | - | Most likely |
| LnHF-HRV | 0/0/100 | 0/0/100 | 0/0/100 | 100/0/0 | 100/0/0 | 100/0/0 | 0/0/100 | 100/0/0 | - | - | Most likely |

Abbreviations: rMSSD, root-mean-square differences of successive heartbeat intervals; SS, stress score; LF-HRV, low-frequency of heart rate variability; HF-HRV, high-frequency of heart rate variability.
[a] Total of intervals varies depending on the duration of the EMDR session for each athlete. All HRV variables were log *100 transformed.
[b] Values are expressed as %.

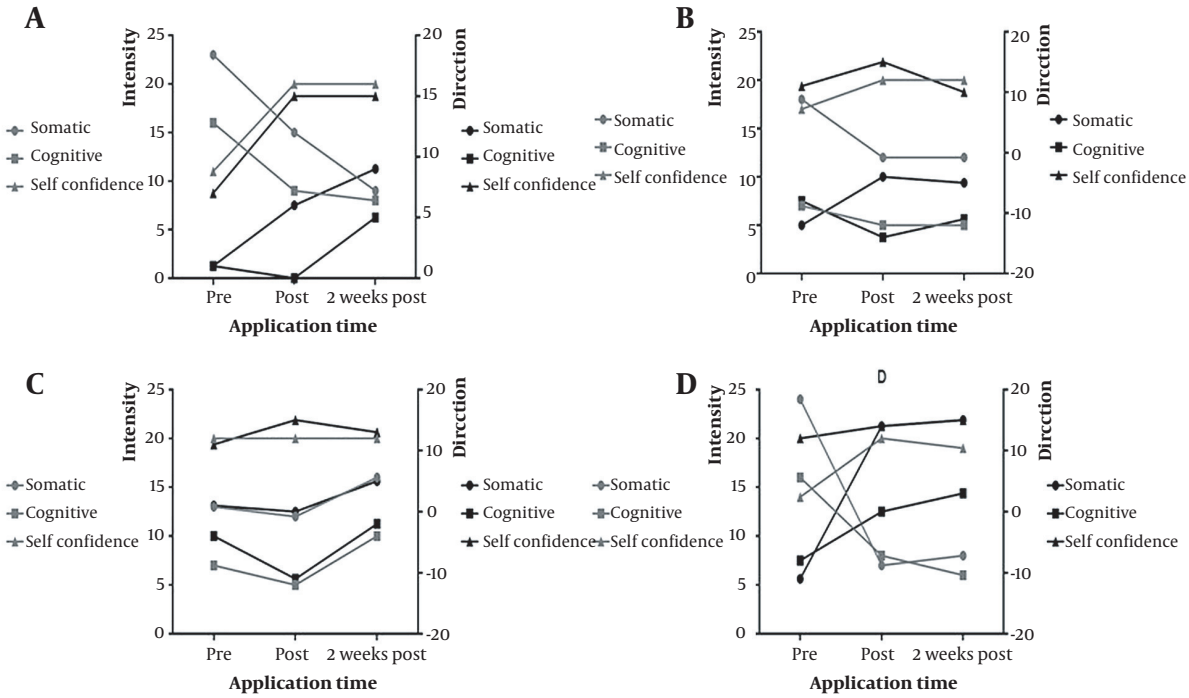


**Figure 1.** CSAI-2RD scales at three application time. Note. A, athlete 1; B, athlete 2; C, athlete 3; D, athlete 4. Pre: CSAI-2RD application pre EMDR intervention; post: CSAI-2RD application post EMDR intervention; 2 weeks post: CSAI-2RD application two weeks post EMDR intervention; somatic: Perceived somatic anxiety; cognitive: Perceived cognitive anxiety; self confidence: Perceived self confidence.

stress symptoms associated with the trauma (7). Our results are reinforced by the research of Bowman and Turner (26) and Turner et al. (27), which demonstrated a positive intervention effect in a single therapy session under a CBT approach if the athletes have prior knowledge about cognitive-behavioral techniques. In our study, all four athletes had prior psychological support and training from sport psychology specialists.

Another interesting finding is the differences in the changes of the cognitive anxiety by the intensity and direction dimensions. Our results suggest that an increase in the intensity of anxiety not necessarily is associated with a poor performance perception. This is in accordance with the previous results reported by Pineda-Espejel et al. (29), as well as with the individual zones of optimal functioning (IZOF) related to anxiety levels (35) which infers that every athlete had their own level of activation for an optimal performance.

On the other hand, the identification and evoke of a sports injury as a traumatic event for the athlete may stimuli behavioral and physiological responses by undergoing the traumatic event through systematic desensitization. The analysis of HRV during the application of EMDR therapy allowed us to observe "most likely" changes with decreases in the LnrMSSD parameters (associated with parasympathetic nervous system -PNS- predominance) of the 4 subjects. Conversely, the LnSS increases during the moments in which the stressful events were evoked for each subject. The above is in line with what has been reported in several studies (22, 23, 36) which associate HRV with emotional regulation. Lower levels of the parameters related to PNS indicate high levels of stress, while the opposite behavior is presented as an automatic response of the vagal tone looking for achieve homeostasis by relaxing the organism (37). According to Duarte and Pinto-Gouveia (18), there is evidence that expresses a relationship between the feeling of safety and well-being associated with low levels of LnHF-HRV, as it was possible to observe in athletes 2, 3 and 4 during different moments of the EMDR intervention. This changes in HRV were in agreement with the phases of reorganization after the re-experiencing of the traumatic event.

Finally, according to the review of the literature, this is the first time that the SS parameter of HRV is associated with the emotional response generated by the reproduction of a traumatic process. Previously, it had only been used as a reflection of the physiological stress caused by the training load as an indicator of the sympathetic re-

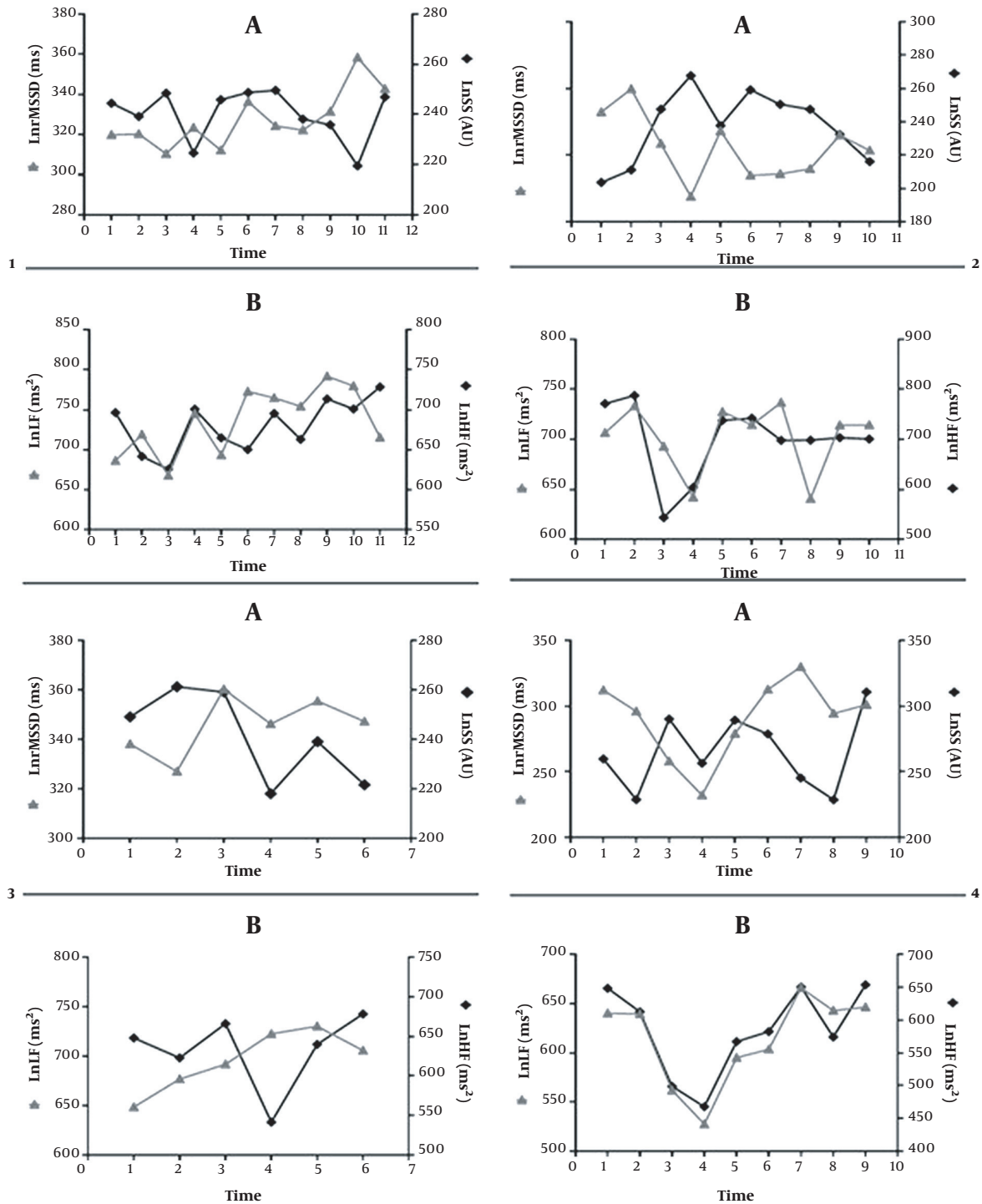


**Figure 2.** Heart rate variability (5 minutes intervals) of athletes 1, 2, 3 and 4 during the EMDR intervention. A, the LogTransformed *100 of the root-mean-square differences of successive hearbeat intervals (LnrMSSD) and stress score (LnSS); B, the log-transformed *100 of the low-frequency heart rate variability (LnLF-HRV) and high-frequency heart rate variability (LnHF-HRV).

sponse of the ANS in athletes (32, 38). The LnSS showed increases during the tapping moments and decreases later in the application of EMDR. This may reflect the sympathetic nervous system (SNS) activity during the experience of stressful events. The relevance of the use of this parameter lies in the fact that, although LF-HRV and HF-HRV parameters have been reported as variables that may reflect respectively a decrease (23) or increase (21) of the autonomic nervous system after exposure to the traumatic memory in patients diagnosed with PTSD, the inconsistent behavior of these parameters has been previously pointed out as a problem for their daily application (32). This problem had been observed in our results. Even if they present qualitatively "most likely" changes, their graphical behavior does not show a consistent trend as do the LnrMSSD and the LnSS.

The present study had several limitations, such as the sample size and the simple-session intervention. In addition, the impossibility to have a measure of the anxiety and self-confidence levels of the athletes before they experienced their traumatic event was another limitation. Nevertheless, the findings reported here suggest the need to expand research on the application of EMDR therapy in athletes with problems related to trauma in their sports practice to reduce their anxiety levels, and to improve their self-confidence and sports performance. Furthermore, although the protocol was a single-session intervention, a previous study (26) supports the possibility of achieving improvements with an intervention session based on the CBT approach, so further research with this approach would be conducted for the strengthening of the avoidance of the use of tools to aid intervention in the field of sport psychology practice on problems related to trauma following a serious injury.

### *5.1. Conclusions*

In conclusion, it is possible to mention that EMDR is a therapy that facilitates athletes to reprocess the information associated with a trauma, which may be causing a blockage in their sports performance. Eye movement desensitization and reprocessing therapy reduces anxiety symptoms associated with a traumatic event and allows to achieve adequate sports performance. In addition, it can also be noted that the LnrMSSD and LnSS parameters of the HRV can be used as a biofeedback strategy for a better efficacy of EMDR-based treatment.

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## Footnotes

**Authors' Contribution:** L.F.R-S. conceived and designed the evaluation, collect the data interpreted them and drafted and revised the manuscript. J.R.H-F. performed the statistical analysis and helped to review the manuscript. All authors read and approved the final manuscript.

**Conflict of Interests:** The authors declare that there are no conflicts of interest.

**Data Reproducibility:** The dataset presented in the study is available on request from the corresponding author during submission or after publication. The data are not publicly available due to maintaining the confidentiality of the participating athletes.

**Ethical Approval:** The study was approved by the Sport Psychology Department of the Autonomous University of Nuevo Leon. The researchers safeguarded the integrity and respected the anonymity of each participants answers based on the guidelines and ethical recommendations for the treatment of subjects and the data obtained as stated in the declaration of Helsinki.

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**Informed Consent:** Participants signed the voluntary participation consent.

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