THE EFFICACY OF NEUROTRACKER ON INDIAN FENCERS : A GENDER COMPARISON

Ms. Sargun Kaur Sethi
M.Sc. Sports Psychology, Department of Sports Psychology, Faculty of Sports Sciences, Sports Authority of India Netaji Subhas National Institute of Sports, Patiala, Punjab India
sargunsportspsychologist@gmail.com

Dr. Deepak Mishra
Scientific Officer, HOD Department of Sports Psychology, Faculty of Sports Sciences, Sports Authority of India Netaji Subhas National Institute of Sports, Patiala, Punjab India

Abstract
***Introduction**: Fencing places strong psychophysiological demands on neuromuscular, eye and feet coordination, agility, strength, attention, and power. It is stated that early identification of the location of the target of an opponent's attack is anticipated to be a critical factor for success because fencing movements are extremely rapid. It is trickier to determine an opponent's intentions and, as a result, to plan for defensive actions and at coordinating their moves. The fencers are frequently most successful between the ages of 25 and 35. **Methodology**: The purpose of this study is to analyse the effectiveness of Neurotracker in increasing attention between male and female athletes. This quantitative (interventional) study comprised of National-level Indian fencers (N=11) of all the events - 3 foil (1 boy, 2 girls), 4 Epee (2boys, 2 girls), 4 sabre (2 boys, 2 girls); Girls (N=6) and boys (N=5). The sample was collected from Sports Authority of India Training Centres SAI(STC), Patiala for intervention and their Pre-test (initial baseline), Post-test (final baseline) was noted . The statistics used were parametric study (paired t) and one-way ANOVA using SPSS version 22. **Result**: Since it is one of its kind as there is no research found on Indian Fencer's attention using Neurotracker there has been positive significance over time in overall data and a negative significance was found among female Indian fencers.*
***Keywords:** Fencing, Neurotracker, Attention, Decision making.*

1 Introduction

"Fencing is like playing chess at lightning speed"
Peter Westbrooke

Fencing is a unique Olympic sport that takes place on a narrow 14x2m piste, where fencers engage in rapid offensive and defensive exchanges. The sport consists of three disciplines: foil, épée, and sabre, each with distinct rules and target areas. Given the fast-paced nature of fencing, athletes require exceptional neuromuscular coordination, quick reflexes, and heightened perceptual-cognitive skills to anticipate and counter their opponents' moves effectively (Abernethy & Russell, 1987).

The sport demands rapid decision-making, precise motor coordination, and strategic execution to excel. It is a high-intensity combat sport that demands superior cognitive abilities, including attention, perception, and memory, to adapt to constantly changing scenarios and anticipate an opponent's next move (Weinberg & Gould, 2007). Psychological skills such as stress management, confidence, and dedication also play a crucial role in an athlete's ability to perform consistently at the highest levels (Komarudin, 2016).

One emerging cognitive training tool that has gained attention in sports psychology is Neurotracker, a three-dimensional multiple object tracking (3D-MOT) system developed by Faubert and colleagues. Neurotracker has been widely used to enhance perceptual-cognitive skills in elite athletes, military personnel, and general populations. Studies suggest that significant cognitive improvements can be observed within the first five sessions of training with Neurotracker (Faubert & Sidebottom, 2012). Despite its increasing application in various sports, limited research has explored its efficacy in fencing, particularly among Indian fencers. Furthermore, the potential gender-based differences in cognitive processing and Neurotracker effectiveness remain unexplored.

1.1 Neurotracker and Cognitive Training in Sports

Neurotracker is designed to improve cognitive flexibility, perceptual awareness, and decision-making speed—skills that are highly relevant to fencing. The 3D-MOT system challenges athletes to track multiple moving objects using their peripheral vision while maintaining central fixation. This enhances neural efficiency in processing complex visual information and making quick decisions under pressure (Parsons et al., 2014).

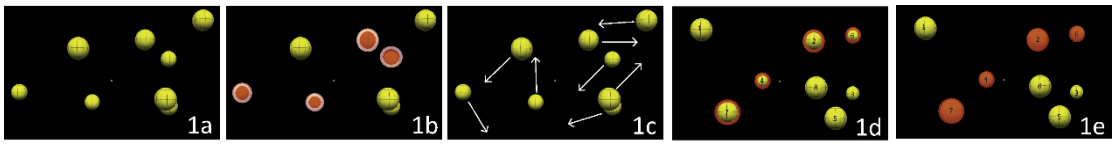

Fig 1. Neurotracker – 3D MOT displaying Dynamic attention

Research indicates that Neurotracker training improves:

- Selective Attention: The ability to focus on relevant stimuli while ignoring distractions (Coull, 1998).
- Divided Attention: The capacity to process multiple stimuli simultaneously, aiding in multitasking during fencing bouts (Coull, 1998).
- Sustained Attention: The ability to maintain focus over prolonged periods, critical for endurance in fencing (Moran, 2003).
- Dynamic Attention: The rapid shifting of focus between different stimuli, similar to the in-game adjustments required in fencing (Faubert, 2018).

2. Review of Literature

2.1 Cognitive Demands in Fencing

Psychological and cognitive abilities significantly influence a fencer's performance, with attention playing a crucial role in detecting and responding to environmental stimuli. Selective attention enables fencers to filter out distractions and focus on relevant visual cues (Coull, 1998; Posner & Boies, 1971). Divided attention allows them to process multiple sources of information simultaneously, such as monitoring their opponent's movements while planning their own actions. Sustained attention ensures they maintain focus over extended bouts, while dynamic attention enables them to shift focus rapidly between offensive and defensive strategies (Moran, 2003; Fernandez-Duque & Posner, 1997; Martinez, 2019; Faubert, 2018).

Faubert (2013) found that elite athletes exhibit better baseline cognitive abilities and faster learning curves in perceptual-cognitive training compared to non-athletes. Furthermore, Romeas et al. (2016) demonstrated that athletes who underwent Neurotracker training exhibited improved response accuracy and reduced impulsive errors, which are essential for high-level performance in sports requiring quick reactions.

2.2 Gender Differences in Cognitive Processing

While cognitive training methods such as Neurotracker have demonstrated positive outcomes in various sports, research on gender-based differences in perceptual-cognitive processing remains limited. Studies suggest that male and female athletes may exhibit variations in reaction time, visual processing speed, and decision-making strategies (Moran, 2012; Hagemann et al., 2010). These differences could influence how male and female fencers respond to Neurotracker training and whether they experience similar cognitive benefits.

Research on attentional focus has shown that elite athletes generally outperform non-elite athletes in cognitive efficiency, but gender-specific trends in attentional resources and cognitive adaptability remain unclear (Ericsson, 2003; Mann, 2013). Exploring these differences could provide valuable insights into optimizing cognitive training approaches tailored to the needs of male and female fencers.

3. Methodology

3.1 Research Topic

To examine the efficacy of Neurotracker in increasing attention among Indian fencers (male and female).

3.2 Hypothesis

Interventional/Experimental study.

The researcher formulated null hypotheses to evaluate the cause-and-effect relationship between Neurotracker and the increase in attention among Indian fencers . Null hypotheses were chosen because there had been limited studies involving Fencing, particularly in India, that examined the variable selected by the researcher. Consequently, the relationship among this variable had not been tested within this population. Therefore, it was essential to establish null hypotheses and assess their relationship.

1. There will be no significant relationship between Neurotracker training on fencing athletes.
2. There will be no significant relationship between male and female fencers.

3.3 Research Design

This study employs a Interventional/experimental design to evaluate the effectiveness of Neurotracker in enhancing attention among Indian fencers (male and female). Using a pre-test and post-test framework, attentional improvements were assessed using Neurotracker training, while null hypothesis framework measures its impact on their training and across gender groups.

3.4 Sample

Due to the availability of fencers, the sampling was convenience-based and stratified. The fencers represented at state, national, and international levels under the SAI Training Centre at NSNIS Patiala were selected for the study. All athletes who fit the inclusion criteria were selected.

Sample Size

The current study includes 11 Indian Fencers.

Participants were National-level Indian fencers (N=11) across all events:

- **Foil**: 3 fencers (1 male, 2 females)
- **Epee**: 4 fencers (2 males, 2 females)
- **Sabre**: 4 fencers (2 males, 2 females)
- **Total**: Girls (N=6), Boys (N=5)

This, thus requires the researcher to be absorbed in the research field, to establish productive rapport with the participants and through theoretical reflection to address the research problem in depth. Therefore, a small number of cases (less than 20) have been found to aid the researcher's close alliance with respondents, and enhance the validity of in-depth investigation in naturalistic settings (Crouch & McKenzie, 2006).

3.5 Data collection method

Data collection procedure

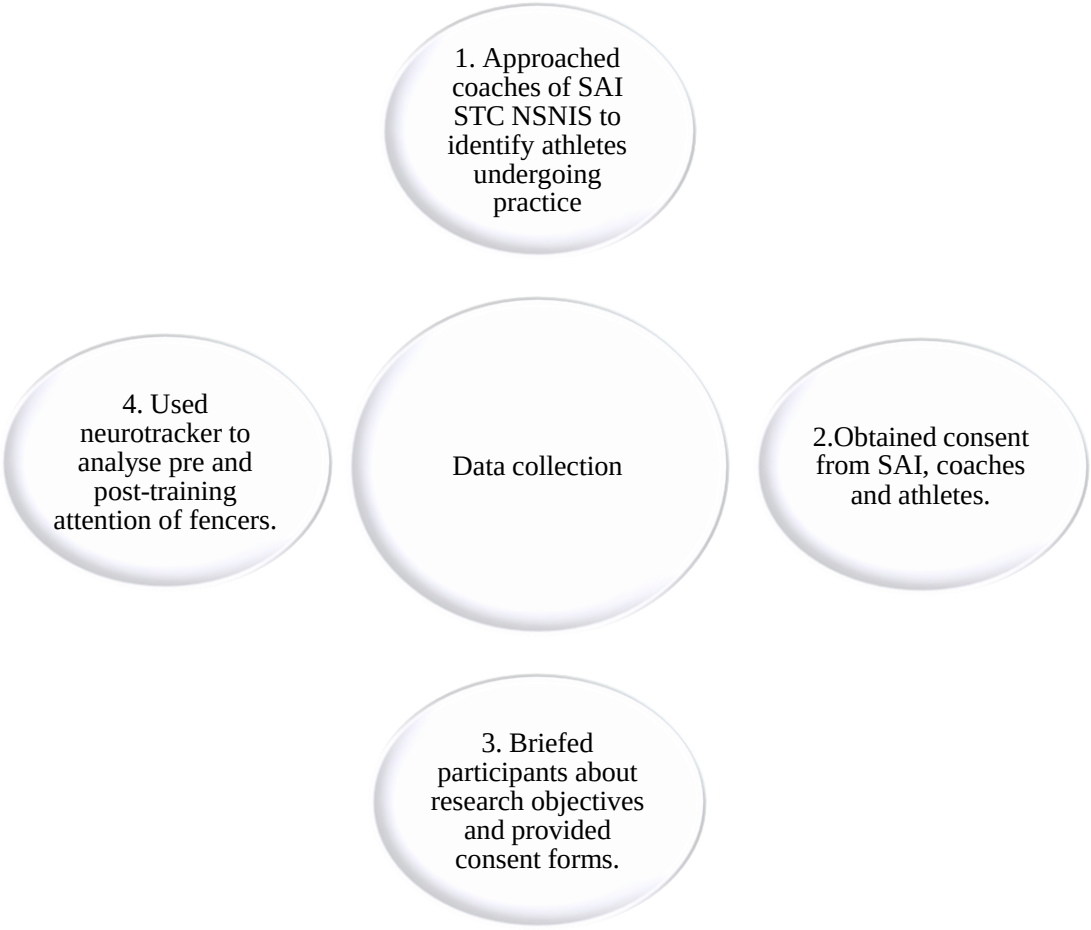

Fig 2. Representation of data collection procedure. (First score indicates initial baseline, last score indicates final baseline.

This study involved approaching the coach of the SAI Training Centre at NSNIS to identify athletes undergoing practice. With the consent of the concerned sports authority/coaches and the respective athletes who fit the research sample criteria, participants were briefed about the research objective and provided consent forms. Neurotracker was used to analyse pre- and post-training attention levels in fencers. The first score indicated the initial baseline, while the last score indicated the final baseline, reflecting the progress of an athlete's attention.

3.6 Statistical Analysis

SPSS Statistics version 22 was used for interventional pre and post-test analysis. A paired t-

test and one-way ANOVA were conducted to observe significance among the sample.

4 Discussion

The study followed an interventional approach. The sample comprised of 11 (5 males and 6 females) Fencers from Punjab for assessment. The total sample included International and National players. The pre and post test data collected was subjected to t test to compare and assess the significance. The mean of pre-test is 3.99 and post-test 4.63. This suggests that Neurotracker positively impacts attentional performance in fencers. The findings of this study highlight the effectiveness of Neurotracker in improving attention among Indian fencers, with notable differences observed between male and female athletes.

Table 4.1 Correlation value of mean t-test between Pre-test and Post-test (N=11)

Group	Pre-Test Mean	Post-Test Mean	t-test (p-value, 2-tailed)	t-test (p-value, 1-tailed)	Significance (5% level)
Combined group	3.994	4.627	0.064	0.032	Close to significance
Male athletes			0.238	0.119	Not significant
Female athletes			0.785	0.039	Close to significance

** correlation is significant at 0.01 level (2-tailed)

* correlation is significant at 0.05 level (2-tailed)

Hypotheses Testing

Hypothesis 1. There will be no significant relationship between Neurotracker training on fencing athletes.

Table 4.1 indicate an overall improvement in attention levels among fencers after training with Neurotracker. The mean pre-training score (3.99) significantly increased to a post-training score of (4.63), suggesting a positive impact of the intervention. However, the statistical significance varied across different groups. The t-test for the combined group revealed a two-tailed p-value of 0.0644, which is close to the significance threshold, indicating a trend toward improvement. The research is in sync with previous researches as **Walton et al. (2018)** explored the efficacy of Neurotracker in elite sports and found that athletes who incorporated cognitive training into their routines exhibited better mental resilience, reduced reaction time variability, and enhanced focus during high-pressure situations.

Hypothesis 2.There will be no significant relationship between male and female fencers.

Table 4.2 shows when analysing attention improvement across different fencing categories (Foil, Epee, Sabre), variations were observed. The **Foil group demonstrated the highest improvement**, particularly among female fencers, with post-training scores showing substantial gains. The Sabre and Epee fencers also displayed improvements, but with more variability.

Table 4.2 Correlation value of mean ANOVA f-test between Pre-test and Post-test (N=11)

S. No	Gender	Event	Pre-Test Mean	Post-Test Mean
2	2	Epee	3.92	3.95
6	2	Epee	4.26	4.74
7	1	Epee	4.41	4.97
10	1	Epee	4.88	3.92
1	2	Foil	3.21	4.23
5	2	Foil	3.81	4.66
8	1	Foil	3.72	6.84
3	2	Sabre	3.85	3.97
4	2	Sabre	3.82	3.76
9	1	Sabre	4.09	5.03
11	1	Sabre	3.97	4.83

* correlation significant at 5% level (f value: 3.01, df 9) 2= female, 1= male

4.3 Statistical Significance and Practical Implications

Table 4.2 ANOVA test (p = 0.034) confirmed that the differences observed among fencers were statistically significant. These findings suggest that Neurotracker is an effective cognitive training tool for fencers, with a stronger impact on female athletes. The results align with previous research indicating that perceptual-cognitive training can enhance visual tracking, selective attention, and reaction speed in sports requiring rapid decision-making. The research is in sync with previous researches as Walton et al. (2018) explored the efficacy of Neurotracker in elite sports and found that athletes who incorporated cognitive training into their routines exhibited better mental

resilience, reduced reaction time variability, and enhanced focus during high-pressure situations.

Conclusion

This study provides evidence that Neurotracker training can enhance attention levels among fencers, particularly among female athletes. While the overall trend supports the benefits of Neurotracker, statistical significance was not uniformly achieved across all groups, indicating that factors such as gender, training experience, or cognitive baseline may influence outcomes. These findings contribute to the growing body of research on cognitive training in sports psychology, emphasizing the importance of individualized interventions to maximize cognitive performance in athletes.

Limitations

Despite its promising results, this study has several limitations:

1. Small Sample Size – The study included only 11 participants, which limits the generalizability of the findings.
2. Lack of Control Group – A control group not undergoing Neurotracker training could have strengthened causal interpretations.
3. Short Duration – The duration of Neurotracker exposure was not extensively tracked, making it unclear if longer training would yield stronger effects.
4. Potential Gender Differences – The sample had an uneven male-to-female ratio, which could have influenced the gender-based statistical significance.
5. Specific to Fencers – The findings may not apply to athletes from other sports, where attentional demands differ.

Future Recommendations

To build upon these findings, future research should consider:

- Larger Sample Sizes: Conducting studies with a greater number of participants to enhance statistical power.
- Control Groups: Including a non-Neurotracker-trained control group to establish clearer causality.
- Longitudinal Studies: Examining the effects of Neurotracker over extended training periods to assess long-term benefits.
- Sport-Specific Comparisons: Evaluating Neurotracker's impact across various sports to determine whether cognitive training effectiveness varies by discipline.
- Gender-Specific Training Protocols: Investigating whether males and females require different cognitive training approaches based on their attention patterns.

These insights can help optimize Neurotracker implementation for athletes aiming to enhance focus, cognitive efficiency, and performance consistency in competitive sports.

References

1. Abernethy, B., & Russell, D. G. (1987). The relationship between expertise and visual search strategy in a racquet sport. *Human Movement Science, 6*(4), 283–319.
2. Weinberg, R. S., & Gould, D. (2007). *Foundations of sport and exercise psychology* (4th ed.). Human Kinetics.
3. Motivational Structure for Sports Practice during COVID-19 Pandemic in Professional Football Players. Sport Mont, 20(3), 127–131. https://doi.org/10.26773/smj.221020 Komarudin. (2016). Psikologi Olahraga. PT. Remaja Rosdakarya.
4. Faubert J. Professional athletes have extraordinary skills for rapidly learning complex and neutral dynamic visual scenes. Sci Rep. 2013;3:1154. doi: 10.1038/srep01154 pmid: 23378899
5. Faubert, J., & Sidebottom, L. (2012). Perceptual-cognitive training of athletes. *Journal of Clinical Sport Psychology, 6*(1), 85–102. https://doi.org/10.1123/jcsp.6.1.85
6. Parsons, B., Magill, T., Boucher, A., Zhang, M., Zogbo, K., Bérubé, S., Scheffer, O., Beauregard, M., & Faubert, J. (2014). Enhancing cognitive function using perceptual-cognitive training. *Journal of Clinical EEG and Neuroscience, 46*(2), 84–95. https://doi.org/10.1177/1550059414563746
7. Coull, J. T. (1998). Neural correlates of attention and arousal: Insights from electrophysiology, functional neuroimaging, and psychopharmacology. *Progress in Neurobiology, 55*(4), 343–361. https://doi.org/10.1016/s0301-0082(98)00011-2
8. Faubert, J. (2018). The cognitive element of sports injuries. *NeuroTracker.* Retrieved from https://www.neurotrackerx.com/author/professor-jocelyn-faubert
9. Moran, A. P. (2003). *The psychology of concentration in sport performers: A cognitive analysis*. Psychology Press.
10. Posner, M. I., & Boies, S. J. (1971). *Components of attention*. Psychological Review, 78*(5), 391–408. https://doi.org/10.1037/h0031333
11. Fernandez-Duque, D., & Posner, M. I. (1997). Relating the mechanisms of orienting and alerting. *Neuropsychologia, 35*(4), 477–486

12. Buil, I., Martínez, E., & Matute, J. (2019). *Transformational leadership and work performance*. Journal of Clinical Sport Psychology, 6, 85–102.
13. Romeas, T., Guldner, A., & Faubert, J. (2016). *Cognitive training for enhancing soccer performance: The effect of a perceptual-cognitive training program on soccer players' decision-making and performance*. *Journal of Sports Sciences, 34*(8), 774–781.
14. Moran, T. P. (2012). *Human attention and the frontal lobe: Insights from research on the cognitive and neural mechanisms of selective attention*. *Neuroscientific Perspectives on Human Cognition, 22*(1), 31–51. https://doi.org/10.1016/j.neuropsychologia.2011.11.022
15. Hagemann, N., Strauss, B., & Lecheler, L. (2010). *The impact of perceptual-cognitive skills on sports performance: A review and theoretical analysis*. *Journal of Sports Sciences, 28*(5), 415–426. https://doi.org/10.1080/02640410903536994
16. Mann, D. L., Williams, A. M., Ward, P., & Janelle, C. M. (2013). Perceptual-cognitive expertise in sport: A meta-analysis. *Journal of Sport and Exercise Psychology, 35*(1), 98-110. https://doi.org/10.1123/jsep.35.1.98
17. Ericsson, K. A. (2003). Development of elite performance and deliberate practice: An update from the perspective of the expert-performance approach. *In J. L. Starkes & K. A. Ericsson (Eds.), Expert performance in sports: Advances in research on sport expertise* (pp. 49-83). Human Kinetics.
18. Walton, C. C., Keegan, R. J., Martin, M., & Hallock, H. (2018). The potential role for cognitive training in sport: More research needed. *Frontiers in Psychology, 9*, 1121