

Composite Effects of Performance Related Anxiety and Mental Fatigue in Performance Trend of Air Rifle Shooters

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Abstract:- Shooting is a physically and psychologically taxing sport. This study serves to establish an integrated relationship of the aforementioned psychosocial factors on the performance score of Air-Rifle Shooters and compare the distribution, variation and association of the said parameters among the three selected categories of rifle shooters, based on the years of their experience: elite, recreational shooters and beginner shooters. 45 shooters were randomly selected from a regional shooting club in West Bengal, Kolkata. The Sports Anxiety Scale (SAS) Questionnaire, was administered and their pre practice and post practice mental fatigue levels was measured using the Critical Flicker Fusion Frequency (CFFF) apparatus.

➤ What we already know

- Rifle shooting is a visually engaging sport, that requires absolute focus and concentration of the marksmen to not only hit the target at hand with utmost accuracy but also to ensure the safety of the other shooters present at the range.
- It is an intricate activity coupling body balance, postural stability and self-control maintained over prolonged periods of time.
- Hence various psychosocial factors such as anxiety and Mental fatigue often leaves a shooter predisposed to impaired marksmanship and overall deterioration.

➤ What this article adds

- Hence it can be concluded that the shooters have developed a level of immunity against visual/ mental fatigue regardless of their seniority in the field.
- This study also reveals that a significant psychological load is experienced by both the beginners and elite groups of shooters however, such psychological loads in the form of “Competition related anxiety” may positively modulate the performance scores in the elites and the beginner alike, as shown by the negative correlation of the performance scores to the various SAS Scores.
- Eustress and Distress both positively and negatively regulates a shooter’s performance.

Keywords:- Beginners, Concentration Disruption, Critical Flicker Fusion Frequency, Elites, Mental Toughness, Recreational shooters, Somatic Trait Anxiety, Sports Anxiety Scale.

I. INTRODUCTION

There are many people across the world, involved with activities of shooting, whether in terms of profession or as an athlete participating in a sports competition.

According to Silva et al.^[1] rifle shooting is an activity of precision, which not only needs immense motor control, but also requires a great level of concentration, to focus and hit the target. Rifle shooting is governed by numerous factors. Hence, various, variable whether physical: body balance, grip strength, posture etc. or psychosocial: mental fatigue, anxiety, self-control could each influence the performance of the competitive rifle shooters.

Thus, mental fatigue and anxiety both associated with performance is one of the most studied topics in sports psychology, and it continues to be a key focus of research for researchers and consultants throughout the world.^[2]

According to Martens(1977), Competitive anxiety can be described as a sport specific trait anxiety that occurs on a regular basis, before or during a competition. Competitive anxiety, such as state and trait anxiety, can occur at the physical or cognitive level, according to the ‘Multidimensional anxiety theory’, on the other hand, somatic anxiety relates to physical reactions to over-activation, such as muscle tightness.^{[2],[3]}

Fatigue being a significant determinant of sporting performance, has been defined as a “reduced capacity of maximal performance.” Fatigue is a multifaceted phenomenon that has been shown to affect performance in a variety of tasks. Fatigue does not always originate in the neuromuscular system. Hence it can be concluded that Mental Fatigue is a psychobiological state generated by prolonged periods of intensive cognitive exertion.^[4]

It is also stated, that fatigue can be classified as acute or chronic depending on how long it lasts. Acute fatigue is quickly relieved by a break or a change in lifestyle, however chronic fatigue is a state of persistent exhaustion that lasts months and cannot be cured by rest. Exhaustion has also been divided into two types: mental weariness, which refers to cognitive or perceptual aspects of fatigue, and physical fatigue, which refers to the actualization of the motor structure. Muscle tiredness occurs when a muscle's ability to operate or its ability to create force decreases with time. In response to contractile motion. It has also been described as a reduction in the power creation. The force behind muscular actions reduces when weariness sets in, leading to a sense in vulnerability.^[5]

Similarly, anxiety related to a competition or performance has been established as a significant predictor of the quality and duration of one's experiences in sports and other success domains such as music, academics, and businesses. In both adults and children, high levels of competitive anxiety are linked to poor performance and diminished enjoyment of involvement. It was also concluded that anxiety coupled with Sport attrition can have serious negative repercussions for youngsters, including a decline in healthy physical activity and involvement in deviant behaviors and is also a predictor of sports participation termination.^{[6],[7],[8]}

In this paper we have attempted to establish the impact of mental fatigue and sport associated anxiety on the performance (score), among various age groups of competitive rifle shooters, during their practice sessions prior to the upcoming state level tournaments.

The objectives of this study are as follows: (a) To check whether there is a significant variation in the values of CFFF, of the elite shooters at the start and towards the end of the practice sessions, held prior to their participation in the upcoming qualifying state tournaments, (b) To test if the variation in the CFFF values is consistent among different groups of rifle shooters i.e. elites, recreational and beginner, (c) To test if there is a significant variation in the performance score among elites, recreational and beginner groups of rifle shooters based on their years of experience, (d) To compare the variation in SAS (Stress Anxiety Score), among the aforementioned categories and establish a relation with the performance score.

II. METHODS

➤ Participants Selection

A total of 45 air rifle shooters aged 10-55 years (mean age 34 ± 3.3 years) were randomly selected from a regional shooting training club of West Bengal. With 15 shooters belonging to the elite group, 15 belonging to the recreational group of shooters and the rest 15 were beginner. Each group comprising of male and female alike, but comprising of different age categories. In the elite's group, there were a total of 11 males and 4 females, the recreational group of shooters all were males, while in the beginner's group 7 were females and 8 were males. The age group of elite shooters mainly

comprised of 13-32 years, while that in beginner group comprised of 10-17 years and in the recreational group comprised of mainly 42-57 years.

➤ The Sport Anxiety Scale (SAS-2)

The (SAS-2) evaluates player's competitive trait anxiety before and during competition. Somatic anxiety, worry and concentration interruption are all the elements on the scale. It is a 15-item questionnaire and each item relating to the statement is rated by the participants on a four-point Likert scale.^{[6],[9],[10],[11]}

The aforementioned questionnaire was administered to measure the sport-specific cognitive and somatic trait anxiety in this study. The digitized version of this questionnaire was circulated amongst the participants via Google forms; these forms were mainly circulated through social media messaging apps like WhatsApp and Gmail.

➤ The Critical Flicker Fusion Frequency Test (CFFF)

Flicker instrument (Model 501c. Takei Kiki Kogyo Co. Ltd, Japan) was used to perform the CFFF test. The CFFF test determines the rate at which successively flickering fusion events, when a light stimuli is applied on the retina occurs. The measure of this rate is expressed in (Hz) and is best known as the "threshold frequency" and often serves as an index of the activity of the central nervous system.^{[12],[13],[14]}

CFFF has been widely used in the field of ergonomics and occupational health, as a standard measure of mental fatigue.^[12] The participants of the present study were asked to take a 15 minutes break prior to the start of the practice sessions and just before they entered the shooting range to practice, their CFFF scores were recorded, following which after a span of an hour their performance scores on the score cards were recorded as well. Thereafter, midway between their practice session their CFFF scores were recorded yet again, followed by their performance scores.

➤ Statistical Analysis:

To perform the statistical analysis on the data, SPSS version 24 was used.

Independent –Samples Kruskal –Wallis test was performed to check whether the distribution of "before practice" CFF (Critical Flicker Frequency), "after" CFF (Critical Flicker Frequency) and the distribution of "before practice" CFF (Critical Fusion Frequency), "after practice" CFF (Critical Fusion Frequency), is the same across a particular category of shooters. Mann-Whitney test^[16] was applied to investigate the probability of the randomly selected values of "before practice" CFF (Critical Flicker Frequency) being greater than values of "after practice" CFF (Critical Fusion Frequency), in both "UP" and "DOWN" modes. Independent –Samples Kruskal –Wallis test was used to check the significance of differences, in the various SAS scores (Somatic Anxiety Score, Competition Anxiety Score, Concentration Disruption Score), between various categories of rifle shooters. Spearman Correlations was used to check the association of various SAS scores with the shooters performance scores and the significance levels were tested at

the 0.05 level (2-tailed). Wilcoxon signed rank test was done to perform pair-wise comparisons of the differences of values in the pre and post practice session Critical Flicker and Fusion Frequencies (Hz) across the categories of type.

III. RESULTS

Upon conducting the Independent-Samples Kruskal Wallis Test to check if the distribution of the various SAS scores (Somatic Anxiety, Worry, Concentration Disruption) and Performance scores across the categories of rifle shooters

, it was observed that there lied a statistically significance levels of .002, .001, .020 and .002 respectively given that ($p < .05$).

Table 1 shows pair wise comparison of various SAS scores such as (Somatic Trait Anxiety, Worry and Concentration Disruption Scores) among the Recreational, Beginner and Elite shooters there exists a statistically significant difference of in the Somatic Trait Anxiety scores, Concentration Disruption Scores and Worry Scores among the Recreational and Beginner group of Rifle Shooters.

Sample 1&2	Test Statistic	Std. Error	Std. Test Statistic	Sig.	Total N: 45
Somatic Anxiety Score					
R-E	-9.089	4.789	-1.901	.057	Test Statistic: 14.852
R-B	-16.642	4.696	-3.544	.000	Degree Of Freedom : 2
E-B	-7.552	4.855	-1.556	.120	Asymptotic Sig. : **.001
Concentration Disruption Score					
R-E	-1.027	4.767	-.215	.829	Test Statistic**: 13.003
R-B	-11.979	4.681	-2.559	.010	Degree of Freedom : 2
E-B	-10.952	4.840	-2.263	.024	Asymptotic Sig. : .002
Worry Score					
R-E	-2.138	4.792	-.446	.655	Test Statistic**: 7.841
R-B	-16.848	4.706	-3.580	.000	Degree of Freedom: 2
E-B	-14.710	4.866	-3.023	.003	Asymptotic Sig : .020

*Significance values have been adjusted using Bonferroni correction for multiple tests.

** The test statistic is adjusted for ties.

Table 1:- Pair wise Comparisons of Somatic SAS scores among different categories of rifle shooters, where R stands for recreational, E stands for elite and B stands for Beginner shooters. The significance level is (.05)

From the computation of Spearman's correlation coefficient (Table 2), it was found that there existed a statistically significant negative correlation of the

performance scores to the various SAS scores among the Recreational, Elites and Beginner groups of rifle shooters.

Category	Spearman's Correlation Coefficient				Sig. Level at (0.05) *
	Performance Score	Somatic SAS	Worry SAS	Concentration Disruption	
N=45	1.000	-.385	-.521	-.370	.009, .000, .012
RECREATIONAL n=15	1.000	-.234	-.399	-.191	.382, .126, .479
ELITE n=15	1.000	-.311	-.274	-.252	.279, .343, .385
BEGINNERS n=15	1.000	.063	-.078	-.079	.824, .781, .780

* Significance levels of Somatic SAS, Worry SAS and Concentration Disruption, respectively.

Table 2:- Computation of Spearman's correlation coefficient between the SAS scores (worry, somatic trait and concentration disruption) and the Performance Scores.

However the results obtained from the statistical analysis of the frequencies of the Critical Flicker and Critical Fusion in (Hz) by the Independent Samples Kruskal Wallis Test, obtained during pre practice sessions and post practice sessions, in both “Fusion” and “Flicker” modes shows that there lies a statistically insignificant variations of .593, .118, .530, .454 given that ($p < .05$) in the values of Critical Flicker and Critical Fusion Frequencies (Hz) across the various categories of the types of rifle shooters, based on their years of experience.

Also as evident from Table 3, the statistical analysis of differences between the pre practice Critical Flicker and Critical Fusion Frequencies (Hz), across the categories of types of shooters, there lies a statistically significant difference in the values of post practice Critical Fusion Frequencies (Hz) in “Flicker” mode, among the Recreational groups of shooters. While a statistically significant difference in values of post practice Critical Flicker Fusion Frequencies were reported in recreational and beginner level shooters, respectively.

Category of shooter	Mann-Whitney U Difference in values (Pre and post practice in Hz)		Wilcoxon W Difference in values (Pre and post practice in Hz)		Z score Difference in values (Pre and post practice in Hz)	
	Critical Flicker Frequency	Critical Fusion Frequency	Critical Flicker Frequency	Critical Fusion Frequency	Critical Flicker Frequency	Critical Fusion Frequency
Elite	76.000	105.000	196.000	225.000	-1.520	-.312
Recreational	101.500	107.000	221.500	227.000	-.458	-.230
Beginners	80.500	103.500	200.500	223.000	-1.336	-.376
Total N =45	766.000	1004.500	1801.000	2039.000	-1.996	-.065

Table 3:- Analysis of differences of values in the pre and post practice session Critical Flicker and Fusion Frequencies (Hz) across the categories of type

IV. DISCUSSION

This study investigated the variation of SAS scores and CFF Frequencies among various categories of rifle shooters based on their years of experience in the sport and its association with the performance scores/ performance trend. In Table 3, we see that the distribution of somatic trait SAS varied across the categories of rifle shooters, with a significance level of .002. This observation can be supported by the fact that these two categories of shooters were the ones having most experience as opposed to the beginner shooters and years of competing in various tournaments and years of consistent practice have conditioned their bodies to withstand the physiological effects anxiety associated with competitive performance that may present itself in the form of restlessness, palpitations, upset stomach, trembling in the limbs etc. Here, the two categories of concern: elites and recreational shooters each have a minimum experience of ten years and twenty year’s worth of experience at most.

On the other hand when the somatic trait SAS scores, between the recreational and beginner groups of shooters were compared, a significance value of .001 was reported as evident from Table 3. This can be attributed to the difference in the seniority and mental toughness among the two categories of rifle shooters. As inferred from the SAS-2 questionnaire administered, the beginners are most concerned over their ability to withstand the hectic training schedule and qualify for the future tournaments.

On the contrary, there was no significant difference found in the somatic trait SAS scores of the elite and the beginner. This observation can be based on the

“Reinvestment Perspective Theory” as proposed by Elton Eustaquio Casagrande and Fernando Valvano Cerezetti, [15],[16] As proficiency increases, in the skill, our specialized knowledge, about what needs to be done to do the task gets more subconscious, and we can smoothly and efficiently carry on with the task. On another note a proficient performer (here being referred to as an elite shooter) has reached automaticity and is thus able to do skills subconsciously and smoothly. When talented performers become tensed or nervous, they tend to reinvest attention in their competence by going along the laid rules of a sport, regressing a skilled performance to a level lower than their proficiency, resulting in performance deficiencies.

Similarly, when pair wise comparison of worry SAS scores among different categories of rifle shooters (table -6), were carried out, an insignificant difference of 1.000 was reported among recreational and elite shooters, while a significant difference of .001 was reported amongst recreational and beginner shooters. As the recreational shooters are mostly composed of athletes who have retired from the sport and are now free from competitive stress, as opposed to beginner who have little to no experience in competitive shooting as they have just enrolled and are preparing to qualify for the preliminary rounds. Their inexperience added with their self- inhibitions, take a toll on their psyche and thus hinder them from giving their best in the performance.

We also found from Table 3, that the beginner and elite shooter’s worry SAS scores, showed an insignificant difference of .008. As proposed by the “Theory of Ironic Process of Mental Control”(TIP) by Zhang et al. [17]

^{[18],[19],[20]}When anxiety is low, conscious resources are available, allowing the monitoring process to reactivate the operating process, allowing purposeful control toward the desired states to be maintained. In short, we are more likely to accomplish our goals, ace a competition when there is little cognitive burden on us, if we were to take a beginner's perspective into consideration the cognitive load would probably stem from trying too hard to meet one's parent's/coach's expectations, trying too hard to qualify for the competition etc. Such thoughts, often gives rise to a high cognitive burden which consumes a considerable percentage of the limited conscious resources, suppressing the operational process and limiting the execution of the skills and the application of knowledge one has to ace a competition/task.

Also as inferred from Table 3, the pair wise comparison of concentration disruption scores, shows no significant difference (0.829) among the recreational and elite group of shooters, but shows a significant difference of .010, among beginner and recreational group of shooters as well as elite and beginner group of rifle shooters showing a significant statistical significance of .024. This observation can be justified by the findings from the SAS-2 questionnaire, for concentration disruption, here the beginner owing to their untrained psyche, are more prone to succumb to wandering thoughts that may interfere with their concentration and intervene with them properly focusing on the targets These findings were consistent with "The Distraction Perspective" theory as stated by Fergus I.M.Craik,^{[21],[22],[23]}. It is also to be noted that our study found a significant negative correlation between the performance score and the SAS scores as a whole as depicted in Table 4, however upon further associating the performance score with the three SAS scores category wise, the association of performance score and the three SAS scores among the elites and recreational shooters remained majorly insignificant, while the association of beginner's performance score to SAS scores showed no statistically significant correlation.

Following, the variations in SAS scores among categories, this study also attempted to test if there existed variations in the distribution of mental fatigue measured through Critical Flicker Frequency and Critical Fusion Frequency readings (in Hz), across the categories of type, and it was discovered that the distribution of both before and after practice Critical Flicker Frequency and Critical Fusion Frequency readings (in Hz), was the same across categories of type with the significance levels being .593,.118,.530 and .454 respectively as evident in Table 6.

Also, the analysis of differences between the before practice Critical Flicker Frequency and Critical Fusion Frequency readings (in Hz) and after practice Critical Flicker Frequency and Critical Fusion Frequency (in Hz); revealed insignificant results for each of the categories. The result is probably owing to the 'mental toughness' of the athletes as stated by Chris Englert et al.^{[24],[25]}, and the visually engaging nature of the sport requiring on to steadily focus on a small target placed at a distance of ten-fifty m depending on the type of air rifle shooting one chooses to compete in. Elite

shooters must maintain attention throughout a tournament, which typically lasts many hours and long-term self-control/discipline (i.e., a subjective estimate of how much mental effort, one is capable of spending in a given task).

Further the environment where the data was recorded also may have played a key role in modulating the athlete's mental fatigue levels, as the practice sessions on the shooting range on the day of data collection was merely a simulation before the actual state level competitions were to be held, giving much time for the athletes to de stress and take occasional breaks in-between practice sessions so by the time the after performance Critical Flicker and Critical Fusion Frequency was recorded the mental fatigue which may have occurred, had already worn off.

V. CONCLUSION

From this study it is concluded that the distribution of somatic trait SAS varied between the groups of rifle shooters. This is due to the disparity in years of experience and mental toughness between the two groups of rifle shooters. The beginners are most anxious about their capacity to handle the stress of the training regimen and qualify for the preliminary rounds of future competitions. The elite and beginner's somatic trait SAS scores, on the other hand, did not differ significantly. However, as far as the elites and recreational shooters are concerned concentration disruption arising from worries of not being able to maintain their rank, can serve as a motivator, since the fear of failing can lead to reallocation of additional cognitive resources, prompting the athletes to surpass their potential and hence maintain a steady performance when apprehensive.

However analysis of CFFF frequencies in both flicker and fusion mode reveal statistically insignificant variations across the categories of type indicating a strong level of immunity against mental fatigue, irrespective of years of experience.

➤ Ethical Approval

This study was approved by the Institutional Human Ethics Committee of the Department of Physiology, University of Calcutta, 'Ref No IHEC/SG/01/2022' dated 3.8.2022 and written informed consent was obtained from all the subjects.

➤ Future Research

The following research needs have been identified:

- Studies must be conducted to investigate the role of nutritional status in the improvement of the ocular health of the shooters.
- Formulation of training plans based on the performance in competitions.
- Design of Ergonomically Fit layout of shooting ranges.

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