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Original Article

Determination of psychological correlates of peak performance in developmental archers

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Abstract:
This study determined optimal zones of heartrate,anxiety intensity and arousal for archery performance among Malaysian elite developmental archers. Using a cross-sectional study design, nineteen archers (Mean age = 15.37± 1.5) participated in the study. Participants underwent three months of routine training session with two competitionswithin the three months. Throughout the training sessions and during competition, archers' heart rate, anxiety intensity, arousal level, and shooting performance were monitored. All parameters were measured weekly until end of the study. The revised Competitive State Anxiety-2 (CSAI-2R) and revised Sport Grid (Sport Grid – R) were used to measure competitive anxiety and arousal. In addition, Polar heart rate monitor (S710i, Polar Electro Oy, Finland) was used to monitor participants' heart rate. Cluster analysis was used to create the archers' performance profile and One Way ANOVA was used to compare the difference between the clusters. The results of ward method revealed a two-cluster profile. Profile 1 exhibits a low range of heart rate, but relatively high in shooting score and psychological variables. Profile 2 is characterized by high range of heart rate but low in shooting score and psychological variables. T-test results revealed significant differences between cluster group in shooting score, cognitive anxiety and somatic anxiety. It is concluded that better shooting score is associate with lower heart rate, lower arousal, higher self-confidence as well as higher in cognitive and somatic anxiety among archers in the current study.
Keywords: Developmental Archers, Heart Rate, Competitive Anxiety, Arousal, Self-confidence

Introduction:

Archery is a sport that demands precision and consistency in shooting to achieve a peak performance.High performance in archery is defined as the ability to shoot an arrow at a given target with accuracy and accumulated total scores.It can be achieved through a comprehensive and systematic training emphasizing on physical, technical, tactical and psychological components.

In sports that involve fine motor skill such as archery, a lower heart rate prior to shooting often lead to greater shooting accuracy (Tremayne & Barry, 2001). A variable that tends to affect heart rate fluctuation is anxiety. In a study conducted by Watkins et al. (1998), they observed direct correlation between anxiety and heart rate. They found that higher restingheart rate is associated with those subjects that have higher trait anxiety than with lower trait anxiety (Watkins et al., 1998).

In archery shooting there is a fixed sequence of very accurate movements that the shooter performs namely, bow holding, drawing, full draw, aiming, release and follow through stages (Haywood & Lewis, 1989). Archery performance will depend upon certain variables, which may include factor such as anxiety as well arousal. Anxiety has been observed as one of the main barriers in athletes' performance. According to Gould et al. (2002), anxiety is an important component in sports as it tends to influence athlete's performance in either positive or negative direction.

Due to individualized nature of the effects of anxiety on performance, Individual Zone of Optimal Functioning (IZOF has been widely used in sport psychology to examine anxiety and performance relationships. IZOF model contends that each athlete has an individual optimal level (high, moderate and low) and intensity zone of anxiety associated with enhanced performance. It is assumedthat there is a large interindividual variability in optimal anxiety and arousal in different athletes. Furthermore, it predicts that successful performance occurs when an athlete's anxiety is near or within the previously established optimal zones (Hanin and Syrj, 1996). However, when it falls outside these optimal zones (i.e. higher or lower), performance is hypothesized to deteriorate.

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Thus, understanding athletes' individual optimal zone by monitoring these performance related variables during training and competition may help them to establish their optimal profile and consequently peak performance. Such profile may then be used to provide a starting point for which individualized training and zone of optimal functioning can be determined. Therefore, the present study sought to determine the optimum zone of heart rate, anxiety, arousal, and self-confidence level among Malaysian elite developmental archers.

Methods

Participants

Nineteenth archers who represent their State for national level competition participated in this study. The age of the participants was between 13 to 17 years old ((Mean age = 15.37± 1.5). To be included in the study, archers must have at least two years of competitive experience representing state in archery competition.

Instruments

Competitive State Anxiety Inventory – 2 Revised (CSAI-2R; Cox, Martens, &Rusell 2003). CSAI-2R was used to measure athlete's competitive state anxiety. The measure consists of three subscales with 5 items for cognitive anxiety, 7 items for somatic anxiety and 5 items for self-confidence The items are attached to a 4-point Likert scale ranging from 1 = *not at all* to 4 = *very much so.* . Subscales scores were calculated by summing the score of each item in each subscale. Its validity and reliability has been widely reported and the Bahasa Malaysia version of this study was validated by Hashim and Zulkifli (2010).

Sport Grid – Revised (Ward & Cox, 2001). The Sport Grid- R by Ward and Cox (2001) was used to measure the cognitive state anxiety and felt arousal. It is a 9 x 9 grids where the participants place an X in the box which best describes how they feel at the moment. The vertical component measures arousal level, while the horizontal component measures thoughts or feelings (cognitive anxiety) on a 9-point scale. These grids assessed their cognitive state anxiety on the continuum "not worried - - - - very worried" and felt arousal on the continuum "very high activation (very "pumped-up") - - - - very low activation (very flat or sluggish)". Its validity and reliability was established by Ward and Cox (2001).

*Polar S710.*Polar S710 heart rate monitor (Polar Electro Oy, Finland) was used to monitor and records archer's heart rate during shooting performance.

Archery Performance Recording Sheet. A simple score sheet was used to record archers shooting performance. Performance was measured for 60m distance shooting.Archers shot 36 arrows from a distance of 60m.

Procedures

Ethical clearance from the University's Research Ethics Board Committee was obtained before the study began. Archers representing an eastern state of Malaysia were approached and briefed regarding the nature and aims of the study. Consented archers were then signed informed consent form. They completed CSAI-2R (Cox et al., 2003) and Sport Grid – Revised (Ward and Cox, 2001). Following the completion of the questionnaires, they were then fitted with a heart rate monitor belt on their chest. After setting-up the heart rate monitor, they were required to shoot 36 arrows from a distance of 60 meters. This measurement flow was repeated weekly for 12 weeks. Besides, archers attended two local tournaments during the study. The tournaments occurred during the 4^{th} and 9^{th} week of the study. The procedure of data collection was the same as in the training sessions. Upon the arrival of the participants at the tournament venue, they were fitted with heart rate monitor belt on their chest. The researches then administered the questionnaires prior to the start of the competition. Participants then commencing their matches. Heart rate data were recorded prior to each of the shot.

Statistical Analysis

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS version 21). Descriptive statistics were calculated for each of the following variable: heart rate, shooting score, cognitive anxiety, somatic anxiety, self-confidence, arousal, and cognitive arousal. Cluster analysis was used to create respondents' profile usingthese variables. The Ward method was used as it minimized the within-cluster differences and avoided problems with forming long, snake-like chains found in other methods, such as the single linkage procedure30. Prior to the analysis, the data were transformed into z-scores in order to standardize the scale. This is necessary given the variability in the response scales of the measures. A One Way ANOVA was used to compare the different between profiles. Statistical significant value was set at $p < 0.05$ and data reported as mean ± standard deviation.

Results

Results of cluster analysis revealed a two cluster solution for the present data (Table 1).For labelling purposes, a median split was used to categorize the variables into high and low categories. To examine the differences between the observed clusters, t-test was used. Table 1 shows the descriptive statistics of heart rate, score, cognitive anxiety, somatic anxiety, self- confidence, somatic and cognitive arousal betweenthe two profiles.

Table 1: *Descriptive statistics of Heart Rate, Score, Cognitive Anxiety, Somatic Anxiety, Self- Confidence, Anxiety Feeling and Cognitive Feeling Across Two Profile*

	Profile 1			Profile 2		
	M	*SD*	*Range*	*M*	*SD*	*Range*
Heart Rate	108.89	12.79	102 – 145	111.37	10.77	106 - 115
Shooting Score	320.76	11.28	318-325	267.7	26.66	241.8 – 284.4
Cognitive	1.91	0.47	1.78-2.14	1.58	0.44	1.16 – 1.92
Somatic	1.59	0.41	1.44-1.73	1.39	0.31	1.14 – 1.74
Self-Confidence	2.92	0.53	2.67- 3.24	2.85	0.49	2.6 – 3.24
Anxiety	6.79	1.43	6.21- 7.21	6.00	2.05	5.0 – 7.0
Cognitive arousal	3.65	1.55	2.85- 4.5	3.78	2.07	3.0 – 4.6

M = Mean, *SD* = Standard Deviation

The results revealed significantly different shooting scores ($p<0.05$). It was observed that the optimum range of heart rate associated with optimal shooting score ranges from 102– 145 bpm for the range of score of 318 – 325 points out of possible 360 points. This finding implying that the lower heart rate could produce better shooting score among the archers. However,no significant difference ($p> 0.05$) in heart rate between the two profiles was observed. Nonetheless, the mean heart rate for Profile 1 exhibits a lower value relative to Profile 2 with a mean of 108.89 bpm and111.37 bpm, respectively. The results of t-test also revealed no significant differences in all measured parameters between the two profiles. Despite these nonsignificant differences, we observed a pattern that better shooting score is associated with lower heart rate, lower arousal, higher self-confidence as well as higher in cognitive and somatic anxiety among archers in the current study.

Discussion

The aim of this study was to examine the optimal psychological and heart rate profile among the elite young archers representing their state at national level competition. In sports that involve fine motor skill such as archery, a lower heart rate prior to shooting often lead to greater shooting accuracy (Tremayne& Barry, 2001). A variable that tend to affect heart rate fluctuation is anxiety. One of notable finding in this study is the pattern of heart rate among archers in Profile 1, which was lower compared to those in Profile 2. Interestingly, this heart rate profile is congruent with the shooting performance pattern between the two groups. The finding implying that better scoring of the athletes with lower heart rate. This finding agreed with the study by Lo, Huang and Hung (2008), who suggested that archery performance is associated to higher parasympathetic activity and a better balance of parasympathetic and sympathetic are beneficial to performance within the sport. Although there was no significant difference was evident, results however showed a better scoring point of the archers.

One of the important factors affecting athletes' performance is anxiety and its effect (Mellalieu, Hanton, & Fletcher, 2006). Anxiety may positively or negatively affectathletes. It may lead to greater alertness and preparedness in facing difficulties. However, it may also prevent a person from reachingtheir goal or peak performance. Contrary to the literature, we observed higher cognitive and somatic anxiety value among those with higher shooting scores and lower heart rate pattern.

Hanin and Syrjä (1996). proposed that each athlete possesses an optimal zone or range of anxiety most beneficial for their performance. This zone could be anywhere on a continuum of anxiety from low to high. IZOF model predicts that best performance occurs when the athlete's anxiety is in their zone of optimal functioning. When an athlete is performing with anxiety in their zone of optimal functioning, the athlete should be experiencing best performance and perceive anxiety as facilitative to their performance. Indeed, during competition, the level of anxiety may change by becoming higher or lower due to the cognitive and somatic component changes specific to the situation.

In terms of self-confidence, archers in Profile 1 exhibit higher mean value of self-confidence compared to mean value in profile 2. This pattern is congruent with higher shooting score exhibit by archers in this profile. Self-confidence, as one of the most important variables related to sport performance, provides possibility for athlete to control negative emotions more effectively (Robazza&Bortoli, 2007). In addition to controlling and reducing negative emotions, this sense of capability helps athlete to do their sport tasks with more success and has a better performance. Based on this, one can explain that self-confidence helps athlete with appropriate usage of coping strategies to manage and control competitive anxiety and through this improve their sport performance.

Arousal was defined as a person's physical activation level and behavioral intensity (Weinberg & Gould, 2003). It reflects the activity level of physiological indicators such as heart rate, breathing rate, response to galvanic skin and brain wave activity (Wang, Marchant and Morris, 2004). The level of arousal experienced by an athlete is an important factor in the subsequent performance, both in terms of movement quality and quantity of outcome (Beuter and Duda, 1985; Landers and Boutcher, 1986). Moreover, an inadequate level of arousal may impair the motivation of athletes to participate in and enjoy movement experience.

Although no significant differences were observed between the two profiles, Profile 1 showed a higher mean value for both somatic and cognitive arousal compared to the mean value of profile 2. This pattern support the hypothesis that lower arousal is associated with both heart rate and shooting performance pattern observed among archers in Profile 1.The result of the discrepancy between this study and other recent studies might depend on many factors such as the complexity of skill, skill level, type of sports and individual differences as well as physical fitness of athletes.

In **conclusion**, the present study observed two different patterns of anxiety, arousal, heart rate and shooting performance. Although only shooting score differ significantly between the two groups, the pattern of other measured variables provides some support for the individualized pattern of anxiety and arousal and sport performances.

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Conflict of interest
The authors declare that they have no competing interests.

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