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EFFECT OF DAY TIME ON COGNITIVE PERFORMANCES OF PREADOLESCENT ATHLETES NURTURED IN A CONTROLLED ENVIRONMENT

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Abstract

Research purpose. The study aimed to examine how the cognitive performances of preadolescent sports trainees living and training under a controlled environment are affected during the three different day times.

Materials and methods. The research involved 16 male sports trainees from the Jharkhand State Sports Promotion Society, Ranchi, who varied in age from 11 to 14 years and had a minimum of two years of training experience in the same academy. To assess cognitive performance like long-term focused attention, ability to react, logical reasoning, reactive stress tolerance, and visual perception, the TATEENS 2 test set from the Vienna Test System was administered. The percentile ranks of all five tests were compared between three different times of the day. The Friedman test and rANOVA were employed to analyze the data of repetitive measurements. The significance level was set at $p < 0.05$.

Results. The p-values for statistical comparisons of reactive stress tolerance, visual perception, logical reasoning, reaction abilities (reaction time and motor time), and long-term focused attention at three different times of the day were all more than 0.05.

Conclusion. Different day times did not significantly affect the cognitive performances of preadolescent sportspersons who lived and trained under similar conditions.

Keywords: time of day, long-term focused attention, reaction ability, logical reasoning, reactive stress tolerance, visual perception, young athletes, Jharkhand.

Introduction

The primary objective of performance research is to find ways to improve physical and mental performances by discovering strategies that provide marginal improvements. Athletic success is determined by the tiniest of margins at the greatest levels of competition and the demand for determining new ways in which to obtain an advantage remains highly desirable (Facer-Childs et al., 2018). Sporting success is not a result of few training years rather it is a result of several training years. Enhancing the physical abilities of children throughout childhood and adolescence to maximize athletic success at adulthood is the goal of youth-based training program used for long term athletic development (Bompa, 1999). For enhancing sporting performance from grass root level along with physical training, psychological training is necessary to inculcate psychological skills to tackle psychological issues that affect sporting performance (Bali, 2015). As performance is not only influenced by physical features, but also by cognition, social context, and the environment in which the activity is carried out (Georgiou et al., 2007; Becchio et al., 2008). Sports are considered to be composed of 90% mental and 10% physical activity (Sinclair & Geige, 2000; Abbas & Jasim, 2018). The behaviour observed in sport is apparent, but the psychological aspect that is responsible for such behaviour may not be directly detected (Raglin, 2001). There are several psychological factors that affect motor behaviour (Stefani et al., 2015) one such ability that influences both motor behaviour and athletic performance is information processing capability (Plessner & Haar, 2006).

The information processing under cognitive approach describes encoding and flow of information by the recep-

tors, and the stages through which this information is processed until a decision is made and a response is executed (Marteniuk, 1976; Singer, 1980). In the stage between perceiving the information through the sensory system (input) and implementing a motor response (output), the cognitive-perceptual mechanism identifies, organizes, and analyzes the information for the purpose of decision making (Singer, 1980).

Biological cycles, in addition to cognitive factors, may have an impact on performance (Ayala et al., 2020). All living organisms' internal cycles (Postolache et al., 2020; Okusaga & Postolache, 2013) are responsible for periodic natural changes in chemical or biological processes (Gabbey, 2019). This is an internal master clock that regulates the body's other clocks, such as the circadian, diurnal, ultradian, and infradian clocks (Ayala et al., 2020). The circadian refers to the periodic changes that follow a 24-hour cycle (Postolache et al., 2020) synchronised by exogenous factors such as light and social cues (Dijk et al., 2012; Shanahan et al., 1997). A day and night cycle is referred to as a diurnal rhythm (Vitaterna et al., 2001). The ultradian cycle is a daily cycle that lasts less than 20 hours, whereas the infradian cycle is a biological cycle that lasts more than 28 hours (Ballastella et al., 2019).

Aside from biological cycles, the time of day at which a skill is performed affects athletic performance (Rodahl et al., 1976). This is determined by an athlete's chronotypology, or sleep-wake rhythm (Putilov, 2017). It is often divided into three chronotypes: early, late, and intermediate (Roenneberg et al., 2003). The sleep-wake cycle has an impact on an individual's psychological and physiological functioning as well as their behaviour (Roenneberg et al., 2003; Bailey & Heitkemper, 2001). The early chronotype, also known as the morning lark, has an earlier sleep-wake cycle than the late chronotype, often known as the night owl (Putilov et al., 2015).

According to evidence from previous studies, type of task and time of day influence cognitive performance (Heijden et al., 2010; Mazzucco et al., 2017), attention and memory (Guerrien et al., 1993), executive control and processing speed (Allen et al., 2008), alertness (West et al., 2002), long-term explicit memory (Maheu et al., 2005; Ramírez et al., 2006; Ralph et al., 2002), sustained attention (Riley et al., 2017), and executive functions (Lara et al., 2014).

Cognitive and physical task performed at day time has a relation with the sleep-wake pattern of an individual (Van Dongen, & Dinges, 2005) that influences psychomotor performance (Payne, 1989), attentional performance, response time, and visual scanning, physical performance, maximum-intensity power (Petit et al., 2013), and psychomotor vigilance; reaction time, and attention (Rosa et al., 2021).

Research indicated, physical performance is linked to an individual's cognitive functioning in a specific setting. However, the previous study only tested one or a few aspects of cognitive capacity. Competitions, like sports, may be planned at any time of day and need strong executive functioning for extended periods of time (Sanders, 1983). As a result, all of the executive functions that are necessary in any sport, regardless of how high or low the stakes must be evaluated in a single trial.

There are various mental activities that may be used to determine or test an individual's cognitive level. (Schuhfried, 2016a) identified some common cognitive dimensions required in every sports, such as focused attention, logical reasoning, reaction time, reactive stress tolerance, and visual perception. The capacity to filter out information pertinent to a choice from a distracting backdrop is referred to as "focused attention." The capacity to recognise systematic methods, patterns, or relationships and make accurate conclusions is referred to as logical reasoning. The ability to respond refers to the ability to react rapidly and efficiently to stimuli, and it is separated into two sections which are reaction speed and motor speed. Reaction speed refers to how quickly an athlete can react to a stimulus, while motor speed refers to how quickly an athlete can complete a single activity. Reactive stress tolerance is a component of attention that evaluates ability to quickly and appropriately reaction to the stimuli along with mental resilience. Visual perception is the ability to see and understand complicated visual clues (Schuhfried, 2016-b).

The study's purpose: The goal of the study was to see how the cognitive performances of preadolescent sports trainees living and training in a controlled environment for minimum of two years are altered at various times of the day.

Materials and methods

Study participants

Selection of Subjects: The study included 16 male sports participants from the Jharkhand Sports Promotion Society. The participants ranged in age from 11 to 14 years old, with a minimum of two years of training and living experience at the academy.

Study organization

Selection of Variables: Focused attention, reaction ability (both reaction and motor speed), logical reasoning, reactive stress tolerance, and visual perception were the factors considered for the research. The independent variables were three separate time ranges (morning 7am-9am, lunchtime 11am-1pm, and evening 3pm-5pm), while the percentile rankings of the chosen variables were preserved as dependent variables.

Selection of Test and Instrument: The administration was done using the TATEENS 2 test set. Five independent tests are included in the test set, each measuring a different characteristic, such as focused attention, reaction ability (which measures reaction and motor speed), logical reasoning, reactive stress tolerance, and visual perception. The test set is described in full in Table 1. The Vienna test system, developed by Schuhfried GmbH, a computerised testing tool, was used to evaluate the cognitive domain. The PR (percentile rank) of the chosen variables was used for scoring.

Consent: Because the athletes were minors (under the age of 18), permissions were obtained from the academy's administration and the athlete's in-charge. Each participant was told about the test ahead of time, and their consent was also obtained.

Test procedure and time frame: To minimise a sudden shift in score from the first to the third test and to familiarise the participant, seven days of training with comparable activities were provided. The time and day of the tests were assigned at random, such that a participant who was tested

Table 1. Test Description of Cognitive Tasks

Dimensions	Tests	Test form	Duration in minutes	Scoring (Percentile Ranks)
Long-term focused attention	SIGNAL	S3	Approx. 25	Number of correct and delayed
Ability to react	RT	S3	Approx. 6	Mean reaction time
	MT			Mean motor time
Logical reasoning	AMT	S4	Approx. 15	General intelligence
Reactive stress tolerance	DT	S1	Approx. 6	Correct response
Visual perception	LVT	S2	Approx. 13	Test Score
Total length if all dimensions presented			Approx. 65	

SIGNAL = Signal Detection, RT = Reaction Time, MT = Motor Time, AMT = Adaptive Matrices Test
DT = Determination Test, LVT = Visual Pursuit Test

in the morning would be retested at noon or evening in the follow-up test. The first test was administered after a ten-day break from training, and the subsequent tests were given at one-month intervals. The instructions were presented in the same consistent way each time the subject requested administration. The date and time of the tests were notified in advance. The tests were administered from 7am to 5pm (morning 7am-9am, noon 11am-1pm, and evening 3pm-5pm). The participants were only permitted to depart when the test had been successfully completed. A practise set was provided by the computer software prior to the start of each test. The actual testing began when the subject acknowledged the practise set. An introspective report (feedback) was gathered at the end of test, and the incentive was delivered.

Statistical Analysis

To ensure data normality, the Shapiro-Wilk test was used. Friedman test was used to compare measures of logical reasoning (AMT) and rANOVA was used to compare measures of reaction ability (AR) and reactive stress tolerance (DT) for data collected at three different times of the day. The level of significance was preserved at $p < 0.05$. The mean values of percentile rankings were used to develop the profile chart.

Results

Table 2 shows the descriptive statistics for the examined variables. In the result, it can be observed that the mean scores of reactive stress tolerance (DT), focus attention (SIGNAL), visual perception (LVT), and reaction speed (RT) and motor speed (MT) associated with to the ability to react (AR) are nearly equal to their median values. Following Shapiro-Wilk tests, it was inferred that these data were normally distributed. The descriptive scores of focused attention (SIGNAL) and visual perception (LVT) were found to be exactly equal in the morning, noon, and evening sessions. Data for logical reasoning (AMT) was not normally distributed in any sessions.

A descriptive graph of cognitive functions at three distinct times of the day is shown in Figure 1. The descriptive information of SIGNAL and LVT in Table 2 were determined to be equivalent. The visual presentation of data in Figure 1 (A) SIGNAL and Figure 1 (F) LVT showed minimal variations.

Table 3 displays the results of comparative statistics using the Friedman test for non-normal data sets (NP) and the rANOVA test for normally distributed data (P). Because the data for SIGNAL and LVT were determined to be equivalent, no comparisons were made for these variables (NCP). As the RT and MT under AR were shown to violate the sphericity assumption, Greenhouse-Geisser degrees of freedom were

Table 2. Descriptive Statistics of Percentile Ranks of Cognitive Performances at Three Different Times of Day

Dimension (Variable)		Time								
		Morning			Noon			Evening		
		Mean ± SD	Median (IQR)	Shaipro-Wilk	Mean ± SD	Median (IQR)	Shaipro-Wilk	Mean ± SD	Median (IQR)	Shaipro-Wilk
SIGNAL		88.68 ± 6.71	88 (8.25)	0.443	88.68 ± 6.71	88(8.25)	0.443	88.68 ± 6.71	88(8.25)	0.443
AR	RT	95.31 ± 3.77	95.5 (6.75)	0.121	95.18 ± 3.69	95.5 (6)	0.918	95.25 ± 3.78	95 (6.75)	0.907
	MT	85.75 ± 5.80	86.5 (7.5)	0.419	85.56 ± 5.46	86.5 (6.5)	0.406	85.25 ± 5.58	86.5 (7.5)	0.305
AMT		48.06 ± 13.77	45 (26.25)	0.006*	48.13 ± 13.81	45 (27)	0.007*	48.44 ± 14.19	45 (27)	0.010*
DT		62.37 ± 11.73	61 (23)	0.276	62 ± 11.49	61 (22.5)	0.22	61.93 ±11.15	62 (20.75)	0.278
LVT		74.31 ± 15.66	76 (28)	0.262	74.31 ± 15.66	76 (28)	0.262	74.31 ± 15.66	76 (28)	0.262

AMT = Logical Reasoning, DT = Reactive Stress Tolerance, SIGNAL = Focused Attention, LVT = Visual Perception, AR = Ability to React, RT = Reaction Time, MT = Motor Time.
* Sig at 0.05 level at Shapiro-Wilk statistics.

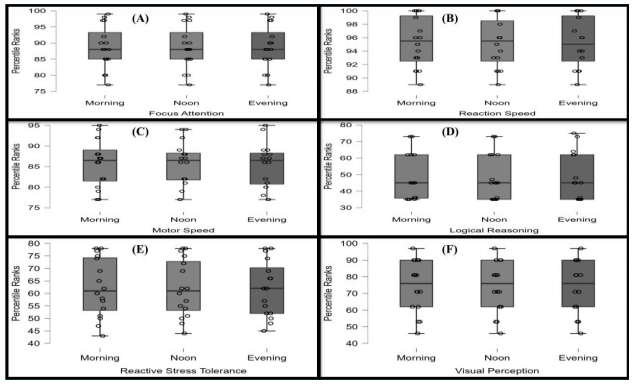

Figure 1. Data Distribution of Cognitive Performances on Three Different Times of Day

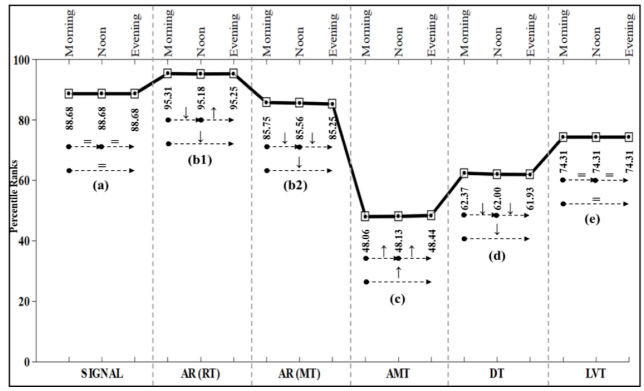

Figure 2. Profile Chart Depicts Percentile Ranks of Cognitive Performances at Three Different Times of Day

Table 3. Comparative Statistics of Cognitive Performances across Three Different Times of Day

Dimension (Variable)		Main Effect			
		df	F/Chi-square	p - value	Test Used
SIGNAL		xxx	xxx	xxx	NCP
AR	RT	1.445#	1	0.359	P
	MT	1.424#	1.022	0.352	P
AMT		2	2.923	0.232	NP
DT		2	0.703	0.503	P
LVT		xxx	xxx	xxx	NCP

*Significant at 0.05 level.
NP= Non-Parametric Test (Friedman), P= Parametric Test (rANOVA), NCP= No Comparison Possible
#= Greenhouse-Giesser Applied

utilised to perform comparisons. When examined at three different times of day, none of the factors were found to be significantly different at $p < 0.05$.

The profile chart in Figure 2 was generated by taking the mean values of each variable. The profile chart summarizes the results depicted in Figure 1 and Table 2.

Discussion

The participants in the study strictly stayed and trained for a minimum of two years in Jharkhand State Sports Promotion Society. According to the past studies, it was observed that the performance of cognitive tasks differed when tested at different times of the day. However, it is not clear whether those studies were conducted in sportsperson living and training under uniform condition. The study aimed to examine the performance of cognitive tasks measured at three different times of the day for the athletes who lived and trained in the same academy, having a similar daytime schedule and lifestyle.

According to the findings, it can be stated that disparities in scores of each parameter did not exist when tested at three different times of the day.

Before reaching a valid conclusion, it is necessary to understand the training and academic schedule of the academy. During regular school days, the cadets trained twice (morning and evening) for six days a week. The duration of training was two hours per session. During the academic vacations, the training sessions were scheduled at forenoon that continued till mid-noon or sometimes afternoon. According to the protocol for avoiding premature specialisation in sports (CSMF, 2000; Launay, 2015; Travassos et al., 2017; Buckley et al., 2017), the subjects received general training appropriate to their age category (chronological, developmental, and training). The majority of trainings were recreational in character, with a focus on long-term athletic development. The institution had a very strict academic programme that ran six days a week from late morning to early afternoon. As cognition is essential in both physical training (Kim et al., 1996) and academic learning (Graizi et al., 2021), it is possible that cadets adapted to the physical and mental load given to them, which may be a reason why the homogeneity in scores existed.

Previous studies implied that such stability of cognitive performance could be attributed to task type, inhibition attentional control, and adaptability.

Task Type: The type of task can be classified into two categories: 1) novel or unfamiliar task, and 2) practised or familiar task. The familiar or well-learned task shows similar or constant performance when performed at any time of the day (Li et al., 1998) whereas the performance on unfamiliar or novel tasks is influenced by the fluctuations of peak and non-peak circadian arousal during the day (May et al., 2005). As it happens in sports competitions, first the athletes are trained, and then they were allowed to participate in competition. Similarly, in the current study, the subjects were trained and then, after an interval, the tests were administered. While the subjects were trained, they were well informed about the task they had to perform. Since the tasks and testing environment were familiar, it can be inferred that due to known and already practised tasks, the time of the day showed no significant differences in the scores of cognitive tasks.

Inhibition Attentional Control: Attentional inhibition is the regulation of an individual's attention and attentional processing priorities, as well as the allocation of attention to target stimuli. Three fundamental components of attentionl control, e.g. blocking distractor stimuli, volitional control of attention, and working memory are necessary for processing priorities (Lavie et al., 2004). Because the trainees were engaged in physical and academic activities throughout the day, it's possible that it helped them to learn how to deal with distractors.

Adaptation: As it was mentioned that subjects had strictly trained and stayed in the same academy for two years, it

is possible that after spending so much time in the same setting, the cadets learned and adapted to function their body at any time of the day. Lally et al. (2010), stated a new habit may take anywhere from 18 to 254 days to establish with an average of 66 days for a new behaviour to become automatic. In addition Chtourou & Souissi 2012, suggested, training adaptations are stronger during the time of day when activities are consistently practiced. Training is fun because it is recreational in nature, which contributes high level of readiness. Pleasure-based behaviours are especially simple to change as they cause the production of dopamine, a chemical that reinforces the habit and generates the desire to repeat the action again (NIH, 2012).

Performing familiar task, developing good control over attentional distractor, and adapting the environmental needs can be related to extended-U model of Hancock et al., 2007, that describes the relationship of stress to performance and adaptation. Chtourou & Souissi, 2012; Gritton, et al, 2012; Rae, et al, 2015 also confirmed that training at a given time of day has no impact on an athlete's cognitive or physical performance. If athletes are nurtured in a controlled environment, the stablility on cognitive performance can be gained.

In a prior study, Pahan & Singh, 2022, observed no significant difference in the percentile ranks of correct response, but the study group differed in terms of committing errors in cognitive task. When the controlled participants were assessed, the findings on cognitive performance were similar (Pahan & Singh, 2021). According to Chtourou and Souissi (2012), Gritton et al. (2012), Rae et al. (2015) training at a given time of day has no impact on an athlete's cognitive or physical performance. As a result, rather of analysing overall task performance, each scoring parameter, such as the number of correct and incorrect responses, the number of stimuli presented and attempted, and the duration of each cognitive activity, can be utilised to arrive at a meaningful conclusion. To confirm the effect of controlled living and training environment, similar study can be conducted by involving sportsperson who travel another venue for competetion.

Conclusion

According to the findings of this research, varied daytimes had no substantial impact on the cognitive performances of preadolescent athletes who lived and trained in identical settings for minimum of two years. The number of stimuli presented and attempted, as well as the overall duration of task completion for each task, may be considered in future research to get a better understanding of cognitive functioning at various times of day.

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ВПЛИВ ЧАСУ ДОБИ НА ПОКАЗНИКИ КОГНІТИВНОЇ ДІЯЛЬНОСТІ СПОРТСМЕНІВ ПЕРЕДПІДЛІТКОВОГО ВІКУ, ЯКИХ ВИХОВУЮТЬ У КОНТРОЛЬОВАНОМУ СЕРЕДОВИЩІ

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Авторський вклад: A – дизайн дослідження; B – збір даних; C – статаналіз; D – підготовка рукопису; E – збір коштів

Реферат. Стаття: 8 с., 2 табл., 2 рис., 58 джерел.

Мета дослідження. Це дослідження мало на меті вивчення впливу на показники когнітивної діяльності спортсменів-вихованців передпідліткового віку, які живуть і тренуються в умовах контрольованого середовища, протягом трьох різних часів доби.

Матеріали та методи. У дослідженні брали участь 16 спортсменів-вихованців академії «Товариство зі сприяння розвитку спорту штату Джаркханд», місто Ранчі (Індія), які були віком від 11 до 14 років і мали принаймні два роки досвіду тренувань у зазначеній вище академії. Для оцінки показників когнітивної діяльності, таких як тривала сконцентрована увага, здатність реагувати, логічне мислення, стійкість до реактивного стресу та зорове сприйняття, був призначений набір тестів «TATEENS 2» з Віденської тесто-

вої системи. Процентильні ранги всіх п'яти тестів було порівняно в три різні часи доби. Для аналізу даних повторних вимірювань застосовували критерій Фрідмана та дисперсійний аналіз повторних вимірювань. Рівень значущості було задано значенням $p < 0,05$.

Результати. Усі p-значення для статистичних порівнянь показників стійкості до реактивного стресу, зорового сприйняття, логічного мислення, здатності реагувати (час реагування та час рухової реакції) та тривалої сконцентрованої уваги в три різні часи доби були вищими за 0,05.

Висновок. Різні часи доби не справляли суттєвого впливу на показники когнітивної діяльності спортсменів передпідліткового віку, які жили та тренувалися в аналогічних умовах.

Ключові слова: час доби, тривала сконцентрована увага, здатність реагувати, логічне мислення, стійкість до реактивного стресу, зорове сприйняття, юні спортсмени, Джаркханд.

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