EFFECT OF CAFFEINE INTAKE ON RECOVERY TIME AFTER 24 HOURS SLEEP DEPRIVATION IN ATHLETES

SPORCULARDA 24 SAAT UYKU YOKSUNLUĞU SONRASI KAFEİN ALIMININ SEZİNLEME ZAMANI ETKİSİ

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ABSTRACT

The purpose of this research is to examine the effect of 400 mg caffeine intake after 24 hours of sleep deprivation on the coincidence anticipation timing performance of athletes. Eleven healthy male athletes voluntarily participated in this study. The study was planned as a random cross-experiment design and the groups were relocated by 1 week intervals and the tests were repeated. Systolic (SBP) and diastolic blood pressures (DBP), heart rate (HR) values were also obtained. When RS and SD group's scores were compared, the AE scores (Z=-2,36; p<, 01 for AE) were statistically significant but CE and VE scores were not statistically significant. When coincidence anticipation timing scores (CE, AE and VE) of SD and Cf groups were compared, there was no statistically significant difference in the CE result, but statistically significant differences were found in the AE and VE results (Z=-2,94 for AE; p<,00; Z=-2,80; p<, 00). When auditory and visual RT measurements of SD and Cf groups were compared, there was no statistically significant difference in auditory RT measurements, but statistically significant difference was found in visual RT measurements (Z=-2,93; p<, 00). When comparing the CE, AE and VE scores of RS and Cf groups, statistically significant differences were found between these groups (Z=-2,55; p<,01 for CE, Z=-2,75; p<,01 for AE, Z=-2,49, p<.01 for VE).

Keywords: Poor Sleepiness, Caffeine, Precognition Hour.

ÖZET

Yapılan bu araştırmanın amacı; yirmi dört saat uyku yoksunluğu sonrası alınan 400 mg kafeinin sporcuların sezinleme zamanı performansına etkisinin incelenmesidir. Bu çalışmaya 11 sağlıklı erkek sporcu gönüllü olarak katılmıştır. Araştırma rastgele çapraz deney deseni olarak planlanmış ve 1 hafta ara ile gruplar yer değiştirerek testler tekrarlanmıştır. Ölçümlerde düzenli uyku (DU), uyku yoksunluğu (UY) ve uyku yoksunluğu sonrası kafein (Kf) ve plasebo (Pls) alımı sonrası sezinleme zamanı sabit hata, mutlak hata, değişken hata (SH, MH, DH) ölçülmüştür. Aynı zamanda kalp atım hızına (KAH), Sistolik ve Diastolik (SKB, DKB) kan basınç değerleri alınmıştır. Araştırmanın sonucunda, DU ve UY skorları karşılaştırıldığında, MH skorları (MH için Z=-2,36; p<,01) istatiksel olarak anlamlı çıkmış ancak SH ve DH skorları istatiksel olarak anlamlı çıkmamıştır. UY ve Kf gruplarının Sezinleme Zamanı SH, MH ve DH skorları karşılaştırıldığında SH veri sonucunda istatiksel olarak anlamlı bir fark bulunmazken, MH ve DH veri sonuçlarında istatiksel olarak anlamlı farklar bulunmuştur (MH için Z=-2,94; p<,00: DH için Z=-2,80; p<,00). DU ve Kf gruplarının Sezinleme Zamanı SH, MH ve DH ölçümleri karşılaştırıldığında istatiksel olarak anlamlı farklar bulunmuştur. (SH için Z=-2,55; p<,01: MH için Z=-2,75; p<,00: DH için Z=-2,49; p<,01). Sonuç olarak; uyku yoksunluğu sonrası algısal performansta düşüş meydana gelmiştir. Birçok değişkende bu düşüş istatiksel olarak anlamlıdır. Uyku yoksunluğu sonrası kafein alımı ise algısal performansı artırmıştır. KAH, Sistolik-Diastolik kan basınçlarında anlamlı bir değişim meydana gelmemiştir.

Anahtar Kelimeler: Uyku Yoksunluğu, Kafein, Sezinleme Zamanı.

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1. ENTRANCE

Psychological factors such as anxiety can prevent athletes from having a good rest and getting a regular and quality sleep before the competition. Sleep is a vital and essential physiological need of all living creatures for a healthy physical and mental life. One third of people's lives is spent during sleep (Fışkın et al., 2009). Insomnia can be defined as a lack of enough sleep and a sleep disorder. This disorder may be characterized by one or more than one symptoms: (I) difficulty in falling asleep, (II) difficulty in staying asleep, (III) waking up too early in the morning or at night, (IV) having insufficient or poor-quality sleep (Lesner et al. 2005). There are many studies on how sleeplessness affects human body and mind (Kutlu, 2014; Youngstedt et al, 2003; Alhola, 2007; Helder, 1989). There are also studies being made on how insomnia affects the performance of athletes during training and competition. Insomnia has a significant impact on an athlete's mood, motor, and cognitive performance (Lieberman et al. 2002). In the daily tempo of long working hours, many people use ergogenic aids for relieving physical as well as mental fatigue. The most important of these aids is caffeine. There are many studies suggesting that caffeine use has a stimulating effect (Dikici et al. 2012; Erdoğan et al. 2009). Caffeine is a substance commonly used in various forms; and it produces different physiological effects in the body. Among various reasons for its use, the most common and known is its stimulatory effect, which is an important factor in staying awake, improving performance and increasing attention. Recent studies on the effects of caffeine have looked into the effects of this substance on the heart and circulatory system, respiratory system and endocrine system as well as the central nervous system (Burke, 2008; Erdoğan et al. 2009). It is thought that caffeine has a stimulating effect especially on the physical and mental performance of athletes, and academic studies frequently focus on this topic (Glaister et al. 2008; Sokmen et al. 2008; Fredholm et al. 1999). The biggest effects of caffeine appeared 1 hour after its administration, but significant effects lasted 8 hours. Even in the most adverse conditions, moderate doses of caffeine can increase cognitive functions, including intelligence, learning, memory and mood. When cognitive performance is critical and needs to be protected during exposure to severe stress, caffeine administration may provide a significant advantage (Lieberman et al., 2002). When mental performance and perceptual motor skills play an important role in individual or team sports, it is ensured that athletes can overcome the problems related to fatigue, sleep deprivation and coincidence anticipation timing with the use of ergogenic aids having stimulant effects such as caffeine (Clark, 2017; Concas et al. 2000; Lieberman et al. 2002). Coincidence anticipation timing involves the synchronization between a moving object and response to this stimulus in the targeted area (Schmidt, 2014). According to another definition, coincidence anticipation timing is the ability to predict the arrival point of an object following a route and when that object would arrive at the designated target point (Akpınar, 2012; Williams, 2000). Inadequacy in coincidence anticipation timing is stated to be the main reason of the technical and tactical errors that occur during the competition in many sports (Akbulut, 2015). When the literature on coincidence anticipation timing is considered, it is seen that coincidence anticipation timing has been studied in relation to age, gender, experience, but studies in different branches are limited in number. All sports skills require advanced perceptual abilities for an effective and efficient performance (Mori, 2012). Coincidence anticipation timing is one of those abilities. In general terms, coincidence anticipation timing is defined as the ability to predict the stopping point of an object following a route and when that object would arrive at that point (Akpınar, 2012). Coincidence anticipation timing can be used for measuring and interpreting perceptual motor skills (Tallis et al., 2013). There are many studies on the effect of sleep deprivation on exercise performance the following day, and the contents of these studies differ from one another. These studies indicate that sleep deprivation positively or negatively affects the aerobic and anaerobic exercise performance (Aydın, 2014;

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Samuels, 2008; Skein et al., 2011). However, there are no studies on coincidence anticipation timing, which is important for perceptual motor skill performance by using caffeine after sleep deprivation. Coincidence anticipation timing is a decisive element for good performance (throwing-catching-hitting), and its importance is increasing day by day (McMorris, 2004). Especially in branches, where coincidence anticipation timing is important, psychological conditions such as anxiety, affecting athletes negatively before the competition, impair their performance along with sleep deprivation. Besides the physical performance of the athletes, perceptual motor skill performance also plays an important role in their success. Sleep plays an important role, especially for the preservation of physical and perceptual performances. Sleep is considered as a restorative process for energy sources, tissue regeneration, heat regulation and cognitive functions. Therefore, those who experience sleep deprivation face negative consequences. Like many people in the world, athletes also use caffeine, an ergogenic aid shown to have stimulatory effects after sleep deprivation. This study will investigate how the coincidence anticipation timing performance of the athletes, who experience sleeplessness before training or competition, is affected, and whether caffeine intake following the sleepless period affects coincidence anticipation time or not.

2. METHOD AND PROCEDURE

The sample of this study consisted of 11 healthy male athletes from different sports branches, aged 23,27±3,79 and with training ages of 10,91±3,93, practicing 4-6 hours a week on average, and who are also students at Bolu Abant İzzet Baysal University, School of Physical Education and Sports. In determining the participants, athletes were asked about their sleep hours in the information form, and those who sleep regularly between 7 and 9 hours daily were chosen. A meeting was held with the students participating in the study, and they were informed about the research to be done. Then, they were asked to read and sign the form stating that they volunteered to participate in the study. 17 athletes took part in the study as volunteers; however, the participants who felt discomfort or who did not follow the test rules during the test were dismissed. Later, 11 male students were divided into two groups as experimental group and control group. Coincidence anticipation timing (AT), Heart Rate (HR), Systolic-Diastolic Blood Pressure, Regular Sleep (RS), Sleep deprivation (SD), Caffeine (Cf) and Placebo (Plc) measurements belongs to the participants were taken in this study.While the participants were given 400 mg of caffeine in the form of two capsules (2X200 mg) of Nutrafx brand, they were also given emptied out capsules of the same brand as placebo. This study was found ethical by the Clinical Studies, Ethics Committee of Bolu Abant İzzet Baysal University, with its decision numbered 2015 / 159.

This study was planned to investigate the effect of 400 mg caffeine on the performance of coincidence anticipation time in amateur athletes, taken after deprivation of a night’s sleep, and it was planned as crossover experiment design. Participants were grouped regular sleep (RS), sleep deprivation (SD), caffeine (C), and placebo (Plc). Coincidence anticipation timing, heart rate (HR) and Systolic - Diastolic blood pressure measurements were obtained for each group. In this study, each participant carried out the test with 20 repetitions during coincidence anticipation timing. On the same day, heart rate, systolic and diastolic blood pressure, height and body weight measurements were taken in laboratory environment. Besides, to get familiar with the test protocol, the participants had 5 trial practices on each test two days before the measurements were carried out. Height, weight and coincidence anticipation timing measurements of the participants were taken in laboratory environment. The participants were informed via SMS messages and asked to get an average of 7-8 hours of sleep on the day before the measurements would be taken and stay away from

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caffeinated foods. Participants continued to perform their daily activities such as going to classes and work. They were kept in the designated areas (laboratory and canteen) in Bolu Abant İzzet Baysal University, School of Physical Education and Sports, between 20.00 hrs. on the evening of the test and 11:00 hrs. on the following day. The students were asked to stay away from exhausting exercises on the day previous to the tests and on the day of the tests. In addition, they are allowed to watch movies or play various games such as play-station and cards. However, they were not allowed to consume caffeinated drinks or foods throughout the night that could cause any discomfort.

On the day of the tests, all participants were made to come to the Sports Physiology Laboratory at BAİBU, School of Physical Education and Sports, at 20.00 hrs. Participants were randomly divided into two groups (caffeine-placebo). In the first week, 6 out of 11 participants received caffeine, whereas 5 received placebo. As of 06:30 in the morning, their equal calorie breakfasts (2 scale Herbal-Life Meal Replacement Feeder Shake Mixture was prepared by mixing with 300-350 ml of milk; and the caloric value of the mixture was ~ 225 kcal) were given to the athletes five minutes apart and by turns. After breakfast, coincidence anticipation timing after sleep deprivation tests were carried out for both groups by turns and within five minutes of each other. Then, in order to standardize the time at which the caffeine effect is maximum and one and a half hours after the breakfast at 8 o'clock, the researcher left the capsules containing 400 mg caffeine directly in the mouths of the participants in the experimental group (6 participants) by turns, starting with the first participant, and within five minutes of each other. On the other hand, the same process was administered to the athletes in the control group (5 participants), while the caffeine-containing capsule was replaced with an empty capsule of the same color and size as the placebo. 55 minutes after giving caffeine and placebo capsules, systolic and diastolic blood pressures and heart rates of all the participants were measured respectively, and the process including the measurements of the coincidence anticipation time was completed in 10 minutes. Following 1 week of rest, the tests were repeated by changing the caffeine and placebo groups and their orders.

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Tablo 1. Work Plan

	1st Phase	2nd Phase	3rd Phase	4th Phase	5th Phase
Resting Measurements	Night 23:00 going to bed Morning 07:00 getting up	Morning 08:30 Gathering at the lab	Detailed briefing about the test	Resting HR, Systolic-Diastolic blood pressure measurements	Resting coincidence anticipation timing measurement
1st week	Night 00:00 going to bed /morning 08:00 getting up/ Daily routine work/classes	Evening 20:00 Gathering at the lab and staying awake all night long	06:30 Breakfast of equal calories By turns and within 5 minutes of each other 08:00 coincidence anticipation timing measurement	08:00 caffeine and placebo intake Experimental/Control group By turns and within 5 minutes of each other	08:55-09.00 HR, Systolic-Diastolic blood pressure measurements for the first athlete coincidence anticipation timing measurement by turns and within 5 minutes of each other
2nd week	Night 00:00 going to bed Morning 08:00 getting up Daily routine work//classes	Evening 20:00 Gathering at the lab and staying awake all night long	06:30 Breakfast of equal calories By turns and within 5 minutes of each other 08:00 coincidence anticipation timing measurement	08:00 caffeine and placebo intake By turns and within 5 minutes of each other Place and the order of the groups change	08:55-09.00 HR, Systolic - Diastolic blood pressure measurements for the first athlete coincidence anticipation timing measurement by turns and within 5 minutes of each other

3. TESTING AND MEASURING TOOLS

3.1. Height and Weight Measurements

In the study, measurement of the height and weight of the participants were done by using a tool brand-named Seca 700, Medical Scales and Measuring Systems, Hamburg-GERMANY. While the measurements were taken, the participants were stood on both legs in a balanced manner, with their heads in the "Frankfort Horizontal Plan" position and their arms on the sides and palms facing the legs. Height measurements were measured with a sensitivity of 0,01 meter, and body weights were measured with a sensitivity of 0.01 kg and recorded in cms.

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3.2. Heart Rate Measurement and Systolic - Diastolic Blood Measurements

HR and systolic - diastolic blood pressure measurements of the participants were taken measured by using Braun BP 1600 Vital Scan. Before the measurement, the participants were asked to rest in the chair for three minutes in the sitting position, and the measurement was performed by attaching the device to the left wrist and keeping the arm at the heart level.

3.3. Coincidence Anticipation Timing Measurement

In order to measure coincidence anticipation time, Bassin Anticipation Timer device (Lafayette Instrument Company, Model 50575), invented by Dr. Stanley Bassin and developed by Lafayette University was used. Sensitivity of the device was set at 0,001 seconds for measurement. Before the measurements, 20 measurements were taken for each athlete by coincidence anticipation time measuring device during the test. The speed of the Bassin Anticipation Timer device was set at 11 mph (5 m/sec.) and the delay time was randomly adjusted to 0-2 seconds. The coincidence anticipation time test position of the participants was vertical to the device and in a way to enable the movement light of the device to approach the participant. The participant stood at the end point of the device and used the dominant hand to hold the stop button of the device at the sternum level with one hand. In order to prevent the participants from seeing the researcher's hand that started the anticipation timer device, the researcher carried out the test by hiding the start command button behind his back. Trials were repeated immediately after recording the result of the previous experiment. The average of 20 trials was calculated in Microsoft Excel according to the constant error (CE), absolute error (AE) and variable error (VE) formulas, and an analysis was made by using SPSS program based on these averages. For coincidence anticipation time, constant error (CE), absolute error (AE), and variable error (VE) were calculated by using the formulas given below (Schmidt, 2014).

3.3.1. Constant Error

$$SH = [\Sigma\ (X\ i - T)\ /\ N]$$

What the symbols stand for in the formula are as follows: Σ: total, i: number of tries Xi: score obtained in the "i try" T: target distance and N: total number of tries.

3.3.2. Absolute Error

$$MH = [\Sigma\ (|X\ i - T|)\ /\ N]$$

What the symbols stand for in the formula are as follows: Σ: total, i: number or tries, Xi: score obtained in the "i try", T: target distance and N: total number of tries, and (|) lines show the absolute value.

3.3.4. Variable Error

$$DH = \sqrt{[\Sigma\ (X_{\ i} - SH)^2 /\ N]}$$

What the symbols stand for in the formula are as follows: Σ: total, i: number of tries, Xi: score obtained in the "i try", SH: simple error score and N: total number of tries.

3.4. Analysis of The Data

To determine whether there was any difference between the groups, The Kruskal Wallis test was used; and Wilcoxon Signed-Rank Test was used for paired comparisons. In this study, the level of significance was set at $p < 0.05$ at the beginning of the study, and statistical analyzes were performed in SPSS package program for Windows.

4. FINDINGS

Coincidence anticipation timing (AT), Heart Rate (HR), Systolic-Diastolic Blood Pressure, Regular Sleep (RS), Sleep deprivation (SD), Caffeine (Cf) and Placebo (Plc) measurements belongs to the participants were taken and evaluated in this study.

Katılımcılara ait kalp atım hızı (KAH), Sistolik Kan Basıncı (SKB), Diastolik Kan Basıncı (DKB), Düzenli Uyku (DU), Uyku yoksunluğu (UY), Kafein (Kf) ve Plasebo (Pls) grupları arasında Sezinleme Zamanı (SZ) ölçümleri Sabit Hata (SH), Mutlak Hata (MH)ve Değişken Hata (DH) değerlerine ait veriler ayrı olarak ele alınmış ve değerlendirilmiştir.

Arithmetic mean ($\bar{X}$) and standard deviation (ss) of physical characteristics, namely the age, height, and body weight of the participating groups are given below. (Table 2).

Tablo 2. Descriptive Characteristics of the Participants (age, height, weight, training ages).

N	Training Ages	Age (year)	Height (cm)	Weight (kg)
11	$\bar{X} = 10{,}91 \pm 3{,}93$	$\bar{X} = 23{,}27 \pm 3{,}79$	$\bar{X} = 180{,}34 \pm 9{,}07$	$\bar{X} = 77{,}44 \pm 19{,}64$

Heart rates and systolic and diastolic blood pressure measurements of the Regular Sleep (RS) and Sleep Deprivation (SD) groups were compared and the findings are given in Table 3.

Tablo 3. Regular Sleep and Sleep Deprivation Groups HR/Sytolic-Diastolic Blood Pressres.

	Group	$\bar{X} \pm S.S$	**Z**	**p**
HR (beats/min)	RS	$\bar{X} = 67{,}55 \pm 11{,}14$	-2,05	,04
	SD	$\bar{X} = 59{,}45 \pm 7{,}20$		
SBP (mmHg)	RS	$\bar{X} = 117{,}73 \pm 18{,}74$	-,13	,89
	SD	$\bar{X} = 121{,}00 \pm 13{,}31$		
DBP (mmHg)	RS	$\bar{X} = 59{,}82 \pm 10{,}10$	-1,16	,24
	SD	$\bar{X} = 62{,}82 \pm 7{,}89$		

When Table 3 is examined and the HR, Systolic (SBP), and Diastolic (DBP) blood pressures of the RS and SD groups are compared, a statistically significant difference (Z=-2,05; P=,04) is found in HR, whereas no statistically significant difference is found in the measurements of Systolic and Diastolic Blood Pressures (For Systolic Z=-,13; P=,89: for Diastolic Z=-1,16; P=,24). In comparison of the measurements of the coincidence anticipation timing of the Regular Sleep and Sleep Deprivation Groups, Absolute Error (AE) and Variable Error (VE) data were compared and the findings are given in Table 4.

Tablo 4. Comparison of Coincidence Anticipation Timing in Regular Sleep and Deprivation Groups.

Coincidence Anticipation Timing	Group	$\bar{X} \pm S.S$	Z	p
Constant Error (ms)	RS	$\bar{X} = -34,72 \pm 20,96$	-1,84	,06
	SD	$\bar{X} = -25,81 \pm 17,12$		
Absolute Error (ms)	RS	$\bar{X} = 52,72 \pm 21,37$	-2,36	,01
	SD	$\bar{X} = 43,27 \pm 12,90$		
Variable Error (ms)	RS	$\bar{X} = 61,81 \pm 40,92$	-1,51	,13
	SD	$\bar{X} = 47,00 \pm 11,22$		

When Table 4 is examined, a statistically significant difference (for AE Z=-2, 36; P=, 01) was found in the AE data result of the coincidence anticipation time of the RS and SD groups. The data showing the size of the error (AE) in the anticipation error time of SD group came out lower than the data of RS group. No statistically significant difference is found in the results of CE and VE data (for SH Z=-1,84; P=,06: for VE Z=-1,51; P=,13).

Heart rate values and the systolic and diastolic blood pressure measurements of the Sleep Deprivation and Caffeine groups are compared, and the related findings are given in Table 5.

Tablo 5. HR/Systolic-Diastolic Blood Pressures of the Sleep Deprivation and Caffeine Groups.

	Group	$\bar{X} \pm S.S$	Z	p
HR (beats/min)	SD	$\bar{X} = 59,45 \pm 7,20$	-,44	,65
	Cf	$\bar{X} = 59,45 \pm 7,99$		
SBP (mmHg)	SD	$\bar{X} = 121,00 \pm 13,31$	-1,20	,23
	Cf	$\bar{X} = 127,09 \pm 15,93$		
DBP (mmHg)	SD	$\bar{X} = 62,82 \pm 7,89$	-,66	,50
	Cf	$\bar{X} = 65,27 \pm 11,46$		

When Table 5 is examined and HR, Systolic (SBP) and Diastolic (DBP) blood pressure measurements of the SD and Cf groups are compared, no statistically significant difference is found between the groups (for HR Z=-,44; P=,65: for Systolic Z=-1,20; P=,23: for Diastolic Z=-,66 P=,50).

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In comparison of the measurements of the coincidence anticipation timing of the Sleep deprivation and Caffeine Groups Constant Error (CE), Absolute Error (AE) and Variable Error (VE) data were compared and the related findings are given in Table 6.

Tablo 6. Comparison of Coincidence Anticipation Timing Between Sleep Deprivation and Caffeine Groups.

Coincidence Anticipation Timing		$\bar{X} \pm S.S$	**Z**	**P**
Constant Error (ms)	SD	$\bar{X} = -25{,}81 \pm 17{,}12$	-,98	,32
	Cf	$\bar{X} = -16{,}63 \pm 12{,}65$		
Absolute Error (ms)	SD	$\bar{X} = 43{,}22 \pm 12{,}90$	-2,94	,00
	Cf	$\bar{X} = 30{,}27 \pm 7{,}82$		
Variable Error (ms)	SD	$\bar{X} = 47{,}09 \pm 11{,}22$	-2,80	,00
	Cf	$\bar{X} = 32{,}18 \pm 7{,}33$		

When Table 6 is examined and the Coincidence Anticipation Time CE, AE, and VE measurements of the SD and Cf groups are compared, no statistically significant difference is found in CE data results (Z=-,98; P=,32), whereas statistically significant differences were found in AE and VE data results (for MH Z=-2,94; P=,00: for DH Z=-2,80; P=,00).

Coincidence anticipation time scores of Cf group (CE, AE, and VE) came out better than those of the SD group. Heart rate values and systolic-diastolic blood pressure measurements of the Sleep Deprivation and Placebo groups were compared and the related findings are given in Table 7.

Tablo 7. HR, Systolic-Diastolic Blood Pressures of Sleep Deprivation and Placebo Groups.

	Group	$\bar{X} \pm S.S$	**Z**	**p**
HR (beats/min)	SD	$\bar{X} = 59{,}45 \pm 7{,}20$	,00	1,00
	Plc	$\bar{X} = 59{,}27 \pm 7{,}73$		
SBP (mmHg)	SD	$\bar{X} = 121{,}00 \pm 13{,}31$	-,30	,76
	Plc	$\bar{X} = 121{,}27 \pm 17{,}04$		
DBP (mmHg)	SD	$\bar{X} = 62{,}82 \pm 7{,}89$	-,83	,40
	Plc	$\bar{X} = 61{,}09 \pm 10{,}42$		

When Table 7 is examined and HR, Systolic (SBP) and Diastolic (DBP) blood pressure measurements of the SD and Plc groups are compared, no statistically significant difference is found between the groups (for HR Z=,00; P=1,00: for Systolic Z=-,30; P=,76: for Diastolic Z=-,83; P=,40).

In comparison of the measurements of the coincidence anticipation timing of the Sleep deprivation and Placebo Groups Constant Error (CE), Absolute Error (AE) and Variable Error

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(VE) data are compared and the related findings are given in Table 8.

Tablo 9. HR, Systolic-Diastolic Blood Pressures of Caffeine and Placebo Groups.

	Group	$\bar{X} \pm S.S$	Z	p
HR (beats/mins.)	Cf	$\bar{X} = 59{,}45 \pm 7{,}99$	,00	1,00
	Plc	$\bar{X} = 59{,}27 \pm 7{,}73$		
SBP (mmHg)	Cf	$\bar{X} = 127{,}09 \pm 15{,}93$	-1,37	,16
	Plc	$\bar{X} = 121{,}27 \pm 17{,}04$		
DBP (mmHg)	Cf	$\bar{X} = 65{,}27 \pm 11{,}46$	-,89	,37
	Plc	$\bar{X} = 61{,}09 \pm 10{,}42$		

When table 9 is examined and HR, Systolic (SBP) and Diastolic (DBP) blood pressure measurements of the Cf and Plc groups are compared, no statistically significant difference is found between the groups (for HR Z=,00; P=1,00; for Systolic Z=-1,37; P= ,16: for Diastolic Z=-,89, P= ,37).

In measuring the Coincidence Anticipation Time of the Caffeine and Placebo groups, Constant Error (CE), Absolute Error (AE) and Variable Error (VE) data were compared by using Wilcoxon Signed-Rank Test for paired comparison and the related findings are given in Table 10.

Tablo 10. Comparison of Coincidence Anticipation Timing Between Caffeine and Placebo Groups.

Coincidence Anticipation Timing	Group	$\bar{X} \pm S.S$	Z	P
Constant Error (ms)	Cf	$\bar{X} = -16{,}63 \pm 12{,}65$	-1,02	,30
	Plc	$\bar{X} = -23{,}09 \pm 18{,}06$		
Absolute Error (ms)	Cf	$\bar{X} = 30{,}27 \pm 7{,}82$	-1,58	,11
	Plc	$\bar{X} = 38{,}72 \pm 17{,}37$		
Variable Error (ms)	Cf	$\bar{X} = 32{,}18 \pm 7{,}33$	-1,15	,24
	Plc	$\bar{X} = 47{,}00 \pm 41{,}09$		

When Table 10 is examined and the Coincidence Anticipation Time CE, AE, and VE measurements of the Cf and Plc groups are compared, no statistically significant difference is found (for CE Z=1,02; P= ,30; for AE Z=-1,58; P=,11: for VE Z=-1,15; P=,24).

5. DISCUSSION AND CONCLUSION

This study was done in order to investigate the effects of sleep deprivation and caffeine intake on coincidence anticipation time (CE, AE, VE), heart rate (HR), systolic

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(SBP) and diastolic (DBP) blood pressures; and this section interprets the findings of the study by drawing support from literature on the subject matter.

6. EFFECTS OF SLEEP DEPRIVATION ON HR, SYSTOLIC-DIASTOLIC BLOOD PRESSURES AND COINCIDENCE ANTICIPATION TIMES VALUES

When the measurements of HR, SBP and DBP, taken after regular sleep and sleep deprivation were compared, this study found a statistically significant difference in HR (Z=-2,05; P=,04), whereas no statistically significant difference was found in Systolic and Diastolic blood pressure measurements (for Systolic Z=-,13; P= ,89: for Diastolic Z=-1,16; P=,24).Furthermore, while a statistically significant difference (for AE Z=-2,36; P= ,01), CE (RS,$\bar{X}$=-34,72±20,96; SD,$\bar{X}$=-25,81±17,12 and VE (RS, $\bar{X}$=61,81±40,92; SD,$\bar{X}$= 47,00±11,22) was found in the result of the Coincidence Anticipation Timing AE of RS and SD groups (RS $\bar{X}$=52,72±21,37; SD: $\bar{X}$=43,27±12,90), no statistically significant difference was found in the data results (for CE Z=-1,84; P=,06: for VE Z=-1,51; P=,13). Although the average data of SD came out better than the average data (CE, AE, VE) of RS coincidence anticipation time, the other results were not significantly significant. When the CE data results of the both groups are examined, the participants are found to have pushed the stop button before the designated point, which means that they tended to push the button early. Literature contains studies about how sleep deprivation affects cognitive and physical performance (Samuels, 2008; Alhola, 2007; Durmer, 2005). In the study by Fullagar et al., Venter states that athletes should sleep 8 to 10 hours, but 7-9 hours of sleep is sufficient for healthy adults, and the athletes have reported that they sleep less than any of these suggestions. According to a survey presented in the same study, three fourths of 890 elite athletes reported that they had an average nightly sleep of 6 to 8 hours; on the other hand, Ohrstrom has reported that 11 % of them get less than 6 hours of sleep at weekends, and Durmer, Axelsson and Dorian state that when adults sleep less than 7 hours, their cognitive performance drops in wakefulness, reaction time, memory, and decision making tests (Fullagar, 2015). Sleep disruption has been associated with the increased perception of negative mood states, suppression of resting HR and core temperature, and reductions in aerobic oxidation capacity and decreased metabolic enzyme activity (Skein et al., 2011).The results of studies on the effect of sleep deprivation on exercise performance vary. In terms of anaerobic and aerobic performance, the negative effects of insomnia start to be noticed at 72 hours of insomnia. It is accepted that high-intensity anaerobic exercises are less affected by long-term sleep deprivation. Aerobic exercise performance is more affected by hormonal and metabolic processes that deteriorate due to sleep deprivation. While physical and physiological variables are not significantly affected from sleep deprivation, significant deterioration occurs in psychological and neurological features (Kurt et al., 2010).

In a study by Oliver et al. (2009), the participants were divided into two groups as the control group, allowed to have normal night sleep, and a sleep group, deprived of sleep at night. Eleven male participants performed a predetermined exercise with 60 % of max VO2 and a 30-minute self-paced running test after 30 hours of sleep deprivation. Heart rate, perceived exercise difficulty, velocity, internal temperature and respiratory parameters were measured. As a result, one night of sleep deprivation had a limited effect on the pacing, cardio-respiratory, or thermoregulation function, reducing the endurance performance. At the same time, heart rate after sleep deprivation decreased by 7-8 beats in 20 and 25 minutes during the distance running test, and the cardiac parameters were not significantly affected by sleep deprivation.

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In a study conducted with twelve volunteer participants, Meney et al. (1998) formed two groups as the control group and the experimental group. After one night's sleep (1st day, 22:30-23:00- 6: 00), the participants in the control group were given a series of tests throughout the day at 06:00, 10:00, 14:00, 18:00, 22:00 and 02:00 hrs. Then, (after sleeping until 9:00 on the 2nd day, and at 10:00, 14: 00, 18:00 and 22:00 hrs.), the participants were given tests at 4 hour intervals. The study consisted of exercise on bicycle ergometer, and measurements of the tympanic membrane temperature (taken from the ear), profile of mood states (POMS), muscle strength, self-selected operating speed (SCWR), perceived exercise and heart rate (HR) measurements. At the end of day 1, a significant negative effect was observed in the mood of the sleep deprivation group, but it did not have any effect on other variables. However, on the second day the mood improved, and tympanic temperature and physical strength showed a tendency to worsen.

Akpınar et al. (2012) conducted a study to compare the coincidence-anticipation timing accuracy of the athletes of different racket sports with various stimulus velocity requirements, in which 90 tennis, badminton, and table tennis players (15 girls, 15 boys for each sport) participated in this study. In order to simulate the velocity requirements of these racket sports, three different stimulus velocities as low, moderate, and high (1, 3, and 5 m/sec.) were used. Analysis results showed that there was an important interaction between the stimulus velocities and racket sports. Absolute error data results showed that tennis players had significantly less absolute error than both Badminton ($\bar{X}$=75,2±12,6) and table tennis ($\bar{X}$=78,3±15,8) players, respectively, at the low stimulus velocity (1 m/sec.: $\bar{X}$=31,4 ± 10,4). Badminton players, in contrast, showed less absolute errors than both tennis ($\bar{X}$=70,4±15,8) and table tennis ($\bar{X}$=49,3±11,7) players in the moderate stimulus velocity (3 m/sec.), respectively. Finally, table tennis players displayed less absolute errors at high stimulus velocity (5 m/sec.: $\bar{X}$=33,0±9,8) than both tennis ($\bar{X}$=76,2±18,8) and badminton ($\bar{X}$=76,2±18,8) players in the high stimulus velocity respectively. Contrary to this, Badminton players showed less absolute errors at the moderate speed (3 m/sec.: $\bar{X}$=39,3±10,8) than tennis and table tennis players, respectively. Analysis results of the variable error revealed a similar tendency to those reported about absolute error. For this reason, visual and motor systems of players from different racket sports may be adapting to a stimulus velocity in coincidence-anticipation timing, which is specific to each type of racket sports.

By applying an exercise program and a proprioceptive balance program, Ceylan and Saygin (2015) in their study measured the coincidence anticipation timing, reaction time, and hand-eye-coordination of the participants; and as a result, comparing the pre-test and post-test measurements of the two groups, they found a statistically significant difference and concluded that the measurements they made were affected positively.

It is known that sleep deprivation causes negative effects on perceptual performance. In our study, the data concerning sleep and sleep deprivation were compared and except for coincidence anticipation time AE value and HR, no statistically significant changes were found in other parameters. Since the physiological parameters in HR could be affected negatively by sleep deprivation, a decrease in the values was observed. In general, participants may not have had enough sleep on the regular sleep night. In addition, before they were included in the study, the participants were selected only by their verbal statements about their sleep hours (how many hours they slept and their sleeping hours). Furthermore, because they are students, the participants may not have slept sufficiently before the first measurement, even though they had been warned beforehand. Therefore, the data results of coincidence anticipation time, HR, systolic-diastolic blood pressure tests of the group were

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close to each other. Although there is a difference between the scores, it is not statistically significant.

7. EFFECTS OF SLEEP DEPRIVATION ON HR, SYSTOLIC-DIASTOLIC BLOOD PRESSURES AND COINCIDENCE ANTICIPATION TIMES VALUES

When the HR, Systolic (SBP) and Diastolic (DBP) blood pressure measurements of SD and Cf groups were compared, no statistically significant difference was found between the groups (for HR Z=-,44; P=,65: for Systolic Z=-1,20; P=,23: for Diastolic Z=-,66; P=,50).

When the HR, Systolic (SBP) and Diastolic (DBP) blood pressure measurements of SD and Plc groups were compared, no statistically significant difference was found between the groups (for HR Z=,00; P=1,00: for Systolic Z=-,30; P=,76: for Diastolic Z=-,83 P=,40).

When the HR, Systolic (SBP) and Diastolic (DBP) blood pressure measurements of Cf and Plc groups were compared, no statistically significant difference was found between the groups (for HR Z=,00; P=1,00: for Systolic Z=-1,37; P=,16: for Diastolic Z =-,89 P=,37).

In addition, while no statistically significant difference (Z=,98; P=,32) was found in CE data result when Coincidence Anticipation Timing CE, AE, and VE measurements of the SD and Cf groups were compared, statistically significant differences were found in AE and VE data results (for AE Z=-2,94; P= ,00: for VE Z=-2,80; P=,00). Cf group had better scores than SD group. Except for CE (Cf, $\bar{X}$=-16,63±12,65; SD, $\bar{X}$=-25,81±17,12), AE (Cf, $\bar{X}$=30,27±7,82; SD, $\bar{X}$=43,22±12,90) and VE (Cf: $\bar{X}$=32,18±7,33; SD, $\bar{X}$=47,09±11,22) data came out statistically significant. In both groups, CE scores are negative, which means that they show a tendency to press the button earlier than the target. Absolute Error, on the other hand, is not about pushing the button early or late during measurements of coincidence anticipation time but is about the size of the general error. Variable error is about the consistency of the constant error. That is, in constant error the participants tended to press the button early or late, and CE scores showed the tendency to press the button early. VE is about the consistency of CE scores in pressing the button early or late in reference to the target.

When Coincidence Anticipation Time CE, AE, and VE measurements of the SD and Plc groups were compared, no statistically significant difference was found (for CE Z=-,62; P=,53: for AE Z=-1,42; P=,15: for VE Z=-1,82; P=,06). CAT data results came out lower than those of SD group, but they are not statistically significant.

When Coincidence Anticipation Time CE, AE, and VE measurements of the Cf and Plc groups were compared, no statistically significant difference was found (for CE Z=-1,02; P=,30: for AE Z=-1,58; P=,11: for VE Z=-1,15; P=,24). Although the coincidence anticipation time CE, AE, and VE data of the Cf group came out lower in comparison to those of Plc group, the results are not statistically significant.

In sleep disorder, the tendency to sleep increases, and adenosine is a factor triggering fatigue or sleep. The concentration of adenosine is higher during sleep. It accumulates in the brain during a long wakefulness. Systemic administration of adenosine and its agonists as well as local perfusions increases sleep and reduces alertness. Studies conducted have found that the effects of caffeine on performance interact with extraversion and time of the day, and some of the negative mood effects observed after prolonged sleep deprivation have been reduced by caffeine intake. Caffeine typically prolongs sleep delay, reduces total sleep time and sleep efficiency, and worsens sleep quality. Genetic studies also contribute to individual susceptibility to sleep disturbance caused by caffeine by isolating the functional polymorphisms of genes involved in adenosine neurotransmission and metabolism (Brice &

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Smith, 2002; Box, et al., 2003; Lorist, 2003; Clark, 2017).

Barry et al. (2008) conducted a study on 24 university students aged between 17 and 36. Students were given 200 mg caffeine and 5 minutes after their caffeine intake, their HR, Systolic and Diastolic Blood Pressures were taken in every 4 minutes, and although there was an increase in the parameters after 32 minutes, but this increase was not statistically significant.

8 trained male basketball players participated in the study conducted by Tosun (2016), which examined the effects of acute caffeine supplementation on repetitive sprint performance and fatigue in young basketball players. Participants took part in the repeated sprint test (10x15 ms, 30 sec. intervals) in two trial conditions as caffeine and placebo. One week break was given after the first test and the trials were crossed. Caffeine/placebo (4 mg/kg) was administered 1 hour before the tests. Body weight, heart rate, serum enzymes, catecholamines, electrolytes and lactate levels were measured before and after the test. Acute caffeine supplementation significantly reduced the mean sprint time and perceived difficulty (RPE) in a 10x15 m repetitive sprint test, while it did not change the best sprint time. Caffeine and placebo trials showed no significant difference in terms of fatigue index, lactate and creatin kinase (CK) values, heart rate.

In a study by Erdoğan (2009), it is stated that the rate of resting heart rate varies from person to person, and also for the same person at different times, and heart rate during rest is lower in athletes. However, increase in heart rate during exercise is higher in people without training than the athletes, according to the same study. Meanwhile, it is stated that caffeine increases the number and the speed of heart beats, but its effect on the speed of heart beat is not constant, and this is mainly due to its blood pressure increasing effect. When caffeine-containing fluids are taken, blood pressure rises first; then, the pulse increases, and after 2 hours, both come to normal levels. It is also stated that the effect on blood pressure depends on the dose of caffeine taken.

12 volunteers (nine female and three male) participated in the study conducted by Tallis et al. (2013) on the ergogenic effect of caffeine support on the mood, perception time and muscle strength of the elderly. In two experimental studies, participants completed the mood and sensation time measurements before and after 60 minutes of caffeine and placebo intake, and also performed the evaluation of isokinetic knee extension force. Raw scores in each of the stimulus rates are summarized as three error points as constant, variable and absolute as a tool for generating dependent variables. As for absolute, constant or variable error, significant effects in coincidence anticipation time responses were not seen at slow (3 and 5 ms./sec.) stimulus velocities. As for the absolute error, an effective interaction occurred before and after the caffeine intake for coincidence anticipation timing responses at rapid response velocities (8 ms./sec.). There was no significant difference in constant or variable error. After caffeine intake, a significant drop in the absolute error (35 %) was observed. However, there was no improvement in coincidence anticipation timing performance in placebo intake. Acute caffeine intake may not be an effective ergogenic aid to increase muscle strength in the elderly adults, but it can probably be used as a nutritional supplement to enhance mood and improve cognitive performance in everyday life tasks, where interactive timing skills are required. When compared with our study, the caffeine showed a stimulating effect on the coincidence anticipation timing AE and VE data, and the results were lower (positive) than the results of other groups.

Saygın et al. (2016) examined the coincidence anticipation timing performances of football players with reference to various stimulus speeds and their game positions. 40 licensed football players (goalkeeper: 10, defense: 10; midfield: 10, forward: 10) participated

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in this study as volunteers. They examined whether the coincidence anticipation timing performance of the football players changed according to different stimulus speeds and player positions and concluded that there was a significant difference (p <0,05) in the absolute error score at the stimulus speed (3mph) according to player positions. When compared to high stimulus speeds (8 mph), absolute error score was found to be less than 3 mph. As a result of the study, it is recommended that activities to enhance the players' performance of coincidence anticipation timing at different stimulus speeds should be included during the planning of the training programs.

The biggest problem in determining the effects of caffeine on human information processing is that although caffeine has similar effects on different brain structures, the functional results of these effects can be quite different in different task parameters and in different arousal states. Furthermore, the link between the effects of caffeine on the information processing system and the underlying neurochemical mechanisms is not clear.

It is observed that intake of low (~40 mg or ~ 0,5 mg/kg) moderate (~300 mg or 4 mg/kg) caffeine extracts is followed by important effects of wakefulness, attention, reaction time but less consistent effects on memory and high level executive functions like decision making (Lorist, 2003; McLellan, 2016).

In their study, Anderson and Horne (2008) reported that caffeine is the most common stimulant used to treat insomnia in the world, but said that still little is known about the placebo effect of caffeine on the people suffering from sleep deprivation. 16 healthy young people participated in the test they conducted, and 3x30 minutes of psychomotor alertness tests were given to the participants in 95 minutes. After a restriction of 5 hours of sleep at night, participants had a mild nap sleep in the afternoon and were tested. One group was given decaffeinated coffee and the participants were asked how they felt. The other group (placebo) was told, "we are going to get you drink a new coffee known as super coffee. This drink produces a sense of high level alertness for 90 minutes following its consumption. You will have this feeling in 10-15 minutes after drinking it." Before the test, the participants were given verbal notices such as, "How do you feel before the test? Are you more alert? You should be feeling more alert." Both groups were given the same product but were directed differently with verbal notifications. In the placebo group, the first two 30 minute tests reaction times were better. This suggests that placebo intake with good verbal orientation may be effective in improving perceptual performance in moderately sleepy people.

The results of studies in the literature presented above are in parallel with our study. After sleep deprivation, heart rate measured after caffeine and placebo intake did not cause any change in Systolic and Diastolic blood pressures. Furthermore, the findings of our study indicate that caffeine has positive effects on the size of the error (AE) and the consistency of the error during the coincidence anticipation timing performance after sleep deprivation, whereas it had very little effect on the direction of the error (CE), making it statistically insignificant. In the literature, it is a very common topic that physical and cognitive performance is not affected after placebo intake. There are also studies, although a few in number, indicating that good results are obtained when the placebo intake is fostered by positive verbal reports after sleep deprivation. In our study, placebo intake had an effect on coincidence anticipation time scores, though that effect was minimal. This makes us think that placebo coupled with positive verbal reports can achieve a positive effect on the cognitive performance.

In the literature review, no study has been found on the effect of caffeine intake on the coincidence anticipation timing performance after sleep deprivation, which makes our study first of its kind in this area. As a result of the scores obtained in our study, it has been

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observed that sleep deprivation causes deterioration, even though minimal, in perceptual performance; and this performance has been observed to improve after caffeine intake.

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